

ASSURING DESTRUCTION FOREVER

NUCLEAR WEAPON MODERNIZATION AROUND THE WORLD



EDITED BY RAY ACHESON

JOHN AINSLIE • JOHN BURROUGHS • MERAV DATAN • HANS KRISTENSEN
ANDREW LICHTERMAN • ZIA MIAN • PAVEL PODVIG • M.V. RAMANA • TIM WRIGHT • HUI ZHANG



Reaching Critical Will

a project of the Women's International League for Peace and Freedom

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Edited by **RAY ACHESON**

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ACRONYMS

BM	Anti-ballistic missile	NPT	Non-Proliferation Treaty
ASMPA	Air-Sol Moyenne Portee Amélioré cruise missile	NNSA	National Nuclear Security Administration (United States)
ASMP	Air-Sol Moyenne Portee cruise missile	NNSP	Next Steps in Strategic Partnership
BARC	Bhabha Atomic Research Centre (India)	NPR	Nuclear Posture Review
CEA	Le Commissariat à L'énergie Atomique et aux Énergies Renouvelables (France)	NSG	Nuclear Suppliers Group
CMRR-NF	Chemistry and Metallurgy Research Replacement Nuclear Facility	NWFZ	Nuclear weapon free zone
CTBT	Comprehensive Test Ban Treaty	PFBR	Prototype Fast Breeder Reactor
DAE	Department of Atomic Energy (India)	PGS	Prompt Global Strike
DAM	Direction des Applications Militaires (France)	PLA	People's Liberation Army (China)
DND	Draft nuclear doctrine	R&D	Research and development
DoE	Department of Energy (United States)	RGP	Rajiv Gandhi Plan for nuclear disarmament
DoD	Department of Defense (United States)	SAF	Second Artillery Force (China)
DPRK	Democratic People's Republic of Korea	SLBM	Submarine-launched ballistic missile
DRDO	Defence Research and Development Organization (India)	SPD	Strategic Plans Division (Pakistan)
DRDL	Defence Research and Development Laboratory (India)	SSBN	Ballistic missile submarine
E2	Enhanced effectiveness programme	START	Strategic Arms Reduction Treaty
FAS	Forces Aériennes Stratégiques (France)	SWU	Separative work unit
FMCT	Fissile material cut-off treaty	TNA	Tête Nucleaire Aéroportée warhead
FOST	La Force Océanique Stratégique (France)	TNO	Tête Nucléaire Océanique warhead
GE	General Electric	UNGA	United Nations General Assembly
GDP	Gross domestic product	UPF	Uranium Processing Facility
GDP	Gaseous diffusion plant	USD	US dollars
HEU	Highly enriched uranium	VLF	Very low frequency
IAEA	International Atomic Energy Agency	WMD	Weapons of mass destruction
ICBM	Intercontinental ballistic missile	WMDFZ	Weapons of mass destruction free zone
ICJ	International Court of Justice		
IISS	International Institute of Strategic Studies		
IPFM	International Panel on Fissile Materials		
LEP	Life extension program		
MIRV	Multiple independently-targeted reentry vehicles		
MIT	Moscow Institute of Thermal		

AUTHOR BIOGRAPHIES

Ray Acheson is the Director of Reaching Critical Will, a project of the Women's International League for Peace and Freedom (WILPF). She is responsible for coordinating, writing for, and editing Reaching Critical Will's publications, such as the *NPT News in Review* and *First Committee Monitor*, as well as research projects such as *Beyond arms control: challenges and choices for nuclear disarmament* and *Costs, risks, and myths of nuclear power*. Previously, Ray worked with the Institute for Defense and Disarmament Studies tracking the manufacture and trade of conventional weapon systems and writing for the organization's flagship journal, the *Arms Control Reporter*. She has an Honours BA from the University of Toronto in Peace and Conflict Studies and is pursuing an MA in Politics at the New School for Social Research.

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John Burroughs, J.D., Ph.D., is Executive Director of the New York-based Lawyers Committee on Nuclear Policy, and an adjunct professor of international law at Rutgers Law School, Newark. He is co-editor and contributor, *Nuclear Disorder or Cooperative Security? U.S. Weapons of Terror, the Global Proliferation Crisis, and Paths to Peace* (2007); co-editor and contributor, *Rule of Power or Rule of Law? An Assessment of U.S. Policies and Actions Regarding Security-Related Treaties* (2003); and author of *The Legality of Threat or Use of Nuclear Weapons: A Guide to the Historic Opinion of the International Court of Justice* (1998). His articles and op-eds have appeared in the *Bulletin of the Atomic Scientists*, the *World Policy Journal*, the *Harvard International Review*, *Newsday*, and other publications.

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Andrew Lichterman is a lawyer and policy analyst for the Oakland, California-based Western States Legal Foundation. He has represented peace and environmental activists in settings ranging from arrests in mass direct actions to environmental challenges to military projects, and also has written extensively about disarmament and disarmament movements in the San Francisco Bay area. As a lawyer, he has represented peace and environmental activists in a variety of settings, and also taught law at alternative law schools for many years. In recent years his work has focused on the purposes and impacts of US nuclear and other strategic weapons programs, including their effect on global disarmament efforts, and on the relationship between nuclear technologies, militarism, and the global economy. He also writes about the politics of disarmament efforts and the relationship between disarmament work and other social movements. He is a member of the boards of the Western States Legal Foundation and of the Los Alamos Study Group, an Albuquerque, New Mexico-based peace organization.

Zia Mian directs the Project on Peace and Security in South Asia at Princeton University's Program on Science and Global Security and teaches at Princeton's Woodrow Wilson School of Public and International Affairs. His research and teaching focus on nuclear weapons and nuclear energy policy, especially in Pakistan and India. He is co-editor of *Science & Global Security*, the international technical journal of arms control, nonproliferation, and disarmament and co-deputy chair of the International Panel on Fissile Materials (IPFM). He is the editor of several books, most recently *Bridging Partition: People's Initiative for Peace between India and Pakistan*, and has also worked on two documentary films for the Eqbal Ahmad Foundation, *Crossing the Lines: Kashmir, Pakistan, India and Pakistan and India under the Nuclear Shadow*. In addition to his research and writing, he is active with a number of civil society groups working for nuclear disarmament, peace, and justice.

Pavel Podvig is an independent analyst based in Geneva, where he runs his research project, "Russian Nuclear Forces". He is also a Senior Research Fellow at the United Nations Institute for Disarmament Research. Pavel Podvig started his work on arms control at the Center for Arms Control Studies at the Moscow Institute of Physics and Technology (MIPT), which was the first independent research organization in Russia dedicated to analysis of technical issues of disarmament and non-proliferation. Pavel Podvig led the Center for Arms Control Studies project that produced the book, *Russian Strategic Nuclear Forces* (MIT Press, 2001). In recognition of his work in Russia, the American Physical Society awarded Podvig the Leo Szilard Lectureship Award of 2008 (with Anatoli Diakov). Podvig worked with the Program on Science and Global Security at Princeton University, the Security Studies Program at MIT, and the Center for International Security and Cooperation at Stanford University. His current research focuses on the Russian strategic forces and nuclear weapons complex, as well as technical and political aspects of nuclear non-proliferation, disarmament, missile defence, and US-Russian arms control process. Podvig is a member of the International Panel on Fissile Materials. He has a physics degree from MIPT and PhD in political science from the Moscow Institute of World Economy and International Relations.

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man, 2003) and author of *Bombing Bombay? Effects of Nuclear Weapons and a Case Study of a Hypothetical Explosion* (Cambridge, MA: International Physicians for the Prevention of Nuclear War, 1999). He is on the National Coordinating Committee of the Coalition for Nuclear Disarmament and Peace (India), a member of the International Panel on Fissile Materials, and on the Science and Security Board of the Bulletin of the Atomic Scientists.

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EXECUTIVE SUMMARY

CHINA

Current status

Estimates suggest China currently has approximately 170 nuclear warheads including approximately 110 operationally deployed nuclear missiles, approximately 60 warheads stored for its submarine-launched ballistic missiles, and bombers. China has not declared publicly that it has ended the production of highly enriched uranium (HEU) and plutonium for nuclear weapons, though it is believed that China stopped production of HEU in 1987 and plutonium by 1990. China's military inventory would be about 16 ± 4 tons of weapon-grade HEU and 1.8 ± 0.5 tons of weapon-grade plutonium.

Modernization

China is concerned with maintaining what it sees as a "limited" and "effective" nuclear arsenal and its modernization programme has focused on increasing the "survivability" of its land-based strategic missiles. It is expected that after this is accomplished, China will speed up the modernization of its sea-based strategic force. US missile "defence" plans will be a major driving force for China's nuclear weapon modernization, as some Chinese officials are concerned that even a limited missile "defence" system could neutralize China's nuclear force.

Economics

It is difficult to estimate the cost of China's nuclear weapon force, however, assuming that China consistently maintains 5% of its overall military expenditure for its nuclear weapons programme, China would have spent between US\$4.5 and \$9 billion on its nuclear programme in 2011. A recent report by Global Zero estimates China's nuclear cost to be \$7.6 billion in 2011.

International law

China has signed but not ratified the Comprehensive Test Ban Treaty (CTBT). Most estimates assume China will ratify the CTBT only after the United States does. China officially supports the commencement of negotiations of a fissile materials cut-off treaty (FMCT) at the Conference on Disarmament, but US plans to develop its missile "defence" capabilities will likely affect Chi-

na's willingness to participate in FMCT negotiations. If China remains concerned about US missile "defence," it would need more fissile materials to fuel additional ICMBs. In terms of disarmament, China is bound by article VI of the NPT to negotiate the elimination of its arsenal, though has consistently demanded the US and Russia reduce their arsenals first.

Public discourse and transparency

China is one of the least transparent of the nuclear weapon states though in theory it might increase transparency if it develops more confidence about the survivability of its nuclear force. There is scant public debate about nuclear weapons in China. After US President Obama outlined his "vision" of a nuclear weapon free world, an online survey conducted by the People's Daily newspaper indicated that 51% of respondents wanted nuclear disarmament while 49% did not.

FRANCE

Current status

France possesses approximately 300 nuclear warheads, approximately 290 of which are deployed or operationally available for deployment on short notice. Its delivery vehicles consist of approximately 40 aircraft assigned to a total of 40 cruise missiles; four nuclear-powered ballistic missile submarines (at least two of which are always fully operational) equipped with nuclear-armed long-range ballistic missiles. France is no longer thought to be producing fissile materials for nuclear weapons. It is believed to have an estimated six tons of plutonium and 26 tons of HEU.

Modernization

France is in the middle of a broad modernization of its nuclear forces involving submarines, aircraft, missiles, warheads, and production facilities that will continue for another decade.

Economics

The French government has indicated that it spends approximately US\$4.6 billion on its nuclear forces each year, though a recent report from Global Zero estimates

that the total cost for 2011 was approximately \$6 billion. The government announced in November 2011 that the deficit would have to be cut by 20% in 2012 with half of the savings coming from spending cuts, but the nuclear weapons budget will reportedly only see a 1.3% decrease.

International law

Officials indicate that France will reject calls for nuclear reductions in the near term, which, especially when considered in context with its substantial nuclear modernization, is in conflict with France's obligations under the NPT to negotiate disarmament.

Public discourse

There is scant debate in France over the composition or cost of its nuclear forces.

INDIA

Current status

India is estimated to have 80–100 nuclear warheads. It is also developing a range of delivery vehicles, including land- and sea-based missiles, bombers, and submarines. There are no official estimates of the size of India's stockpile of fissile materials, though it is known that India produces both HEU for its nuclear submarines and plutonium for weapons. India is estimated to have a stockpile of 0.52 ± 0.17 tons of weapon-grade plutonium by the end of 2011. There has been speculation that India has used reactor-grade plutonium in its nuclear weapons, in which case, the nuclear arsenal could potentially be much larger, as India has approximately 3.8 to 4.6 tons of separated plutonium from its power reactors. Its fast breeder reactor programme also provides another potential source of producing weapon-grade plutonium.

Modernization

The primary focus of modernization has been on increasing the diversity, range, and sophistication of nuclear delivery vehicles. Its most recent missile tests were conducted in December 2011. Based on official reports and tests, it appears that India is aiming to have all legs of its nuclear triad operational by 2013. There are also plans to expand the nuclear weapons and missile production complex as well as the capacity to enrich uranium.

Economics

The expansion of India's nuclear and missile arsenals are part of a larger military build-up and consistently-increasing military spending. However, there is no reliable public estimate on nuclear weapon spending in India. Historically, the nuclear and defence research

establishments have wielded considerable social, political, and economic power. They have been joined in recent decades by government laboratories, public sector and private companies, and universities, to form a burgeoning and powerful military-industrial complex.

International law

Since the 1974 nuclear test, the Indian government's focus in arms control diplomacy has been to resist signing onto any international treaties that impose any obligations on its nuclear arsenal. This allows the government to maintain that it is a responsible member of the international community because it has not breached any agreement. It also interprets this as meaning there are no legal constraints on any modernization activities that may affect the quantity or quality of its nuclear weapons. However, its activities may not be in complete concordance with international law; the 1996 advisory opinion of the International Court of Justice maintained that the obligation for disarmament is not restricted to signatories of the NPT.

Public discourse

Over the years, the idea that India has a right to possess nuclear weapons has become widely shared across much of the political spectrum. While nuclear weapons used to be seen as a "necessary evil," there is no more enthusiasm for India to become a bonafide nuclear weapon power that can exercise its military might in the region. While the government continues to promote the 1988 Rajiv Gandhi plan for nuclear disarmament, this is somewhat hypocritical when viewed in the light of its ongoing modernization plans.

ISRAEL

Current status

Estimates about the size of the arsenal are based on the power capacity of the nuclear reactor near Dimona. Experts estimate that Israel's current nuclear force ranges from 60–80 weapons at the low end to over 400 at the high end. The most frequently cited figure is 100–200 warheads. It is assumed that Israel has a triad of delivery systems: land, air, and sea. It is estimated that by the end of 2003, Israel could have produced approximately 510–650 kg of weapons-grade plutonium. Estimates of HEU production are even more difficult to make though public information suggests Israel has an uranium enrichment programme.

Modernization

In November 2005, Israel reportedly signed a contract worth US\$1.7 billion with Germany for the construction of two more submarines, with the first one to be completed by 2012. In light of current and planned nuclear

capabilities, it seems that the country is continuing to “enhance” its triad of delivery systems. Nuclear weapons modernization is related to modernization activities in the security sector generally, including in areas of information technology, advanced military technology, and outer space technology.

Economics

There is no reliable public estimate on nuclear weapon spending in Israel.

International law

Israel has signed but not ratified the CTBT. It is party to a number of non-proliferation-related agreements, on the basis of which it projects itself domestically and internationally as a responsible non-proliferant. Israel has not signed or ratified the NPT and interprets this as meaning it is not bound by the article VI disarmament obligation.

Public discourse

The policy of opacity entails a nuclear weapons capability about which “everyone knows” (domestically and internationally) and an umbrella of secrecy covering the physical and doctrinal elements of this capability. The secrecy surrounding Israel’s nuclear programme has taken on a life of its own at the domestic level with Israelis practicing self-censorship on a wide range of nuclear issues. At the same time, a discourse does exist at the academic level and increasingly in the media driving in large part by debate over Iran’s nuclear programme. This discourse relies primarily on foreign sources. Historically, public opinion polls have indicated support for the nuclear option though a new survey has indicated that 65% of Israelis would prefer a nuclear weapon free Middle East to the current situation.

PAKISTAN

Current status

Pakistan is currently estimated to have 90–110 nuclear weapons. It has a number of short-range, medium, and longer-range road-mobile ballistic surface-to-surface missiles in various stages of development. It has developed a second generation of ballistic missile systems over the past five years. It is estimated that Pakistan could have a stockpile of 2750 kg of weapon-grade HEU and may be producing about 150 kg of HEU per year. Estimates suggest Pakistan has produced a total of about 140 kg of plutonium.

Modernization

Pakistan has been rapidly developing and expanding its nuclear arsenal, increasing its capacity to produce plutonium, and testing and deploying a diverse array

of nuclear-capable ballistic and cruise missiles. Pakistan is moving from an arsenal based wholly on HEU to greater reliance on lighter and more compact plutonium-based weapons, which is made possible by a rapid expansion in plutonium production capacity. Pakistan is also moving from aircraft-delivered nuclear bombs to nuclear-armed ballistic and cruise missiles and from liquid-fueled to solid-fueled medium-range missile. Pakistan also has a growing nuclear weapons research, development, and production infrastructure. A long-term concern now driving Pakistan’s nuclear programme is the US policy of countering the rise of China by cultivating a stronger strategic relationship with India. This may tie the future of Pakistan and India’s nuclear weapons to the emerging contest between the United States and China.

Economics

There is almost no information about the funding of Pakistan’s nuclear weapons programme. It is clear that a significant fraction of Pakistan’s financial resources go to its nuclear weapons, but that this cost is not a large share of its overall military spending. Estimates indicate that Pakistan spends about US\$2.5 billion a year on nuclear weapons. Despite extensive foreign military assistance, Pakistan’s effort to sustain its conventional and nuclear military programmes has come at increasingly great cost to the effort to meet basic human needs and improve living standards. The 2011 budget increased military spending by over Rs. 50 billion but cut social and economic development by Rs. 100 billion.

International law

Pakistan is not a signatory to the NPT nor has it signed the CTBT and it appears to recognize no legal obligation to restrain or end its nuclear weapons and missile programme. The government has, however, said it supports negotiation of a nuclear weapons convention. Pakistan has blocked negotiations of an FMCT at the Conference on Disarmament arguing that it would only further entrench asymmetries between the nuclear weapon possessors. It has indicated it would support talks if were granted an exemption on nuclear trade from the Nuclear Suppliers Group as India has been.

Public discourse

The government has sought to create a positive image of the nuclear weapons programme, often by linking it to national pride and identity. Pakistan’s major political parties publicly support the nuclear weapons programme. The central thrust of most public debate about Pakistan’s nuclear weapons is the struggle with India. Pakistan’s nuclear weapons are widely seen as a response to India’s.

RUSSIAN FEDERATION

Current status

Russia is estimated to have about 11,000 nuclear weapons: 2430 strategic and about 2000 non-strategic warheads that are considered operationally deployed; and about 3000 strategic and up to 3300 non-strategic warheads awaiting dismantlement. Russia's delivery vehicles include about 330 operationally deployed ballistic missiles of five different types that carry about 1100 warheads; nine submarines carrying 16 SLBMs; and 72 heavy bombers capable of carrying more than 800 air-launched cruise missiles. Russia is estimated to have about 737±120 tons of HEU and 145±8 tons of weapon-grade plutonium.

Modernization

Russia's modernization plans indicate that it is determined to maintain parity with the United States in terms of number of warheads and delivery systems. Most of the currently operational ICBMs are being retired but new multiple-warheads missiles are being deployed to replace them. In 2011 the government decided to begin development of a new multiple-warhead liquid-fuel ICBM, which is supposed to be ready for deployment in 2016 although development will likely take longer. There are no plans to extend modernization of the strategic fleet beyond the planned construction of eight Project 955 submarines. In the next few years, Russia will continue an overhaul of its current strategic bomber fleet and start work on a new-generation strategic bomber.

Economics

Modernization of the nuclear arsenal is part of a broader rearmament programme that is expected to spend about US\$600 billion on various military systems in 2011–2020. About 10% of these funds will be spent on strategic force modernization. Financial constraints could affect the scale of these plans, though the rearmament effort appears to have strong support of the political leadership and public, so significant cuts to the modernization programme are unlikely. This situation may change if political environment in Russia would allow an open discussion of government spending priorities and the role of nuclear weapons in the national security policy, but so far this discussion has been very limited.

International law

Official documents of the Russian government do not question Russia's right to possess nuclear weapons, though they also recognize its responsibilities as an NPT nuclear weapon state including to pursue a world free of nuclear weapons as a means of achieving security for all. Official policy assumes the right of first use

of nuclear weapons, though the policy has a limited range of scenarios under which this would be considered. Both Russia and the United States consider their bilateral arsenal reductions to contribute toward the goal of article VI of the NPT.

Public discourse

Public opinion in Russia tends to support the nuclear status of the country—according to a poll conducted in 2006, 76 percent of all the respondents believed that Russia “needs nuclear weapons.” More than half of the population consider nuclear weapons to be the main guarantee of the security of the country and about 30 percent of respondents believe that nuclear weapons play an important, although not a decisive, role. To a large extent, the lack of critical assessment of the role of nuclear weapons is a result of the lack of an open and informed discussion of national security priorities and policies that would involve independent voices. While there are non-governmental research organizations that are involved in the discussion of defence policies, there are no independent public organizations that would have nuclear weapons related issues on the agenda.

UNITED KINGDOM

Current status

In September 2010, the UK government announced that it had “not more than 225” Trident nuclear warheads and that this would be reduced to “not more than 180” by the mid 2020s. The UK's only delivery system is the Trident D5 missile. Until 2010 each of the two or three armed Vanguard class submarines carried between 12 and 14 operational D5 missiles. This will be reduced to eight missiles per submarine over the next few years. It is estimated that the UK has produced over 3.5 tons of weapon-grade plutonium and that it has acquired from the United States 21–22 tons of HEU and has produced 4–5 tons itself.

Modernization

The UK has plans to upgrade and extend the lives of its warheads in conjunction with the United States. It will be making a decision on whether or not to design and build a successor to Trident in 2015–2020. US modernization of the D5 missile system will apply equally to the missiles deployed on British submarines. The UK is also planning to replace the Vanguard class submarine. There are also plans to upgrade and expand facilities at the Atomic Weapons Establishment (AWE), including by constructing a new enriched uranium facility and a new warhead assembly/disassembly facility, refurbishing the plutonium fabrication facility, and more.

Economics

Annual expenditure on the UK nuclear weapons programme, including AWE, is currently estimated as £2.1 billion in 2010/11. Meanwhile, public expenditure is due to be cut by 5.3% between 2011/12 and 2016/17. The government's aim is to reduce public spending from 46.6% of the GDP to 39%.

International law

In 2006 the UK government claimed that its plan to replace Trident was consistent with the NPT because the Treaty does not set a timetable for nuclear disarmament and does not specifically prohibit the updating of nuclear capabilities. This implies that the UK government thinks it can continue indefinitely to retain and modernize its nuclear forces. Its current plan is not to keep nuclear weapons for a short period of a few years, pending multilateral progress on disarmament, but to introduce a new system that can remain in service until the 2060s.

Public discourse and transparency

The UK government has disclosed some of its plans for modernization, but there have been important limits to its transparency. It has tried to keep the Mk4A warhead modification program out of the limelight. The upgrading of AWE is presented as if it were disconnected from the development of a successor warhead. The government uses safety and surety as arguments to support the modernization of British nuclear forces. The Trident force operates from Faslane, Scotland. The Scottish National Party, which is strongly opposed to Trident, has formed the Scottish government since May 2007. In May 2011 it won a majority in the Scottish Parliament and will hold a referendum on Scottish independence in August 2014. If successful, this would result in an end to the UK hosting its nuclear weapons in Scotland.

UNITED STATES

Current status

The US government indicates it has an active stockpile of 5113 nuclear weapons. Independent estimates indicate it also has approximately 3500 "retired" warheads, an unknown number of which are being maintained for possible reactivation. The US currently reports 1790 strategic nuclear weapons as deployed on ICBMs, SLBMs, and heavy bombers. This does not include warheads that are in the stockpile that could be carried by delivery systems not defined as deployed. Independent estimates indicate the US stockpile has 760 non-strategic weapons with about 200 deployed, most of them at air bases in NATO countries in Europe. The US currently deploys 448 ICBMs; D5 SLBMs on 12 Tri-

dent submarines, currently carrying 249 SLBMs; and two long-range heavy bombers. The US has produced approximately 850 tons of HEU and 85 tons of weapon-grade.

Modernization

The US government is officially committed to modernizing its nuclear bombs and warheads; the submarines, missiles, and aircraft that carry them; and the laboratories and plants that design, maintain, and manufacture nuclear weapons. US policy and budget documents all manifest an intent to keep some thousands of nuclear weapons in active service for the foreseeable future, together with the capability to bring stored weapons back into service and to design and manufacture new weapons should they be desired. The US also has been engaged for more than a decade in efforts aimed at taking advantage of improvements in the accuracy of long range missiles and re-entry vehicles to develop the means to deliver non-nuclear weapons anywhere on earth in short order. Furthermore, the US is refurbishing and upgrading many of the facilities where nuclear weapons are designed, tested, and manufactured.

Economics

US nuclear weapons, the associated systems for fighting nuclear wars, and the factories and laboratories to design, produce, and maintain it all are owned, managed, and operated by an interlocking network of public agencies and private corporations. These in turn are part of a military-industrial-political complex of unprecedented size and power, a social phenomenon still so new and large that it remains incompletely understood. The fiscal year 2012 US military budget, including nuclear weapons spending, totaled about US\$650 billion, which is about 43% of global military spending. At the time of the Fiscal Year 2012 President's Budget Request submitted to Congress in early February 2011, the administration anticipated spending approximately \$88 billion for bombs and warheads and supporting infrastructure and about \$125 billion for delivery systems over a ten year period. Despite austerity measures, an announcement was made in January 2012 that the 2013 military budget will make no significant cuts that would affect current US nuclear weapons systems.

International law

More than four decades after the United States signed and ratified the NPT, it retains a nuclear arsenal large enough to end civilization in short order. None of its bilateral reduction agreements with Russia fundamentally change the character of nuclear weapon deployments. The US has signed but not ratified the CTBT; ratification was rejected by the US Senate in 1999 even after a bargain was made to modernize its arsenal in exchange for ratification. Meanwhile, the US announced its withdrawal from the Anti-Ballistic Missile Treaty in

2011; continuing US development and deployment of ballistic missile “defence” systems remains an impediment to disarmament progress. Endless modernization 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, 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.

Public discourse

In the broader populace, there is little debate about US nuclear weapons policies or spending. Thirty years on from the outpouring of disarmament sentiment that brought a million people out to protest in Central Park, little is left in the way of a disarmament movement in the United States. What remains is a scattering of organizations, some more towards the “arms control” end of the spectrum that always were part of the political mainstream and some that are institutionalized remnants of movements past. The former always have pursued a remedial and incrementalist politics. Most who work in the latter have come to believe that they have no choice. Either way, what public discussion there is about US nuclear weapons policy is dominated by specialists.

INTERNATIONAL LAW

The application of international law to modernization, especially qualitative modernization, faces multiple challenges. In the NPT context, while nuclear weapon states have endorsed in principle the CTBT, FMCT, and capping and reducing nuclear arsenals, they have resisted specific commitments with respect to qualitative modernization. Thus the 2010 NPT Review Conference could only record the “legitimate interest” of non-nuclear weapon states in “constraining” development and improvement of nuclear arsenals.

There is no international institutional mechanism for assessment of nuclear weapons programmes and the state of their compliance with international law with respect to cessation of the nuclear arms race and nuclear disarmament. Nor is there any international mechanism for enforcement of compliance. In the NPT review process and in the UN General Assembly First Committee, a few states devote at most several sentences to general statements on the subject of modernization. No ad hoc official international expert groups have examined the subject. NPT states parties not only do not have any institutional capability for assessment and enforcement of compliance with article VI, they have not developed such a capability with respect to

non-proliferation. That is handled by the International Atomic Energy Agency, a wholly distinct body whose Board of Governors has a restricted membership, and the UN Security Council.

The establishment of adequate institutional capability to monitor nuclear weapons matters would help develop reliable information and a shared understanding of applicable standards, and thus the trust needed for a workable process of global disarmament. It would counteract the tendency of states, especially powerful ones, to treat international law and institutions as manipulable for their own ends, rather than as global public goods whose integrity should be preserved.

Notwithstanding those challenges, international law bearing on modernization is reasonably well developed. It is a normative code that the ‘invisible college’ of non-governmental analysts exemplified by the authors in this collection, as well as disarmament experts and advocates within and without governments around the world, can and should draw upon in working for an end to modernization and a beginning of global disarmament.

DIVESTMENT FOR DISARMAMENT: CHALLENGING THE FINANCING OF NUCLEAR WEAPON COMPANIES

In order to ban the use and possession of nuclear weapons by all states, the modernization of nuclear arsenals must be effectively challenged. Divestment is one such strategy for mounting this challenge.

In four of the nine nations that possess nuclear arms—the United States, Britain, France and India—private companies are heavily involved in the design, manufacture, modernization, and maintenance of nuclear warheads, their delivery vehicles (missiles, submarines and bombers), and related infrastructure. Vested interests in nuclear arms production are a major impediment to disarmament. The nuclear weapons industry is booming, with more than US\$100 billion spent on nuclear weapons programmes globally in 2011, much of which went to private military contractors. These companies employ lobbyists to patrol the corridors of power in search of the next big deal.

Divestment focuses on financial institutions—banks, asset managers, insurance companies and pension funds—that invest in nuclear weapons companies, either by providing capital loans or through the ownership of bonds or shares. Divestment helps to establish, or reinforce, the illegitimacy of the nuclear weapons industry by building understanding and acceptance of the illegality of these weapons and drawing attention to the catastrophic humanitarian and environmental harm they cause. The ultimate aim of divestment is to force nuclear weapons companies to withdraw from the industry, fearing financial losses or damage to their

reputation. If companies choose to withdraw from the industry because of the commercial harm caused to them by divestment, decision makers will feel less pressure to continue investing in nuclear weapons modernization programmes.

The nuclear weapons industry is the most illegitimate of all industries. It threatens every one of us. Yet mainstream financial institutions across the world continue to invest in companies that participate in this grossly immoral, earth-endangering industry. It is up to civil society to act to stop this complicity. It is time for a global divestment campaign to challenge the build-up and modernization of the world's most destructive weapons. Such a campaign will be vital to the success of a genuine, total ban on these ultimate instruments of terror.

POLITICAL WILL: CIVIL SOCIETY, SOCIAL MOVEMENTS, AND DISARMAMENT IN THE 21ST CENTURY

As the articles in this volume show, all of the nuclear weapons states are modernizing their nuclear arsenals, and some are continuing to expand them. It appears likely that smaller but still potentially world-destroying nuclear arsenals have been normalized, and are an integral part of the political and economic architecture of the global system as it now exists. Despite social and political changes of a magnitude that from the perspective of the Cold War times might have been expected to make nuclear disarmament possible, the nuclear dinosaurs appear to have adapted successfully to their new environment. The task now is to imagine conditions in which humanity can outlive them, and the means to bring those conditions about.

When seeking to explain the perennial absence of disarmament progress in international negotiating fora, diplomats and NGO staffers alike often will cite the absence of "political will". How such political will might be created, however, is seldom seriously analyzed or discussed.

Much of the work done by civil society at the international level has focused on developing mechanisms and tools to implement disarmament institutionally and technically once the requisite "political will" exists. While useful, it has not actually generated "political will". Creating the political will for disarmament requires the construction of movements within states, particularly in states that deploy nuclear weapons or in which there are powerful elements that might wish to acquire them. Constructing movements capable of supporting the conditions for disarmament will vary depending on the role that nuclear weapons and nuclear technology plays in national economies, development discourses, and in the military and geopolitical strategies of particular national elites. As during the

Cold War, the internationalist character of disarmament work will consist of finding common ground between the relevant movements in parallel on both sides of confrontations between states that involve nuclear weapons, including efforts by nuclear weapons states to prevent additional states from acquiring them.

Movements sufficient to create the political will to eliminate the danger of nuclear weapons use, and finally the weapons themselves, will not arise from within the professional and institutional worlds of arms control and disarmament. Even the kind of debate and analysis needed to understand what must be done to create the political conditions for disarmament have largely failed to take hold within disarmament discourses and institutions. It is a time for all of us who work not just for disarmament but for peace and justice to be looking outward: for allies, for hope, and for understanding of what must be done. Only by building a place where we can have the conversation about how to make another world possible, will we be able to start moving towards a world where nuclear weapons have no place.

INTRODUCTION

RAY AGHESON

In the middle of the 2010 nuclear Non-Proliferation Treaty (NPT) Review Conference, the Obama administration submitted a “Section 1251” report to the US Senate, attached to its request for the Senate’s consent to ratify the New Strategic Arms Reduction Treaty (START) the US had signed with the Russian government. Included in this report was a commitment to spend 180 billion USD on the modernization of the US nuclear weapons complex: its warheads, its delivery systems, and its production infrastructure. The report outlined a comprehensive plan to (1) maintain nuclear weapon delivery systems; (2) sustain a “safe, secure, and reliable” US nuclear weapons stockpile; and (3) modernize the nuclear weapons complex.¹

Inside the United Nations, where state parties to the NPT were gathered to develop a comprehensive plan for implementing the Treaty—including the disarmament obligations contained in article VI—not a word was said about this report. The day before the report was released, the South African and Irish delegations had pointed out that arsenal reductions, such as the modest ones contained in New START, do not automatically translate to a commitment to nuclear disarmament.² They and many others, notably the Non-Aligned Movement, have over the years argued that modernization of nuclear weapons is contrary to obligations to disarm. Yet on 13 May 2010, when the first US president with a “vision” of a world free of nuclear weapons committed his administration to providing billions upon billions of dollars to extending the life of the US nuclear weapon enterprise for the indefinite future, there was no outrage in the conference rooms.

In the meantime, throughout the Review Conference the nuclear weapon states had been insisting that fulfillment of article VI of the NPT is everyone else’s responsibility. In their joint statement, they continued to put disarmament off into the distant future, arguing that other states need to first “create the conditions” that they deem necessary to fulfill their own obligations under article VI.³ They argued, “All other States must contribute to fulfilling these disarmament goals by creating the necessary security environment, resolving regional tensions, promoting collective security, and making progress in all the areas of disarmament.”⁴

However, as the Brazilian ambassador pointed out, the vast majority of non-nuclear weapon states “have never put their non-proliferation duties on hold, condi-

tioning their fulfillment to indefinite, more favourable international conditions.”⁵ The international community cannot leave it up to the nuclear weapon states to decide when they are ready to disarm. Allowing these states to retain their nuclear weapon capabilities, accepting their reliance on nuclear weapons as a form of security and defence, and remaining silent when they develop new weapons and facilities might be the greatest challenge to international peace and stability that the world is facing.⁶

As of March 2012, the nuclear weapon possessors—China, Democratic People’s Republic of Korea, France, India, Israel, Pakistan, Russia, the United Kingdom, and the United States—are estimated to possess approximately 19,500 nuclear weapons.⁷ Furthermore, the United States is not the only one to have plans to modernize its nuclear complex—all of the nuclear weapon possessors are engaged in modernization activities.

This study explores these nuclear weapon modernization programmes in depth. Non-governmental researchers and analysts, leading and knowledgeable experts about nuclear weapons programmes and policies, provide information on the plans of China (Hui Zhang), France (Hans Kristensen), India (M.V. Ramana), Israel (Merav Datan), Pakistan (Zia Mian), Russia (Pavel Podvig), the United Kingdom (John Ainslie), and the United States (Andrew Lichterman).⁸ They also analyze the costs of nuclear weapons in the context of the economic crisis, austerity measures, and rising challenges in meeting human and environmental needs. Combined, the nuclear weapon possessors have spent approximately one hundred billion USD on their nuclear programmes. At this rate, they will collectively spend at least one trillion USD on nuclear weapons over the next decade.⁹

At the same time as they commit billions of dollars to their nuclear weapon arsenals, most of these states are simultaneously making significant cuts in their social welfare systems, such as health care, education, and childcare. This arguably constitutes a violation of human rights. Adequate resources are critical to the realization of human rights and several instruments of international law mandate the prioritization of human rights over militarism.

For example, article 2.1 of the International Covenant on Economic, Social and Cultural Rights (ICESCR) instructs all state parties “to take steps, individually and

through international assistance and co-operation, especially economic and technical, to the maximum of its available resources, with a view to achieving progressively the full realization of the rights recognized in the present Covenant by all appropriate means, including particularly the adoption of legislative measures.” The Maastricht Guidelines on violations of economic, social, and cultural rights clarifies that a state is in violation of the Covenant if it fails to allocate the maximum of its available resources to realizing human rights.¹⁰ Article 26 of the UN Charter itself calls for the “establishment and maintenance of international peace and security with the least diversion for armaments of the world’s human and economic resources.”

Continued investment in nuclear arsenals will continue to drain the world’s resources, which will have particularly harsh impacts on the world’s poor. Over 1.2 billion people live in what is known as “extreme poverty”, i.e. less than 1.25 USD per day. The Millennium Development Goals (MDGs) state that poverty in the world is to be halved by 2015, but not enough effort or money is expended to achieve this goal. The World Bank estimates that it would take between 35 to 76 billion USD per year until 2015 for the world community to be able to live up to the MDGs. This is but a fraction of the one trillion USD that will likely be spent on nuclear weapons over the next decade.¹¹

The money spent on nuclear weapons not only detracts from the resources available to tackle the converging ecological, economic, and energy crises, but also reinforces the institutions that benefit from weapons and war. As one of the chapters in this report explores, “nuclear establishments and military-industrial complexes exist today in the context of (and, to a degree still inadequately understood, in the service of) an aggressive corporate capitalism that now encompasses virtually the entire planet.”¹² Author Andrew Lichterman argues, “It is in this broader global context that we need to view nuclear weapons.”

This chapter, on political will, is one of three thematic chapters in this study that look at some of the key challenges and opportunities to prevent nuclear weapon modernization and achieve disarmament. A second examines the application of international law to modernization. The third analyzes the feasibility of divestment campaigns as a way to challenge the financing of nuclear weapon companies. Tim Wright, one of the authors of the recently released report *Don’t Bank on the Bomb: The Global Financing of Nuclear Weapons Producers*, explains that divestment can help “establish, or reinforce, the illegitimacy of the nuclear weapons industry by building understanding and acceptance of the illegality of these weapons and drawing attention to the catastrophic humanitarian and environmental harm they cause.”¹³

Divestment is indeed a valuable tool for governments and civil society to take direct action against the

profit of nuclear weapons. However, divestment alone, and calls for “disarmament for development,” do not solve the entrenched structural challenges of nuclear weapons and the systems that sustain them. As Lichterman argues in his chapter, we need to develop “a deeper critique of the current conjuncture, a vision of an alternative path forward that reduces the demand for weapons and military services, and a strategy for advancing along that path.”¹⁴ He argues that it is the “fundamental institutional arrangements of our economy and their relationship to the technologies, built world, and development path that they entail” that must also be challenged. Rejecting the argument that before the elimination of nuclear arsenals can be negotiated, the world must be free of war and international tensions, Lichterman writes:

We do not have to wait until we have removed the causes of war to advocate for disarmament, or to develop the movements and social change strategies that make disarmament possible. Removing the causes of war and working for nuclear disarmament are part of the same larger project. Making the world more economically equitable lessens the danger of war. Giving all people a voice in the decisions that affect every sphere of their lives lessens the danger of war—and almost certainly increases the chances that economic life will become more fair as well. Moving towards a way of life that is consistent with the rhythms and limits of the ecosystems that sustain us likely reduces the dangers of war over the long term. Nuclear weapons and nuclear power are both leading instances of the irrationalities that result from a social world that has been constructed to concentrate power in the hands of tiny minorities, and to make it possible for them to maintain and defend their power.¹⁵

Currently, there are no near-term prospects for nuclear disarmament. Russia and the United States have engaged in bilateral negotiations; however, Hans Kristensen of the Federation of American Scientists has explained that while New START “reduces the legal limit for deployed strategic warheads, it doesn’t actually reduce the number of warheads. Indeed, the treaty does not require destruction of a single nuclear warhead and actually permits the United States and Russia to deploy almost the same number of strategic warheads that were permitted by the 2002 Moscow Treaty.”¹⁶ Furthermore, as Shannon Kile, Senior Researcher at the Stockholm International Peace Research Institute (SIRPI) has argued, “It’s a stretch to say that the New START cuts agreed by the USA and Russia are a genuine step towards nuclear disarmament when their planning for nuclear forces is done on a time scale that encompasses decades and when nuclear modernization is a major priority of their defence policies.”¹⁷ While both Russia and the United States are considering cuts to their arsenals that go further than those required by New START

(see their respective chapters in this study), their simultaneous plans for and investment in modernization undermines the idea that either country is actively pursuing disarmament.

“Consider this brash analogy,” says Darwin Bond-Graham of the Los Alamos Study Group, a watchdog of the US nuclear weapons laboratory in New Mexico:

If the two states that hunt the vast majority of the world’s whales (out of the ten states that still allow this practice) agreed to a bilateral international treaty concerning whaling which stated that all parties ‘seek a world free of whaling,’ and if whaling states party to this treaty agreed to reduce their harvests by 10%, and yet the convention concretely allowed for the use of new hunting techniques, the killing of new species, hunting in new waters and the design and construction of advanced new whaling ships and harpoons, would it be hailed as an anti-whaling treaty? Indeed, if part of the domestic political deal made within whaling states in order to secure ratification in their legislatures included large investments in a ‘national whaling complex’ that would be able to build these ships and harpoons a century into the future, would anti-whaling activists publicly support it? Would they call it a good first step toward an end to whaling?¹⁸

Meanwhile, none of the other nuclear weapon possessors have expressed willingness to engage in reductions, or even negotiations for reductions, until the US and Russian arsenals have come down to “strategic parity” with their own. The Conference on Disarmament, the UN-affiliated body in Geneva in which multilateral disarmament agreements are to be negotiated, has been unable to even adopt a programme of work in 15 years, let alone engage in negotiations on any topic. France, Russia, the United Kingdom, and the United States have made it clear that they object to the negotiation of a nuclear weapons convention that would ban the possession and use of nuclear weapons. They have all, in one way or another, reiterated President Obama’s remarks that until nuclear weapons are eliminated, they will retain them¹⁹—a catch-22 of epic proportions.

In article VI, the NPT contains a legally-binding obligation for five of the eight nuclear weapon possessors to achieve an agreement on the elimination of nuclear weapons. None of the five are in compliance with this obligation. At each meeting of NPT state parties, these countries profess their continued commitment to disarmament and report on the “measures” they have undertaken to fulfill this commitment. Through action 1 of the 2010 NPT Review Conference final document, all state parties are further committed “to pursue policies that are fully compatible with the Treaty and the objective of achieving a world without nuclear weapons.” Yet in reality, each of the nuclear weapon states are pursuing programmes for the modernization, refurbishment, and lifetime extensions of their nuclear

weapons. Those programmes are contrary to the article VI obligation of cessation of the nuclear arms race at an early date pending nuclear disarmament, as explained in John Burroughs’ thematic chapter on international law. The three non-NPT state parties—India, Israel, and Pakistan—have also indicated their intention to maintain and/or modernize their arsenals rather than disarm, despite some rhetoric to the contrary. And as the international law chapter sets forth, these latter three states do indeed have obligations to disarm, despite their refusal to join the NPT.

This study is for both civil society and governments. We hope it is useful in preparing for the next review cycle of the NPT and for challenging the rhetoric of the nuclear weapon possessors. Exposing the reality of their modernization plans demonstrates that stronger and more concrete commitments must be extracted now, in the immediate term, in order to ensure that the global nuclear weapon enterprise is not extended into the indefinite future. It also demonstrates the need for civil society to focus on challenging key structures and processes of our political and economic institutions in order to truly effect change that will impact the nuclear weapon policies of our governments.

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MODERNIZATION IN ...

CHINA

HUI ZHANG

China has upheld its nuclear policy of maintaining a minimum deterrent with a no-first use pledge and avoiding a nuclear arms race since its first nuclear explosion in 1964.¹ Following the guiding principles of its nuclear policies, the main purpose of China's nuclear modernization is to assure what it considers to be a "limited," "reliable," and "effective" counterattack nuclear capability for deterring a first nuclear strike. To maintain an "effective nuclear deterrent," China will continue to modernize its nuclear force posture accordingly along with other countries' military developments and the international security environment. However, the nuclear force will likely be kept at the minimum level Beijing feels is required to deter a nuclear attack. China could have the smallest arsenal of nuclear weapons and stocks of fissile materials for weapons among the five original nuclear weapon states.

STATUS OF CHINA'S NUCLEAR FORCES

Estimates of Chinese nuclear force are difficult, given the fact that China has revealed little information about its nuclear force posture. However, based on the intentions of China's nuclear modernization and Western government and non-government estimates,² China has a total inventory of approximately 170 nuclear warheads including approximately 110 operationally deployed nuclear missiles (mainly land-based nuclear ballistic missiles, of which approximately 35 can reach the continental United States), approximately 60 warheads stored for its submarine-launched ballistic missiles (SLBMs), and bombers (see table 1). Each of those nuclear ballistic missiles carries a single warhead. The warheads are separated from the missiles under normal circumstances.³

To make a reasonable estimate of China's nuclear force, it is necessary to understand the intention of China's nuclear modernization. Under the guideline of China's no-first use doctrine and the principle of a "lean and effective" (*jinggan youxiao*) nuclear force, the main goal of China's nuclear modernization, initiated in the 1980s, is to secure a limited and reliable second-strike nuclear force to deter a nuclear attack. Unlike the United States' focus on counterforce targeting policy, which needs a large arsenal to eliminate the adversary's nuclear force, China has a retaliatory

countervalue posture for which China believes a small force is enough. In 1978, Deng Xiaoping provided the guidance for the future development of China's nuclear force. He emphasized that China's strategic weapons "should be updated (*gengxin*) and the guideline [for their development] is few but effective (*shao er jing*). Few means numbers and effectiveness should increase with each generation."⁴ The *gengxin* (upgrade) means here mainly replacing the older ones by new, "better" ones. Mao Zedong once also remarked that one should "have a little bit (of nuclear weapon), keep (the weapons) a little bit, make (the weapons) a little bit better" (*you yidian, shao yidian, hao yidian*).⁵ This "yidian" (a little bit) policy has been kept by the several generations of Chinese leaders.

To have a small arsenal capable of counterattack, China's nuclear modernization has been focusing on the quality over the quantity of its nuclear arsenal during the past three decades. As professor Hu Side, the former president of Chinese Academy of Engineering Physics (the Chinese Los Alamos) emphasized, "China's nuclear modernization [is conducted] under the guideline of China's nuclear policy, maintaining the principle of counterattack in self-defense and avoiding [an] arms race," and one feature of China's nuclear modernization is that "China's nuclear modernization is impossible and unnecessary to be accomplished through simple increase of the number of nuclear weapons."⁶

Specifically, China's nuclear modernization has been focusing on increasing the survivability of its nuclear force by replacing older, liquid-fueled missiles with solid-fueled, mobile ballistic missiles and constructing underground tunnels that can act as missile bases. The pace of China's nuclear modernization efforts has been slow and gradual for the past three decades. It should be noted that since the Taiwan strait crisis in 1996, the secondary artillery has emphasized modernization of conventional missiles as well and increased significantly the size of the conventional arsenal (in particular the DF-21 C missiles). However, there is no obvious increase of nuclear warheads.⁷

Delivery systems

Land-based ballistic missiles

Given that China has no reliable operational air-based (bomber) or sea-based (SSBN) nuclear force, China's nuclear modernization since its initiation in

1980 has focused on increasing the survivability of its limited land-based strategic missiles by the People's Liberation Army Second Artillery Force (PLASAF). As its recent Defense White Paper states, "Following the principle of building a lean and effective force, the PLA Second Artillery Force (PLASAF) strives to push forward its modernization and improves its capabilities in rapid reaction, penetration, precision strike, damage infliction, protection, and survivability, while steadily enhancing its capabilities in strategic deterrence and defensive operations."⁸

Based on the intention of China's nuclear modernization and Western publications, it is estimated that China could have approximately 110 land-based, nuclear-capable ballistic missiles, including up to 20 silo-based, liquid-fueled DF-5A (CSS-4) intercontinental ballistic missiles (ICBMs); approximately 10 solid-based, road-mobile DF-31 ICBMs; approximately 15 solid-based, road-mobile DF-31A ICBMs; approximately 10 liquid-fueled, limited-range DF-4 ICBMs; approximately 5 liquid-fueled DF-3A intermediate-range ballistic missiles; and approximately 50 road-mobile, solid-fueled DF-215 medium-range ballistic missiles (MRBMs).

The US Department of Defense (DoD) has reported consistently that China has 20 DF-5A—a liquid-fueled, two stage, silo-based ICBM with a range beyond 13,000 kilometers, which can reach the continental United States.⁹ It can deliver a 4–5 megaton warhead. China began to develop the DF-5A in the late 1980s, mainly in order to enhance the range of DF-5s that had entered service in 1981. The DF-5A was deployed in the 1990s. After this, China had the capacity to target the continental United States.¹⁰ It has been reported that it takes up to two hours for launch preparation. Given that it is silo-based and has extensive fueling requirements, the DF-5A could be vulnerable to a first strike. One focus of the modernization programme is to replace those older, liquid-fueled ICBMs with the new solid-fueled DF-31A ICBMs. In 2006, the DoD reported that China had about 20 DF-5A before it started to deploy the DF-31A in 2007.¹¹ As the DF-31A starts to deploy over the coming years, it may be reasonable to expect that at least some DF-5A will be replaced. However, China's underground great wall project initiated in 1985—aimed at increasing the survivability of those land-based missiles through underground tunnels to shield them¹²—could motivate China not to replace all those DF-5As so quickly. Based on those considerations, the author assumes China could have less than 20 DF-5A by 2011.

As a key part of Chinese second generation ICBMs, the DF-31A achieved initial operational capability (IOC) in 2007. The DF-31A is a solid-fueled, three stage, road-mobile ICBM with a range over 11,200 kilometers. It can deliver a 200–300 kilotons warhead. The DF-31A is carried on a six-axle transporter-erector-launcher. Based on the DoD report, China deployed less than 10

DF-31As in 2008 and between 10–15 DF-31As in 2009. However, the 2011 DoD report did not provide the specific number deployed in 2010. It noted "additional CSS-10 Mod 2s" will appear by 2015. The Federation of American Scientists report estimated China deployed 10–20 DF-31As by 2011.¹³ It is reasonable to assume China has approximately 15 DF-31As.

Based on China's minimum deterrence policy—it "will limit its nuclear capabilities to the minimum level required for national security"¹⁴—approximately 15 DF-31As with about 20 DF-5As (thus a total 35 longer-range ICBMs) would meet its "minimum need". It should be noted that while Beijing does not disclose the specific number of its "minimum need," a nuclear force with approximately ten warheads reaching a target country may be considered enough to inflict "unacceptable damages" (as discussed in the following sections). As more DF-31As are deployed, it could be expected that more DF-5As would be phased out. However, the total amount of around 35 should be not changed significantly.

One major target for this longer-range ICBM would be the continental United States. If China thought 20 ICBMs were enough to deter a US first strike in the 1980s and 1990s, the minimum nuclear force capable to reach the target after surviving the first strike would be around 10 warheads, which could inflict unacceptable damages for United States. However, with the development of US satellite surveillance capabilities and the increased accuracy of its nuclear weapons, the survived weapons would be much lower than the needed minimum level. To maintain the "needed" minimum nuclear force, China started the underground great wall project in 1985, which can protect most of its missiles. Thus, a total of 20 longer-range missiles could be enough to deter a US nuclear attack without a missile defence system. However, facing a ground-based midcourse missile defence system currently deployed by the United States (with about 30 interceptors), a total of around 35 ICBMs would meet its "minimum needed" weapons. Assuming most of those Chinese missiles would survive a first strike due to the protection from the underground great wall, and that every two interceptors of missile defence can kill each incoming ICBM, and then around 10 ICBMs would reach their target. In addition, decoys and missile defence countermeasures would help those missiles to overcome the midcourse missile defence system.

China also has the older, first generation DF-4. The DF-4, deployed in 1980, is a liquid-fueled, two stage, limited-range ICBM (5,400+ km). It is stored in cave bases and needs to be pulled out to the fixed prepared-launch site for launch. It is being replaced by the new solid-fueled DF-31 and DF-215. The DoD reported China had about 16–24 DF-4s in 2006 when the DF-31 was first introduced.¹⁵ The DoD estimated China had 15–20 DF-4s in 2009.¹⁶ The *Military Balance* report of

the International Institute of Strategic Studies (IISS) estimated China had approximately 10 DF-4s in 2010.¹⁷ It is reasonable to assume China has approximately 10 DF-4s.

The DF-31 is a solid-fueled, three stage, road-mobile ICBM with a range over 7,200 kilometers. As with the DF-31A, the DF-31 is carried on a six-axle transporter-erector-launcher. It can cover targets in Russia and Asia. Based on the DoD report, China deployed less than 10 DF-31 by 2009. IISS estimated China had approximately 12 DF-31s in 2010.¹⁸

Based on China's principle of "minimum needs," it is reasonable to assume China has approximately 10 DF-31s by 2011. Thus, a total of 20 DF-31 and DF-4s could meet China's minimum needs. As more DF-31s are deployed, more DF-4s would be replaced. However, the total ICBMs in this category (in term of range) would not be increased significantly according to the current analysis of China's security. The main target of the DF-4 during the cold war was Moscow. As with the DF-5A, about 20 weapons would have an effective deterrent. Given that China and Russia have improved their relations significantly, China has no rational to have a significant increase in this category of missiles. While those missiles can target India, the DF-21 could also reach India if needed. In addition, given China's focus on countervalue targeting policy (i.e. population centers), the US Guam military base would not be a focus for China's strategic weapons.

China is phasing out its oldest and near-retired DF-3A. The liquid-fueled, single-stage, medium-range DF-3A with a range over 3000 km is being replaced by the DF-21. It is mainly for regional "deterrence". The 2011 DoD report estimated China has 5–20 DF-3As.¹⁹ IISS estimated that China had about two DF-3As by 2010.²⁰ The 2008 DoD report expected the DF-3A to be retired by 2010.²¹ Most of the DF-3As could be replaced by the DF-21s. China could have approximately five DF-3As by 2011.

The DF-21 family is the most important MRBM system of the Second Artillery for regional nuclear deterrence. This family includes the DF-21 (CSS-5 Mod 1), DF-21A (CSS-5 Mod2), DF-21C, and DF-21 D. However, only the DF-21 and DF-21A are for nuclear mission. This mobile and solid-fueled missile has a range of more than 1750 km. China began serious deployment of the DF-21 in 1991. After its deployment for two decades, the DF-21 could replace most of those DF-3As. The DoD estimated that China had about 19–50 in 2005 and 40–50 in 2006 nuclear-armed CSS-5 Mod 1 and CSS-5 Mod 2 MRBMs. The 2011 DoD report estimated China had 75–100 missiles of the whole DF-21 family, including conventional mission missiles as well (e.g. DF-21C).

However, there is no evidence to show that China has a rationale to significantly increase its DF-21s with nuclear missions during such a short period. In fact, after about 15 years of deployment of DF-21s (1991–2005),

its deployment for nuclear mission should be nearly accomplished. Most likely, the new increase in the DF-21 family is contributed by its conventional missions. In fact, the Second Artillery has emphasized its dual missions (nuclear and conventional) since the early 2000s. A study of the Project 2049 Institute also emphasized that "[d]espite a significant expansion of Second Artillery's missile brigade infrastructure over the last 15 to 20 years, a review of China's nuclear warhead storage and handling system offers no obvious signs of a significant increase in China's nuclear stockpile." Furthermore, "Much of the missile infrastructure expansion, beyond short range ballistic missile brigades deployed opposite Taiwan, appears to accommodate new brigades equipped with DF-21 (CSS-5) medium range ballistic missiles, including the terminally-guided DF-21C and perhaps the DF-21D maritime variant in the near future."²² The Project 2049 Institute report further stated that "the absence of a clear sign of nuclear warhead growth and expansion of missile infrastructure could indicate an extension of Second Artillery's conventional mission."²³ In short, as a conservative estimate, China could have no more than 50 DF-21 MRBMs that are nuclear capable.

Submarine-launched ballistic missiles

After about two-decade's worth of efforts, the People's Liberation Army Navy started to operate its sole Xia-class SSBN (Type-092) in early 1980.²⁴ It is equipped with 12 JL-1 SLBMs (Julang-1, "Great wave-1"). Each JL-1 missile has a single warhead and a range of 1700 km. However, the 2011 DoD Report states, "The operational status of China's single XIA-class ballistic missile submarines (SSBN) ... remains questionable." It is reported that the Xia-class has never conducted a deterrent patrol.²⁵ In fact, the DoD recent reports do not count the JL-1 in the Chinese missile forces.

This old, first generation Xia and its JL-1 is being replaced with the second generation Jin-class SSBN (Type-094) and the new JL-2. The Jin-class SSBN can carry 12 JL-2 SLBMs with a much longer range (7400 km, a modification model of DF-31) than that of JL-1. As the deployment of the new Jin-class SSBNs with JL-2 SLBMs, it will further secure China's second-strike capability.

Based on the 2011 DoD report and the FAS report, China built a maximum of three Jin-class SSBNs by 2010. The first one appears ready to enter service soon. However, it is uncertain when China will have the operational JL-2 and the combination of the Jin-class SSBN with the JL-2 SLBM. In addition, US naval intelligence projected in 2007 that China might build five Jin-class SSBNs.²⁶ However, the US intelligence community often overstates China's nuclear force, and the number of five is likely too high. China has maintained only one SSBN for the past three decades, and China's nuclear modernization focus is mainly on updating its

old SSBM with higher quality ones, instead of generating larger numbers. Thus, China would have no intention to expand its sea-based nuclear force by such a large amount. Furthermore, if China can operate three SSBMs in the future, and even if only one-third of those SSBMs can survive a first strike, then China will still have about 12 SLBMs for counterattack, which would meet China's "minimum need for deterrence," as is the case for the land-based missiles. Meanwhile, if China feels confident about survivability of its land-based strategic nuclear force by the protection of its "underground great wall," China would have no rationale to have more than three new SSBNs under current security circumstance. In short, the author assumes that China could have up to three Jin-class SSBNs with 36 JL-2 SLBMs. As the new SSBNs are fully deployed, those old Xia-class SSBM and JL-1 missiles will be fully phased out.

It can be expected that, after its three-decade modernization programme, with a focus on increasing the survivability of its land-based missiles, China will speed up the modernization of its sea-based strategic force to secure a second-strike force in the coming years. As retired PLA General Xu Guangyu told Reuters in 2010, "International experience shows the most effective second-strike capability is submarines ... and upgraded missiles are a focus."²⁷ Indeed, China's 2011 Defense White Paper states that "the PLA Navy (PLAN) endeavors to accelerate the modernization of its integrated combat forces, enhances its capabilities in strategic deterrence and counterattack, and develops its capabilities in conducting operations in distant waters and in countering non-traditional security threats."²⁸

Bombers

China's air-based nuclear force is the weakest leg among its triad. China's aged strategic bomber force consists about 20 Hong-6 bombers (with a combat radius of approximately 3000 km, each with one bomb) based on the old design of the Soviet Tu-16 Badger bomber. This small arsenal could be used as a secondary mission for a small number of bombers.²⁹ All current publications indicate China has no operational strategic nuclear bombers.

However, China could have no rationale to have a larger air-based nuclear force. Given their relatively short operating range and poor penetrability, those bombers would be very difficult to fly into an enemy's heartland to destroy strategic countervalue targets, e.g. cities. Moreover, during the cold war, the major target of those bombers was the Soviet Union/Russia. However, the relationship between China and Russia has recently improved significantly. China has improved relations with other neighbors as well. Thus, there is no rationale to expend its air-based force due to geopolitical considerations.

That said, China will likely maintain a small arsenal of bombers in the near future, which will be consistent with its principle of a pursuit of "a small but inclusive" (*xiao er quan*) force. Zhou Enlai emphasized in 1970 that China "must build a certain number of [nuclear weapons] with a certain quality and a certain variety."³⁰ "A certain variety" of weapons means here to support a strategic nuclear triad, which Chinese leaders view as a symbol of China's great-power status. Thus, China's small arsenal of strategic bombers mainly has symbolic meaning and a minor "deterrent" effect.

Table 1: China's nuclear forces 2011					
Type	NATO Designation	Year Deployed	Range (kilometers)	Yield (kilotons)	Number of warheads
Land-based ballistic missiles					
DF-5A	CSS-4	1990s	13,000+	4,000-5,000	<20
DF-31A	CSS-10 Mod 2	2007	11,200+	200-300?	15
DF-4	CSS-3	1980	5,400+	3,300	10
DF-31	CSS-10 Mod 1	2006	7,200+	200-300?	10
DF-3 A	CSS-2	1971	3,000+	3,300	5
DF-21	CSS-5 Mods 1/2	1991	1,750+	200-300	50
<i>Subtotal:</i>					110
Submarine-Launched ballistic missiles					
JL-1	CSS-NX-3	1986	1,000+	200-300	(n.a)
JL-2	CSS-NX-4	?	7,400	200-300 ?	(36)
Bombers					
H-6	B-6	1965	3,100	---	20
Total					166

Source: The US DoD annual report on Military Power of the People's Republic of China; the annual Military Balance reports of the International Institute of Strategic Studies; and FAS/NRDC "Nuclear Notebook" section on China's nuclear force in issues of The Bulletin of the Atomic Scientists.

Given the experience that China has had with its 12 JL-1 SLMBs for the sea-based leg of the triad for the past several decades, China may want to have a small arsenal of bombers with no more than 20 warheads/ bombers—even if these weapons did not have an operational capability.

Tactical nuclear weapons

There have been rumors for many years that China has tactical weapons. In 1988 China tested a 1–5 kiloton nuclear device with an enhanced radiation yield, or a “neutron bomb”.³¹ Some CIA declassified documents also indicated that China pursued or possessed several types of non-strategic weapons, including ballistic missiles, cruise missiles, and artillery.³² However, Chinese nuclear experts argue that the deployment of tactical nuclear weapons is not consistent with China’s no-first-use policy. From the beginning of China’s nuclear age, Mao Zedong and the following generation of leaders have viewed nuclear weapons as strategic tools to deter nuclear threats or the use of nuclear weapons against China, not as war-fighting tools. Chinese nuclear experts have argued that the “neutron bomb” test was for tracking and understanding its effect as part of defence studies. In practice, while it should not be difficult for China to have tactical weapons, China does not do so.³³ In fact, the tests of low-yield weapons conducted before 1996, when China ended its tests, were reportedly mainly for “safety purposes” and the miniaturization of warheads, which would be used for the next generation of missiles.

Fissile materials

While China has not declared officially that it has ended highly enriched uranium (HEU) and plutonium production for weapons, based on new public information it is believed that China stopped production of HEU in 1987 and of plutonium by about 1990. All its previous military production facilities have been closed, converted, or are being decommissioned.³⁴

Highly-Enriched Uranium (HEU)

China has produced HEU for weapons at two facilities: Lanzhou gaseous diffusion plant (GDP), which began operating in January 1964 and provided HEU for China’s first nuclear test in October 1964; and Heping GDP, a “Third Line” facility that began operating in 1975. Based on new public information, it is believed that the Lanzhou and Heping GDPs stopped production of HEU in 1979 and 1987, respectively.

The total separative work units (SWUs)—the amount of separation achieved by the enrichment process—produced by the Lanzhou and Heping GDPs could have produced roughly 20 tons of weapon-grade HEU. Subtracting the SWU consumption for enriching uranium for non-weapon purposes, China’s military inventory of weapon-grade HEU would be about 16±4

tons of HEU for weapons. This new estimate is significantly lower than previous estimates, which range from 17–26 tons of HEU.

Plutonium

China has produced plutonium for weapons at two nuclear complexes: The first is the Jiuquan Atomic Energy Complex, near Yumen in Gansu province. This site includes China’s first plutonium reactor, which began operation in 1966, and the associated reprocessing facilities. The second is the Guangyuan plutonium production complex, located at Guangyuan in Sichuan province. This was the “third line” plant backing up the Jiuquan complex and also included a plutonium reactor and reprocessing facility. The reactor began operation in 1973. Based on new public information, it is believed that the Jiuquan and Guangyuan reactors stopped plutonium production in 1984 and 1989 respectively.

China’s two plutonium production reactors produced an estimated 2±0.5 tons of weapon-grade plutonium. It is estimated that about 200 kg of plutonium have been consumed in China’s nuclear tests. Thus, its current inventory of weapon-grade plutonium would be 1.8±0.5 tons available for weapons. The new estimates are significantly lower than most previous independent estimates, which range from 2.1 to 6.6 tons of plutonium.

The estimates show that China could have the smallest military stockpile of HEU and plutonium available for weapons among the five acknowledged nuclear weapon states, which is consistent with China’s “minimum nuclear deterrence” policy.

MODERNIZATION: GUIDING PRINCIPLES AND DRIVERS

China’s government has repeatedly stated that it is pursuing a “self-defensive” nuclear strategy. As its 2006 White Paper on Defense states, the fundamental goal of China’s nuclear strategy is “to deter other countries from using or threatening to use nuclear weapons against China. China remains firmly committed to the policy of no first use of nuclear weapons at any time and under any circumstances.”³⁵ China upholds the principles of “counterattack in self-defense and limited development of nuclear weapons,” and aims at building “a lean and effective nuclear force capable of meeting national security needs.” Furthermore, the government insists that “China exercises great restraint in developing its nuclear force. It has never entered into and will never enter into a nuclear arms race with any other country.” The 2007 fact sheet published by the Ministry of Foreign Affairs declared, “Among the nuclear-weapon states, China has performed the least number of nuclear tests and possesses the smallest nuclear arsenal.”³⁶

It can be expected that China’s future development of nuclear forces will follow China’s nuclear policy with

a no-first-use pledge and “minimum deterrence”. This strategy has been consistently embraced by top Chinese leaders, from Mao Zedong to the current leader, Hu Jintao, who believes a small arsenal capable of counterattack should be enough to deter a nuclear strike. As Mao stated a few months after China’s first nuclear test, “We don’t wish to have too many atomic bombs ourselves. What would we do with so many? To have a few is just fine.”³⁷ Similarly, Deng Xiaoping once emphasized that China’s small number of nuclear weapons “is only to show that we also have what you have. If you want to destroy us, you yourself have to suffer some retaliation as well.”³⁸

While many experts and scholars suspect China’s no-first-use pledge is insincere or claim that it is just a declaratory policy, China has maintained a much smaller and simpler nuclear arsenal than the other nuclear weapon states and has de-mated its warheads from its missiles. The Second Artillery conducts war planning and training under the assumption that China will absorb a first nuclear blow and use its nuclear forces only to retaliate.³⁹ The increased stockpiling of China’s conventional missiles by the Second Artillery could further enhance the credibility its no-first-use pledge. Furthermore, China’s nuclear force posture seems to be determined primarily by its strategy, not financial or technological constraints. China’s economic and technological development since the 1980s indicates that it could expand its nuclear force if it determined this to be in its strategic interest. Yet, China still has a very limited nuclear force and there is no evidence that China plans on changing it in the near future.

The Chinese government insists that China continues to modernize its nuclear force only in order to maintain a reliable second-strike retaliatory capability. Chinese president Hu Jintao has emphasized that China’s modernization programmes are designed to ensure that the “nuclear deterrent” is “safe, reliable, and effective” under “any” circumstance. Similarly, many Chinese officials and nuclear weapon experts argue that China’s nuclear modernization programme is to be conducted under the guidance of China’s nuclear policy, maintaining the principle of counterattack in self-defence and avoiding an arms race. The main features of China’s nuclear modernization programme, as emphasized by Professor Hu Side, include the beliefs that it is impossible and unnecessary to accomplish China’s nuclear modernization “requirements” through a simple increase of the number of nuclear weapons; that modernization will provide assurance of safety of its nuclear arsenal; that investment in modernization will be limited at very low level; and that modernization will be conducted without nuclear testing.⁴⁰

The main goal of China’s nuclear modernization is said to be increasing “survivability, reliability, and safety” for its small nuclear arsenal and maintaining an “effective” second-strike nuclear force. The following

equation indicates the relationship between the “effectiveness” of China’s nuclear force and the level of armament the government says it requires for a “minimum deterrent”:

$$N_{\text{effectiveness}} = N_{\text{minimum level}} / [(survivability \text{ from a first strike}) \times (penetrability \text{ of a missile defence})]$$

$N_{\text{effectiveness}}$ represents an “effective nuclear force” to meet China’s minimum requirement under different circumstance. The $N_{\text{minimum level}}$ is the minimum nuclear force that will reach the target after surviving a first nuclear strike and penetrating a missile defence system. It would be relatively kept constant. Thus, the specific number of warheads required for an effective nuclear force ($N_{\text{effectiveness}}$) is dynamic and changeable, relying on a number of factors including survivability after the first strike and the penetration rate through an enemy’s missile defence system (if deployed). The minimum nuclear force ($N_{\text{minimum level}}$) itself, however, is constant and does not need to change. In short, to maintain an “effective nuclear deterrent,” China will continuously modernize its nuclear force according to its perception of international security circumstances.

China’s officials have never declared the specific number of weapons needed for its minimum nuclear force (i.e. the $N_{\text{minimum level}}$). Mao Zedong stated, “In any cases, we won’t build more atomic bombs and missiles than others.” He also said that “a few atomic bombs are enough (for China). Six are enough.”⁴¹ While six warheads is likely not be the specific number in the mind of Chinese leaders, a minimum nuclear force with approximately ten warheads reaching a target country may be considered enough to inflict unacceptable damages. Based on a Natural Resources Defense Council study,⁴² the average number of fatalities per attacking weapon (e.g. the DF-5A with a 4-5 MT warhead) is about 800,000, and the average number of casualties per weapon is about two million for these nuclear airbursts. Thus, ten DF-5As would kill about 8 million people and incur casualties of 20 million. It is probable that Chinese officials would consider this enough to “deter” a nuclear first strike.

China’s nuclear modernization for the last three decades has focused on increasing the survivability of its strategic land-based missiles by measures such as developing new solid-fueled and mobile missiles and building underground tunnels to shield those missiles. These measures are mainly in response to the development of military capabilities of other countries, including the improvement of space surveillance to locate and target Chinese missiles, either fixed- or mobile based; the increased accuracy of nuclear weapon attacks; and long-range conventional strike capabilities. Once China has confidence in its land-based missiles, it will likely speed up the modernization of its sea-based nuclear force.

Without concerns about US missile defence, China’s modernization programme would likely continue to

focus on quality over quantity. However, US missile defence plans will be a major driver for China's nuclear weapon modernization. Some Chinese officials are concerned that even a limited missile defence system could neutralize China's smaller nuclear force. China is also concerned about US cooperation with Japan and Taiwan on missile defence systems. China's current arsenal of longer-range ICBMs (about 35 ICBMs) could meet its "minimum nuclear deterrent" facing the current US deployed missile defence system. However, China's plans could change significantly if the United States were to deploy a more comprehensive or more operationally successful missile defence system. This might include building more warheads that can overcome missile defences, in addition to developing decoys and missile defence countermeasures.⁴³

Washington's strategic nuclear intentions toward Beijing could also influence China's nuclear modernization plans. In particular, China worries that the United States could use nuclear weapons against China in a potential Taiwan conflict. The Bush administration's 2002 Nuclear Posture Review specifically mentions the possibility of using nuclear weapons during a conflict in the Taiwan Strait and the possible use of tactical nuclear weapons.⁴⁴ From 1980 to 1995, China's nuclear modernization programme was conducted at a very modest pace because Beijing saw less of a nuclear threat from Washington. However, since the Taiwan crisis in mid-1990s, China has become more concerned about US threats. These days, many Chinese officials worry about the United States' strategic intention to shift the focus of its military strategy to the Pacific and East Asian region.

ECONOMICS

China does not release information about how much it has spent on its nuclear weapons. It is difficult to make an estimate. Chinese experts of nuclear weapons believe China invests at a very low level for its nuclear weapon programmes.⁴⁵

Beijing insists that it coordinates military modernization with national economic development. As stated in its recent White Paper, "China adheres to the principle of coordinated development of national defense and economy. In line with the demands of national defense and economic development, China decides on the size of defense expenditure in an appropriate way, and manages and uses its defense funds in accordance with the law."⁴⁶

China's officially announced defence budget of 601 billion yuan (about 91.5 billion USD) for 2011 is an increase of 12.7% over the 533 billion yuan (\$81.3 billion [USD]) authorized in 2010.⁴⁷ However, many foreign

US MISSILE DEFENCE PLANS WILL BE A MAJOR DRIVER FOR CHINA'S NUCLEAR WEAPON MODERNIZATION.

analysts do not believe that the Chinese official data represent the real Chinese military-related spending.⁴⁸ The 2011 DoD report estimated that China's total military-related spending for 2010 was over \$160 billion, almost double the official Chinese estimates. The Stockholm International Peace Research Institute estimated that China spent \$119 billion on defence in 2010, a 46% increase over Chinese official data.⁴⁹

It is even more difficult to estimate the spending on nuclear forces without knowing the specific portion of the overall military budget dedicated to nuclear weapons. Assuming that China consistently maintains 5% of its overall military expenditure for its nuclear weapons programme, as suggested by an Indian analyst,⁵⁰ China would thus have spent between \$4.5 and \$9 billion on its nuclear programme in 2011. A recent report by Global Zero estimates that China's core nuclear cost to be \$6.4 billion in 2011, and its full cost to be \$7.6 billion.⁵¹

INTERNATIONAL LAW

Comprehensive Test Ban Treaty (CTBT)

Its most recent white paper indicates that China "supports the early entry into force of the Comprehensive Nuclear Test Ban Treaty (CTBT)" and that it has "strictly abided by its commitment to a moratorium on nuclear testing and has actively participated in the work of the Preparatory Commission of the Comprehensive Nuclear Test Ban Treaty Organization, and is steadily preparing for the national implementation of the Treaty." China signed the CTBT in 1996 but has not yet ratified it, partly because it was rejected by the US Senate in 1999. Most likely, Beijing's ratification of the CTBT will follow Washington's ratification of the Treaty.

In practice, the CTBT will constrain China's nuclear modernization the most among the NPT-recognized nuclear weapon states. China conducted only 45 tests before its testing moratorium commitment in 1996. This leaves China with a very limited number of tested warhead designs certified for deployment. The lack of test data would limit China to further develop new and smaller warheads.

Some analysts claim that China has deployed multiple independently-targeted reentry vehicles (MIRVs) on its new road mobile DF-31s and DF-31As or the JL-2 in order to defeat potential missile defences. However, China's limited nuclear test data indicate China would not be able to design sufficiently smaller warheads for MIRVing those missiles.⁵² While China is reportedly able to MIRV its older, liquid-fueled DF-5A ICBMs,⁵³ China does not do it yet. Responding to a limited US missile defence system, China may prefer to take sim-

pler ways including decoys and missile defence countermeasures. As those DF-5A ICBMs are phased out, if China wants to have the option to MIRV its new mobile DF-31s and DF-31As, it would meet the technical constraints imposed by the CTBT.

It should be noted that MIRVing those land-based ICBMs may be not consistent with China's long-held campaign for no-first-use, because MIRVs are more appropriate for first-use nuclear attacks. However, the further development of US missile defences could push China to consider the option to MIRV its SLMBs. Once again, it will be constrained by CTBT.

Fissile material cut-off treaty (FMCT)

In its recent White Paper, China's government indicated its supported for "the early commencement of negotiations on the Fissile Material Cut-off Treaty (FMCT) at the Conference on Disarmament (CD)"⁵⁴

However, US development of missile defence will affect China's willingness to participate in FMCT negotiations. Indeed, due to its concerns about US missile defence and potential space weaponization technology, China strongly indicated its preference to simultaneously address both the FMCT and the prevention of an arms race in outer space (PAROS) during the early 2000s. In recent years, China's position has not demanded simultaneous negotiations, though it continues to promote, with Russia, a draft treaty on preventing space weaponization.

If Beijing remains concerned about US missile defence, it might decide to build more ICBMs, which would mean it would need more plutonium and HEU to fuel those weapons. A calculation of this measure would undermine possible Chinese support for FMCT negotiations.

China currently has a military inventory of about 1.8 tons of plutonium and 16 tons of weapon-grade HEU. It would not support an arsenal of more than 1000 warheads.⁵⁵ In practice, part of the fissile material stocks would be used as a reserve for future needs. The other four of the five NPT-recognized nuclear weapon states devote half or less of their fissile materials to their weapons. If this were the case for China, the upper-boundary on its arsenal would be around 500 warheads. It should be noted that a recent study by Georgetown Professor Phillip Karber suggests China could have 3000 nuclear weapons based on assumptions that more underground tunnels means holding more missiles and more nuclear weapons.⁵⁶ Obviously, China's inventory of fissile materials is not able to fuel such a huge arsenal.

China's current fissile materials will likely provide a sufficient amount for its current modernization plans. However, as the United States expands its missile defence system, China may seek to produce more fissile materials, possibly going as far as to refuse to negotiate and/or ratify an FMCT.

Nuclear disarmament

China's official policy has always called for "the complete prohibition and thorough destruction of nuclear weapons," as stated in its recent Defense White Paper.⁵⁷ Furthermore, the White Paper emphasizes that in order to "attain the ultimate goal of complete and thorough nuclear disarmament, the international community should develop, at an appropriate time, a viable, long-term plan with different phases, including the conclusion of a convention on the complete prohibition of nuclear weapons." China is the only country among the five NPT nuclear weapon states to support on paper a nuclear weapons convention (NWC). China is also the only of these states to vote in favour of the annual UN General Assembly resolution "Follow-up to the advisory opinion of the International Court of Justice on the Legality of the Threat or Use of Nuclear Weapons," which underlines "the unanimous conclusion of the International Court of Justice that there exists an obligation to pursue in good faith and bring to a conclusion negotiations leading to nuclear disarmament in all its aspects under strict and effective international control," and calls for the negotiation of an NWC.

However, China maintains that "countries possessing the largest nuclear arsenals bear special and primary responsibility for nuclear disarmament" and thus they "should further drastically reduce their nuclear arsenals in a verifiable, irreversible and legally-binding manner, so as to create the necessary conditions for the complete elimination of nuclear weapons."

Before "the complete prohibition and thorough destruction of nuclear weapons," China will continue to modernize its nuclear force in order to assure a "limited, reliable and effective second-strike nuclear capability for deterring a first nuclear strike." However, if Washington and Moscow move forward to a deeper cut of their nuclear force, China will have to reassure both capitals that it will cap its arsenal at a low level (say 200 warheads).

PUBLIC DISCOURSE AND TRANSPARENCY

While many Western analysts complain that Beijing keeps its nuclear force posture opaque, Beijing believes the transparency of its nuclear strategy and nuclear doctrine is more important than that of the force posture and that the opacity of its force posture can serve to enhance the "deterrence effect" of its small nuclear force. Beijing has not revealed the details of its plans for modernization of its nuclear force; however, China's nuclear modernization programme will likely continue to be guided by its nuclear policy, which is characterized by a no-first-use pledge and a commitment to "minimum nuclear deterrence".

If Beijing develops more confidence about the survivability of its small nuclear force, the govern-

ment might become more open about its nuclear programmes. Increasing transparency and developing relevant and mutual confidence-building measures would certainly contribute to stabilizing the relationship between China and the United States, which is in everyone's interests.

Beijing has made clear its nuclear policies by issuing defence white papers since 1998. However, the Chinese public gets information about its nuclear posture mainly through Western publications.

While some scholars and security analysts in China challenge the government's official nuclear policies, in particular its unconditional no-first-use pledge, there are few civil society groups that engage in critical analysis of China's nuclear weapons policies and programmes.

After US President Barack Obama declared on 5 April 2009 his vision of a nuclear weapon free world in Prague, debates have been stimulated in the Chinese public regarding whether or not China should follow suit. On 23 September 2009, the *Global Times*, an English-language website run by the Communist Party's People's Daily newspaper, conducted an online survey of the internet users. About 51% of respondents agreed to support the call for a nuclear free world, and 49% disagreed.⁵⁸ The supporters believe complete dismantlement of nuclear weapons will eventually benefit China's national interest, while others do not believe so.

The voices against China's nuclear weapon programme have been very weak in China. However, concerns about the safety of nuclear power plants, in particular in the wake of Japan's Fukushima nuclear disaster in March 2011, are increasing along with the emergence of anti-nuclear movement in some local communities within China that host nuclear power reactors, through mainly online anti-nuclear campaigns.⁵⁹

NOTES

1. "China's National Defense in 2010," Information Office of the State Council of the People's Republic of China, March 2011, www.gov.cn/english/official/2011-03/31/content_1835499.htm.
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FRANCE

HANS KRISTENSEN

France spends approximately US\$4.6 billion (€3.5 billion) on its nuclear forces each year. Like several of the other nuclear weapon states, France is in the middle of a broad modernization of its nuclear forces involving submarines, aircraft, missiles, warheads, and production facilities that will continue for another decade.

Having recently completed a reduction of its air-delivered nuclear forces, the indication from public statements and conversations with officials is that France will reject calls for additional nuclear reductions in the near term. Such a rejection is, especially when considered in context with its substantial nuclear modernization, in conflict with France's obligations under the nuclear Non-Proliferation Treaty to pursue additional reductions of nuclear weapons.

STATUS OF FRENCH NUCLEAR FORCES

As of early 2012, France possessed a stockpile of an estimated 300 nuclear warheads. Approximately 290 of these warheads are deployed or operationally available for deployment on short notice. A small number

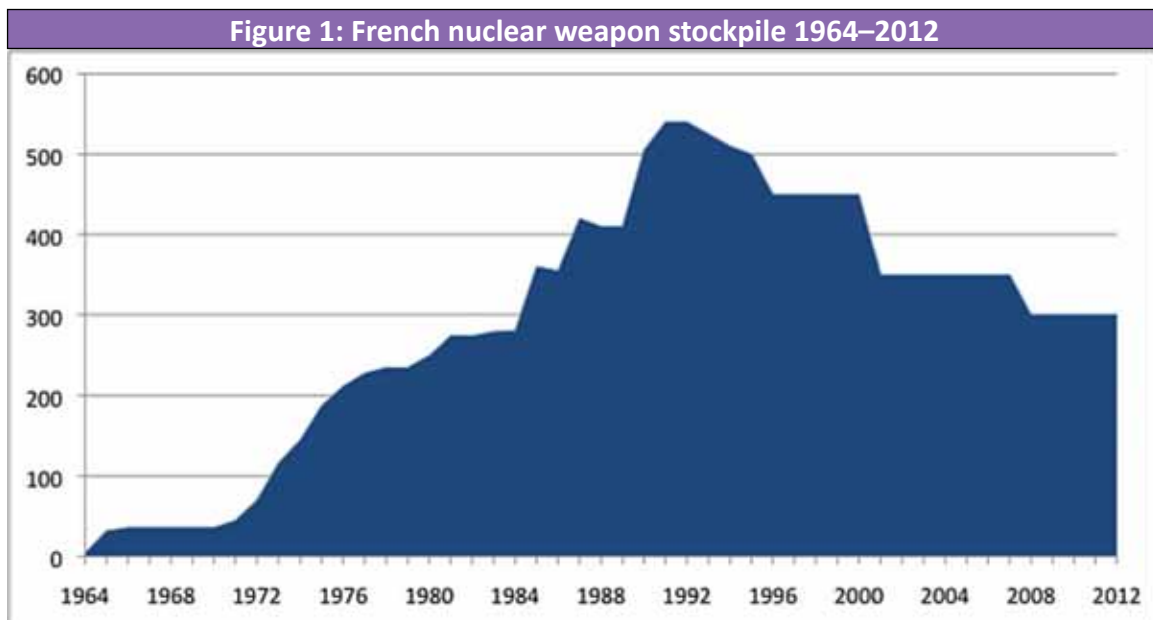
of additional warheads are in maintenance or awaiting dismantlement.

The current forces level is the result of recent adjustments made to the posture following President Nicolas Sarkozy's announcement on 21 March 2008, that the "arsenal" would be reduced to "fewer than 300 warheads" by cutting one of three nuclear bomber squadrons.¹

Sarkozy also declared that France "has no other weapons besides those in the operational stockpile."² The statement was probably intended to signal that France, unlike the United States, does not have a designated reserve of non-deployed warheads that could be uploaded onto delivery systems to increase the size of force if necessary.

It seems likely, however, that in addition to the operational stockpile of warheads deployed on ballistic missiles and in storage facilities with operational forces, a small number of additional warheads are present in the maintenance cycle of the industrial complex either as new warheads, warheads undergoing repairs, or retired warheads awaiting dismantlement.

For example, at the time of Sarkozy's statement in 2008, the new Air-Sol Moyenne Portee Améliorée



The roughly 300 nuclear warheads in the current French nuclear weapons stockpile correspond to about half of the peak stockpile size at the end of the Cold War, and about equal to the stockpile size in 1984.

(ASMPA) cruise missile with the new Tête Nucleaire Aéroportée (TNA) warhead was not yet in the “operational stockpile” even though the warheads had been produced. Since then, the ASMPA has replaced the Air-Sol Moyenne Portee (ASMP), whose TN81 warheads have been retired and are awaiting dismantlement. Likewise, from 2015, the new TNO warhead will begin replacing the TN75 on the M51 submarine-launched ballistic missiles (SLBMs). Production of the Tête Nucleaire Oceanique (TNO) warheads is probably complete but they are not yet in the “operational stockpile.”

The current operational stockpile of nearly 300 warheads, Sarkozy declared, “is half of the maximum number of warheads we had during the Cold War.”³ The peak occurred in 1991–1992 at end of the Cold War, and the size of today’s stockpile is about the same as in 1984 (see Figure 1), although the composition is significantly different.

Delivery systems

France’s nuclear posture is based on two types of delivery vehicles: aircraft and ballistic missiles (see Table 1). France also used to deploy nuclear medium-range ballistic missiles in silos at Plateau d’Albion, but all were deactivated in 1996.

Land-based aircraft

The land-based aircraft are organized under the Strategic Air Forces (Forces Aeriennes Strategiques, or FAS),

which operates two nuclear-capable fighter-bombers: the Mirage 2000N K3 and the Rafale F3. The force is in the middle of a transition from the old Mirage to the new Rafale, which by the end of this decade will completely replace the Mirage in the nuclear strike mission. Approximately 40 aircraft (20 of each type) are thought to be assigned a total of 40 ASMPA cruise missiles.

The Mirage 2000N K3, which first entered operations in 1988, carries two pilots and has an unrefueled combat range of approximately 1480 km. The standard nuclear strike configuration is with the ASMPA on the centerline pylon and two 1700-liter fuel tanks under the wings. The remaining Mirage 2000Ns at Istres will be replaced by the Rafale in 2018.

The two-seater Rafale F3 nuclear version, which first entered service in 2009 at Saint Dizier airbase, has an unrefueled combat range 1850 km. As with the Mirage 2000N, the standard nuclear strike configuration for the Rafale F3 is with the ASMPA on the centerline pylon and two fuel tanks under the wings. Initially projected at 294 aircraft (232 for the Air Force and 60 for the Navy), the Rafale programme has been scaled back to 132 aircraft for the Air Force (and 48 Ms for the Navy).

France operates a fleet of 14 Boeing-produced C-135FR tankers to refuel its nuclear strike aircraft. The tankers are organized under the 0/93 Bretagne squadron at Istres airbase. The C-135FR is schedule to be replaced with a new tanker from 2017, possibly in collaboration with the United Kingdom.

Table 1: French nuclear forces, 2012

Delivery vehicle	No. operational	Year deployed ^a	Range (kilometers) ^b	Warheads x yield (kilotons)	Warheads
<i>Land-based aircraft</i>					
Mirage 2000N/ASMPA	20	1988/2009	2,750	1 TNA x variable to 300	20
Rafale F3/ASMPA	20	2008/2010	2,000	1 TNA x variable to 300	20
<i>Carrier-based aircraft</i>					
Rafale MF3/ASMPA	10	2010/2011	2,000	1 TNA x variable to 300	10
<i>SLBMs^c</i>					
M45	32	1997	5,000+	4-6 TN75 x 100 ^d	160
M51.1	16	2010	6,000+	4-6 TN75 x 100 ^e	80
M51.2	n.a.	2015	6,000+	4-6 TNO x 100	n.a.
Total	98				290^f

^a For aircraft, the first number is for the aircraft, the second is for when the ASMPA became operational with that aircraft.

^b For aircraft the range of the aircraft is listed. The maximum range of the ASMPA is 500 kilometers.

^c Three sets of missiles are deployed on three of four SSBNs in the operational cycle.

^d Compared with its predecessor, the M4, the M45 carries “higher-performance TN75 nuclear warheads (stealthier RV and penetration aids).”⁴

^e The M51, which first became operational on the Terrible in late-2010, has “significantly greater range and payload capacity, as well as greater accuracy”⁵ than the M45 and can potentially carry more than six warheads. Under normal circumstances, however, the M51 probably carries the same number of warheads as the M45 to maximize range. Payloads of individual missiles may vary significantly depending on mission.

^f In addition to the operational stockpile, a small number of additional warheads are thought to be undergoing maintenance or awaiting dismantlement. The TN81 warhead was retired with the ASMP missile in 2010. Moreover, new TNO warheads for the M51.2 are either in production or stored for deployment from 2015.

The ASMPA is a nuclear enhanced medium-range air-to-ground missile with a ramjet engine and a maximum range of 500 km. The missile carries the new TNA warhead with an estimated maximum yield of 300 kilotons, although lower yield options are thought to be available. MBDA Missile Systems states that the TNA is a “medium energy thermonuclear charge, a concept validated during the last nuclear testing campaign [in 1995-1996]. Simulators have proven its effective operation.”⁶ Although validated by live nuclear tests, the French Ministry of Defence states that the TNA is the only nuclear warhead that has been designed and certified by simulation rather than nuclear tests.⁷

Following initial design development in 1997, the ASMPA production contract was awarded in 2000 to Aerospatiale Matra Missiles at a value of more than five billion French Francs (~US\$1 billion).⁸ Aerospatiale Matra Missiles later merged with other companies to form the MDBA, the current producer of ASMPA. The ASMPA programme cost \$146 million (€110 million) in 2011, with another \$68 million (€51 million) budgeted for 2012 as the programme is nearing completion.⁹

The ASMPA first became operational on 1 October 2009, on the Mirage 2000Ns of the 3/4 “Limousin” Fighter Squadron at Istres airbase in southern France. The ASMPA was declared operational on the Rafale F3s of the 1/91 “Gascogne” Fighter Squadron during a ceremony at Saint-Dizier airbase (Air Base 113) on 1 July 2010. Production and delivery of the ASMPA and its TNA warhead was completed in 2011.

Following the announcement by President Sarkozy in 2008 that the air-based nuclear posture would be reduced by one-third, the Strategic Air Force has been significantly reorganized in recent years. Of the three nuclear fighter-bomber squadrons that existed in 2008, two have been disbanded, one transferred, and an ear-

lier disbanded squadron has been re-established at a new location. Of the two squadrons previously based at Luxeuil airbase, one (1/4 Dauphine) was disbanded in 2010 and the other (2/4 La Fayette) was moved to Istres airbase where it replaced the 3/4 Limousin squadron in 2011. Two squadrons now remain: the 2/4 “La Fayette” squadron at Istres airbase near Marseille and the 1/91 “Gascogne” squadron at Saint Dizier airbase east of Paris (see Table 2).

Apart from the decision to reduce the nuclear posture, the reorganization also reflects modernization of the remaining aircraft and weapons. In the nuclear mission, the Rafale is gradually replacing the Mirage 2000N, and the ASMP cruise missile that first entered service in 1988 has been replaced by the ASMPA.

Along with reorganization and modernization of the aircraft and their weapons, the nuclear custodial units have also been reorganized. The nuclear weapons custodial unit at Istres has been converted to ASMPA, and the nuclear weapons unit at Luxeuil has been disbanded. The nuclear weapons custodial unit at Saint Dizier that previously provided ASMP support to one of the two nuclear squadrons that used to be at Luxeuil, has now been converted to ASMPA to support the new 1/91 Gascogne squadron at Saint Dizier.

The airbase at Avord (BA 702) continues to provide nuclear support to the fighter squadrons. The base has a nuclear weapons storage area managed by a nuclear weapons custodial unit and recently converted to the new ASMPA missile.

Sea-based aircraft

The aircraft carrier Charles de Gaulle (R91) is equipped to carry ASMPA cruise missiles for delivery by Rafale MF3 fighter-bombers organized under the 12F squadron.

Table 2: French strategic air force nuclear reorganization

Base	2008	2012
Avord (BA 702)	14.004 DAMS	91.532 DAMS
Istres (BA 125)	3/4 Limousin Sq Mirage 2000N K3/ASMP 11.004 DAMS	2/4 La Fayette Sq Mirage 2000N K3/ASMPA 11.004 DAMS
Luxeuil (BA 116)	1/4 Dauphine Sq Mirage 2000N K3/ASMP 2/4 La Fayette Sq Mirage 2000N K3/ASMP 13.004 DAMS	No nuclear units but serves as dispersal base
Saint Dizier (BA 113)	18.004 DAMS*	1/91 Gascogne Sq Rafale F3/ASMPA 18.004 DAMS

Key: ASMP = Air-Sol Moyenne Portee; ASMPA = Air-Sol Moyenne Portee Améliorée; BA = Base Aériennes; DAMS = Dépôt Atelier de Munitions Spéciales (special weapons depot); Sq = Squadron. * Provided ASMP support to the 1/4 Dauphine squadron at Luxeuil.

This mission was previously performed by the Super Étandard, but the Rafale MF3 has taken over this mission and the Super Étandard is scheduled to be retired in 2015–2017. When not deployed on the carrier, the air wing is based at Landivisau in northern France.

When deployed, the Charles de Gaulle does not carry nuclear weapons under normal circumstances. Its complement of ASMPA missiles is probably stored at one of the airbases, probably Istres. Management of the ASMPA cruise missile for the Rafale MF3 on the Charles de Gaulle carrier is supported by centre d'expérimentations pratiques et de réception de l'aéronautique navale (center for practical experiments and integration of naval aviation, CEPA/10S) at Istres airbase (AB 125).

Sea-launched ballistic missile submarines

France operates four Triomphant-class nuclear-powered ballistic missile submarines (SSBNs) equipped with nuclear-armed long-range ballistic missiles (SLBMs). The fleet, which is known as the FOST (La Force Océanique Stratégique), is based at the Ile Longue peninsula near Brest.

range and payload capacity, as well as greater accuracy.¹³ Increasing warhead load makes little sense today so the M51 probably carries the same number of warheads as its predecessor to maximize countermeasures and range.¹⁴

Conversion of the remaining three SSBNs to the M51 will happen during their normal maintenance and refueling cycles. The contract for the second (*Vigilant*) was awarded in 2010, and third conversions (*Triumphant*) will be signed in 2012. The final conversion (*Téméraire*) contract is planned in 2015 for completion in 2018.¹⁵ A total of \$248 million (€187 million) was spent on M51 conversion in 2011, and another \$278 million (€210 million) is budgeted for 2012.¹⁶

From 2015, apparently beginning with the *Vigilant*, the M51.1 will be replaced with a modified version, the M51.2, which will carry a new warhead known as the TNO (Tête Nucléaire Océanique).¹⁷ The development contract was awarded to EADS Astrium Space Transportation in the third quarter of 2010.

Operation of the SSBN force reportedly costs more than \$2 billion (€1.5 billion) per year,¹⁸ and a French audit report in 2010 found that the unit cost of the SSBNs had increased by more than 50 percent.¹⁹

Table 3: French SSBN missile and warhead modernization

SSBN Name	2008	2015	2018
Le Triomphant	M45/TN75	M51.1/TN75	M51.2/TNO
Le Téméraire	M45/TN75	M51.1/TN75	M51.2/TNO
Le Vigilant	M45/TN75	M51.2/TNO	M51.2/TNO
Le Terrible	M45/TN75	M51.1/TN75*	M51.2/TNO

Of the four SSBNs, at least two are always fully operational, one of them at sea on “deterrent patrol”. A deterrent patrol reportedly lasts about 10 weeks.¹⁰

Ballistic missiles for non-operational submarines are stored at the Ile Longue base in unique silos, and the warheads are at the weapons storage facility near Saint-Jean, approximately 4 kms south of the Ile Longue.

The French SSBN force is in the middle of an upgrade from the M45 to the M51 missile. Currently, three of the four SSBNs are equipped to carry the M45, while the fourth submarine (*Terrible*) became operational with the M51 in late 2010.

The M45 entered service in 1997, has a range of more than 5000 km and can carry up to six TN75 thermo-nuclear warheads. The TN75 was proof tested during France’s final nuclear test series at Mururoa in 1995–1996.

The current version of the M51 is known as M51.1. The production contract was awarded to EADS Astrium SPACE Transportation in 2004 at a price of \$3 billion (€3 billion).¹¹ Production of the M51.1 cost \$821 million (€620 million) in 2011 and another \$857 million (€647 million) is budgeted for 2012.¹²

The M51.1 carries the same warhead (TN75) as the M45, but the M51.1 reportedly has “significantly greater

Although not nuclear-armed themselves, Rubin-class nuclear-powered attack submarines play an important part in the nuclear mission by providing protection to SSBNs deploying on patrol.²⁰ The Rubin-class will be replaced by the Barracuda-class starting in 2016.

Fissile materials

France is no longer thought to be producing fissile materials for nuclear weapons. Large quantities produced during the Cold War are more than sufficient for the current warhead level. Plutonium production at the Marcoule facility ceased in 1992 with an estimated six tons remaining. HEU production ended in 1996 with an estimated 26 tons remaining, and the HEU production plant at Pierrelatte has been dismantled.²¹

THE NUCLEAR WEAPONS COMPLEX

France’s nuclear weapons complex is managed by the DAM (Direction des Applications Militaires), a department within the Nuclear Energy Commission (Le Commissariat à L’énergie Atomique et aux Énergies Renouvelables, CEA). DAM is responsible for research,

Table 4: French Nuclear Weapons Complex		
Name of Facility	Location (coordinates)	Role
Centre d'Etudes de Valduc (CEA Valduc)	Burgundy (47°34'37.02"N, 4°52'6.79"E)	Warhead production and dismantlement. Hydrodynamic test center added from 2014.
DAM-Ile-de-France (CEA Bruyères-le-Châtel)	Ile-de-France (48°35'40.53"N, 2°12'0.30"E)	Warhead design research and computer simulation.
Centre d'Etudes de Ripault (CEA Ripault)	Centre (47°17'26.05"N, 0°40'13.66"E)	Research and production of non-nuclear components, including high explosives.
Centre d'Études Scientifiques et Techniques d'Aquitaine (CESTA)	Aquitaine (44°38'46.70"N, 0°47'42.20"W)	Design of equipment for nuclear weapons, reentry vehicles, and coordinates the development of nuclear warheads. The site is the location of the Mejoule facility designed to study the fusion process of secondaries.
Centre d'Etudes de Vaujour-Moronvilliers (CEA Moronvilliers)	Champagne-Ardenne (49°14'5.32"N, 4°19'16.88"E)	Airix x-ray machine used to study hydrodynamic behavior of pre-fission implosion of primary. Airix being moved to Valduc.
Centre d'études de Gramat (CEA Gramat)	Midi-Pyrénées (44°44'23.44"N, 1°44'3.05"E)	National center for studying vulnerability of nuclear weapons systems to nuclear effects.

design, manufacture, operational maintenance, and dismantlement of nuclear warheads. Of CEA's 15,000 employees, more than 4,700 are working for the DAM. In 2010, the DAM received €1.7 billion of the €4.2 billion allocated to CEA.

Following the decision to end nuclear testing in 1996, France has reorganized its nuclear weapons centers. Today, DAM operates six sites (see Table 4).

Warhead design and simulation of nuclear warheads take place at the DAM-Ile-de-France (Bruyères-le-Châtel) Centre approximately 30 kilometers south of Paris. The centre houses Tera 100, a super computer that went into operation in July 2010. The previous generation super computer, Tera 10, is also located at the centre, which employs about half of the people affiliated with the military section (DAM) of the CEA.

The Valduc Center (Centre d'Etudes de Valduc, or CEA Valduc) is responsible for nuclear warhead production, maintenance, and dismantlement. It is located approximately 30 kilometers northwest of Dijon and is undergoing expansion to accommodate new facilities resulting from the 2010 French-British defence treaty. The AIRIX x-ray radiography facility is being moved to Valduc from the Moronvilliers center to become operational in 2014. A second radiography facility will be added by 2019, and a third by 2022 to form the Epure facility.

The CESTA (Centre d'Études Scientifiques et Techniques d'Aquitaine) near Le Barp is responsible for the design of equipment for nuclear weapons, reentry, and coordinates the development of nuclear warheads. The site is also the location of the new Megajoule laser, France's equivalent of the US National Ignition Facility. Construction of Megajoule, which will study the thermonuclear process in warhead secondaries, began in 2005 and will be completed in 2014. A smaller Laser Integration Line (LIL) laser has been operating at CESTA since 2002 to validate the Megajoule design. The Megajoule reportedly costs €3 billion.²² CESTA was established in 1965 and employs 970 people.

The Vaujour-Moronvilliers Centre 60 kilometers east of Reims includes the Airix x-ray pulse machine established in 2000 to study the pre-fission hydrodynamic behavior of imploding high explosives in a nuclear warhead primary. The results are used to validate warhead simulation computer codes. Airix will be dismantled and re-established at Valduc in 2014.

The Gramat Centre (Centre d'études de Gramat) is responsible for hardening nuclear weapons against radiation. The centre was transferred to the CEA in 2010.

Combined, warhead simulation costs accounted for approximately \$831 million (€627 million) in 2011 with another \$857 million (€647 million) budgeted for 2012.²³

NAVAL NUCLEAR PROPULSION

In addition to nuclear weapons production, France spends considerable resources on building nuclear propulsion for naval vessels that carry the nuclear weapons. France currently has 11 nuclear-powered naval vessels in operation: four Triumphant-class ballistic missile submarines, six Rubis-class attack submarines, and one Charles de Gaulle-class aircraft carrier. Although nuclear-powered attack submarines are not nuclear-armed, they play an important role in the nuclear posture by protecting SSBNs on patrol.

Construction of a replacement for the Rubin-class is underway, known as the Barracuda-class, at a price of more than €8.6 billion with the first unit expected in 2017.²⁴

Construction of nuclear-powered vessels happens at the naval shipyard in Cherbourg on the English Channel. Development and testing of the nuclear reactors takes place at CEA Cadarache center north of Toulon. Production of the reactors happens near Nantes at the naval propulsion factory of DCNS (Direction des Constructions Navales), the manager of the naval shipyard at Cherbourg. Refueling of the nuclear-powered vessels takes place at the naval shipyard in Toulon. The fuel-life of French naval reactor cores is probably 6-8 years.

POLITICAL ECONOMY, INTERNATIONAL LAW, AND PUBLIC DISCOURSE

Assessing the total cost of French nuclear forces is difficult. There is no detailed official public budget and reports vary depending on sources and cost categories counted. But two sources in 2011 reach comparable estimates. A study by Global Zero set the number at approximately \$6 billion (€4.1 billion) in 2011, of which some \$4.7 billion (€3.2 billion) were so-called core costs from 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.²⁵ In comparison, a report from the French Parliament's defence committee sets the appropriated "deterrence" cost at \$4.6 billion (€3.5 billion).²⁶

The government announced in November 2011 that the deficit would have to be cut by 20 percent in 2012 with half of the savings coming from spending cuts.²⁷ Yet the defence committee report indicated that the nuclear weapons budget will only see a 1.3 percent decrease in appropriations, from \$4.6 billion (€3.5 billion) in 2011 to \$4.5 billion (€3.4 billion) in 2012.²⁸

Although there is some debate in France over the

composition and cost of the nuclear forces, it is not a very prominent debate. Moreover, the French government has strongly opposed ideas for additional reductions in its nuclear forces—neither unilaterally nor as part of a potential NATO decision to reduce its nuclear forces in Europe. The condition in the NATO Lisbon Summit declaration that the Defence and Deterrence Posture Review would only examine the contribution of nuclear forces assigned to NATO apparently was in-

THE FRENCH GOVERNMENT HAS STRONGLY OPPOSED IDEAS FOR ADDITIONAL REDUCTIONS IN ITS NUCLEAR FORCES—NEITHER UNILATERALLY NOR AS PART OF A POTENTIAL NATO DECISION TO REDUCE ITS NUCLEAR FORCES IN EUROPE.

cluded in the text at the insistence of the French government.²⁹ Although the French government will insist that its recent reduction of the land-based air-delivered nuclear force is consistent with France's obligations under article VI of the nuclear Non-Proliferation Treaty to pursue nuclear reductions, its rejection of additional reductions and its ongoing modernization if its nuclear forces might be seen as being out of sync with those obligations.

Given this situation, and that the budgetary pressure on the defence budget is likely to continue in the foreseeable future, one option for additional reductions in France's nuclear forces might be to consider retiring the ASMPA nuclear cruise missile. The United Kingdom has already made such a transition by retiring its air-delivered nuclear weapons, and for France to terminate its land-based nuclear capability would not only save money but also free the bomber squadrons from the additional burden of maintaining nuclear proficiency and instead focus on their conventional mission.

Pressure is building for Russia and the United States to reduce their non-strategic nuclear forces in Europe, and although the French government calls its air-delivered weapons *strategic*, the short range ASMPA is of course just as tactical as a Russian AS-4 cruise missile on a Tu-22M3 Backfire bomber or an American B61 bomb on an F-16 fighter-bomber. A French decision to retire the ASMPA would place France on the forefront of the nuclear agenda in Europe and increase the pressure on Russia and the United States to reduce their short-range nuclear weapon systems.

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INDIA

M.V. RAMANA

Ever since the 1998 nuclear tests, and indeed even well prior to that, India has been in the process of “modernizing” its nuclear arsenal, and more generally its military capabilities. The main focus of modernization in terms of its nuclear arsenal has been on increasing the diversity, range and sophistication of ways of delivering weapons. There has also been a wide ranging research effort that the government has sought to keep unconstrained.¹ Though we do not explore the subject here in any detail, over the last decade, there has been a growing ballistic missile defence program that seeks to deploy a multi-layered system to intercept incoming attacks.

Much of the information in this chapter is based on independent estimates. There is little information available from India’s government on most nuclear weapon matters except at the most general level. The one exception is in the case of ballistic missiles, where every (successful) test launch is much lauded as a mark of the country’s prowess in destructive ability, with statements extolling the multiple characteristics of the missile, such as its accuracy, range, and the payload it can carry.

STATUS OF INDIA’S NUCLEAR FORCES

India’s nuclear weapons programme first became public knowledge in 1974 when it conducted a nuclear weapon test at the Pokharan site, not far from the border with Pakistan. It followed this test 24 years later in May 1998 with five nuclear explosions again at Pokharan, albeit with planned attempts in the early 1980s and 1995 to conduct nuclear tests.² Much of what is known about the designs of the nuclear weapons in India’s arsenal comes from official statements in the immediate aftermath of the 1998 tests.

An official press release from 17 May 1998 put out by the Department of Atomic Energy (DAE) and the Defence Research and Development Organization (DRDO) stated that the nuclear establishment had carried out “design and development of various kinds of nuclear explosives, e.g. fission, boosted fission, thermonuclear and low yield” and tried to ensure “long shelf life of device components and optimisation of the yield-to-weight ratio.”³ In other words, officially, there were four different designs tested: a regular fission design, a thermonuclear (hydrogen bomb) design,

a boosted fission design that served as the primary explosive to produce the radiation that compresses the secondary (fusion) part of the two-stage thermonuclear weapon, and a design that produces a relatively low explosive yield. In practice, however, it is likely that only one or two of these have been incorporated as weapons in the arsenal. Various heads of the DAE have maintained that the 1998 tests have given India “the capability to build fission and thermonuclear weapons with yields up to 200 kt.”⁴

The most likely design to have been weaponized is the fission one, which was a more sophisticated and light-weight version of the design tested in 1974. Indeed, in a subsequent public talk in New Delhi in 2000, then Indian Atomic Energy Commission (AEC) chairman R. Chidambaram said, “The 15 kiloton device was a weapon which had been in the stockpile for several years.”⁵ He termed the others “weaponisable configurations” which had to be “converted into a weapon”. There is no official confirmation of whether this conversion has subsequently occurred, though one expects, going by past history,⁶ that the teams of scientists and engineers involved in designing the Pokharan explosions have been working on this and related tasks.⁷

The 17 May 1998 press release also declared that the three “tests conducted on 11 May, 1998 were with a fission device with a yield of about 12 kT, a thermonuclear device with a yield of about 43 kT and a sub-kilo ton device.”⁸ These yield estimates have been contested; based on seismic signals detected around the world, international seismologists suggested that the total yield was only 16–30 kilotons.⁹ Scientists and engineers from the DAE published a number of papers arguing for their version of the yields.¹⁰ Though there was no real resolution of this debate over the success of the tests, it seemed likely that some of the designs may not have worked.

Further evidence for the failure of one of the designs came in 2009 when one of the senior members of the DRDO, K. Santhanam, revealed that the yield of the “thermonuclear device test was much lower than what was claimed” so as to offer a reason for asserting “that India should not rush into signing the CTBT [Comprehensive Test Ban Treaty].”¹¹ Eager to establish their credibility, the former and current heads of the DAE argued that Santhanam’s analysis and the “doubts” he had expressed about the 1998 tests had “no scientific basis.”¹²

But their arguments were essentially a reiteration of their earlier claims with no new data offered in support.

There is also considerable uncertainty about the low yield devices tested in 1998. First, seismic evidence suggests that these did not explode with the claimed yields.¹³ Again, DAE scientists tried to contest this by publishing papers, but these suffered from serious scientific flaws and were hardly convincing.¹⁴ Second, and perhaps more important, is the question of whether Indian nuclear planners envision developing and deploying tactical nuclear weapons with low yield. Officially, the low-yield devices that were tested in 1998 had “all the features needed for integration with delivery vehicles” and were for “developing low-yield weapons and of validating new weapon-related ideas and subsystems.”¹⁵ However, there is little evidence of India including, or desiring to include, tactical weapons with low-yield in its nuclear arsenal.¹⁶ Indeed, strategic analysts have argued that the “Indian nuclear arsenal does not need tactical nuclear weapons—and never will.”¹⁷

Another possibility that was suggested by some analysts was that this involved the use of reactor-grade plutonium. The implications of this possibility are discussed below.

Finally, the 17 May 1998 press release also declared that the tests “significantly enhanced our capability in computer simulations of new designs and taken us to the stage of sub-critical experiments in the future, if considered necessary.”¹⁸ In 2009, DAE leaders again reiterated that there was “no need for so many tests” because of the increase in scientific knowledge and advancements in computer technology.¹⁹ Regardless of the veracity of these claims, the statement implies the desire, if not the actual ability, for using computer-based capabilities for refinements in weapons design.

Delivery systems

The primary focus of efforts at furthering India’s nuclear arsenal has been on developing delivery vehicles for the weapons designed and tested by DAE. In fact, because there is so little public discussion on the nuclear weapons themselves, the frequent testing of a diverse array of ballistic missiles, of increasingly longer range, is the most visible reminder of India’s growing nuclear capability. India has also developed or otherwise acquired components of an early warning system and an anti-ballistic missile (ABM) defence system.²⁰

Dating back to 2003, India’s official nuclear doctrine is very brief and gives little detail on what it envisions for its nuclear arsenal.²¹ However, a few years earlier, the National Security Advisory Board released a draft report on a nuclear doctrine (DND) for India that is far more detailed.²² Even though this document does not have official stature, the subsequent development of India’s nuclear arsenal has followed the broad lin-

eaments laid out in the DND. The DND calls for India’s nuclear forces to be deployed on a triad of delivery vehicles of “aircraft, mobile land-based missiles and sea-based assets” that are structured for “punitive retaliation” so as to “inflict damage unacceptable to the aggressor”. This triad now comprises land-based mis-

THE MAIN FOCUS OF MODERNIZATION IN TERMS OF ITS NUCLEAR ARSENAL HAS BEEN ON INCREASING THE DIVERSITY, RANGE AND SOPHISTICATION OF WAYS OF DELIVERING WEAPONS.

siles and missiles that can be fired from sea, including from submarines, and aircraft capable of carrying and dropping nuclear bombs.

The main land based nuclear delivery system is the Agni series of missiles. Work on the Agni started as part of the Integrated Guided Missile Development Programme in 1983, but the missile has been substantially redesigned since the 1998 nuclear tests.²³ The most recent of the series, tested successfully in November 2011, is the 3500 kilometer (km) range, two-stage Agni-4 missile that is capable of carrying a payload of 1000 kg, sufficient for a nuclear warhead.²⁴ The Agni-3 also had a range of 3500 km and was tested in June 2006, April 2007, May 2008, and February 2010.²⁵ The Agni-2 missile with a range of 2000 to 2500 km has been flight-tested a number of times, the most recent of which was in October 2011.²⁶ Likewise, the 700 km range Agni-I has been tested several times, most recently in December 2011.²⁷ Finally, with a much smaller range of 150 km is the nuclear-capable Prithvi-1 missile, which has also been tested numerous times. Defence officials and media commentators routinely describe other missiles such as the Prithvi-2 and Prithvi-3 (Dhanush) as nuclear-capable,²⁸ but it is not clear if these are really intended as nuclear delivery vehicles.

The Prithvi-I, Agni-1, and Agni-2 have been inducted into the military.²⁹ The International Institute for Strategic Studies estimates that the military possesses about 80 to 100 Agni-1 missiles and 20–25 Agni-2 missiles, and up to about 20 Prithvi-1 missiles.³⁰ These numbers are much higher than the estimates for nuclear warheads because all of these are intended as capable of carrying both conventional and nuclear payloads.

Though it is clear that the Indian Air Force does have aircraft that it plans to use in nuclear strike missions, there is some dispute over which aircraft it would use. For example, the 2010 Nuclear Notebook of the *Bulletin of the Atomic Scientists* lists the Mirage 2000-H, the Jaguar IS/IB, and possibly the MIG-27 as likely contenders.³¹ Many media commentators mention the Russian Sukhoi-30 MKI planes as one that can be rigged to carry nuclear weapons.³² US strategic analyst Ashley Tellis, on the other hand, has argued that the Russian airplanes may not be well suited to the nuclear delivery role and has suggested that the Jaguar and the

Mirage 2000 are the most likely aircraft to be used to drop nuclear weapons.³³

The Navy's part of the triad revolves around the nuclear submarine that India has been developing for over three decades, reportedly with some limited Russian help.³⁴ By the late 1990s, a design for the reactor of this submarine was finalized. Testing of a prototype reactor commenced at Kalpakkam in southern India somewhere around 2000–2001.³⁵ The submarine, named Arihant, was launched in 2009.³⁶ A second nuclear submarine named Aridaman is reportedly under construction and construction of a third, as yet unnamed, submarine is in the early stages.³⁷

In December 2010, the Chief of the Navy stated that India would soon have an operational triad of aircraft, land-based missiles, and (nuclear-powered) submarine-launched missiles for delivery of nuclear warheads, and offered late-2011 or early-2012 as the date for operationalization of the Arihant.³⁸ However, in January 2012, it was reported that the submarine is going to undergo the crucial sea acceptance trials in February of the year to be followed by weapon trials and that the submarine will likely be formally inducted into the Navy "hopefully in 2013".³⁹

In addition to the domestic submarine, the Indian Navy has also leased a Nerpa class nuclear submarine from Russia so as to gain experience in operating such platforms.⁴⁰ The lease is for a period of ten years and the contract is said to be worth over \$900 million.⁴¹ The leased submarine is expected to be armed with 300 km range cruise missiles with conventional warheads but the Navy will use it "to train its sailors in the complex art of operating nuclear submarines".⁴²

The Arihant is likely to use the Sagarika, also called the K-15, with a range of 700 km as the submarine-launched ballistic missile to deliver nuclear weapons. The first four launches of the Sagarika were kept a secret; only the successful fifth test in February 2008 was publicly announced.⁴³ A subsequent test was carried out in November 2009.

There are also plans to modernize or otherwise further advance delivery systems. The two main foci are the development and deployment of longer range missiles and fully inducting the nuclear submarine into active service. As mentioned earlier, the nuclear submarine is expected to be operationalized shortly. The head of the DRDO, V. K. Saraswat, announced in February 2010 that India would conduct a test of a 5000 km Agni-5 missile "within a year".⁴⁴ In May 2011, it was reported that Prime Minister Manmohan Singh took stock of the country's nuclear arsenal, with discussions focusing on the status of the 5000 km range Agni-5 missile that is under development, and the Arihant submarine.⁴⁵

Fissile materials

There are no official estimates of the size of India's stockpile of fissile materials; unofficial estimates have

considerable uncertainties. It is known though that India produces both highly enriched uranium (HEU) and weapon-grade plutonium. The HEU is believed to be of an enrichment level that is considerably lower than the level used in weapons deployed by countries like Russia and the United States and intended only to fuel the nuclear submarine fleet that India is building. For use in the explosive cores of nuclear weapons, India chose early on to use plutonium because HEU was believed to be more expensive and difficult to produce.

India has historically produced weapon-grade plutonium at its two production reactors, CIRUS and Dhruva, both at the Bhabha Atomic Research Centre (BARC), in Mumbai.⁴⁶ BARC is the primary location where most of the nuclear weapons work in the country is carried out. Besides the reactors, the Trombay reprocessing plant, where plutonium is extracted from the spent fuel generated by these production reactors, is also located in BARC.⁴⁷ Metallurgical activities involving plutonium are also carried out in the same complex.⁴⁸

Of the production reactors at BARC, the 40 MWt CIRUS reactor, which began operating in 1963, was shut down in December 2010. On the basis of assumed capacity factors, India is estimated to have a stockpile as of the end of 2011 of weapon-grade plutonium of 0.52 ± 0.17 tons.⁴⁹ Of this, about 0.09 tons may have been consumed in nuclear weapons tests and in the first core of the Fast Breeder Test Reactor. The remaining stockpile of weapon-grade plutonium should suffice to produce about 90 warheads.

There is also the possibility of using reactor-grade plutonium to make nuclear weapons. While there is no official confirmation of this possibility, there has been ample speculation that one of the devices tested in 1998 used reactor-grade plutonium.⁵⁰ If this is the case, then the nuclear arsenal could potentially be much larger. The estimated stockpile of separated plutonium from power reactors is 3.8 to 4.6 tons.⁵¹ Assuming that about 8 kilograms of the material is required for a weapon, this stockpile could be used to make 475 to 575 weapons.

Officially, however, this stockpile of reactor-grade plutonium is intended for use as fuel for India's planned fast breeder reactor programme.⁵² The official Indian doctrine calls for a "credible minimum deterrent" and although there has always been deliberate official ambiguity about what minimum means, the doctrine is usually interpreted as not calling for a very large arsenal, certainly not in the range of 500 weapons. There is thus no strong reason to assume that the reactor-grade plutonium will be used to make weapons. At the same time, this stockpile has been a reason for Pakistan to maintain that it needs to expand its fissile material stockpile significantly and block progress on the fissile material cut-off treaty at the Conference on Disarmament.⁵³

The fast breeder programme, however, provides another potential source of producing weapon-grade plutonium. During the negotiations and public debates surrounding the nuclear deal that was negotiated with the United States, however, the DAE strenuously kept the Prototype Fast Breeder Reactor (PFBR) being constructed at Kalpakkam in southern India as well as eight other electricity production reactors outside of international safeguards. The PFBR can produce about 144 kilograms (kg) of weapon-grade plutonium every year if it operates at 75% efficiency.⁵⁴ This is sufficient for fabricating nearly 30 weapons every year and would represent a major increase in weapons production capacity.

THE PURPOSE OF [THE US-INDIA DEAL] WAS MADE CLEAR BY A US OFFICIAL WHO SAID THE UNITED STATES' GOAL IS TO HELP INDIA BECOME A MAJOR WORLD POWER IN THE 21ST CENTURY... WE UNDERSTAND FULLY THE IMPLICATIONS, INCLUDING MILITARY IMPLICATIONS, OF THAT STATEMENT.⁶⁹

India has also produced HEU to fuel its nuclear submarine propulsion program at its Rare Materials Plant in Rattehalli, Mysore (Karnataka). The HEU is said to be between 30 and 45% of uranium-235, much less than weapon-grade. Assuming an enrichment level of 30%, India is estimated to have had a stockpile of 2.0 ± 0.8 tons of highly enriched uranium as of the end of 2011.⁵⁵

There are at least some publicly known bases for estimating stockpiles of fissile materials. These include characteristics such as power levels of nuclear reactors and procurement records of equipment for making uranium centrifuges.⁵⁶ This estimate provides an upper estimate of the number of weapons that could be manufactured from this stockpile. But there is almost no public information available to make knowledgeable guesses about how much of this stockpile has actually been converted into weapons.

In 2010, the Nuclear Notebook of the *Bulletin of the Atomic Scientists* estimated that India has 60 to 80 assembled nuclear warheads, with only about 50 fully operational.⁵⁷ The 2011 yearbook from the Stockholm International Peace Research Institute estimated that as of January 2011, India had 80–100 nuclear warheads.⁵⁸

THE NUCLEAR WEAPONS COMPLEX

For some time now, there have been plans to expand the nuclear weapons and missile production complex. The nuclear establishment is in the process of building a new complex in the city of Vishakhapatnam, which will be larger than the existing BARC complex. It will host a plutonium production reactor that is to come up in the “2017–18 timeframe”.⁵⁹

The capacity to enrich uranium is also being enhanced. In addition to the existing Rattehalli complex, which is undergoing an expansion, there are also plans

for a second uranium enrichment facility, the “Special Material Enrichment Facility,” in Chitradurga district in Karnataka. According to the Chairman of the Atomic Energy Commission, this facility will not be safeguarded and India is “keeping the option open of using it for multiple roles”.⁶⁰ However, because the existing enrichment capacity is already sufficient for the nuclear submarine fleet that India is building,⁶¹ it is possible that this facility is used to produce low enriched uranium for power reactors.

The missile production complex is also undergoing expansion. The public sector company that manufactures the Agni and Prithvi missiles, in addition to a number of other missiles, is reported to be planning to invest Rs. 40 billion (approximately \$0.8 billion) to open five new manufacturing units.⁶² In 2006–2007, the company first managed to produce 15 Prithvi missiles.⁶³ Currently, the company is believed to produce 20 missiles every year.⁶⁴ Plans to step up production of the Agni ballistic missiles were reportedly “in the pipeline” in 2007.⁶⁵ The increased production rate was partly a result of opening up missile production to the private sector; “The private industry has emerged as a co-developer of the sub-systems of the missiles, which is helping us in cutting down development time,” according to DRDO head Saraswat.⁶⁶

THE ROLE OF THE UNITED STATES

India has relied extensively on other countries to further its modernization programmes. In recent years, its modernization efforts were supported enthusiastically by the United States, especially under President George W. Bush. As part of its effort to contain China, the Bush administration sought to aid Indian capabilities in a variety of ways, especially after the two countries entered into a broad agreement in January 2004. Termed the “Next Steps in Strategic Partnership” (NSSP) initiative, the 2004 agreement stated that the United States would provide India with access to aid, information, and technology [euphemistically termed “increased cooperation”] in civilian nuclear activities, civilian space programmes, and high-technology trade,⁶⁷ as well as on missile defence.⁶⁸ The purpose of this agreement was made clear by a US official who said the United States’ “goal is to help India become a major world power in the 21st century... We understand fully the implications, including military implications, of that statement.”⁶⁹

The most prominent agreement that followed NSSP was what became dubbed the US-India nuclear deal, the effort to get the Nuclear Suppliers Group to waive its usual requirements when exporting nuclear technology to India.⁷⁰ Though ostensibly about civilian

nuclear energy, the debates underlying the US-India nuclear deal were all about whether or not India would gain or lose nuclear weapon capabilities. But gains to India's military capabilities were desirable to the Bush administration. As Ashley Tellis, who was advisor to the US ambassador to India during those years, put it: "If the United States is serious about advancing its geopolitical objectives in Asia, it would almost by definition help New Delhi develop strategic capabilities such that India's nuclear weaponry and associated delivery systems could deter against the growing and utterly more capable nuclear forces Beijing is likely to possess by 2025."⁷¹

The Indian elite largely shares this view of China being a great rival and a competitor not just for the domination of Asia, but also for the increasingly scarce resources, raw materials, and fuels needed to power the rapid economic growth in the two countries. Among the resources that have been often discussed in the media is water.⁷² Competition between the countries over resources has also received some attention from academics.⁷³ Some are concerned that this competition would bring it into conflict with China.⁷⁴

When added to the decades-old border dispute between the two countries, it provides Indian military planners a good justification, at least in the eyes of the elite, for an increased build-up in both conventional and high tech arenas. Typical of this strain of thinking was the 10 August 2009 speech of the outgoing chief of the Indian Navy, who said that

coping with China will certainly be one of our primary challenges in the years ahead.... China's known propensity for 'intervention in space' and 'cyber-warfare' would also be major planning considerations in our strategic and operational thinking.... On the military front, our strategy to deal with China must include reducing the military gap and countering the growing Chinese footprint in the Indian Ocean Region. The traditional or 'attritionist' approach of matching 'Division for Division' must give way to harnessing modern technology for developing high situational awareness and creating a reliable stand-off deterrent.⁷⁵

The effort to bring the United States and India closer militarily has persisted under President Barack Obama as well. As US ambassador to India, Timothy Roemer, noted in a speech in New Delhi in April 2011, "On se-

curity, defense, and intelligence, our cooperation has taken off since the signing of the Counterterrorism Cooperation Initiative, which I signed in July 2010."⁷⁶ Speaking of the sales of C-130 aircraft, Roemer argued that the "sales strengthen the strategic partnership between our two countries, and demonstrate our enduring commitment to sharing the world's best technology with India."⁷⁷

ECONOMICS AND POLITICAL ECONOMY

The expansion of India's nuclear and missile arsenals are part of a larger military build-up since the tests. Contrary to claims by nuclear weapon advocates that building nuclear weapons would reduce conventional military expenditure,⁷⁸ actual figures have been consistently increasing. As a fraction of gross domestic product (GDP), this has ranged from 2.3 to 3 percent, despite the significant increases in GDP that the country has witnessed over the decade.

As a result of the rapid pace of India's military modernization and the inability of the domestic industry to supply the necessary equipment, India was the world's largest recipient of major conventional weapons over the period 2006-10.⁸⁰

Many of these "conventional" weapons are aimed at modernization of military capabilities. This effort has primarily focused on technology,⁸¹ its acquisition and its implementation in military capabilities and planning. The Indian Navy, for example, has been investing in "electronic intelligence" and other electronic warfare systems, seeking to spend half a billion dollars in this effort.⁸²

These expenditures have gone largely unquestioned. There is little public or political debate on defence spending. Indeed it has been observed that in India "the defence budget has at times been approved by Parliament without a debate."⁸³

Historically, the nuclear and defence research establishments, which have been aptly termed a 'Strategic Enclave' by scholar Itty Abraham,⁸⁴ have wielded considerable social, political, and economic power. The enclave has significantly influenced national policy on a variety of issues and greatly shaped the nature of India's nuclear arsenal.⁸⁵

In recent decades, this enclave has been joined by a variety of other players, including government labora-

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Military expenditure (bn Rs)	703	722	774	964	1025	1091	1182	1475	1820	1911
Military expenditure (bn constant 2009 US \$)	22.6	22.5	23.0	26.7	28.2	28.4	28.8	32.1	35.8	34.8

Source: Stockholm International Peace Research Institute⁶⁸

tories, public sector and private companies, and universities, to form burgeoning and powerful military-industrial complex. The Agni-3 project, for example, involved over 250 firms, several research laboratories, and academic institutions.⁸⁶ This practice started in earnest with the establishment of the Integrated Guided Missile Development Program in 1983.⁸⁷ The bulk of the private companies involved seem to be large industrial firms, many of which are multinational, that manufacture multiple products. Prominent examples are Tatas, Godrej, and Larsen & Toubro.⁸⁸ Many of these companies are also involved with the nuclear submarine project as well.⁸⁹ Other large companies are involved in providing ancillary equipment; for example, Agni missiles are transported on trucks made by Ashok Leyland,⁹⁰ one of India's largest commercial vehicle manufacturers. Specialized firms that focus on niche sectors also play a role.

Various government-owned research and development enterprises have also been drawn into contributing to the nuclear arsenal. One of the early contributors was the Department of Space—the missile programme benefitted enormously from technologies developed by it, most prominently solid rocket boosters.⁹¹ More recently, a number of other public sector companies have joined this effort. For example, the public sector company Midhani produces the special tough and light steels used in missiles.⁹²

As the Indian economy expands and trade with various countries around the world increases, buying military technology has also become a major component of the trade balance. The case of the United States has already been described at some length. Russia has been another big source of defence imports and knowledge transfer. India has leased a nuclear powered submarine from Russia and the two countries have embarked on the joint production of a cruise missile called Brahmos. According to the Naval officer who headed the nuclear submarine project, “The Russians arranged to train our officers for operating nuclear submarines and also leased us the Charlie nuclear submarine for practical training and use. But there was no import of technology- only transfer of knowledge.”⁹³

At the ideological level, an important role was performed by a subsection of what is often dubbed the “bomb lobby,” which is comprised of key politicians and bureaucrats, the strategic enclave, and “strategic experts” located mainly in think tanks. The latter two groups provided many of the arguments justifying nuclear weapons and have largely dominated media discussions on nuclear and military issues. Sociologically, these groups can be described as “professionals” who tend to “put meaning in the service of power than to speak truth to power” and have a strong “identification with the apparatuses of the state.”⁹⁴

DISCOURSE

Since 1998, nuclear advocates have been striving to make India's nuclear arsenal seem both a natural acquisition and a source of pride. Perhaps this mixture is best seen in the first full-length official statement after the 1998 tests presented by Prime Minister A. B. Vajpayee to the Indian parliament. Entitled “The Evolution of India's Nuclear Policy,” the paper states that India is a “Nuclear Weapons State” and this status is “India's due” and “the right of one-sixth of humanity.”⁹⁵ Thus, the possession of nuclear weapons is portrayed as giving its possessor a special status, implicitly that of a great power, but that very status is a natural one for India to possess.

Over the years, the idea that India has the right to these weapons, and that it should have ability to possess and make more of these weapons, has become widely shared, across much of the political spectrum. This shared belief was made clear during the course of

OVER THE YEARS, THE IDEA THAT INDIA HAS THE RIGHT TO THESE WEAPONS, AND THAT IT SHOULD HAVE ABILITY TO POSSESS AND MAKE MORE OF THESE WEAPONS, HAS BECOME WIDELY SHARED, ACROSS MUCH OF THE POLITICAL SPECTRUM.

the very contentious and long-drawn debate over the US-India nuclear deal, when both the government and the main party in opposition, the Bharatiya Janata Party, differed primarily over whether going through with the deal—particularly the proposed separation of civilian and nuclear facilities—would make more difficult the creation of a large nuclear arsenal, but expressed no doubts about the desirability of such a large arsenal.⁹⁶

The arguments for acquiring nuclear weapons have also changed over the last two decades. During the early to mid-nineties, one oft heard argument from those espousing nuclear weapons in India was that while these were evil, they were a necessary evil. Today, it is common to see an unabated enthusiasm for the development of a full-fledged arsenal so that India can become a bonafide nuclear weapon power that can exercise its military might at least across the Indian Ocean and South Asian regions, if not the world at large.

The nuclear establishment and the media have also frequently catered to what historian Vinay Lal identifies as the national obsession for records. Records, especially those that measure the nation-state's achievements in comparison to other countries, are particularly important to the Indian elite. “It is the political and economic elite in India who reminds us that India stands third in the strength of its scientific manpower, that it is a member of the ‘Nuclear Club’, that its software engineers have conquered (so to speak) the heights of Silicon Valley, and that it is only Third World nation to join a few of the post-industrial countries as an exporter

of satellite and rocket technology.”⁹⁷ Thus, for example, the Indian navy leasing a nuclear submarine from Russia was announced in the *Times of India*, a widely circulated newspaper, with the storyline “India becomes 6th nation to join elite nuclear submarine club.”⁹⁸

As in many other countries, scientists and engineers involved in the nuclear and missile development efforts have been feted. The most prominent of these was Abdul Kalam, who was awarded the Bharat Ratna, the highest civilian honor, and became the president of the country. Kalam, a mild mannered engineer,⁹⁹ was immensely popular, especially among the elite and his appointment is representative of the way they (the Indian elite) view nuclear weapons, missiles, and other accouterments of military power. For the elite, Kalam symbolized, in the words of a prominent media commentator, “the hopes and ambitions of an emerging India, a new age guru for a new India.”¹⁰⁰

One notable characteristic of Kalam has been his abiding faith in the military-industrial complex as the motor of progress.¹⁰¹ In his numerous addresses to audiences ranging from school children to elite policy makers as well as his prolific writings, Kalam often extolled the importance of various military and nuclear technologies for broader development, to make India what he calls a “developed nation.”¹⁰² Such identification is deeply appealing to elite Indians because it provides an easy way to deflect the standard “guns versus butter” arguments that are not surprisingly often invoked in a country like India with a large poor population.

The effort to publicly extol participants in the nuclear and missile enterprises includes not just the top leaders of the DAE and the DRDO, but also lower-level officials. A good example of the effort to make prominent such officials is the case of Tessy Thomas, the leader of the team that oversaw the development of Agni IV. In her case, the press made much of her being a woman overcoming the “glass ceiling” and breaking “gender barriers in the decidedly male preserve of strategic weapons and nuclear-capable ballistic missiles.”¹⁰³ While these barriers are real and Thomas must have had to perform extremely well in order to be promoted to her position, the effect of this praise is to make the development of nuclear-capable missiles a goal to be aspired to for women as well.

INTERNATIONAL LAW

The shift in discourse in India’s official positions on nuclear weapons is also apparent with regard to international law.

Ever since the 1974 nuclear test, the Indian government’s focus in arms control diplomacy has been to resist signing onto any international treaties that impose any obligations on its nuclear arsenal. This allows the government to maintain that it is a responsible member of the international community because it has not

breached any agreement. Indeed, in a press statement from 18 May 1998, Jaswant Singh, a senior government official and a key strategist for the Bharatiya Janata Party, stressed precisely this when he said, “In undertaking these tests, India has not violated any international treaty obligations.”¹⁰⁴ Since then India has held fast to the position that even though it has a moratorium on nuclear tests, it will not sign the Comprehensive Test Ban Treaty. Neither has it agreed to a freeze on fissile material production pending the negotiation of a fissile material treaty. There are thus no legal constraints on any modernization activities that may affect the quantity or quality of its nuclear weapons.

Yet, its activities may not be in complete concordance with international law. In 1996, the International Court of Justice (ICJ) offered an historic Advisory Opinion where it ruled that “the threat or use of nuclear weapons would generally be contrary to the rules of international law applicable in armed conflict, and in particular the principles and rules of international humanitarian law” and endorsed unanimously a legal obligation on all states “to pursue in good faith and bring to a conclusion negotiations leading to nuclear disarmament in all its aspects under strict and effective international control.”¹⁰⁵ The ICJ maintained that the obligation for disarmament is not restricted to signatories of the nuclear Non-Proliferation Treaty (see the chapter on international law for further details).

Earlier, as the case was being considered, India submitted a memorial that stands in blatant contrast to the positions Indian officials have maintained since the 1998 nuclear weapon tests. To better understand the contrast, we start with the official nuclear doctrine of the country issued in January 2003.¹⁰⁶ In its very first statement, the doctrine states that the country’s policy is to build and maintain “a credible minimum deterrent”. It then goes on to warn: “nuclear retaliation to a first strike will be massive and designed to inflict unacceptable damage.” Unacceptable damage, in plain English, means that these nuclear weapons would be dropped on cities, each killing hundreds of thousands or even millions of innocent people.

The Indian memorial to the ICJ, on the other hand, argued that nuclear deterrence should be considered “abhorrent to human sentiment since it implies that a state, if required to defend its own existence, will act with pitiless disregard for the consequences of its own and adversary’s people.”¹⁰⁷ The memorial also asks whether “the use of nuclear weapons would be lawful as a measure of reprisal or retaliation if the same is used by any adversary in the first instance” and goes on to argue that

even where a wrongful act involved the use of a nuclear weapon, the reprisal action cannot involve use of a nuclear weapon without violating certain fundamental principles of humanitarian law. In this sense, prohibition of the use of a nuclear weapon

in an armed conflict is an absolute one, compliance with which is not dependent on corresponding compliance by others but is requisite in all circumstances. In view of the above, the use of nuclear weapons even by way of reprisal or retaliation appears to be unlawful.¹⁰⁸

In just a few years, therefore, India moved from a clear and forthright condemnation of deterrence and nuclear retaliation to an enthusiastic invocation of deterrence and a policy of “unacceptable damage”. Its ideas on non-proliferation—when interpreted as just the prevention of acquisition of nuclear weapons by new states—have also changed. Such a shift in attitude was on display during the unexpected vote against Iran at the International Atomic Energy Agency in 2005. In an earlier era, Indian leaders would have denounced the hypocrisy of the United States, with its immense nuclear arsenal, lecturing Iran about its small uranium enrichment plant. Now, India’s rhetoric focuses on why nuclear proliferation is dangerous and why Iran should not be allowed to have nuclear technology. Non-proliferation, which used to be seen as immoral, has come to take the place of disarmament as the most important goal of Indian diplomacy.¹⁰⁹

CONCLUSION

In international fora, India has often advanced initiatives in favour of global nuclear disarmament. Historically it supported numerous resolutions at the United Nations General Assembly (UNGA) calling for the elimination of nuclear weapons.¹¹⁰ One initiative that Indian diplomats and government officials appear to be particularly proud of is former Indian Prime Minister Rajiv Gandhi’s plan (RGP) for time bound nuclear disarmament, which was initially unveiled at the UNGA’s third special session on disarmament in 1988.¹¹¹ This plan has since been revived. In September 2011, for example, Prime Minister Manmohan Singh said at the UNGA that the RGP “provides even today a concrete road map for achieving nuclear disarmament in a time-bound, universal, non-discriminatory, phased and verifiable manner.”¹¹² Earlier in the year, the government set up a panel to revisit the RGP and push for global nuclear disarmament.¹¹³

Such public advocacy for the RGP, however, is somewhat hypocritical when viewed in light of the ongoing modernization plans described in this paper. The original RGP is unequivocal in its call for strong restraints on weaponization and modernization: “The very momentum of developments in military technology is dragging the arms race out of political control. The race cannot be restrained without restraining the development of such technology.... The disarmament approach must devise arrangements for controlling the continuous qualitative upgradation of nuclear and conventional weapons.”¹¹⁴ Current Indian policy, on the

other hand, has encouraged continuous upgradation, i.e., modernization, of nuclear weapons and missiles. Furthermore, it has also attempted to directly or indirectly thwart any international treaties to control such efforts.

NOTES

1. Some months after the May 1998 nuclear tests, while speaking in the Indian parliament, Prime Minister Vajpayee assured its members: “While our decision is to maintain the deployment of a deterrent which is both minimum and credible, I would like to reaffirm to this House that the government will not accept any restraints on the development of India’s R&D capabilities.” Brahma Chellaney, “Expert Comment: New nuclear clarity with old waffle,” *Hindustan Times*, 3 January 1999.
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3. *Joint Statement by Department of Atomic Energy and Defence Research and Development Organisation*, Department of Atomic Energy & Defence Research and Development Organization, 17 May 1998, <http://www.acronym.org.uk/sasia/spind.htm>.
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 109. The opportunistic switch in stance is somewhat akin to what has been called the third class railway compartment syndrome. Those waiting on a crowded platform clamour in the name of justice and fairness to be let into compartment. But once inside, the opportunist shuts the door and keeps the others outside, with force if necessary.
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 111. The document is reproduced in the 2011 report of the informal group on the Rajiv Gandhi Action Plan set up by the Indian government that is available at <http://www.gsinstitute.org/gsi/docs/RGAP.pdf> and <http://www.pugwashindia.org/images/uploads/Report.pdf>. The plan starts with the requirement that all countries offer a binding commitment to eliminating nuclear weapons in stages, by the year 2010 at the latest.
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ISRAEL

MERAV DATAN

The twin themes of this study are modernization and nuclearization. Specifically, the collection in this volume explores how the former is applied to the latter in various states, with a view to drawing conclusions about progress towards nuclear disarmament. In the case of Israel, far more is known about its approach to modernization (in the most general terms and in the military context) than about its approach to nuclear issues. Whatever factual information is publicly available relies on sources outside of Israel.

The analysis below will first explore relevant foreign sources in an effort to summarize the factual information available regarding Israel's nuclear weapons programme and plans for its modernization. It will then draw on relevant domestic sources in order to provide a broader context for these issues. Finally, it will attempt to extrapolate from Israel's general approach to modernization and then apply the conclusions of this exercise to Israel's nuclear policy.

ACCORDING TO FOREIGN SOURCES STATUS OF ISRAELI NUCLEAR FORCES

Since 1970, when the *New York Times* published revelations based on US intelligence assumptions, it has been widely assumed that Israel possesses nuclear weapons.¹ Because Israel has never officially confirmed or denied having nuclear weapons, the scope and nature of its nuclear arsenal is based on the assessments of foreign sources, which vary widely. Based on available foreign information, the current status and modernization plans of Israel's nuclear program are outlined below.

Nuclear weapons and fissile material

Estimates about the size of the arsenal are based on the power capacity of the nuclear reactor near Dimona (which, like the overall program, is subject to secrecy and uncertainty) ranging from 24MWt to 70MWt or more² and on assumptions about production that in turn are based on speculation, scientific calculations, and unconfirmed revelations dating back to 1986.³

The Institute for Science and International Security has calculated that by the end of 2003, Israel could have produced approximately 510–650 kg of weapons-grade plutonium, depending on assumptions about the reac-

tor. Estimates about highly enriched uranium are even more difficult to make, although public information suggests that Israel has a uranium enrichment programme.⁴ Estimates of current nuclear weapons forces range from 60–80⁵ at the low end to over 400.⁶ The most frequently cited figure is 100–200 warheads.⁷

Delivery systems

The Sdot Micha Air Force Base is believed to host nuclear-tipped missiles.⁸ It is also assumed that Israel has a triad of delivery systems: land, air, and sea.⁹ Specifically, Israel is believed to have deployed a cumulative total of 100 *Jericho-I* (500 km range) and *Jericho-II* (1,500 km range) ballistic missiles, both of which are nuclear capable as well as mobile by land or rail. The range of the *Jericho-II* and its 1,000 kg payload “make it well suited for nuclear delivery.”¹⁰ Israel's space-launch rocket, the *Shavit*, which is similar to the *Jericho-II*, could “also be conceivably modified to deliver a nuclear weapon, thus granting Israel the ability to deploy an intercontinental ballistic missile if there were ever a political desire to do so,”¹¹ although there is no indication of such a desire at this time. In terms of modernization, Israel is currently developing a new ballistic missile, the *Jericho-III*, which is believed to have a maximum range of 4,000–6,500km.¹²

Israel's aircraft capabilities give it the option of using its F-16 *Falcons* or F-15 *Eagles* to deliver nuclear weapons. Both have a range of 2,500 km.¹³ As of late 2008, Israel was believed to have well over 200 *Falcons*, which it had purchased from the United States, although “it is assumed that only a fraction of this number will have the modifications, trained crews, and practiced procedures necessary to make them suitable for the nuclear mission.”¹⁴ Israel's 87 *Eagle* fighter and ground attack aircraft were more recently purchased from the US, which itself designated the F-15E *Strike Eagle* for delivery of nuclear weapons, an indication that Israel could do the same.¹⁵

Israel's sea-launched nuclear capability is based on three *Dolphin*-class submarines that were bought from Germany, all of which were received and deployed by the year 2000.¹⁶ These submarines are believed to be armed with dual-capable cruise missiles that were developed in Israel, with each missile having an estimated range of 1,500 km.¹⁷ Reports claiming that these submarines are armed with modified US *Harpoon* anti-

ship missiles (some of which could have been modified to deliver nuclear weapons to land targets) have been denied, but “[i]n 2003, in an interview with the *Los Angeles Times*, Israeli and American officials announced that Israel had deployed U.S. supplied Harpoon ASCMs on its Dolphin submarines and modified the missiles to carry nuclear warheads.”¹⁸ In terms of modernization, in November 2005, Israel reportedly signed a contract worth \$1.17 billion (USD) with Germany for the construction of two more submarines, with the first one to be completed by 2012.¹⁹ In light of current and planned nuclear capabilities, “it seems clear that the country is continuing to enhance its own triad of land, sea, and air launched nuclear systems.”²⁰

Infrastructure

The Israel Atomic Energy Commission (IAEC), “among the most secretive organisations in Israel,” is the government agency that oversees the country’s nuclear activities.²¹ All factual information about its operations, including budget, organizational structure, relations with other military and defense organizations, and parliamentary oversight, is classified.²² The IAEC is chaired directly by the prime minister and operates “to a certain extent under a dual identity,” serving both as the government agency that executes national nuclear policy and as a body staffed by nuclear scientists that carries out Israel’s nuclear research. The IAEC also represents Israel in international nuclear fora.²³

The IAEC oversees the operation of Israel’s two national nuclear-research facilities. The Negev Nuclear Research Center, located near the southern desert town of Dimona, “includes working units for a full array of nuclear-weapons-related activities, from uranium conversion, fuel fabrication and uranium enrichment, to a plutonium-production reactor and reprocessing mechanisms, and possibly weapons-specific facilities” and is reportedly believed to serve as “Israel’s national laboratory in the nuclear field.”²⁴ As noted above, estimates vary regarding the reactor’s capacity. The original capacity of 24MWt was reportedly expanded to 40MWt and later to 70MWt.²⁵

The Soreq Nuclear Research Center, located approximately 40km south of Tel Aviv, was purchased from the US as part of the “Atoms for Peace” program. It was originally constructed as a 1MWt light-water research reactor and later expanded to 5MWt. It is the only facility in Israel under IAEA safeguards. According to the Soreq website:

Its R&D activities include laser and electro optics, nuclear medicine, radiopharmaceutics, non-destructive testing, space components characterization and testing, crystal growth, development of innovative

radiation detectors and sophisticated equipment for contraband detection. It offers radiation protection training, and operates personal dosimetry service. It is a major distributor of radio-pharmaceuticals for medical diagnostics and therapy.²⁶

In sum, Israel is assumed to have “full fuel-cycle capabilities”²⁷ but specific details and current information is not available. It is also assumed that other nuclear activities related to weaponization are “carried out in other secret facilities.”²⁸ It is further believed that “Israel is upgrading its deterrence capabilities.”²⁹

Policy

The secrecy surrounding Israel’s nuclear activities serves the policy of nuclear “ambiguity” or, as it is increasingly being described, “opacity.”³⁰ Nuclear opacity has been defined as a situation in which “a state’s nuclear capability has not been acknowledged, but is recognized in a way that influences other nations’ perceptions and actions.”³¹ In Israel’s case, this policy was

the product of a compromise with the United States that emerged during the years leading up to conclusion of the nuclear Non-Proliferation Treaty (NPT), the period during which Israel

was reportedly developing its first nuclear weapons.³² The NPT was opened for signature in 1968 and entered into force in 1970.

Israel had reportedly completed its first nuclear device by May 1967.³³ Despite US pressure, in 1968 Israel informed the US that because of its security needs, it could not sign the NPT at that time. A nuclear option was seen as an existential necessity. In 1969 Israeli Prime Minister Golda Meir and US President Richard Nixon reached a secret agreement that laid the foundation for a tacit “don’t ask, don’t tell” policy between the two states with respect to Israel’s nuclear-weapons capability.³⁴ The US accepted that Israel felt a security-based need to have a nuclear-weapons capability, and Israel agreed not to undermine the NPT by openly declaring its nuclear capability. The secrecy surrounding Israel’s nuclear programme is an outgrowth of this compromise.

ACCORDING TO DOMESTIC SOURCES

The policy of opacity has shaped and circumscribed Israel’s non-proliferation, arms control, and disarmament policies. Despite this opacity, however, Israel does participate publicly in some non-proliferation activities and agreements. In fact, Israel is generally supportive of the non-proliferation regime, and particularly in recent years, has made efforts to be recognized as a technologically advanced, mature state committed to the “spirit of the NPT.”³⁵ Interest in participating in

THE US ACCEPTED THAT ISRAEL FELT A SECURITY-BASED NEED TO HAVE A NUCLEAR-WEAPONS CAPABILITY, AND ISRAEL AGREED NOT TO UNDERMINE THE NPT BY OPENLY DECLARING ITS NUCLEAR CAPABILITY.

international nuclear activities (including an India-like exception to Nuclear Supplier Group guidelines) and a recurring but fledgling interest in exploring nuclear energy options have informed this new approach. Similarly, domestic discourse, though far from democratically free and open, exists but is also circumscribed by the policy of opacity.

International Law

Israel has signed but not yet ratified the Comprehensive Nuclear Test Ban Treaty (CTBT). It actively participates in verification activities of the CTBT Organization Preparatory Committee. Israel is a signatory or party to a number of non-proliferation-related (safety and security) agreements, including the Vienna Convention on Civil Liability for Nuclear Damage, the Convention on the Physical Protection of Nuclear Material, the Convention on Early Notification of a Nuclear Accident, the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, Convention on Nuclear Safety, the Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the IAEA, and a Safeguards Agreement applicable to the Soreq nuclear facility.³⁶

On the basis of the above legal commitments, in combination with its NPT non-party status and its emphasis on security and secrecy surrounding nuclear activities, Israel projects itself both domestically and internationally as a responsible non-proliferant (in the sense of not supplying nuclear technology to others but, rather, having an interest in sharing safety and security expertise). Not having signed the NPT, Israel is not bound by its article VI disarmament obligations under a strict treaty-based interpretation of international law, which is the prevalent view in this context. Arguments based on customary international law that posit a universal obligation to disarm have not gained ground or drawn attention (or a rebuttal) within Israel, but they would likely be countered by the argument that Israel is not bound by agreements that it has not signed (a view consistent with Israel's general approach to international legal norms and obligations) and has, in fact, systematically rejected. The "persistent objector" exception to a customary international legal norm would likely be invoked in the event that customary international law is given consideration. In this context, any modernization of nuclear weapons would not be perceived by Israel as a conflict with international legal commitments.

Security and space modernization

Nuclear weapons modernization is related to modernization activities in the security sector generally, for example through the underlying infrastructure of C4I (command, control, communications, computers, and intelligence). Modernization efforts in this sector can be expected to serve the nuclear weapons infrastruc-

ture as well. In this area Israel is regarded as very advanced. Information technology and advanced military technology are among Israel's main exports, including to other technologically advanced countries.³⁷ The government also encourages and enables research and development in information technology.³⁸

Outer space is another area in which military and civilian capabilities overlap. Rocket science is in part missile technology, and advances in the former are applicable to the latter. Israel has advanced missile capabilities, as noted above, and engages actively in outer space activities with both civilian and military applications. In its own words, "Israel attributes great importance to international cooperation in the area of space technology, and believes that it is necessary and essential." The government says it continues "to share the vision and broad objectives of the United Nations' efforts in this field, namely to secure, promote, and broaden the peaceful use of outer space."³⁹

The Israel Space Agency has signed cooperation agreements with the space agencies of Canada, France, Germany, India, the Netherlands, Russia, Ukraine, and the United States as well as the European Space Agency, and agreements are pending with Brazil, Chile, and the Republic of Korea. Israel launched its first satellite in 1988, and the space agency's description reflects the proud self-perception of modern, cutting-edge capabilities inherent in this development.⁴⁰

The history of Israel in space is short but remarkable. It started in 1988 with the launch of Ofeq 1 by the Shavit launcher, affiliating Israel to [sic] the very exclusive club of seven countries who launched a self-developed satellite with their own made launcher.

Israel has several satellites in orbit and more in development, serving a variety of purposes, some of which have direct military (C4I) applications. The use of outer space and dependence on space-based vehicles also create new vulnerabilities, such as disruption of essential communications that can, in turn, pose serious security challenges. For this reason, space security has been the subject of increasing attention in recent years. Here too, Israel is an active participant. At a recent UN conference on space security, for example, two of the twenty-two speakers were from Israel.⁴¹

The capabilities and developments described here do not provide evidence of nuclear weapons modernization, but they do indicate that Israel has the military and technological capabilities and the stated security interests that make nuclear weapons modernization possible.

Discourse

The policy of opacity entails a nuclear weapons capability about which "everyone knows" (domestically and internationally, with the former reliant on the latter) and an umbrella of secrecy covering the physical and doctrinal elements of this capability. The nuclear-

capable aspect of opacity, which is perceived as provocative or in violation of international law by Israel's critics, is projected within Israel as a policy of *restraint*, of which secrecy is an element: Israel does not advertise its nuclear capability; Israelis do not conduct parades celebrating their nuclear capabilities (unlike other countries); secrecy is the alternative to open declaration of a nuclear option, which would be provocative. This is the prevalent perception.

The secrecy surrounding Israel's nuclear programme, which has its origins in the US-Israel compromise discussed above, has taken on a life of its own at the domestic level. The origins of opacity are no longer the driving force as Israelis practice self-censorship on a wide range of nuclear issues. At the same time, a discourse does exist at the academic level and, increasingly, in the media, driven in large part by debate over Iran's nuclear programme and the best response. This discourse relies on foreign sources as a factual foundation, but that has not prevented a relatively open discourse at the elite level within the contours of academic and think-tank dialogue. For example, a recent publication by the Institute for National Security Studies (Israel's foremost security think tank) addresses "the Obama vision" of nuclear disarmament from an Israeli perspective (generally regarding this vision as unrealistic).⁴²

It has frequently been asserted that Israel views its nuclear programme as a "sacred national insurance policy"⁴³ and even critics of the policy in its current form have asserted that "for a state born out of the Holocaust

Times within the US) observing that, in the words of a participating Israeli delegate "the sky didn't fall on us." The secrecy born of the policy of opacity had bred a fear of discussing the issues that turned out to be unfounded. What is most telling about this editorial, however, is that despite a faithful translation between the Hebrew and English versions, the headlines differed.⁴⁷

In English the editorial was entitled "Israel is clinging dearly to its policy of nuclear ambiguity" and the subheading went on to state, "Israel has never claimed that there is no possibility it will change its nuclear policy one day. But for Israel that's a vision for the distant future."⁴⁸ The Hebrew version was identical except for the headline, which directly translates as "Disarmament, But Not Now."⁴⁹ *Ha'aretz* is a daily newspaper published in both Hebrew and English, and not surprisingly, the emphasis in coverage differs slightly: a foreign-language target audience is not likely to seek an Israeli newspaper for coverage of news that has no direct bearing on Israel, whereas Hebrew-language readers are more likely to rely on *Ha'aretz* if it is their newspaper of choice for coverage of any news, domestic or foreign. What is telling in the case of the editorial mentioned above is the difference in emphasis when the same editorial is packaged for foreign vs. domestic consumption. In the former case the emphasis is on maintenance of the old nuclear policy, and the words "clinging dearly" imply a near-desperate tone (not actually reflected in the body of the editorial). In the latter case the emphasis is on disarmament, a relatively new idea for a domestic audience.

A NEW SURVEY HAS INDICATED THAT 65% OF ISRAELIS WOULD BE WILLING TO GIVE UP NUCLEAR WEAPONS IF IRAN WAIVED ITS OWN PROGRAMME—THAT IS, THEY WOULD PREFER A NUCLEAR-WEAPONS-FREE MIDDLE EAST TO THE CURRENT SITUATION.⁴⁶

and surrounded by the hostile Arab world, not to [acquire a nuclear weapons capability] would have been irresponsible."⁴⁴ Historically, public opinion polls have indicated support for the nuclear option, more recently reinforced by a belief (among 66% to 82% of Israelis) that Iran would use nuclear weapons to destroy Israel.⁴⁵ Most recently, however, a new survey has indicated that 65% of Israelis would be willing to give up nuclear weapons if Iran waived its own programme—that is, they would prefer a nuclear-weapons-free Middle East to the current situation.⁴⁶

A somewhat superficial but nevertheless telling example illustrates the difference between Israel's domestic and international discourses as well as the potential for change within Israeli policy. Following the recent and first-ever IAEA forum on a nuclear weapons free zone (NWFZ) in the Middle East, which Israel had resisted for 11 years, an editorial was published in the newspaper *Ha'aretz* (relatively elite mainstream newspaper, comparable to the reputation of the *New York*

NWFZ/WMDFZ

The NWFZ goal is not a new idea among Israel's diplomatic representatives, however. Israel has joined the consensus UN General Assembly resolution on a Middle East NWFZ since 1980, but with reservations. As stated in Israel's most recent explanation of vote on this resolution:⁵⁰

It has been Israel's longstanding position that the essential preconditions for the establishment of the Middle East as a mutually verifiable zone, free of weapons of mass destruction and delivery systems, are comprehensive and durable regional peace, and full compliance by all regional states with their arms control, disarmament and non-proliferation obligations.

During the UN General Assembly meetings Israel annually asserts that "it remains committed to a vision of the Middle East developing eventually into a zone free of Chemical, Biological, and Nuclear weapons as well as ballistic missiles" but that these issues can only

be “realistically addressed within the regional context.” A NWFZ, or a WMDFZ (which, as Israel notes, is unprecedented) “must be based on arrangements freely arrived at through direct negotiations between the states of the region and those directly concerned, applying a step by step approach.”⁵¹

As noted above, Israel recently reversed its position of refusing to participate in an IAEA forum on the NWFZ issue. The conference was academic and non-binding, with the stated goal of learning from other NWFZs, but nevertheless Israel had resisted such a meeting for 11 years. It has also participated recently in other conferences aimed at exploring this issue, including an August 2010 meeting in Cairo, sponsored by an Australia- and Japan-led initiative, and a June 2011 meeting in Brussels initiated by the European Union. These developments indicate a more relaxed attitude towards participation in governmental meetings on the issue of a WMDFZ or NWFZ, possibly because of increased international attention and effort surrounding this issue since the 2010 NPT Review Conference and the decision to hold a conference on the topic in 2012.

As of the time of this writing, however, Israel does not intend to participate in the 2012 conference. Following the 2010 NPT Review Conference, the government of Israel announced:

As a non-signatory state of the NPT, Israel is not obligated by the decisions of this Conference, which has no authority over Israel. Given the distorted nature of this resolution [the 2010 final document decision convening the 2012 conference], Israel will not be able to take part in its implementation.⁵²

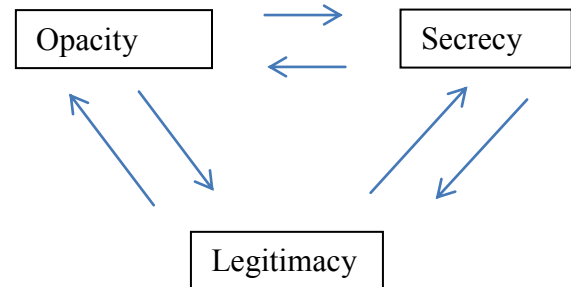
Israel’s reasoning, reportedly, is that it did not take part in formulating the terms of reference for the 2012 meeting, nor is it a member of the NPT, whose 1995 Resolution is at the basis of this meeting. From Israel’s perspective, the terms of reference deal only with part of the regional security dilemma (which includes conventional weapons and strategic threats to Israel) that Israel is interested in addressing and which would have been included in the terms of reference had Israel participated in their formulation.⁵³ Nevertheless, the 2012 conference has been the subject of discussion in security circles within Israel and has succeeded in drawing attention to this issue.

Opacity, secrecy, and legitimacy

The domestic discourse on nuclear issues is characterized by what has been termed the “enigma of opacity”: ignorance is a qualification for speaking on nuclear issues.⁵⁴ Anyone who “knows” cannot speak openly about the issues, while anyone who speaks must first profess ignorance by asserting reliance on foreign sources.

At the basis of nuclear policy is the question of legitimacy (Israel’s right to exist). Perceived existential threats informed, drove, and shaped the development

of a nuclear programme and pursuit of a nuclear deterrent. US-led non-proliferation efforts shaped the further development of this deterrent in secrecy. Deterrence, however, requires that others (the target audience) be aware of Israel’s capability. Thus it relies on foreign sources and indirect references because a strictly secret nuclear programme would have no deterrent value. This interaction between secrecy and opacity is further shaped by questions of Israel’s legitimacy or right to exist. On the one hand, Israel still perceives deterrence as a guarantor of its existence, that is, opacity as an existential issue. On the other hand, international criticism of Israeli nuclear policy, which is unique in the global arena, feeds into and reinforces challenges to Israel’s legitimacy. The trilateral interplay among these issues—opacity, secrecy, and legitimacy—is represented in the figure below:



One presumably unintended consequence of the internalized secrecy within Israeli society is that the phrase “according to foreign sources” has come to imply sensitive and secret information about internal domestic issues. It is ironic and perhaps unique among nations that the term “foreign sources” in Israel refers to “our own innermost secrets”.

MODERNIZATION AND NUCLEARIZATION

At its inception, Israel’s nuclear programme was perceived as being ahead of its time for the small, newly established state: “It took more than a little *chuzpa* to believe that tiny Israel could launch a nuclear program.”⁵⁵ The sense of subdued pride over the technological capability permeates references to the nuclear programme. Publicly available information, as characterized by the description of activities at the Soreq facility referenced above, reflects a wide range of technologically advanced research projects. Israel is generally perceived to be a modernized and technologically advanced state, including in the military sphere, and this perception applies to the nuclear sector as well.

At a popular, admittedly cursory level, a Google search serves to illustrate the point that efforts towards modernization in general are promoted and viewed positively in Israel, and that modernization is a salient

theme in the military sector. Google is no substitute for in-depth research, of course, but by definition it can provide a snapshot of popular perception within the computer-literate sector, which is a very relevant sector in the context of modernization. The first several pages of a Google search on “Israel” and “modernization” produced the following results:

- Articles on modernization in the military sector: 43%
- Articles on modernization in the high-tech civilian sector: 25%
- Articles on modernization in the social, political, and sociological sectors: 32%

The first category includes articles about modernization within Israel’s own military (68% of this category) and articles about Israeli services provided for the modernization of foreign militaries’ assets such as tanks and aircraft (32%).

The results indicate that, within a society where modernization is a salient aspiration, it is most prominent in the military sector and includes an exportable expertise. Combining the first two categories above indicates that modernization is particularly associated with technological innovation, both military and civilian. Only one-third of the references to modernization related to sociological, social, or political dimensions.

CONCLUSION

The history of Israel’s nuclear programme and its current status indicate that this programme has always been a priority project at the national level and has benefitted from the input provided by advanced, innovative technology and skilled human resources. Indications of modernization plans, in particular with respect to land and sea delivery systems, suggest that the nuclear programme will continue to be a priority project that benefits from cutting-edge technological advances and specially recruited and trained human input. The cultural context, with its emphasis on technological modernization, is fertile ground for modernization in the nuclear sector.

Israel’s international legal commitments as these are perceived domestically pose no obstacle to such modernization. In fact, Israel’s status as non-state party of the NPT is a hindrance to development of a nuclear power programme because Israel would need international support and trade in nuclear materials for such a programme. Nonetheless, Israel seeks to become a more active participant in the global nuclear marketplace, where its potential contributions would be along the lines of technological innovation rather than raw material. The publicly known aspects of Israel’s international nuclear activities are centered on safety and security issues (the latter in particular being a natural consequence of the nature of Israel’s own program) and on verification activities. These capabilities suggest po-

tential disarmament-related functions that could be further developed in the appropriate political context.

In sharp contrast to the technological aspects of Israel’s nuclear programme, its nuclear policy has never been modernized. The policy of opacity developed in parallel to and simultaneous to conclusion of the NPT. By 1970 the NPT had entered into force, Israel was assumed to have nuclear weapons, and the policy of opacity was established. More than 40 years later, the NPT is still in force but has become nearly universal and—despite its shortcomings—has played a key role in constructing a global non-proliferation norm, defying predictions that there would be dozens of nuclear-weapon states. Israel’s nuclear programme has advanced in quantity and quality. Only the policy of opacity remains unchanged, despite changing political and technological contexts.

NOTES

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2. *Ibid.*, p. 130.
3. Before the revelations by former Dimona nuclear technician Mordechai Vanunu were published in the London *Sunday Times* in 1986 it was generally estimated that Israel had two to three dozen nuclear weapons. *Ibid.*, p. 130
4. *Ibid.*, p. 132, citing David Albright, “ISIS Estimates of Unirradiated Fissile Material in De Facto Nuclear Weapon States, Produced in Nuclear Weapons Programs,” Institute for Science and International Security (ISIS), Washington, 2003 (revised 2005); ISIS, *Israeli Military Stocks of Fissile Material As of Late 2003* (revised 2005), <http://isis-online.org/isis-reports/detail/israeli-military-stocks-of-fissile-material-as-of-late-2003/>.
5. US Defense Intelligence Agency (1999), cited in IISS, p. 133.
6. *Jane’s Intelligence Review* (1997), cited in IISS, p. 133.
7. IISS, p. 133, citing Stockholm International Peace Research Institute (SIPRI), *SIPRI Yearbook 2007: Armaments, Disarmament and International Security*, Stockholm, 2007, p.548. See also Ian Kearns, *Beyond the United Kingdom: Trends in the Other Nuclear Armed States*, Discussion Paper 1 of the BASIC Trident Commission, London, 2011, p. 27 (hereinafter “BASIC”), citing Robert S. Norris, William M. Arkin, Hans M. Kristensen, and Joshua Handler, “Israeli nuclear forces, 2002,” *Bulletin of the Atomic Scientists*, September/October 2002, p.75.
8. IISS, *op. cit.*, p. 131.
9. BASIC, *op. cit.*, p. 28.
10. IISS, *op. cit.*, pp. 132-133, citing Joseph Cirincione, *Deadly Arsenal: Nuclear, Biological, and Chemical Threats*, second edition, Washington, 2005, p. 261.
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13. *Ibid.*
14. BASIC, *op. cit.*, p. 28.
15. *Ibid.*, citing International Institute for Strategic Studies, *The Military Balance*, Washington, 2011, p.314.
16. BASIC, *op. cit.*, p. 27, citing Robert S. Norris, William M. Arkin, Hans M. Kristensen and Joshua Handler, “Israeli nuclear forces, 2002,” *Bulletin of the Atomic Scientists*, September/October 2002, p.75.
17. *Ibid.*, p. 28, quoting Norris et al., *ibid.*, p.75: “In June 2002, former Pentagon and State Department officials told the *Washington Post* that Israel was arming three diesel-powered submarines with cruise missiles capable of carrying nuclear warheads.”
18. *Ibid.*, p. 28, n. 125, quoting Nuclear Threat Initiative, *Israel Profile*,

- http://www.nti.org/e_research/profiles/Israel/Nuclear/index.html.
19. Nuclear Threat Initiative, *Israel Profile*, *ibid*.
 20. BASIC, *op. cit.*, p. 28.
 21. IISS, *op. cit.*, p. 129.
 22. *Ibid*.
 23. *Ibid.*, p. 130.
 24. *Ibid*.
 25. *Ibid.*; ISIS Reports, *Israeli Military Stocks of Fissile Material As of Late 2003, Revised 2005*, <http://isis-online.org/isis-reports/detail/israeli-military-stocks-of-fissile-material-as-of-late-2003/>.
 26. http://www.soreq.gov.il/default_EN.asp.
 27. IISS, *op. cit.*, p. 131.
 28. *Ibid*.
 29. *Ibid.*, p. 119. See also BASIC, *op. cit*.
 30. Historically the term most frequently used was “ambiguity” but in recent years “opacity” has gained currency. The latter is closer to the Hebrew term (*amimut*), which implies something “unclear” or “opaque.” Avner Cohen has advocated use of the term “opacity” (originally in 1987-88 in an article with Benjamin Frankel), and this term has been increasingly accepted in recent years, particularly in academic circles. See Avner Cohen, *Israel and the Bomb*, New York, 1998.
 31. Cohen, *op. cit.*, p. 2.
 32. *Ibid.*, pp. 277-321.
 33. IISS, *op. cit.*, p. 122. Cohen, p. 275.
 34. IISS, *op. cit.*, p. 123. See also Cohen, pp. 277-321; Seymour M. Hersh, *The Samson Option: Israel's Nuclear Arsenal and American Foreign Policy*, New York, 1991.
 35. IISS, *op. cit.*, p. 126.
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 43. IISS, *op. cit.*, p. 128.
 44. Cohen, *op. cit.*, p. 9.
 45. Alan Dowty, “Iran and the Bomb: Israel's Analogies,” Middle East Strategies at Harvard, 2009, <http://blogs.law.harvard.edu/mesh/2009/05/iran-and-the-bomb-israels-analogies/>.
 46. Yitzhak Benhorin, “We'll give up nukes if Iran does same,” *Yediot Achronot*, 1 December 2011, <http://www.ynetnews.com/articles/0,7340,L-4155677,00.html>.
 47. Admittedly, an example is not proof. Without speculating as to the source or reason for the different headlines, they are offered here as illustrations of a difference in approach to nuclear issues at the domestic and international levels, whether by design or unintentionally.
 48. Yossi Melman, “Israel is clinging dearly to its policy of nuclear ambiguity,” *Ha'aretz*, 24 November 2011, <http://www.haaretz.com/print-edition/features/israel-is-clinging-dearly-to-its-policy-of-nuclear-ambiguity-1.397389>.
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 51. *Ibid*.
 52. Statement by the Government of Israel on the Middle East Resolution passed at the NPT Review Conference, 29 May 2010, <http://www.pmo.gov.il/PMOEng/Archive/Press+Releases/2010/05/spokemes29052010.htm>. The statement above incorrectly refers to the 2010 decision to convene a conference in 2012 as a “resolution.” In Hebrew “resolution” and “decision” are the same word (and Israel might be unfamiliar with NPT processes).
 53. Shimon Stein, Comments on 2012 WMD-Free Zone, Conference on Arms Control in a Changing Middle East, Institute for National Security Studies, Tel Aviv, 14 November 2011, available on video at: http://video.tau.ac.il/index.php?option=com_k2&view=item&id=1947:arms_control_in_a_changing_middle_east_02_09&Itemid=56&lang=he.
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PAKISTAN

ZIA MIAN

Since its nuclear tests in May 1998, Pakistan has been rapidly developing and expanding its nuclear arsenal. It is producing highly enriched uranium (HEU) and plutonium—the key ingredients for nuclear weapons—and is increasing its capacity to produce plutonium by building new production reactors. It is also testing and deploying a diverse array of nuclear-capable ballistic and cruise missiles, with ranges from 60 km to 2000 km.

Even though Pakistan is still developing its nuclear arsenal, there is some modernization taking place. Pakistan is moving from an arsenal of weapons based wholly on HEU to greater reliance on lighter and more compact plutonium-based weapons. The shift to plutonium based weapons is being made possible by a rapid expansion in plutonium production capacity, with two production reactors under construction to add to the two reactors that are currently operating. Pakistan is

STATUS OF PAKISTAN'S NUCLEAR FORCES

Estimates of Pakistan's nuclear weapons stockpile have grown as it continues to produce fissile material for nuclear weapons and to expand its fissile material production capacity, especially for plutonium. According to a secret US cable published by Wikileaks, US officials suggested in 2008 that Pakistan was “producing nuclear weapons at [a] faster rate than any other country in the world.”¹

As of 2011, the US government estimates Pakistan's stockpile to range from 90 to over 110 weapons.² This compares to early 2008 US estimates of a Pakistani arsenal of 70 to 80 weapons, but possibly ranging from 60 to 90 weapons. These government estimates are similar to those made by independent analysts (see Table 1).³

There is little information on the yields of Pakistan's nuclear weapons. The yields of the six nuclear weapon

Year	1998	99	00	01	02	03	04	05	06	07	08	09	10	2011
Estimated no. of weapons	2	8	14	20	26	32	38	44	50	60	70	80	90	100

Source: Adapted and updated from Robert S. Norris and Hans Kristensen, “Global Nuclear Weapons Inventories, 1945–2010,” Bulletin of the Atomic Scientists, July/August 2010, Vol. 66, No. 4, pp. 77–83.

also moving from aircraft-delivered nuclear bombs to nuclear-armed ballistic and cruise missiles, and from liquid-fueled to solid-fueled medium range missiles. Pakistan has received direct assistance from China for both its nuclear weapons and missile programmes, and from North Korea for its missile programme.

There is almost no information about the funding of Pakistan's nuclear weapons programme and little useful information about Pakistan's overall military spending. It is clear, however, that a significant fraction of Pakistan's financial resources go to its nuclear weapons programme, but that this cost is not a large share of its overall military spending. Pakistan's military spending is subsidized by large amounts of military aid from the United States and subsidized arms sales from China. Pakistan also receives large amounts of international aid to help it meet basic social and economic development needs.

tests carried out on 28 and 30 May 1998 are disputed, with Pakistan claiming explosive yields of tens of kilotons, while independent seismologists estimate the total yields were about 10 kt and 5 kt for the tests on 28 May and 30 May respectively.⁴

There is also little known about Pakistan's weapon designs, although Pakistan is believed to have received in the early 1980s a first generation Chinese weapon design that used HEU.⁵ The nuclear tests in 1998 may all have used HEU for the solid or hollow shell (known as a ‘pit’) of fissile material that undergoes the explosive nuclear chain reaction. Today, Pakistan could use HEU or plutonium pits, or a combination of both in ‘composite’ pits. The use of plutonium allows for the production of lighter and more compact nuclear warheads, more suitable for use in ballistic and cruise missile warheads. Pakistan may also have developed more advanced ‘boosted’ weapons, which inject tritium gas into the pit just before it explodes to increase the fraction of the fissile material that undergoes fission and so

significantly increase the explosive yield of the nuclear weapon. Pakistan is not believed to have developed thermonuclear weapons (hydrogen bombs).

Delivery systems

Pakistan is still in the process of developing a range of delivery systems for its nuclear weapons. Pakistan has a number of short-range, medium, and longer-range road-mobile ballistic surface-to-surface missiles (SSMs) in various stages of development. It also is moving from liquid-fueled missiles to solid-fueled missiles. Pakistan has received assistance from North Korea and China with its missile programme.

Pakistan Army's Strategic Force Command has tested both short- and long-range missiles. The *Abdali* missile, with a range less than 200 km, is a simple solid-fueled missile that Pakistan began testing in 2002. A March 2011 test was described as "part of the process of validation and technical improvements" for the missile, which Pakistan's Chairman of the Joint Chiefs of Staff Committee described as providing "an operational level capability, additional to the strategic level capability, which Pakistan already possess."⁶

In January 2003, the liquid-fueled *Ghauri* missile (sometimes called *Hatf V*) was inducted into the army. It is believed to be derived from the Democratic People's Republic of Korea (DPRK)'s *No-Dong* missile. Work on the *Ghauri* missile started in the early 1990s and the first test was carried out in 1998. Pakistan may have received assistance from DPRK in developing this missile.

The 750 km-range solid-fueled *Shaheen-I* was handed over to the military in March 2003.⁷ It is believed to be derived from the Chinese M-11 missile and US officials have suggested China may have provided Pakistan with M-11 missile components, 34 intact M-11 missiles, and "blueprints and equipment ... to build a plant for making missiles," as well as technical assistance with further development of this missile.⁸

Pakistan has developed a second generation of ballistic missile systems over the past five years. *Shaheen-II* is a 2000 km-range solid-fueled missile, first tested in 2004. In April 2008, the Pakistan Army's Strategic Force Command carried out a training launch of *Shaheen-II* that was reported to have "validated the operational readiness of a strategic missile group equipped with the *Shaheen II* missile."⁹ This suggests that missile may have entered service.

In 2011, Pakistan carried out the first test of a possible battlefield nuclear missile, the 60 km-range *Nasr* missile, described in an official statement as able to carry "nuclear warheads of appropriate yield" and as "consolidating Pakistan's deterrence capability at all levels of the threat spectrum."¹⁰

Pakistan is also developing a nuclear-capable ground-launched cruise missile (*Babur*) and an air-launched cruise missile (*Ra'ad*) with ranges of about 600 km and 350 km respectively. Pakistan began test-

ing these missiles in 2005 and 2007 respectively, with the most recent tests being conducted in 2011.¹¹ The 2005 India-Pakistan Agreement on Pre-Notification of Flight Testing of Ballistic Missiles commits the two states to give 72 hours notice before a ballistic missile flight test and to not test missiles close to their borders. It does not cover cruise missiles.

Despite frequent media reports, the capabilities of Pakistan's nuclear weapon delivery systems, and the current status of their technical development and operational readiness is unclear. Table 2 presents one estimate by independent analysts.

There is little public information about the storage

Table 2: Pakistan's nuclear weapon delivery systems, 2011

Delivery System	Range	Deployment
Aircraft		
Aircraft F-16A/B	1,600	1998
Mirage V	2,100	1998
Ballistic missiles		
Abdali (Hatf-2)	180	(2012)
Ghaznavi (Hatf-3)	400	2004
Shaheen-1 (Hatf-4)	>450	2003
Ghauri (Hatf-5)	1200	2003
Shaheen-2 (Hatf-6)	2000	(2011)
Nasr (Hatf-9)	60	(2014)
Cruise missiles		
Babur (Hatf-7)	600	(2011)
Ra'ad (Hatf-8)	350	(2013)

Source: Hans Kristensen and Robert S. Norris, "Pakistan Nuclear Forces 2011," Bulletin of the Atomic Scientists, Volume 67, No. 4, pp. 91-99.

and deployment of Pakistan's nuclear weapons. It is believed that "missiles are not mated with warheads and the physics packages (the fissile cores) are not inserted into the warheads themselves."¹² Reports suggest that while warheads are kept in component form, possibly by "isolating the fissile 'core' or trigger from the weapon and storing it elsewhere... all the components are stored at military bases."¹³

The locations of Pakistan's nuclear weapons storage and deployment are not known with great confidence. Eight possible sites have been suggested (Table 3).

Fissile materials

There is no official information on Pakistan's fissile material production sites—although Pakistan and India each year exchange lists of nuclear facilities as part of their 1988 Agreement on the Prohibition of Attack against Nuclear Installations and Facilities.¹⁴ These lists are not made public, however. They may include both military and civilian nuclear facilities.

Table 3: Pakistan's nuclear weapon storage and deployment sites

Facility name/location	Province	Weapons	Function
Fatejhang National Defense Complex	Punjab	SSM	Missile development and potential warhead storage capability
Masroor Weapons Depot	Sindh	Various	Potential storage of bombs for Mirage Vs at Masroor Air Base, and/or warheads for SSMs
Sargodha Weapons Depot	Punjab	Various	Potential storage site for bombs for F-16s at nearby Sargodha Air Base, and warheads for SSMs
Shanka Dara Missile Complex	Punjab	SSM	Missile development and potential warhead storage capability
Near Quetta Air Base	Balochistan	Bombs	Potential storage site with underground facilities in high-security weapons storage area
Wah Ordnance Facility	Punjab	Various	Possible warhead production, disassembly and dismantlement facility
Unknown air force facility	?	Bombs	Central air force storage facility with bombs for F-16s at F-16s at Sargodha Air Base, and Mirage Vs at Kamra Air Base
Unknown army facility	?	SSM/GLCM	Central army storage facility with warheads for SSMs and Babur cruise missiles

Source: Robert S. Norris and Hans Kristensen, "Worldwide Deployments of Nuclear Weapons, 2009," Bulletin of the Atomic Scientists, November/December 2009.

Pakistan has developed an extensive nuclear infrastructure that allows it to produce both HEU and plutonium for weapons. This includes capacity for uranium mining, uranium enrichment, nuclear reactor fuel fabrication, nuclear reactor construction, and spent fuel reprocessing for plutonium recovery. Table 4 presents one list of Pakistan's fissile material production-related sites compiled from open sources. While the histories and operating capacities of these facilities are not clear, it is well known that Pakistan has been producing HEU for nuclear weapons since the early 1980s and producing plutonium for weapons since the late 1990s.

Accurate estimates about Pakistan's production of HEU for its nuclear weapon programme are limited by uncertainty about Pakistan's enrichment capacity and the operating history of its centrifuge plants at Kahuta and Gadwal.¹⁵ It is estimated that, as of 2011, Pakistan could have a stockpile of about 2750 kg of weapon-grade (90%-enriched) HEU and may be producing about 150 kg of HEU per year.¹⁶ Assuming that about 20 kg of HEU is required per warhead, Pakistan's current stockpile would be sufficient for about 140 weapons. An additional 100 kg may have been consumed in Pakistan's six nuclear weapon tests in 1998.

As of the beginning of 2012, Pakistan continues to expand its capacity to produce weapons plutonium. The *Khushab-I* plutonium production reactor, a heavy-water-moderated, light-water-cooled, natural-uranium-fueled reactor with a capacity of about 40–50 MWt,

has been operating since 1997–1998. The *Khushab-II* reactor started operation in late 2009 or early 2010. Work on a third production reactor at the site started in 2005 and is nearing completion. Construction started in early 2011 on a fourth reactor. All these reactors are believed to be of similar power and to be able to produce about 6–12 kg per year of weapons plutonium depending on how efficiently they are operated. As of the start of 2012, Pakistan is estimated to have produced a total of about 140 kg of plutonium.¹⁷ Assuming 5 kg per warhead, this would be sufficient for almost 30 warheads.

Pakistan reprocesses the spent fuel from the *Khushab* reactors at the Rawalpindi New Labs facility, which has two reprocessing plants, each with an estimated capacity of 10–20 tons per year of spent fuel.¹⁸

Infrastructure and organization

Pakistan has a growing nuclear weapons research, development, and production infrastructure. It is managed by the military-run Strategic Plans Division and overseen by a National Command Authority (NCA) set up in February 2000 by General Pervez Musharraf. The NCA has responsibility for policy concerning the development and use of Pakistan's nuclear weapons. The NCA is chaired by the Prime Minister, and includes the ministers of foreign affairs, defence, and interior, the chairman of the Joint Chiefs of Staff committee, the military service chiefs, the director-general of Strategic Plans Division, and technical advisers.

The Strategic Plans Division (SPD) has responsibility for strategic weapons development and nuclear weapons planning and operations, as well as security of the nuclear complex. It also has an arms control group. The total number of staff of the SPD and the various programmes it is responsible for is uncertain. A 2011 report suggested a total of about 70,000 professional staff in the entire strategic weapons complex.¹⁹ A February 2010 US diplomatic cable released by Wikileaks cites a Russian Foreign Ministry official's claim that "there are 120,000–130,000 people directly involved in Pakistan's nuclear and missile programmes, working in these facilities and protecting them."²⁰ A former SPD official has indicated that the organization has a division of 9000–10,000 people responsible just for the security of the nuclear weapons complex.²¹

The nuclear weapons development and production infrastructure managed by SPD has three broad divisions: the A.Q. Khan Research Laboratory (Kahuta)

produces enriched uranium; the Pakistan Atomic Energy Commission is responsible for uranium mining, fuel fabrication, reactor construction and operation, and spent fuel reprocessing to produce plutonium; and the National Development Complex is responsible for weapons and delivery system research and production.²² These three bodies are managed by the National Engineering and Scientific Commission.

Pakistan's nuclear weapons are assigned to its Army Strategic Force Command, which has responsibility for ballistic and cruise missiles, and the Air Force Strategic Command, which deals with nuclear armed aircraft. Pakistan has a Naval Strategic Force Command, charged with exercising "technical, training, and administrative control over the strategic delivery systems," but it is not known if this command has yet been issued any nuclear weapons.²³ Pakistan may seek to put nuclear-armed cruise missiles on some of its submarines, or modify existing naval missiles to be nuclear capable.²⁴

Table 4: Pakistan's fissile material related facilities

Location	Facility Type	Material
Dera Ghazi Khan	Uranium mine, ore concentration plant, conversion plant	Uranium
Kahuta	Enrichment (Khan Research Laboratories)	HEU
Gadwal (Wah)	Enrichment (secondary plant)	HEU
Chaklala	Enrichment (pilot plant)	HEU
Sihala	Enrichment (pilot plant)	HEU
Golra	Enrichment (pilot plant)	HEU
Khushab-I	Heavy-water reactor 40–50MWt	Plutonium
Khushab-II	Heavy-water reactor 40–50MWt	Plutonium
Khushab-III	Heavy-water reactor 40–50MWt (under construction)	Plutonium
Khushab-IV	Heavy-water reactor 40–50MWt (under construction)	Plutonium
Chashma (Khushab)	Reprocessing facility (under construction)	Plutonium
Rawalpindi	Reprocessing facility-I (New Laboratories)	Plutonium
Rawalpindi	Reprocessing facility-II (New Laboratories)	Plutonium
Khushab-I and II	Tritium production	Tritium
Chashma (Kundian)	Reactor fuel-fabrication plant	
Multan	Heavy-water production facility	
Khushab	Heavy-water production facility	

Source: Adapted and updated from Nuclear Black Markets: Pakistan, A.Q. Khan and the Rise of Proliferation Networks, International Institute of Strategic Studies, London, 2007.

ECONOMICS

Pakistan releases no information on its nuclear weapon budget. Historically, the government has not even provided a breakdown of its overall military spending plans to parliament as part of the annual national budget. The annual military budget was debated in parliament in 2008 for the first time since 1965.²⁵

The secrecy about the history and scale of the nuclear weapon and missile programmes, the extent of external technical and material support, and the effect of indirect support through military and economic aid means the full cost of Pakistan nuclear weapons programme cannot be estimated with any reliability. Pakistan's nuclear weapons programme is a state programme. Private companies are involved to the extent that they serve as agents to procure materials and technologies from the international market, including the black market, which would not otherwise be available for sale to Pakistan because of export controls that seek to prevent nuclear proliferation.

In 2001, retired Major-General Mahmud Ali Durrani suggested that Pakistan's annual expenditure on "nuclear weapons and allied programs" was about \$300–400 million (USD) and that Pakistan "will now need to spend enormous amounts of money for the following activities: a) a second strike capability; b) a reliable early warning system; c) refinement and development of delivery systems; d) command and control systems."²⁶ Citing an earlier estimate by Rammanohar Reddy for the cost of nuclear weapons development by India, General Durrani also suggested that Pakistan might

of 2011, and possibly as much as \$2 billion per year if health and environmental costs are included—and projected to rise significantly because of Pakistan's expanding nuclear programme.²⁹ This estimate relies on an unsubstantiated 2009 Pakistani newspaper report that annual spending on "core classified development programs" was not more than Rs. 10 billion and that overall the "strategic organisations of the country... got less than 0.5 per cent of the GDP."³⁰

Assuming that Pakistan spends on the order of 0.5% of GDP on its nuclear weapons, and using purchasing power parity rather than market exchange rates to convert Pakistani rupees to US dollar equivalents, suggests that in 2009 nuclear weapon programme spending amounted to about \$2.2 billion a year (the GDP was about \$441 billion in purchasing power parity, and \$162 billion in nominal terms).³¹ For 2011, the nominal GDP was \$211 billion, about \$484 billion in purchasing power parity terms. This would suggest that in 2011 Pakistan spent about \$2.4 billion on its nuclear weapons programme.

For Pakistan to spend about \$2.5 billion per year on its nuclear weapons is feasible. The annual official military spending for 2011–2012 was budgeted at Rs. 444.2 billion, a 30% increase from the previous year.³² Reports suggest this military budget does not include military pensions and various other direct and indirect costs associated with the armed forces and that including these costs would increase Pakistan's total military budget for 2011 to around Rs. 675 billion (about \$21 billion, using current purchasing power parity exchange rates).³³ This would suggest that, in purchasing power terms, as

THE SECRECY ABOUT THE HISTORY AND SCALE OF THE NUCLEAR WEAPON AND MISSILE PROGRAMMES, THE EXTENT OF EXTERNAL TECHNICAL AND MATERIAL SUPPORT, AND THE EFFECT OF INDIRECT SUPPORT THROUGH MILITARY AND ECONOMIC AID MEANS THE FULL COST OF PAKISTAN NUCLEAR WEAPONS PROGRAMME CANNOT BE ESTIMATED WITH ANY RELIABILITY.

need to spend about 0.5% of gross domestic product (GDP) for a period of at least ten years on such nuclear weapons activities.²⁷

A significant increase in nuclear weapon spending after 2000 (when SPD had been established) was affirmed by Pervez Musharraf, who held the positions of Chief of Army Staff and President. In 2004, in a speech at an army garrison, General Musharraf claimed that during the previous three to four years the government had spent more on the nuclear weapons programme than in the previous 30 years.²⁸ This would be consistent with the large expansion in fissile material production capabilities and new missile system development after 2000. Musharraf indicated that the spending increase was part of a 15 year plan.

A more recent estimate suggests Pakistan's nuclear spending could be about \$800 million per year as

of 2011, Pakistan spent the equivalent of about 10% of its conventional military budget on nuclear weapons.

Pakistan is not reliant only on its own resources to support its military spending, including on nuclear weapons, or to meet its development needs. Since 2001, Pakistan has received an estimated \$22 billion in military and economic assistance from the United States, of which over \$14 billion was military assistance and over \$7 billion was economic aid of various kinds.³⁴ The Congressional Research Service reported that in 2006, the United States signed arms deals with Pakistan for over \$3.5 billion, including for 36 new F-16 jet fighters (\$1.4 billion) and associated missiles and bombs (over \$640 million) and upgrades for Pakistan's existing, older F-16 fighters (\$890 million).³⁵

Reflecting its concerns after September 2001 about the vulnerability of Pakistan's nuclear weapon and

fissile materials to seizure by Islamist militants, the United States has provided Pakistan on the order of \$100 million worth of assistance to secure its nuclear weapons, facilities, and materials.³⁶ This has included “training of Pakistani personnel in the United States and the construction of a nuclear security training center... [and] a raft of equipment from helicopters to night-vision goggles to ... fencing and surveillance systems, and equipment for tracking nuclear material if it left secure areas.”³⁷

Pakistan has also received extensive military assistance from China for its nuclear weapons, missile, and conventional weapons programmes.³⁸ According to A.Q. Khan, in the early years of Pakistan’s uranium enrichment programme, China supplied 15 tons of uranium hexafluoride (the gas used in centrifuges), 50 kg of weapon-grade HEU (enough for two weapons), the design details for a nuclear weapon, and technical help with the nuclear weapons programme.³⁹ Khan claims he provided China with the details of the European uranium enrichment gas centrifuges that Khan had acquired and provided training for Chinese technicians.⁴⁰

China’s conventional military assistance to Pakistan is beginning to rival the scale of support provided by the United States. In 2011, China agreed to fully fund the sale of 50 JF-17 jet fighters with advanced avionics to Pakistan.⁴¹ According to Pakistan’s Defence Minister Ahmad Mukhtar, these jets cost about \$20–25 million each, which suggests that the total cost of the 50 JF-17 deal with China is about \$1 billion or more.⁴² Pakistan is also seeking to buy six new submarines from China.⁴³ Pakistan dependence on military assistance from China is likely to grow as Pakistan’s poor relations with the United States worsen.

Despite extensive foreign military assistance, Pakistan’s effort to sustain its conventional and nuclear military programmes has come at increasingly great cost to the effort to meet basic human needs and improve living standards. Pakistan’s economic and social development expenditure in 2010–2011 was Rs. 617 billion, i.e. about 10% less than the spending on conventional military forces.⁴⁴ The 2011 budget increased military spending by over Rs. 50 billion, but cut social and economic development spending by Rs. 100 billion.

Given its high levels of military spending and poor government finances because of governance failures, Pakistan is dependent on economic aid to meet even basic development needs. In December 2011, the World Bank announced a \$5.5 billion aid package to support “poverty reduction and development” in Pakistan for the three-year period 2012–2014.⁴⁵ For comparison, between 1952 and 2003, the World Bank committed \$18.2 billion of aid to Pakistan.⁴⁶ A comparison of a different sort is offered by the estimated damage of \$10 billion caused by the 2010 floods in Pakistan that displaced some 20 million people and flooded over 50,000 square km area of land, and is described by the government

of Pakistan as an “unprecedented calamity”.⁴⁷ This amount is the equivalent of about four to five years of Pakistan’s estimated nuclear weapons spending.

INTERNATIONAL LAW

Pakistan is not a signatory to the nuclear Non-Proliferation Treaty (NPT), nor has it signed the Comprehensive Test Ban Treaty (CTBT), and it appears to recognize no international legal obligation to restrain or end its nuclear weapons and missile programme.⁴⁸ Pakistan has said, however, that it supports “negotiation of a nuclear weapons convention along with a phased programme for the complete elimination of nuclear weapons within a specified time frame.”⁴⁹

Pakistan has sought to block talks at the United Nations Conference on Disarmament on a possible international treaty banning the production of fissile materials for nuclear weapons (commonly known as a Fissile Material Cut-off Treaty or FMCT). Pakistan has argued that:

A cut-off in the manufacturing of fissile material must be accompanied by a *mandatory programme for the elimination of asymmetries* in the possession of fissile material stockpiles by various states. Such transfer of fissile material to safeguards should be made first by states with huge stockpiles, both in the global and regional context.⁵⁰

This position is driven by Pakistan’s long-running search for strategic parity with India. India is seen as having a larger stockpile of fissile materials and a potentially greater capacity to produce such material.⁵¹ Pakistan now cites in particular the nuclear deal between the United States and India, approved in 2008, ending the ban on the sale of nuclear materials and technology to India that had been in place since 1974, and the subsequent exemption granted to India from similar restrictions by the 46-nation Nuclear Suppliers Group (NSG). NSG guidelines had forbidden members from selling uranium, nuclear reactors, and fuel cycle technologies to countries that were outside the NPT because such sales could allow the target countries to expand their nuclear weapons programme.

In late 2011, Zamir Akram, Pakistan’s ambassador to the UN Conference on Disarmament, proposed that if Pakistan received a waiver from the NSG similar to the one granted to India, Pakistan would be willing to join talks on an FMCT.⁵²

While Pakistan has not accepted any legal restraint on its nuclear weapon, ballistic missile, or fissile material programmes, it is the subject, along with India, of a unanimous UN Security Council resolution calling for such restraint—Resolution 1172 (June 1998):

Calls upon India and Pakistan immediately to stop their nuclear weapon development programmes, to refrain from weaponization or from the deployment of nuclear weapons, to cease development of ballis-

tic missiles capable of delivering nuclear weapons and any further production of fissile material for nuclear weapons, to confirm their policies not to export equipment, materials or technology that could contribute to weapons of mass destruction or missiles capable of delivering them and to undertake appropriate commitments in that regard.⁵³

As of 2012, Pakistan is clearly in violation of this Security Council resolution, as is India.

PUBLIC DISCOURSE

Nuclear weapons have played a major role in Pakistan's domestic political discourse for over 30 years. Prime Minister Zulfikar Ali Bhutto, who launched the nuclear weapons programme in 1972, famously declared that Pakistan would get the bomb even if its people had to eat grass. Since then, Pakistani governments have sought to create a positive image of the nuclear weapons programme, often by linking it to national pride and national identity.

The official effort to build public support for the nuclear weapons programme was clearly evident on the first anniversary of the 1998 nuclear tests, which the government had declared to be the 'Day of Deliverance.' The government ordered ten days of national celebrations.⁵⁴ The state media was deployed with national television and radio networks all carrying programmes on the nuclear tests. Cities and towns were decorated with banners and posters of leading nuclear weapons scientists and the Prime Minister against a backdrop of mushroom clouds. Replicas of Pakistan's ballistic missiles and giant models of the mountain where the test were carried out were put up in several cities. Public events included competitions to find the ten best patriotic songs, fairs, marches, sports events, and special prayers. Such events have continued, albeit on a smaller scale, and without state sponsorship, largely organized by right-wing Islamist and nationalist political parties and groups.⁵⁵

Pakistan's major political parties publicly support the nuclear weapons programme. Zulfikar Ali Bhutto's Pakistan People's Party (PPP), including under its leader Benazir Bhutto, claims credit for the nuclear programme. The PPP has been the governing party in Pakistan since the 2008 elections. Pakistan's other major political party, the Pakistan Muslim League (PML), also claims credit for the bomb, pointing out that it was a PML government led by Prime Minister Nawaz Sharif that ordered the 1998 nuclear tests. The party in government claims credit for new developments such as new production facilities and missiles, and Prime Ministers make a point of inaugurating new nuclear facilities and are photographed at nuclear missile tests.

Military leaders also publicly emphasize the importance of the nuclear weapons programme. In the wake of the September 2001 attacks on the United States,

General Pervez Musharraf, who had seized power in a coup in 1999, addressed the Pakistani nation and explained that Pakistan faced a critical choice: support the United States in the imminent war against Al-Qaeda and the Taliban in Afghanistan or suffer the consequences. He explained, "We have to save our interests. Pakistan comes first, everything else is secondary."⁵⁶ Musharraf said that "our critical concerns are our sovereignty, second our economy, third our strategic assets (nuclear and missiles), and forth our Kashmir cause." To defend these interests, Pakistan gave its support to the United States and abandoned its Taliban allies.

The central thrust of most public debate about Pakistan's nuclear weapons is the struggle with India that has shaped Pakistan's history and politics since the two countries were formed by the partition of British India into independent states. Pakistan's nuclear weapons are widely seen as a response to India's nuclear weapons and its larger conventional military forces, and the experience of wars in 1947, 1965, 1971, and 1999. Pakistani fears of Indian hegemony have increased in recent years as India's economy has started to grow at a much faster rate than Pakistan's and as India has increased its already much larger military budget at a much faster rate. A longer-term concern now driving Pakistan's nuclear programme is the United States' policy of countering the rise of China as a potential great power competitor by cultivating a much stronger US strategic relationship with India. This latter concern may tie the future of Pakistan's nuclear weapons, and those of India, to the emerging contest between the United States and China.

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RUSSIAN FEDERATION

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STATUS OF RUSSIA'S NUCLEAR FORCES

The structure and composition of Russia's nuclear forces largely reflect the evolution of the force that was created by the Soviet Union during the cold war. Russia continues to maintain the strategic triad of land-based intercontinental missiles, submarines with sea-launched ballistic missiles, and long-range bombers. In addition, Russia has kept its arsenal of tactical nuclear weapons, which is believed to include weapons that could be deployed on submarines, short- and intermediate-range aircraft, and air-defense missiles. Interceptors of the Moscow missile defence system are also believed to carry nuclear warheads.

Russia also maintains the infrastructure that was built to support operations of nuclear forces—an early-warning system that includes satellites and radars, and a command and control system that could allow the strategic forces to operate in the extreme conditions of a nuclear attack.

Nuclear weapons: stocks, deployed, storage, dismantlement

According to the most recent New START data exchange, in September 2011 Russia had 516 operationally deployed strategic launchers that carried 1,566 nuclear warheads.¹ The actual number of delivery systems and warheads in the strategic arsenal is somewhat higher, mostly because New START does not accurately account for warheads associated with strategic bombers. Overall, as of 2011, Russia was estimated to have about 2,430 warheads in its strategic arsenal.²

The number of warheads associated with non-strategic delivery systems is somewhat harder to estimate, for Russia never disclosed information about its tactical nuclear forces. It is believed to have about 2,000 non-strategic warheads that could be considered operational.³ According to Russia's official statements, all these warheads are consolidated at centralized storage facilities.⁴

In addition to warheads that are associated with operationally deployed strategic and non-strategic systems, Russia has a substantial number of warheads awaiting dismantlement. This category is estimated to include about 3,000 strategic and up to 3,300 tactical warheads.⁵

These estimates suggest that Russia has a total arsenal of about 11,000 nuclear warheads. Non-deployed

nuclear warheads and the warheads that are awaiting dismantlement are stored at centralized facilities managed by the 12th Main Directorate of the Ministry of Defence.⁶

Russia does not maintain a large stock of reserve inactive warheads that could be operationally deployed at a relatively short notice. Instead, it has traditionally relied on its capability to remanufacture warheads as necessary. It is estimated that Russia remanufactures about 200 warheads each year.⁷

The number of warheads associated with operationally deployed strategic and non-strategic systems is unlikely to change significantly, since the deployment of new systems in the course of strategic modernization will be balanced by withdrawal of old warheads. The total number of warheads will probably decline in the coming years as Russia will continue its warhead dismantlement programme. The current dismantlement rate is believed to be about 400–500 warheads a year (this number includes warheads that are being remanufactured).⁸

Russia's warhead manufacturing capacity is sometimes quoted as giving it a capability to quickly increase the number of deployed nuclear warheads. While theoretically some of this capability does exist, in practice the number of warheads that Russia could deploy is determined by the availability of delivery vehicles rather than warheads. This is particularly true for strategic weapons—the number of warheads that Russia declared as operationally deployed (1,566 in September 2011)—its very close to the maximum number of warheads that Russia's deployed missiles can carry, so any "surge capacity" that Russia may have is quite insignificant.

Delivery systems

Russia maintains the strategic nuclear triad that that was built during the Soviet years—land-based intercontinental ballistic missiles (ICBMs), strategic nuclear submarines with submarine-launched ballistic missiles (SLBMs), and long-range bombers.

Land-based intercontinental missiles

The Strategic Rocket Forces that operate the ICBM leg of the strategic triad historically has been the largest component of the Soviet and Russian strategic forces. It currently includes about 330 operationally deployed

ballistic missiles of five different types that carry about 1100 warheads.⁹

The oldest ICBMs in the force are liquid-fuel silo-based missiles that carry multiple independently-targeted reentry vehicles (MIRV)—R-36M2 (Western designation SS-18) with ten warheads and UR-100NUTTH (SS-19) with six warheads. As of the end of 2010, the Strategic Rocket Forces had about 55 R-36M2 missiles and about 50 missiles of the UR-100NUTTH type. These missiles carry almost 840 warheads, more than half of all Russia's operationally deployed strategic nuclear warheads. In addition, Russia has two types of single-warhead missiles—about 140 road-mobile Topol (SS-25) missiles and 70 missiles of the Topol-M (SS-27) type, which are deployed both as road-mobile and as silo-based missiles. In 2010 Russia also began deployment of a MIRVed version of the Topol-M missile. Known as RS-24 Yars, the missile is believed to carry up to four independently targeted warheads.

The main problem that Russia is facing regarding the land-based component of its strategic triad is that most of the currently operational ICBMs have reached the end of their lives and are being withdrawn from service. The SS-19 missiles were deployed in the early 1980s and although their service life was extended to 33 years, the missiles will have to be decommissioned in the next few years. Single-warhead SS-25 Topol missiles also have been removed from service for several years now, even though their service life has been recently extended to 25 years.¹⁰ All these missiles are expected to be withdrawn from service by 2020.¹¹

As a result of this process, by 2020 Russia's ICBM force will consist of about 50 R-36M2/SS-18 MIRVed silo-based missiles and some 180 Topol-M and RS-24 ICBM, deployed in silos and on road-mobile launchers.¹² The R-36M2 modification of the SS-18 missile, which was produced and deployed in the late 1980s/early 1990s, could probably stay in service as long as until 2026, provided its service life is extended to 33 years, which seems likely.¹³ Topol-M and its R-24 MIRVed version are relatively new missiles—the first Topol-M was deployed in 1997 and most of these missiles would probably be able to remain on duty until 2025-2030.

This composition of the force will allow Russia to maintain the size of the ICBM leg of the strategic triad at the level of about 1000 warheads through at least the mid-2020s.¹⁴ The Rocket Forces would therefore preserve their status as the key component of the strategic triad. To deal with the inevitable withdrawal from service of R-36M2 missiles, Russia has started development of a new MIRVed liquid-fuel ICBM that is supposed to replace R-36M2. This project is covered in more detail in the section on modernization.

Strategic submarines

As of the end of 2011, Russia's strategic submarine force included six Project 667BDRM (Delta IV) subma-

ines and three submarines of the older Project 667BDR (Delta III) class. Each submarine carries 16 SLBMs—R-29RM with four warheads and R-29R with three warheads respectively. While the total number of nuclear warheads that can be deployed on SLBMs is more than 500, about two submarines are in overhaul at any given time, which means that the number of operationally deployed SLBM warheads is about 400.¹⁵

Submarines of the Project 667BDR class are currently based at the Pacific fleet base Vilyuchinsk at the Kamchatka peninsula. They will probably be withdrawn from service in the next few years and will be replaced by new Project 955 Borey submarines.

Most of the Project 667BDRM submarines underwent an overhaul in the last decade or so and would probably be able to stay in service for additional 10–15 years and probably longer. As part of the overhaul the submarines are receiving newly manufactured missiles of the R-29RM/SS-N-23 type. These missiles, known as Sineva, are essentially a moderate modification of the original liquid-fuel R-29RM missiles that submarines of this class were carrying before the overhaul. Russia has also tested a modification of the R-29RM Sineva SLBM that can carry up to ten warheads.¹⁶ This version of the missile, known as Liner, could be deployed on submarines alongside with the regular R-29RM Sineva missiles, increasing the number of SLBM warheads if necessary.

In 2012, Russia is expected to accept for service the first Project 955 Borey submarine equipped with the new Bulava SLBM. This will be a significant milestone for the programme that has experienced serious delays from the very beginning. Construction of the lead ship of the Project 955 class, Yuri Dolgorukiy, began in 1994, but initially it was designed to carry a different type of SLBM. In 1998, the government made the decision to develop the Bulava missile instead, resulting in a significant delay in the program. The submarine was eventually delivered to the navy in 2011 and performed a series of test launches of the Bulava SLBM. Second submarine of this class, Alexander Nevskiy, began sea trials in October 2011.¹⁷ One more submarine, Vladimir Monomakh, is under construction.

Development of the Bulava missile encountered some technical problems—it failed in eight out of 12 flight tests conducted in 2005–2009. After a serious overhaul of the missile production process, the flight test program eventually had a string of successful launches in 2010–2011. This will allow the navy to accept the missile for service in 2012.¹⁸ It is likely that the first two Project 955 submarines with Bulava missiles will begin service in 2012–2013.

According to the current plan, the Russian Navy expects to receive eight new submarines of the Project 955 class. Each submarine will be equipped with 16 missiles that are projected to carry up to six warheads each. If the Project 955 construction program is com-

pleted as planned, these submarines would be able to carry 128 missiles with 768 nuclear warheads. These submarines will replace Project 667BDR ships in the Pacific and eventually some of the Project 667BDRM submarines as well.

The strategic fleet rearmament programme is unlikely to significantly increase the size of the SLBM leg of the strategic triad. Taking into account the submarines in overhaul, the number of operationally deployed SLBM warheads will remain on the level of 400–500 warheads.

Strategic bombers

Strategic bombers traditionally played a secondary role in Soviet and then Russian nuclear postures. That role is unlikely to change in the future—there are no plans to do so. The modernization programme that is currently underway is aimed primarily at maintaining the strategic bomber force in its current configuration and giving the bombers the capability to carry out conventional missions.

In 2011, Russia had 72 heavy bombers—13 Tu-160 aircraft and 59 turboprop Tu-95MS. Together, these bombers are capable of carrying more than 800 air-launched cruise missiles, although the actual number of cruise missiles that are available for deployment is probably somewhat smaller. According to the New START accounting rules, each bomber is counted as carrying a single nuclear warhead, reflecting the fact that no bombers are routinely deployed with nuclear armaments and therefore cannot be considered as operationally deployed.

Most of the currently operational bombers were built in the late 1980s, so they are currently undergoing overhaul to extend their service life. As part of this process, which is expected to take up to 15 years, Tu-160 aircraft receive an upgrade of their avionics, which is supposed to equip them for missions with conventional high-precision munitions. Tu-95MS bombers also receive a moderate upgrade, but it appears that they will continue to be assigned nuclear missions.¹⁹

Early warning and command and control

In addition to maintaining the full strategic triad, Russia has preserved key elements of the infrastructure that supports operations of strategic nuclear forces—the early-warning and command and control systems. It also operates a missile defence system deployed around Moscow that is supposed to protect the capital from a limited missile attack.

The early-warning system includes two tiers—a network of radars that could detect incoming missiles and a constellation of satellites that could provide early detection of missile launches.

Most of the early warning radars that were built during the Soviet time were located outside of Russia, so after the breakup of the Soviet Union Russia lost a

number of important nodes of the network—Skrunda in Latvia, Mukachevo and Sevastopol in Ukraine. However, Russia preserved the capability to use the radars in Belarus, Azerbaijan, and Kazakhstan. In the 2000s, Russia also began deployment of new radars on its own territory that will eventually allow it to phase out those that are located outside Russia.

At the end of 2011, the Russian network of early warning radars included two old Daryal radars in Pechora and Gabala, Azerbaijan, built in the early 1980s. One Volga radar is operating in Baranovichi, Belarus. This radar is relatively new—it has been fully operational since 2002. Older radars of Dnestr-M/Dnepr type are deployed in Olenegorsk, Mishelevka (near Irkutsk), and Balkhash, Kazakhstan. These radars were built in the 1970s.

There are two types of new early warning radars that Russia has been deploying since the mid-2000s—Voronezh-M and Voronezh-DM. The first Voronezh-M radar was deployed in Lekhtusi (near St.-Petersburg) in 2006. Two Voronezh-DM radars have been built in Arnavir at the south of Russia—they will replace the radars in Ukraine and Azerbaijan. A Voronezh-DM radar in the Kaliningrad region began initial operations in 2011. Two Voronezh-M radars are being built in Mishelevka and one Voronezh-DM radar is expected to be built in Barnaul. The radars in Pechora and Olenegorsk will be replaced by new Voronezh-type radars as well.²⁰

The space-based component of the early-warning system in 2011 included four satellites placed on highly-elliptical orbits. The satellites worked as part of the system, known as US-KS, which first became operational in 1982. The current system is capable of detecting missile launches from the territory of the United States, but does not seem to be able to see launches originated elsewhere.²¹ Russia is developing a new space-based system, known as EKS, that will provide more reliable coverage of all areas of possible missile launches. The new system is expected to enter the flight test stage in 2012–2013.²²

The currently deployed command and control system that provides communication between the central command authority and individual launchers has been described as a “third-generation” system. According to the Russian military, this system provides the Strategic Rocket Forces not only with the capability to control individual launchers, but also with the flexible targeting capability.²³ In 2012 the Strategic Rocket Forces are planning to begin deployment of a “fourth-generation” command and control system.²⁴

The missile defence system deployed around Moscow, known as A-135, includes the Don-2N battle-management radar in Pushkino and 68 short-range interceptors of the 53T6 (Gazelle) type, deployed in silos at five sites near Moscow. In the past, the system also included 32 long-range interceptors, but they have been withdrawn from the system. The interceptors are

believed to be equipped with nuclear warheads. The system has only a limited capability against a ballistic missile attack. According to Soviet estimates made at the time the system was being built, A-135 is able to intercept one or two “modern ICBMs”.

Fissile materials

Russia’s stock of weapon-grade materials is far larger than it would be necessary to support the current nuclear force. At the end of 2011 Russia was estimated to have about 128±8 tonnes of weapon-grade plutonium, of which 88 tonnes is either in weapons or available for military purposes, and about 737±120 tonnes of highly enriched uranium (HEU). Of this amount, about 666 tonnes are available for weapons and for fueling naval, research, and civilian reactors.²⁵

The total amount of weapon-grade plutonium produced in Russia is estimated to be 145±8 tonnes. About 17 tonnes have been used in nuclear tests or lost in waste or lost nuclear warheads.²⁶ Russia shut down most of its plutonium production reactors in the early 1990s. Three reactors, however, continued to operate until 2008–2010, since they provided heat for nearby cities.²⁷ About 15 tonnes of plutonium that have been produced by these reactors after September 1994 are covered by Russia’s pledge not to use it for military purposes. Also, Russia declared 25 tonnes of plutonium from its pre-1994 stock as excess to national security needs. This material is not available for military purposes as well, leaving the potential military stock of 88 tonnes.

The 25 tonnes of excess military plutonium and 9 tonnes of the plutonium produced after 1994 will be eliminated as part of Russia’s obligations under the US-Russian Plutonium Management and Disposition Agreement that was finalized in April 2010.²⁸ In September 2010 the United States and Russia invited the International Atomic Energy Agency (IAEA) to establish verification measures with respect to the plutonium disposition program.²⁹

The plutonium disposition program in Russia will include elimination of the weapon-grade plutonium in fast reactors. Only one of these reactors, BN-600, is currently operational. The second one, BN-800, is currently under construction and is expected to begin operations in 2014. In order to begin the plutonium elimination activities, Russia will have to develop the technology to produce plutonium-containing fuel assemblies for the BN reactors and to build a facility that will manufacture the fuel. The United States and Russia pledged to commit about \$3 billion toward this goal (\$300 million provided by the United States), but they do not expect the disposition activities to begin before 2018.³⁰

In addition to the weapon-grade plutonium, as of the end of 2010 Russia had 48.4 tonnes of unirradiated separated civilian plutonium.³¹ Virtually all this material is stored at a dedicated storage facility at the RT-1 reprocessing plant at the Mayak Combine.

The Soviet Union stopped production of highly enriched uranium (HEU) in 1988. Before that it had produced about 1470±120 tonnes of 90% HEU equivalent. About 287 tonnes of HEU have been used in various applications, military as well as civilian.³² In addition to the weapons complex, among the largest users of HEU in Russia are the submarine fleet, civilian nuclear-powered ships, and the two tritium production reactors. Also, Russia operates more than 80 research reactors, critical and subcritical assemblies that use highly-enriched uranium.³³

There are two major HEU elimination programmes in Russia—the US-Russian HEU-LEU deal, also known as the Megatons to Megawatts programme, and the Material Conversion and Consolidation project. The HEU-LEU program blends down military-origin HEU to produce low-enriched uranium that is then used to fuel US nuclear reactors. The programme, which began in 1996, will eliminate 500 tonnes of HEU by 2013, when it is scheduled to end. As of the end of 2011, it has successfully eliminated 442.5 tonnes of HEU.³⁴ The Material Conversion and Consolidation project is also a joint US-Russian effort. It provides Russian research facilities with US financial assistance in order to eliminate their stocks of HEU by blending it down. The amount of HEU eliminated by the program was expected to reach 13.5 tonnes by October 2011 and 17 tonnes by October 2015, when the programme will end.³⁵

To sum this up, the two programmes eliminated 456 tonnes of HEU as of the end of 2011. They are expected to eliminate additional 61 tonnes in the coming years. This leaves about 666 tonnes of HEU that is available for military or civilian use.

Most of the military nuclear material that is not in use is stored at one of the large storage facilities managed by the Rosatom State Corporation. These facilities are located in so-called closed cities—Ozersk, Seversk, Zheleznogorsk, Sarov, and Snezhinsk.³⁶ The weapon-origin plutonium that Russia declared excess to its national security needs has been moved to the Fissile Material Storage Facility at Mayak, which Russia built with US assistance.³⁷ The facility is expected to store 25 tonnes of weapon-origin plutonium.³⁸ The weapon-grade plutonium produced after 1994, which Russia pledged not to use for weapons purposes, will be stored in Zheleznogorsk.³⁹

DEVELOPMENT AND PRODUCTION INFRASTRUCTURE

Nuclear weapons

The work on nuclear weapons development is the responsibility of nuclear weapon laboratories that are subordinated to the State Corporation Rosatom—the All-Russian Scientific Research Institute of Experimental Physics (VNIIEF) in Sarov (formerly Arzamas-16) and the All-Russian Institute of Technical Physics (VNI-

ITF) in Snezhinsk (Chelyabinsk-70). The third laboratory, the All-Russian Institute of Automatics (VNIIA) in Moscow, is involved in weapon research that does not deal with fissile material components. The laboratories also take part in civilian research programs.

The weapon laboratories conduct research that allows them to maintain the current nuclear arsenal and develop new nuclear warheads. In particular, they developed warheads for new ballistic missiles that are introduced to active service—Sineva, Bulava, RS-24, and Liner.⁴⁰ The new warheads are reportedly based on the designs that were tested before the end of nuclear testing in Russia. To support the weapon development process Russia conducts subcritical experiments at the nuclear test site at Novaya Zemlya and relies on computer models.

In addition to weapon development, Rosatom is responsible for all aspects of fissile material production and for storage of military-related nuclear material that is not used in weapons or in other military applications (e.g. fuel of naval reactors).

In the past, Rosatom operated plutonium production reactors at the Mayak Plant in Ozersk (Chelyabinsk-65), Siberian Chemical Combine in Seversk (Tomsk-7), and the Mining and Chemical Combine in Zheleznogorsk (Krasnoyarsk-26). All these reactors have been shut down. In 2012 Rosatom is expected to close the chemical reprocessing plant in Zheleznogorsk that has been extracting weapon-grade plutonium from spent fuel of production reactors.⁴¹ The military reprocessing plants in Seversk and Ozersk have been shut down earlier.

The Mayak Plant continues to operate two production reactors, Ruslan and Lyudmila, that were built to provide tritium for the weapon program. Since Russia has plenty of tritium from dismantled weapons, these reactors have been converted to the production of isotopes for civilian purposes. However, they maintain the capability to produce tritium if necessary.⁴²

Russia's uranium enrichment complex includes the Urals Electrochemical Plant in Novouralsk (Sverdlovsk-44), Siberian Chemical Combine in Seversk (Tomsk-7), Electrochemical Plant in Zelenogorsk (Krasnoyarsk-45), and Electrolyzing Chemical Combine in Angarsk. All these facilities operate gaseous centrifuges to enrich uranium. With the exception of Angarsk, all of them were involved in production of HEU for the military programme, which was discontinued in 1988. Today, all enrichment plants produce low-enriched uranium for civilian purposes.⁴³

Russia operates two major warhead assembly and dismantlement facilities—the Electrochemical Instrument Combine in Lesnoy (Sverdlovsk-45) and the Instrument Building Plant in Trekhgornyy (Zlatoust-36).⁴⁴ The plant in Lesnoy has the capability to produce and handle HEU components for nuclear weapons. Plutonium components of nuclear charges are handled at the metallurgical facilities of the Mayak Plant, which can

also produce HEU components.⁴⁵ The weapon laboratories, VNIIEF and VNIITF, also have small-scale material handling and warhead assembly and disassembly facilities. All these facilities provide Russia with the capability to maintain its current active nuclear arsenal by providing the necessary remanufacturing capability.

Delivery systems

Development of land-based and sea-based ballistic missiles is mostly concentrated in two design bureaus that act as primary contractors for a strategic system. The Moscow Institute of Thermal Technology (MIT) is the lead design organization for solid-propellant ballistic missiles. It has developed Topol (SS-25), Topol-M (SS-27), and RS-24 ICBMs and the Bulava SLBM. It is also working on a range of other projects. The second design bureau, the Makeyev State Missile Center in Miass, is the lead developer of submarine-launched ballistic missiles. The Center designed the R-29R and R-29RM SLBMs that are currently deployed on Project 667BDR and Project 667BDRM submarines. It also designed the new modifications of the R-29RM missile—Sineva and Liner. In 2011, the Makeyev design bureau was awarded a contract to develop a new liquid-fuel silo-based ICBM.⁴⁶

All solid-propellant ballistic missiles are produced at the Votkinsk Plant. There are three types of strategic missiles that are currently in production—Topol-M and its RS-24 Yars modification, and Bulava. Liquid-fuel missiles are produced at the Krasnoyarsk Machine-Building Plant. Today, the plant is manufacturing Sineva and Liner modifications of the R-29RM missile.

The lead design organization responsible for development of strategic submarines is the Central Design Bureau for Marine Engineering “Rubin” in St.-Petersburg. This design bureau developed all ballistic missile submarines of the Russian Navy—Project 667BD, Project 667BDRM, and Project 955. The only class of submarines that is currently in production is Project 955 Borey (and its modifications). These submarines are built at the Sevmash ship-building plant in Severodvinsk.

Strategic bombers that are currently in service—Tu-95MS and Tu-160—were developed by the Tupolev design bureau that remains the leading developer of long-range bomber aircraft. As of 2011, no new aircraft are being produced. However, some planes are undergoing modernization at the Kazan Aviation Plant (Tu-160) or at the Taganrog Aviation Plant (Tu-95MS).

ECONOMICS AND MODERNIZATION PLANS

Modernization of the strategic forces is part of the broader rearmament programme that is expected to spend 19 trillion rubles (about \$600 billion at the current exchange rate) on various military systems in 2011–2020. About 10% of the total funds allocated for

rearmament, or 1.9 trillion rubles, will be spent on the modernization of the strategic forces.⁴⁷ It should be noted, however, that the state rearmament program for 2006–2015, which was as ambitious as the new one, fell far short of its goals, so it is far from certain that the 2011–2020 programme will be completed as planned.⁴⁸

Military spending is one of the largest spending categories in Russia's federal budget. In 2012 the government expenditure is expected to reach 12.7 trillion rubles, which means that the rearmament programme will account for about 15 percent of the government spending. Indeed, the three-year budget plan assumes that the share of military spending in the budget will increase from 14.6 percent in 2012 to 18.8 percent in 2014. At the same time, the budget plan calls for reduction of a number of social programmes—for example, spending on education will decrease from 5.1% in 2011 to 3.4% in 2014; on health, from 4.6% to 3.2%.⁴⁹

The Russian government has not published a full account of specific strategic weapons modernization programmes or their cost. Nevertheless, the publicly available information allows one to outline the key elements of the strategic modernization effort.

Rearmament of the ICBM leg of the strategic triad concentrates on deployment of multiple-warhead RS-24 Yars missiles. These ICBMs will replace the currently deployed Topol (SS-25) and, to some extent, UR-100NUTTH (SS-19) missiles. Being a multiple-warhead missile, RS-24 allows Russia to keep the number of deployed warheads at the relatively high level without the need to produce a large number of missiles. At the same time, if future arms control agreements would require it, Russia could quickly reduce the number of deployed warheads without decommissioning its ICBMs.

In addition to the RS-24 deployment, Russia is working on a number of other ICBM projects. In 2011 the government made a decision to begin development of a new multiple-warhead liquid-fuel ICBM.⁵⁰ The new missile is supposed to be ready for deployment in 2016, although the development will almost certainly take longer. Another new ICBM is developed by the Moscow Institute of Thermal Technology. There is almost no information about this project beyond the fact that the missile failed in a test conducted in September 2011. It appears that it has not received a full approval yet.⁵¹

At this point, there are no plans to extend modernization of the strategic fleet beyond the planned construction of eight Project 955 submarines. Starting with the fourth or fifth hull, the submarines will receive an upgrade—the new submarine is known as Project 955A class—but the number of new submarines and the type of missiles they will carry will remain unchanged. Depending on the progress with construction of new submarines the six older ships of the Project 667BDRM class might stay in service longer than previously planned, probably until 2020. If so, they are likely to receive the Liner modification of the R-29RM SLBM,

which could carry up to ten warheads, allowing the navy to maintain the number of warheads in the sea-based leg of the strategic triad at the level of 400–500 warheads in the event of delay with the construction of Project 955 submarines.

As far as the strategic aviation is concerned, in the next few years Russia will continue an overhaul of its current strategic bomber fleet. At the same time, it started preliminary work on a new-generation strategic bomber, known as a PAK DA (Advanced Aviation System for the Long-Range Aviation). It is expected that the Tupolev Design Bureau will present a preliminary draft design of the new aircraft in 2012 and produce a prototype in 2020. The new bomber is not expected to enter service until about 2025.⁵²

Russia's strategic modernization plans demonstrate that it is determined to maintain its strategic nuclear forces and to preserve the parity with the United States in the number of warheads and delivery systems. Arms control and disarmament efforts could change these plans and result in a smaller force, but it is likely that most of the reductions would be done by reducing the number of deployed warheads rather than by eliminating strategic launchers.

Financial constraints could also affect the scale of strategic modernization. Although Russia has managed to minimize the effects of the recent economic recession, its economy is heavily dependent on export of natural resources, so a fall in oil and gas prices could force the government to reconsider its spending priorities. However, the rearmament effort appears to have strong support of the political leadership and the public, so significant cuts of the modernization programme are unlikely. This situation may change if the political environment in Russia would allow an open discussion of government spending priorities and the role of nuclear weapons in the national security policy, but so far this discussion has been very limited.

INTERNATIONAL LAW

Issues related to the legitimacy of nuclear weapons under the international law are rarely discussed in Russia. The official National Security Doctrine, approved in 2009, calls for maintaining “strategic stability” and lists strengthening Russia's strategic nuclear forces as one of the priorities of the national defense policy.⁵³ The military doctrine adopted in 2010 also emphasizes the role of Russia's nuclear forces in maintaining strategic stability in the world.⁵⁴

Although the official documents do not question Russia's right to possess nuclear weapons, they also recognize its responsibilities as a nuclear weapon state member of the nuclear Non-Proliferation Treaty (NPT). The national security doctrine recognizes the goal of building a world free of nuclear weapons as part of the overall progress toward strategic stability with equal

security for all.⁵⁵ High priority is also given to nuclear disarmament and to nuclear non-proliferation.

In its military doctrine, Russia reserves the right to use nuclear weapons “in response to a use of nuclear or other weapons of mass destruction against her and (or) her allies, and in a case of an aggression against her with conventional weapons that would put in danger the very existence of the state.”⁵⁶ While this policy assumes the right to a first use of nuclear weapons, the range of scenarios in which Russia would consider using nuclear weapons is somewhat limited. It should be noted that early versions of the military doctrine apparently included an option of preventive use of nuclear weapons, which was later removed from the document.⁵⁷

As part of the bilateral US-Russian nuclear arms reduction process, Russia has substantially reduced its strategic nuclear arsenal. Both countries consider these reductions to be their contribution toward the goals of article VI of the NPT.⁵⁸ In addition, Russia periodically reiterates its commitment to the US-Russian Presidential Initiatives of 1992, in which the two countries declared their intent to substantially reduce their arsenals of non-strategic nuclear weapons. Russia concentrated all its non-strategic nuclear weapons at centralized storage facilities on its national territory.⁵⁹ However, Russia has been reluctant to discuss legally-binding measures related to its tactical nuclear weapons before the United States removes its nuclear weapons from Europe.

PUBLIC DISCOURSE

Public opinion in Russia tends to support the nuclear status of the country—according to a poll conducted in 2006, 76 percent of all the respondents believed that Russia “needs nuclear weapons.” More than half of the population consider nuclear weapons to be the main guarantee of the security of the country and about 30 percent of respondents believe that nuclear weapons play an important, although not a decisive, role.⁶⁰

The public discussion of issues related to nuclear weapons reflects these attitudes—their role in providing for the security of the country is almost never questioned. To a large extent, the lack of critical assessment of the role of nuclear weapons is a result of the lack of an open and informed discussion of national security priorities and policies that would involve independent voices. While there are non-governmental research organizations that are involved in the discussion of defence policies, there are no independent public organizations that would have nuclear weapons related issues on the agenda. Accordingly, the public discussion is focused largely on technical issues of US-Russian arms control negotiations and nuclear non-proliferation.

The strategic modernization programme described above is also rarely criticized, despite its very substantial cost. The government has presented the programme

as an essential element of the strategy that would allow Russia to maintain its nuclear arsenal and to preserve approximate parity with the United States. This strategy, in turn, has been described as the only way to preserve the sovereignty of the country and its status in international affairs.⁶¹ In general, public opinion in Russia tends to view favourably the efforts to support the defence industry and introduce modern equipment to the armed forces.⁶² Government policy and public attitudes combine to ensure that the strategic modernization efforts undertaken by the Russian government will continue as one of the high-priority programmes that are unlikely to be affected by budgetary pressures.

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UNITED KINGDOM

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STATUS OF UK'S NUCLEAR FORCES

Nuclear weapons

Stocks

In its Strategic Defence and Security Review, published in September 2010, the UK government announced that it had a total stockpile of “not more than 225” Trident nuclear warheads and that this would be reduced to “not more than 180” by the mid 2020s.¹

The UK Trident warhead shares some common features with the American W76 design, but it is not identical. At least three of the key components in the UK warhead are purchased from the United States, but the high explosive is British.² In 1978 and 1979 the UK conducted a series of nuclear tests to develop its own small high-yield warhead design.³ This could be the basis of its Trident warhead. On the other hand, the UK received information on the W76 design from the United States in August 1980.⁴ The W76 is thought to have a yield of around 100 kilotons. An analysis of British nuclear tests between 1982 and 1991 suggests that the yield of the UK warhead is between 80 and 110 kilotons.⁵

For most of the Cold War, the UK deployed sub-strategic nuclear weapons. In 1993 the government abandoned its plan to build a new air-launched weapon, which would have continued this capability. The free-fall WE-177 nuclear bombs were reaching the end of their life. In order to retain some ability to launch a limited nuclear strike, the Ministry of Defence (MoD) allocated the sub-strategic role to its sole remaining nuclear force, Trident. In March 1998, George Robertson, Defence Minister, said that the UK “has some flexibility in the choice of yield for the warheads on its Trident missiles.”⁶ The White Paper on Trident replacement in December 2006 referred to “the continuing availability of a lower yield from our warhead.”⁷ The number of lower-yield warheads is not known, but these are likely to constitute only a small proportion of the total stockpile.

Deployed

The number of armed Trident submarines fluctuates because of the submarine refit cycle. Each submarine carries out a series of trials for around one year after completing a major refit. During this post-refit

period, only two Vanguard class submarines are armed with Trident missiles. At other times, there are three armed submarines.

In 2010 each armed submarine carried a maximum of 48 warheads. The MoD is reducing this “over the next few years” to a maximum of 40 per submarine.⁸ This was implemented on one submarine by June 2011.⁹

Currently the UK maintains some warheads in an operational state in addition to those on submarines. In 2010 there were “fewer than 160” operationally available warheads. This is 16 more than the maximum number that could be carried on three armed submarines. Over the next few years the total number of operationally-available warheads will be reduced to “no more than 120,” which is the same as the new maximum number for three armed submarines.¹⁰

Storage

Warheads that are not deployed on submarines are stored in the Re-entry Body Magazine at the Royal Naval Armaments Depot Coulport. Storage capacity at the warhead assembly site, the Atomic Weapons Establishment (AWE) Burghfield, is limited to work-in-progress and warheads awaiting dispatch.

Dismantlement

The decommissioning of WE-177 nuclear bombs was completed by March 1998.¹¹ Disassembly of the Chevaline warhead, which was replaced by Trident, was completed by February 2002.¹² AWE may still retain the plutonium pits from some of these warheads.

Delivery systems

The UK's only nuclear delivery system is the Trident D5 missile. The US Strategic Systems Program (SSP) supplies all the components of the D5 system including missiles, launcher, fire control, guidance, and navigation.

The UK has tested a Trident D5 missile over a range of 5,000 nautical miles.¹³ When equipped with the Mk4 Re-entry Body, each missile can carry a total of 12 objects. Some of these are nuclear warheads and the remainder are decoys.

Until 2010 each of the two or three armed Vanguard class submarines carried between 12 and 14 operational D5 missiles. This will be reduced to eight missiles per submarine over the next few years.¹⁴

Fissile materials

When the UK government decided to acquire the Trident system, it calculated that it would need significant additional stocks of plutonium and highly enriched uranium (HEU).¹⁵ Plutonium was produced in the UK.¹⁶ HEU was procured from the United States.¹⁷

An analysis of published movements of plutonium through AWE suggests that Calder Hall and Chapelcross power stations produced over 1 tonne of weapon-grade plutonium for the Trident programme between 1985 and 1995.¹⁸ The stockpile of military plutonium rose to 3.5 tonnes by 1995, when the UK ceased production of fissile materials. In 1999 the MoD placed 0.3 tonnes of weapon-grade plutonium under international safeguards, leaving 3.2 tonnes which are not subject to these safeguards.¹⁹ The UK would appear to hold a substantial reserve of military plutonium, which is not subject to international safeguards, in addition to the material in warheads.²⁰

In 2006 the UK government published a report on the historical accounting of HEU.²¹ This report is short on detail.²² It says that the total amount of HEU which the UK had acquired by 2002 was 26.36 tonnes. 4.72 tonnes of this had been removed, leaving a balance of 21.64 tonnes.²³ The UK produced between 4 and 5 tonnes of HEU at Capenhurst between 1954 and 1962.²⁴ This implies that the UK procured an additional 21-22 tonnes of HEU from the US between 1964 and 2002.²⁵

The report does not say what form this material takes. Large quantities of HEU were acquired for the naval nuclear propulsion programme. Some of the stock will be in the form of fuel on submarines. A significant amount may be in used fuel cores which have been removed from submarines and stored at Sellafield.²⁶ The size of the stocks held for future warheads and new fuel cores is not known.

The UK's nuclear-powered submarine programme creates an ongoing demand for weapons-grade HEU.²⁷ This may be met by placing new orders with the United States. The UK government is considering options for the acquisition of HEU for its Trident replacement programme.

Infrastructure

Nuclear warheads are developed and manufactured at the AWE sites of Aldermaston and Burghfield in Berkshire. The work at Aldermaston includes the production of plutonium, HEU, and Beryllium components and research into warhead design. Warheads are assembled and disassembled at Burghfield.

Vanguard class submarines operate from Faslane and nuclear warheads are stored at Coulport. Both sites are parts of HM Clyde Naval Base in Scotland.

Submarines are built at Barrow in Furness. The fuel

cores for naval reactors are manufactured by Rolls Royce in Derby. There is normally one Vanguard class submarine in refit at Devonport dockyard. Rolls Royce operates a prototype submarine reactor at HMS Vulcan, Dounreay. It is planning to close down this reactor in 2015 but to keep on the workforce until 2030.²⁸

The nuclear firing chain is a "substantial element" of the overall infrastructure which supports Trident.²⁹ It includes Command, Control, Communications, and

Computers (C4). There are three key facilities: the Nuclear Operations and Targeting Centre, underneath the MoD Main Building in Whitehall,

London; Commander Task Force (CTF) 345, at the Permanent Joint Headquarters, Northwood, Middlesex; and Corsham Computer Centre, a deep underground bunker in Wiltshire that processes the UK's fire control and targeting software. Launch instructions would be issued over all available frequencies from the Defence Communications hub, which is also at Corsham. The primary means of maintaining radio contact with submarines is over Very Low Frequency using two transmitters at Skelton and Anthorn in Cumbria.

The Strategic Weapons System Integrated Project Team (SWS IPT) at Abbey Wood in Bristol provides logistical support for the Trident programme.

MODERNIZATION

In December 2006 President Bush wrote to Prime Minister Blair, agreeing to support the British nuclear weapon programme. Bush referred to "the steps outlined in your letter to maintain and modernize the U.K.'s capability in this area for the longer term".³⁰

Warheads

Warhead Modification Program (Mk4A)

The US Departments of Energy and Defence have a joint program to upgrade their W76-0/Mk4 warheads to a new W76-1/Mk4A specification. In 2007 there was a UK project called the "Mk4A refurbishment programme".³¹ Annual reports from the Defence Nuclear Environmental and Safety Board in 2006-2008 referred to a "Warhead Modification" program.³² The 2006 report described this as "the planned modification of the nuclear warhead (principally the Mk4A AF&F upgrade)".³³ The AF&F is the Arming, Fusing, and Firing system. The annual report from the Nuclear Weapons Regulator for 2004/5 also mentioned the "introduction of replacement AF&F".³⁴

Defence Ministers Lewis Moodie and John Reid failed to disclose the existence of the Mk4A upgrade project when questioned by Members of Parliament in 2002 and 2006.³⁵ The MoD mentioned "some relatively minor upgrading and refurbishment" of the Trident

warhead in a memorandum to the House of Commons Defence Committee in 2006. In reply to a follow-up question Des Browne, Defence Minister, said on 18 December 2006: “We occasionally replace components of our nuclear warheads, if and when they become obsolete, but we have no plans to upgrade or refurbish our Trident warhead stockpile in the next five years.”³⁶

In 2007 AWE failed to censor an advert that was circulated to recruitment agencies. The advert was for a Warhead Electrical Engineer who would “support the approval program for the introduction of the Mk4A AF&F System into UK Trident”.³⁷ The *Guardian* newspaper reported this on 14 March 2007. Only then did Browne acknowledge that the MoD was replacing the AF&F on the Trident warhead.³⁸ On 4 December 2009 his successor, Bob Ainsworth, admitted for the first time that the AF&F on the British Trident warhead was purchased from the United States.³⁹

The replacement of the AF&F is not a minor upgrade. The US Departments of Energy and Defense designed the original W76-0/Mk4 warhead for the relatively inaccurate C4 missile. It did not intend to use the C4/Mk4 combination against hardened targets.⁴⁰ The original AF&F was designed for airburst detonation.⁴¹ The US Navy subsequently deployed the W76-0/Mk4 warhead on the D5 missile, which is far more accurate than C4. In April 1992 the US Departments of Energy and Defense began a study into future warheads for Trident. One outcome of this study was the development of a new AF&F that would enable upgraded (Mk4A) warheads on D5 missiles to be effective against hardened targets.⁴²

The 1994 draft military characteristics for Mk4A included “near surface burst,” which was not an option for Mk4.⁴³ This upgrade would improve the warhead’s effectiveness against hardened targets. The 1994 report indicated that the D5/Mk4A combination would be effective against a range of targets, the hardest of which would be SS-11 missile silos.⁴⁴

In 1997 Rear Admiral P Nanos, the Director of Strategic Systems Programs, wrote that the:

the Mk4 was never given a fuse that made it capable of placing the burst at the right height to hold other than urban industrial targets at risk. With the accuracy of the D5 and Mk4, just by changing the fuse in the Mk4 reentry body, you get a significant improvement. The Mk4, with a modified fuse and Trident II accuracy, can meet the original D5 hard target requirement.⁴⁵

The US plan was to incorporate features from the Mk5 AF&F in the upgraded Mk4A. The Mk5 had been designed for attacking one of the hardest targets, SS-18 missile silos, with the higher-yield W88 warhead.⁴⁶ The Mk4 AF&F is considerably smaller than the Mk5. Sandia National Laboratory in New Mexico, USA freed up space on the Mk4A by developing a single complex battery which replaces two batteries on the Mk5.⁴⁷ Because

it is newer, the electronics on the Mk4A are substantially more powerful than on the Mk5.⁴⁸ The Mk4A has a new radar fuse and a sophisticated control system.⁴⁹

In 2007 Browne said that the Mk4A AF&F would be introduced “over the next decade” on UK warheads.⁵⁰ The annual report from defence nuclear safety report in 2008 said that there were delays in the warhead modification project and that these were “symptomatic of the proximity of the UK introduction program to the completion of US development and production.”⁵¹ The first W76-1 warheads were delivered to the US Navy in 2009. So the upgraded Mk4A warhead is likely to enter service with the Royal Navy over the next few years.

In March 2011 Sandia National Laboratory announced that it had conducted “the first W76-1 United Kingdom trials test” at their Weapons Evaluation and Test Laboratory (WETL) and that this had “provided qualification data critical to the UK implementation of the W76-1.”⁵² One of the centrifuges in WETL simulates the ballistic trajectory of the W76/Mk4 submarine-launched reentry-vehicle.⁵³

One purpose of the American W76-1 programme is to extend the life of the warhead to match the revised life of the D5 missile, which is to remain in service until 2040. AWE has also been focusing on stretching the life of the UK Trident warhead. In 2001 a major objective of the UK nuclear weapons programme was to keep the warhead in service “over a period much longer than its originally intended service life.”⁵⁴ In 2003 AWE indicated that the current warhead was due to be retired around 2025.⁵⁵ The 2010 Value for Money Review postponed the introduction of the successor warhead by seven years.⁵⁶ This implies that the replacement date would be around 2032. In 2010 the government said that the current warhead would remain operational into the 2030s.⁵⁷ Keeping the warhead in service for an additional seven years is likely to require a more extensive modification programme.

Details of the US W76-1 Life Extension project suggest components which AWE may refurbish or replace during their upgrade of the British warhead (see Table 1).

The US supplies the Gas Transfer System (GTS) for the UK Trident warhead.⁵⁹ The GTS is a warhead component that stores tritium and injects it into the plutonium pit. In the early 2000s the US Department of Energy replaced the original W76 GTS, Heather, with a new model, Acorn.⁶⁰ In 2004 AWE was introducing a replacement GTS, presumably Acorn, into British warheads.⁶¹ Los Alamos National Laboratory has designed an improved version, Acorn II, and this is part of the US W76-1 Life Extension program. Acorn II is likely to be part of the UK warhead modification programme.

The new GTS designs are more capable than earlier models. A review of US research and development in this area pointed out: “The tritium GTS can be the easiest way to improve the performance margin of an existing weapon without extensive rebuilding of the weapon

or its nuclear components. Changes to the tritium GTS can sometimes compensate for the potential loss of performance margin due to aging or other phenomena.”⁶²

The high explosive will be replaced in the US warhead Life Extension programme and it can be assumed that AWE has similar plans. The proven 30-year life of PBX9501 high explosive is a key factor in establishing the projected life of the refurbished American W76-1 warhead. The UK warhead does not use PBX9501, but a British equivalent, EDC37. AWE has carried out a series of trials to extend the life of EDC37.⁶³ However, it may not have been able to match the long life of the US explosive.

Successor warhead⁶⁴

The 1998 Strategic Defence Review said that the UK should not abandon its capability to design and build a successor to Trident.⁶⁵ In 2002 the Chief Scientific Adviser carried out a review of the UK’s nuclear weapon infrastructure. This resulted in the Nuclear Warhead Capability Sustainment Programme (NWSCP).⁶⁶ NWSCP had two aims: “maintain a minimum capability to design and produce a successor nuclear warhead should this prove necessary” and “maintain its existing warhead portfolio in a safe, secure and dependable state for an extended fixed period”.⁶⁷ Clive Marsh, Chief Scientist at AWE, said that most of their research and development work focused on design capabilities, including the potential to develop a successor, as distinct from supporting the current warhead.⁶⁸

The first stage in the revival of AWE was that AWE Management Limited (AWEML), which had taken over the establishment in 2000, changed the management and operational systems.⁶⁹ This led, in 2003, to the MoD extending AWEML’s contract from 10 years to 25 years.⁷⁰ In July 2005 the government announced the start of a large investment programme, under NWSCP, to rebuild facilities and recruit new staff.

The December 2006 White Paper said that a future parliament would have to decide “whether and how we may need to refurbish or replace the warhead”.⁷¹ However, refurbishment is probably only being considered as a

short-term option. To sustain a nuclear force until the 2060s, the MoD is looking at replacement, with remanufacture of the current design a second choice. On 29 June 2007 David Gould, the senior official responsible for defence procurement, told an Industry Day meeting that their plan was “to replace the entire Vanguard Class submarine system. Including the warhead and missile.”⁷²

In May 2011 the government said that a decision “on a replacement warhead” would be required in future.⁷³ This decision, which had been scheduled for 2010–2015, was postponed to 2015–2020.⁷⁴

The MoD has been keen to distinguish between having the capability to develop a successor warhead and taking the decision to develop such a weapon. For example, in November 2007 Defence Minister Des Browne told Parliament that there was “no programme to develop a new UK nuclear warhead”, but he acknowledged that there was ongoing work “to inform future decisions”.⁷⁵

Browne added that some of this work was being undertaken with the US and that this “includes reference to the proposed US Reliable Replacement Warhead (RRW)”.⁷⁶ In 2008 Frank Miller, who played a central role in US-UK nuclear relations, said: “They [the UK] will need a Reliable Replacement Warhead of their own. In fact they are working on one. It has a different name. It’s got a different acronym. But they are working on the same kind of thing for their W76 variant”.⁷⁷ Jeffrey Lewis of Arms Control Wonk reported that the UK design was called the “High Surety Warhead”.⁷⁸

There are a number of signs which indicate that AWE is not just sustaining generic capabilities for warhead development, but that it is developing designs as options for a successor warhead. The MoD set up a Warhead Pre-Concepts Working Group.⁷⁹ There is also a UK Re-entry System (Options) program.⁸⁰ AWE is the Coordinating Design Organisation for “potential successor warhead candidates”.⁸¹ There is a directorate within AWE responsible for work on the Successor, separate from other directorates which deal with Trident and Capability.⁸²

Table 1: US and UK modernization

Component	US W76-1 Life Extension	UK Warhead Modification
Arming, Fusing and Firing System (AF&F)	New Mk4A (MC4700)	New US Mk4A (MC4700)
Gas Transfer System	New Acorn II	Probably new US Acorn II
High Explosive	Remanufacture PBX9501	Remanufacture EDC37 ?
Canned Sub-Assembly	Refurbish	Not known
Interstage special material	Remanufacture Fogbank ⁵⁸	Not known
Plutonium pit	Requalify each pit	Not known
Pit tube	Replace	Not known
Cabling	Replace	Not known.
Detonators	Replace	Not known (UK design)
Purge valve	Replace	Not known

AWE recently carried out a cost-benefit analysis of its Technology Division. One of the criteria in this analysis was support for future options. For each component in a successor warhead, the survey asked: Do we need a new design? Can we buy off the shelf? Can we work with a partner?⁸³

Owen Price, a senior official at AWE, said the Establishment has been increasing the range of tasks that it can carry out, in order to improve its ability to design and build a new warhead.⁸⁴ He highlighted systems engineering and warhead integration as two critical capabilities AWE will need to develop for a successor warhead programme.⁸⁵ In 2006 AWE was recruiting engineers who would transfer warhead-to-weapon integration capability from the US to the UK.⁸⁶

Three areas where AWE is working on new designs are AF&F, Gas Transfer Systems, and Neutron Generators.

The UK is developing an AF&F for a successor warhead. This is in addition to the Mk4A AF&F upgrade for the current warhead. The new initiative is a joint AWE, US Air Force, and US Navy project. The goal is “the development of a joint arming, fusing, and firing system for application to the Air Force Mk12A, the Navy Mk5 and a UK re-entry system.”⁸⁷ This is related to UK successor warhead designs of a specific size.⁸⁸ A joint working group of US Navy, US Air Force, and British engineers leads the work.⁸⁹ Their plan is to use the same components, and possibly the same system, on the three weapons.

AWE is producing Demonstrators to test new AF&F concepts in laboratory conditions and in a relevant environment.⁹⁰ They are developing electronics,⁹¹ circuit boards,⁹² High Integrity Software and Hardware,⁹³ firing sets,⁹⁴ and capacitors⁹⁵ for AF&Fs. The engineers designing these components are expected to spend some of their time working in the US.⁹⁶ Likewise, their American counterparts at Sandia National Laboratory have been told they will be collaborating with AWE.⁹⁷

AWE is designing new Gas Transfer Systems (GTS). This includes developing “designs of hydrogen storage and delivery systems for possible future warheads.”⁹⁸ The establishment has recruited staff to design new GTS and to test the new models in the UK and US.⁹⁹ Specialists at Aldermaston are developing new pressure vessels and joining technologies.¹⁰⁰ AWE is working with two American laboratories, Sandia and Los Alamos, to design “long-life GTS.”¹⁰¹ The laboratories have shared their advanced designs for GTS valves.

AWE recruited engineers and scientists, between 2006 and 2011, to develop new neutron generators and their components.¹⁰² In 2008 the Establishment was developing “novel neutron tube” designs for neutron generators in collaboration with the US.¹⁰³

AWE’s research into AF&F, GTS, and Neutron Generators is unusual, because current practice is to buy these components from the US. Price says that war-

head components that are currently procured from the US might, for the successor warhead, be designed and manufactured in the UK.¹⁰⁴

One focus of recent warhead research is surety, which encompasses safety, security, and use control. The term “High Surety Warhead” has been associated with AWE’s new warhead and with the US Department of Defense’s proposal to merge the W88 and W78 warhead designs.¹⁰⁵ The Enhanced Nuclear Safety Product Realisation Team at AWE is developing new surety concepts. Engineers are producing demonstrators of new components and testing them in laboratory and relevant environments.¹⁰⁶ New strong-link safety systems are being developed.¹⁰⁷ In 2009 Sandia National Laboratory was working with AWE on improved Magnetic and Electrical strong-link designs for future systems.¹⁰⁸ Furthermore, Kansas City Plant is supporting UK work on new surety components.¹⁰⁹

AWE is working closely with the Los Alamos and Lawrence Livermore National Laboratories on enhanced surety.¹¹⁰ This includes joint research into Multi-Point Safe warhead designs.¹¹¹ Current warheads are designed so that they will not produce a yield if the explosive accidentally detonates at one point. A multi-point safe design should not produce any yield if the explosive detonates simultaneously at several points. Multi-Point Safety is a design objective set by the Defence Nuclear Safety Regulator in the UK, but AWE cannot meet this target by modifying the current design.¹¹² This implies that its work on Multi-Point Safety is for a successor warhead. The US Department of Energy plans to develop its knowledge of a Multi-Point Safe design by 2016 and to understand the performance of this design in a realistic environment by 2018.¹¹³ AWE’s timescale is likely to be similar, or longer. One option for the UK warhead replacement will be a Multi-Point Safe design. But this may not be the most likely option. One Point Safe alternatives would be simpler and easier to certify.

AWE has recruited scientists to review alternative materials for use in future warheads. The current UK Trident warhead includes Beryllium.¹¹⁴ A future UK warhead might, like the proposed US Reliable Replacement Warhead design, introduce a replacement for Beryllium. AWE has been considering the use of Insensitive High Explosives (IHE) in nuclear warheads since 1977.¹¹⁵ It is likely that a future AWE design would incorporate IHE.

Delivery systems

Modernization of the D5 missile system

The US Strategic Systems Program (SSP) is extending the life of the D5 Trident weapon system. They are updating all the Trident subsystems: launcher, navigation, fire control, guidance, missile, and re-entry.¹¹⁶ All of these modernization measures apply to the system deployed on British submarines. In December 2006, US

President Bush wrote to Prime Minister Blair, saying, “We will work to ensure that the necessary components of the overall system are made available to the United Kingdom to support life-extended D5 missiles.”¹¹⁷

The US Navy is ordering 24 new D5LE missiles each year.¹¹⁸ In addition, it is upgrading existing missiles. The D5 Life Extension (D5LE) missile is due to enter service in the Royal Navy towards the end of this decade.¹¹⁹

A key part of the D5LE program is the development, by Charles Stark Draper Laboratory, of a new guidance system, Mk6LE.¹²⁰ Draper is replacing the gyroscope, accelerometer, and stellar camera in the guidance module.¹²¹ The new system will use software rather than hardware for some functions.¹²² As a result, Mk6LE will be more flexible and easier to upgrade than the current Mk6 unit.¹²³ The new guidance system will be able to “support new missions”.¹²⁴ It will “allow for mission adaptability”.¹²⁵

Draper has, over several decades, improved the performance of missile guidance systems. The effect has been to make each new generation of ballistic missiles more accurate than the last. Its development of the Mk6LE is a continuation of this trend.¹²⁶ The combination of new hardware and software in this advanced guidance system will improve the capability of the D5 missile.

In addition to replacing the guidance system, the US Navy is also building new flight electronics for the modernized D5LE missile. The new system will replace obsolete parts with modern components.¹²⁷

The Fire Control System (FCS) is a computerized network on the submarine which controls the launch of Trident missiles. SSP initially supplied the Mk98 Mod 3 FCS for British submarines. It replaced this with the Mod 5 in 2002/03.¹²⁸ This upgrade was part of the SLBM Retargeting System, which was designed to increase the flexibility and speed of retargeting.¹²⁹

SSP has recently produced Mod 7, the next upgrade of the FCS. The first two Vanguard class submarines had been fitted with Mod 7 by April 2011.¹³⁰ General Dynamics Advanced Information Systems (GDAIS) is designing a further modification, Mod 9.¹³¹ This will operate on British submarines in conjunction with the upgraded, Mk6LE, missile guidance system.¹³²

In addition, SSP is developing a new Shipboard Data System for the Trident FCS.¹³³ This is due to enter service in 2012.¹³⁴

In September 2009, SSP commissioned work to develop the FCS system for the UK Successor submarine and the US Ohio replacement submarine.¹³⁵

The Trident navigation system provides information on the exact position of the submarine and is critical for missile accuracy. SSP is upgrading the navigation system in two phases. In the first stage, it will modernize some components while retaining the core system, Electro Static Gyro Navigation (ESGN). By 2014 it will update the Global Positioning System (GPS) and

Navigation Sonar, and replace the Local Area Network (LAN).¹³⁶ This initial navigation upgrade will be carried out on British as well as American Trident submarines.¹³⁷ SSP will develop a new navigation trainer for Faslane naval base.

The second stage of the upgrade will replace ESGN with a new Inertial Navigation System (INS). SSP plans to achieve Initial Operating Capability of INS on US submarines in FY2020. It also plans to install INS on the UK Successor submarine.¹³⁸

The US Navy and Royal Navy are jointly developing a new Submarine Communications Buoy for very low frequency (VLF) communications with submarines.¹³⁹ VLF is the primary method of issuing launch instructions to submerged Trident submarines.

Successor submarine

The UK government’s plan to replace the Vanguard class submarine was published in December 2006 and endorsed by Parliament in March 2007. Officials then drew up two families of options for the successor submarine. “Adapt Astute” would be an Astute class submarine, powered by a PWR2 reactor, with an added ballistic missile compartment. “Derived Submarine” would be a new design, powered by a new PWR3 reactor. It would “not only deliver a safer, but also a more capable submarine than the PWR2 Adapt Astute.”¹⁴⁰ This second option was described as “a new design developed from Astute technologies with updates where appropriate to achieve performance or improved availability, reliability and maintainability.”¹⁴¹

On 18 May 2011, Defence Secretary Liam Fox told Parliament that the Government had selected the PWR3 (Derived Submarine) option for the successor submarine. Dr Fox said that the new submarine “will be powered by a nuclear propulsion system known as Pressurised Water Reactor 3, which will incorporate the latest safety technologies and ensure our future nuclear-armed submarines have the performance required to deliver our minimum credible deterrent out until the 2060s.”¹⁴²

The PWR3 reactor will be based on a modern American design.¹⁴³ It will have a passive cooling system that can operate without coolant pumps.¹⁴⁴ The new reactor will be quieter and more efficient.¹⁴⁵ The US Navy developed reactors with passive cooling systems to reduce the noise made by nuclear submarines.¹⁴⁶

When the UK government decided to replace Polaris with Trident, one of the factors it considered was the vulnerability of the ballistic missile submarine (SSBN) to future anti-submarine warfare technology. Submarine design has progressed to make vessels progressively quieter. The US Navy is developing new stealth technology for the Ohio Replacement, on the assumption that the submarines will remain in service until the 2080s.¹⁴⁷ They are working with the Royal Navy in a joint research program, from FY2010 to FY2014, to re-

duce the electromagnetic signatures of the Successor and Ohio Replacement submarines.¹⁴⁸ The UK government's choice of PWR₃ for the successor submarine and the research into reduced electromagnetic signatures are signs that it plans to make the new submarine more difficult to detect than current vessels.

The US Navy is designing a Common Missile Compartment (CMC) for the British successor and US Ohio Replacement submarines. Initial research costs were paid by the UK, which will contribute 12.5% to the overall cost. The British CMC unit was initially designed for 12 missile tubes. In September 2010 the UK government announced that the new vessel would carry eight missiles.¹⁴⁹ As a result, "work is ongoing with the US to look at how best to include our requirement for eight operational missiles into this design."¹⁵⁰

The US government has decided that the D5 missile will be "the initial baseline mission payload" for the Ohio Replacement.¹⁵¹ It is designing the CMC around the specifications of D5.

Replacement submarine-launched ballistic missile

The intention is that the UK successor submarine will remain in service until the 2060s and the US Ohio replacement will be operational until the 2080s. The Life Extension programme for D5 will only sustain this missile until the early 2040s. D5 will not be available for most of the intended lives of the new submarines. The UK government has acknowledged that "investment in a replacement ballistic missile would eventually be needed."¹⁵² Rear Admiral Benedict, head of the US Strategic Systems Program, has revealed that the Pentagon is considering sharing some of the development effort for a new ICBM and a new SLBM. He said "This is not a decision we can postpone through 2020-2030—this is a near-term decision that will affect sustainment and recapitalization."¹⁵³

Infrastructure

Laboratories/production facilities

In November 2005 the MoD told the House of Commons Defence Committee about its plan to upgrade facilities at AWE. The MoD explained, "This additional investment at AWE is required to sustain the existing warhead stockpile in-service irrespective of decisions on any successor warhead."¹⁵⁴ However, an earlier document suggests that some of the new facilities are specifically for a successor warhead. In 2002 AWE was considering whether to build a new warhead assembly/disassembly facility at Aldermaston rather than Burghfield. One reason it did not locate the building at Aldermaston was that "there might not be sufficient room at Aldermaston to accommodate facilities for a successor programme as well as Trident."¹⁵⁵ If the MoD had not authorized substantial new investment in AWE then its warhead options for the successor system would have been limited.¹⁵⁶

The Nuclear Warhead Capability Sustainment Programme (NWCSP) covered both the redevelopment of physical infrastructure and the recruitment of additional staff for AWE. A screening form for NWCSP, completed in 2007, described the programme as "a series of coordinated activities and construction projects which will underpin the requirement that the UK shall retain an independent capability to design, manufacture put into service and safely maintain a nuclear physics package for a warhead."¹⁵⁷ The goals of the project were to enable AWE to build a successor warhead and to keep the current warhead in service for longer than originally intended. In 2007 Nick Bennet, Director of Strategic Technologies in the MoD, said that the NWCSP included "some 100 facility schemes focused at AWE over the next 20 years."¹⁵⁸ The work covers both research and production capabilities, with a combination of new build and refurbishment projects.

The government amended the AWE modernization program following the 2010 Value for Money Review. Some projects were cancelled, others modified and the future of several elements remains in doubt.

Research and test facilities

Laser (Orion)

AWE has a High Energy Density Physics programme, which provides information on the performance of materials in extreme conditions. AWE uses this data to build computer simulations of nuclear explosions. One of the goals the program is to give British scientists access to American research efforts.¹⁵⁹ AWE has completed the construction of a new laser, Orion, which is many times more powerful than the earlier Helen laser. Orion was being commissioned during 2011.¹⁶⁰ High Energy Density Physics research at Aldermaston is "typically in support of secondary physics."¹⁶¹ Orion will be able to simulate, for a fraction of a second, the intense heat and extreme pressures that are experienced during the fusion stage of a thermonuclear explosion.¹⁶²

Hydrodynamics (Teutates)

The construction of new hydrodynamic facilities was part of the initial plan for the redevelopment of Aldermaston. AWE planned to have a new Hydrus facility in operation by 2015.¹⁶³ It was to "surpass equivalent facilities elsewhere."¹⁶⁴ AWE played a leading role in developing the radiographic machines used in hydrodynamic tests.¹⁶⁵ It was developing an Inverted Voltage Adder (IVA) machine for the first axis of Hydrus and carried out experiments at the American RITS-6 facility to develop the technology for this machine.¹⁶⁶

In November 2010 this plan was radically changed when agreement was reached with France on the Teutates project.¹⁶⁷ Britain will support the construction of a new test facility in France. The French will move their current Airix x-ray machine to this new Anglo-French hydrodynamic facility, Epuré, at Valduc. Epuré will be operational for the French program in 2014 and for the

British programme in 2016. Teutates is a key part of a new Anglo-French Defence and Security Treaty.

Construction of the proposed Hydrus test facility in Aldermaston has been cancelled. But Britain will build a Technology Development Centre (TDC) at AWE by 2014. TDC will develop a second x-ray machine for Epuré by 2019 and a third by 2022. A second firing point will also be established by 2022.

Airix has a similar performance to the first axis at the American DAHRT facility at LANL.¹⁶⁸ It is significantly less powerful than the IVA machine that AWE were planning to build for Hydrus. Aldermaston's research into the latter is likely to form the basis for the second axis at Epuré.

The proposed Hydrus facility had been due to play an important role in the US Dynamic Plutonium Experiment (DPE) program. According to documents from the US Department of Energy, "The Hydrus facility is deemed essential to aiding in DPE decisions in the 2015-2017 time frames."¹⁶⁹ The capability sought by the US National Nuclear Security Administration (NNSA) will probably only become available at Teutates in 2019 at the earliest.

Although France and Britain will share the same research facility they will not share the detailed results from the experiments.

Material Sciences Laboratory

AWE plans to build a new Combined Non Metallurgy and Material Science laboratory (Octans) at Burghfield.¹⁷⁰ The Establishment has recruited new staff to work on material science. Its remit includes the development of replacement materials for use in nuclear warheads.¹⁷¹

Computing

AWE has purchased supercomputers that have been amongst the most powerful deployed anywhere in the UK at the time. It acquired Blue Oak (2.8 teraflops) in 2002, then Redwood (34 teraflops) in 2006 and Blackthorn (145 teraflops) in 2010.¹⁷² It plans to build a 4,500 square feet computing complex, Project Orchard.¹⁷³

Manufacturing and production

Enriched uranium facility

AWE is building a new Enriched Uranium Facility (EUF), Project Pegasus, which is due to be in service by 2016.¹⁷⁴ The building will service "enriched uranium components" of current warheads and "undertake the specialised chemical and metallurgical operations needed to manufacture enriched uranium components for successor warheads to Trident, should they be built."¹⁷⁵

EUF has a similar role to the proposed new US Uranium Processing Facility (UPF) at Y-12.¹⁷⁶ The main tasks of the American plant are to manufacture, assemble, and dismantle the Canned Sub Assembly and radiation case of warheads.¹⁷⁷ The Canned Sub Assembly includes the secondary or fusion stage of a thermonu-

clear weapon and the radiation case is the special metal case that encloses the primary and secondary. The "enriched uranium components" which will be produced and handled by the EUF at Aldermaston are probably the radiation case and HEU part of the Canned Sub Assembly.

EUF will carry out the initial stage of the fabrication of fuel rods for naval nuclear reactors.¹⁷⁸ It will also store enriched uranium and conduct surveillance and research into enriched uranium warhead components.

AWE is also spending £32 million refurbishing the current HEU facility, building A45.¹⁷⁹

Warhead assembly/disassembly

AWE has been given planning permission to build a new facility, Project Mensa, to assemble and disassemble nuclear warheads at Burghfield. Construction was due to start in 2010.¹⁸⁰ The building will have Assembly Cells, where the high explosive and radioactive components of warheads are combined, and a Main Process Building.¹⁸¹ Mensa will "maintain the existing assembly/disassembly capability" and fulfill the requirements of the warhead maintenance programme.¹⁸² It will be only slightly smaller than the current facility.¹⁸³ It would appear to be designed to support a warhead stockpile of a similar size to that held by Britain in the 1980s and 1990s.

Plutonium fabrication

AWE will carry out a £272 million programme of refurbishment and modernization of building A90, which manufactures the plutonium pits for British nuclear warheads.¹⁸⁴ A90 is a replica of building PF-4 in Los Alamos, which is the current American pit production facility.

High explosives fabrication

West Berkshire Council granted planning permission for a new High Explosives Fabrication Facility (HEFF), Project Circinus, at Aldermaston. This will process the high explosive for nuclear warheads. HEFF is located in the middle of the Western part of AWE Aldermaston, as far as possible from other facilities on the site, particularly those handling radioactive material.

Conventional Manufacturing Rationalisation

In 2008 West Berkshire Council granted AWE permission to build a Conventional Manufacturing Rationalisation (CMR) facility at Burghfield. This would replace several buildings at Aldermaston. The start to construction work was delayed and in April 2011 the Council renewed their permission, subject to advice from the Health and Safety Executive. AWE will use the building for the manufacture of non-nuclear components of nuclear warheads.

Timescale and costs

In November 2011 the government published details of £1,938 million capital expenditure at AWE, however this figure does not include all the proposed projects.¹⁸⁵ The planned in-service dates and costs are:

- 2007/10—New office block for 1,200 staff (Gemini) [£78 m]; IT servers [£32 m]; office buildings [£27 m].
- 2010/15—High Explosives Fabrication (Circinus) [£231 m]; Small Components Interim (Leo) [£16 m]; High Performance Computing (Orchard); Laser (Orion) [£183 m]; Technology Development Centre (Tuetates).
- 2016/20—Enriched Uranium Facility (Pegasus) [£634 m]; Warhead Assembly & Disassembly (Mensa) [£734 m]; Non Metallurgy and Material Science Laboratory (Octans).

The future of several projects is uncertain, following the Strategic Defence and Security Review. These include high explosives climatic trials, chemical processing (Astra), high explosives assembly for trials, and small components (Libra).¹⁸⁶

Other infrastructure

The 2006 White Paper said that the government expected to spend £2–3 billion, at 2006 prices, on infrastructure over the life of the successor submarine.¹⁸⁷ The 2010 defence review indicated that the government “agreed to defer and potentially to remove over £1 billion of future spending on infrastructure over the next 10 years.”¹⁸⁸ The postponement was for a period of ten years.¹⁸⁹ The submarine infrastructure facilities at Faslane, Coulport, Devonport, and Barrow each have a projected lifespan of 40 years. The MoD plans to extend the life of these facilities to keep them operational until 2040.¹⁹⁰ Its plans for the remaining projected life of the successor submarine, until the 2060s, are not clear.

In February 2010 Derby City Council approved a planning application from Rolls Royce to build a new manufacturing facility at Raynesway with 15,230 square meters of floor space.¹⁹¹ By 2017 the new facility will replace current buildings which are used for the manufacture of fuel cores for nuclear submarines.¹⁹² The Raynesway site also conducts research into naval reactors and propulsion systems. It is at the centre of the development of the PWR3 reactor for the successor submarine.

There were initial proposals to modernize the Nuclear Command and Control system or “Nuclear Firing Chain”. In November 2010 the Defence Minister announced that these plans had been postponed for ten years and might be cancelled.¹⁹³

Timelines

Nuclear warhead

- Upgrade of current warhead to Mk4A: 2012–17?
- Stockpile reduction to 180 warheads: mid 2020s
- New warhead: decision 2015–20, in service 2030s

Missile

- D5 life extension: in service with the Royal Navy around the end of this decade
- New missile: in service 2040

Missile support systems

- Mk98 Mod 7 Fire Control System: 2011
- Shipboard Data System: 2012
- Upgrade of ESGN navigation system: 2014

Successor submarine

- Start of concept phase: 2007
- Initial Gate decision: May 2011
- Design and order for long lead items: 2011–16
- Main Gate decision: 2016
- First of class in service date: 2028
- Decommissioning: 2060s

Infrastructure

- AWE modernization 2005: 2020
- New manufacturing facility for submarine reactor fuel: 2017
- Shiplift (Faslane), Explosives Handling Jetty (Coulport) & Dry Dock (Devonport): plan to extend life to 2040
- Command and control upgrade: work postponed until after 2020.

A timeline in the December 2006 White Paper showed that the successor submarine would be withdrawn from service between 2050 and 2055.¹⁹⁴ This date has since been pushed back for two reasons. Firstly, the Coalition Government postponed the in-service date from 2024 to 2028. Secondly, it decided to adopt the PWR3-based submarine design. Had it opted for PWR2 then the new submarine would have had a projected life of 25 years with a possible extension to 30 years. PWR3 will be able to remain in service for longer.¹⁹⁵ The May 2011 Initial Gate report says the submarines will be operational “until the 2060s”.¹⁹⁶ The US Navy extended the life of its Ohio-class submarines to 40 years.¹⁹⁷ It is possible that the new British submarines, with an American-designed PWR3 reactor, could remain operational until as late as 2070.

ECONOMICS AND POLITICAL ECONOMY

Annual expenditure on the UK nuclear weapons programme, including AWE, was between £1.1 and £1.2 billion in each year between 1998/9 and 2004/5.¹⁹⁸ It increased to £1.7 billion in 2007/8 and 2008/9.¹⁹⁹ In 2007, annual expenditure, including work on a replacement system, was projected to rise to £2 billion in 2009/10 and £2.1 billion in 2010/11.²⁰⁰ Procurement costs alone were expected to amount to 3% of defence expenditure over the main period they were incurred.²⁰¹ The current government has not published more recent estimates of annual costs.

Cost projections

In December 2006 the Labour government published outline estimates of the costs of modernizing

UK nuclear forces.²⁰² In 2008 the National Audit Office argued that more detailed and robust figures should be produced when the project reached its Initial Gate.²⁰³ The Initial Gate decision was taken in May 2011. At this time the Coalition government published a short report but it did not include comprehensive and detailed cost projections.²⁰⁴ Capital costs published in December 2006 were:²⁰⁵

- Submarines (four boats): £11-14 billion
- Warhead refurbishment/replacement: £2-3 billion
- Infrastructure: £2-3 billion
- Sub-total: £20-25 billion

The 2006 report also gave the following costs:

- D5 Missile Life Extension: £250 million
- Replacement missile: £1.5 billion
- Annual in-service costs: £1.5 billion.²⁰⁶

All of the above figures were based on 2006/7 prices. In May 2011 the MoD said that the submarine element would still be within the £11-14 billion range, at 2006/7 prices. It also gave a new figure for the submarines at outturn prices, including inflation in the year the costs would be incurred, of £25 billion.²⁰⁷ The MoD has not published the method used to produce this figure, but it suggests that the cost will be near the top of their earlier range, i.e. £14 billion at 2006/7 prices.

The figures published for the Trident replacement program do not include the costs of upgrading AWE. In November 2011, Peter Luff, Junior Defence Minister, indicated that the total cost of a list of AWE modernization projects would be £1938 at 2010/11 prices.²⁰⁸ The list did not include a new laboratory, the Technology

However, this may have been exaggerated. One or more of these refits were probably already scheduled. It is unlikely that a postponement of four years would require three additional submarine refits.

Comparative costs

The £2 billion annual cost of Trident could instead pay for the construction of 100 new schools every year. In 2004 the Labour government launched a major Building Schools for the Future programme, which replaced secondary schools across England. This project was scrapped by Michael Gove, the education minister, in July 2010.²¹³ The average capital cost of building a new school in 2007 was around £20 million.²¹⁴

Instead of funding Trident, the government could reverse its plans to cut welfare benefits for the disabled. The Welfare Reform Bill will introduce means testing for young disabled people and for those who have had cancer for more than one year.²¹⁵ These measures are designed to save £1.6 billion, less than the annual cost of Trident.

The impact of austerity measures

Public expenditure in the UK is due to be cut by 5.3% between 2011/12 and 2016/17. The government's aim is to reduce public spending from 46.6% of GDP to 39% of GDP.²¹⁶ This is expected to result in the loss of 710,000 public sector jobs.²¹⁷ The impact is likely to be greatest in the poorer areas of the UK.²¹⁸ In January 2012 unemployment reached 2.68 million (8.4%), which is the highest it has been for 17 years.

THE £2 BILLION ANNUAL COST OF TRIDENT COULD INSTEAD PAY FOR THE CONSTRUCTION OF 100 NEW SCHOOLS EVERY YEAR.

Development Centre, and several other projects. The total amount of new money being spent on AWE, in addition to normal running costs, is significantly higher than this. Between 2005/6 and 2007/8, the government spent £1.1 billion on the construction of new facilities and the recruitment of additional staff, under the Nuclear Warhead Capability Sustainment Programme.²⁰⁹ This work continued beyond 2007/8, but the government has not released equivalent figures for later years. It has only published the overall costs of AWE. From these overall figures, it is possible to deduce that an extra £1.6 billion was spent in the years 2008/9–2010/11 and that a further £2 billion has been allocated for 2011/12–2013/14, over and above normal operating costs.²¹⁰ The additional work includes the Mk4A warhead refurbishment programme as well as the construction and refurbishment of facilities.²¹¹

Extending the life of the current Vanguard class submarines, in order to postpone the in-service date for the replacement, introduced extra costs. Parliament was told that an additional £1.3 billion would be required because of the need for three Long Overhaul Periods.²¹²

One of the greatest changes is a 25% reduction in the amount that will be spent on pensions for public service workers. Workers in the public sector will be faced with working longer for a smaller pension.²¹⁹ The age at which people will be entitled to a state pension has been raised. The greatest increase in the age limit applies to women.

In 2010 Liam Fox, the Defence Minister, acknowledged that there was a £38 billion black hole in the defence budget for the period 2010–2020.²²⁰ This projected shortfall rose to £42 billion if the costs of Trident replacement were included.²²¹ The MoD is planning to cut its budget by £4.4 billion between 2011/12 and 2014/15. Most of the savings are scheduled for the later years in this period.²²²

The regular army will be cut from 100,000 to 84,000. One of the two new Queen Elizabeth class aircraft carriers will be mothballed immediately after it is built. Nimrod maritime reconnaissance aircraft were scrapped after a £3.6 billion upgrade.²²³

The number of MoD civil servants will be reduced by 40%. One of the sites which will be most affected is

the Defence Equipment and Support headquarters at Abbey Wood in Bristol. One quarter of the 8,000 staff members are expected to lose their jobs.²²⁴ One of Abbey Wood's biggest projects is Trident replacement.

In January 2012 the *Telegraph* reported that the MoD was planning a further £2 billion cuts. An MoD source said that most of the savings would come from a "ruthless approach" to renegotiating existing contracts with the private sector.²²⁵ This second round of cuts was also expected to result in further reductions in civil service numbers.

Professor Malcolm Chalmers of the Royal United Services Institute has identified the Trident replacement programme as one of three projects that pose substantial financial risk to the MoD. He argues that it could wreck the government's plan to bring the deficit in the defence budget under control.²²⁶

In September 2010 the government announced that it had been able to make savings of £1.2 billion, at out-turn prices, in the Trident replacement programme from a Value for Money Review.²²⁷ It is not possible to assess how likely it is that these savings can be achieved, because the MoD's explanation is incomplete. The projected cost of the Common Missile Compartment has been reduced by £250 million. In addition the MoD hopes to save £900 million across the whole nuclear-powered submarine program as a result of the Submarine Enterprise Performance Programme, through rationalizing facilities and improved contracting. Only part of this should be attributed to the Trident replacement project. The MoD has a poor record in controlling the cost of major projects, including the Astute class submarine, so this reduction may be an aspiration rather than a reasonable expectation.

The government claimed that the review would "reduce costs by £3.2 billion".²²⁸ However, £2 billion of this figure is not true savings, but deferrals. It has postponed planned expenditure of £1 billion on infrastructure and £500 million on a replacement warhead to after 2020.[Ⓜ] The remaining £500 million deferral is not explained.

In May 2011 the government announced that it had chosen a submarine design with a new PWR3 reactor, rather than one based on the existing PWR2 reactor. This is likely to undermine their attempts to reduce costs, at least in the period prior to 2030. The capital costs of the PWR3-based design will be higher than the PWR2 option.²³⁰ The MoD said that selecting PWR3 would increase the cost by £50 million per boat over a 25-year life. The in-service costs for PWR3 will be lower, so the increase in the initial capital cost of the PWR3 option is probably more than £50 million per boat.²³¹ The savings claimed in the Value for Money Review will be at least partly offset by the additional costs of the PWR3 option.

The Alternatives review, which is being led by Nick Harvey, was set up to placate the Liberal Democrat wing of the Coalition. It was initially thought that there was little chance that the government would seriously

consider any radical proposals which it produced. However, the ongoing economic crisis may force a re-think. Options in Harvey's review, such as reducing the submarine order from four to three or taking Trident off patrol, are likely to receive a more sympathetic hearing in Whitehall. While supporters of Trident within the MoD are unwilling to budge on either issue, the calls for change from other elements of the military and from the Treasury may start to have an impact.

The Value for Money Review introduced a delay of four years to the in-service date, to save money. This brought the UK programme close to the timescale of its US counterpart. On 26 January 2012 the US government announced that there would be a two year delay in the in-service date for their Ohio replacement. If the MoD sticks to its current timeline then it will find that costs will rise, because it will be out of step with American efforts. They may decide to push back the successor submarine in-service date by two years, which would reduce short-term costs. This might require a rethink of the policy of continuous patrols.

Private companies

The key UK-based companies in the Trident programme include BAE Systems, Babcock Marine, Rolls Royce, and Serco. BAE Systems operates the submarine construction yard at Barrow in Furness. Babcock Marine runs Devonport dockyard, which refits nuclear submarines, and support facilities at the Clyde Naval Base. Rolls Royce designs, manufactures, and supports the nuclear reactors on British submarines. Serco have a one-third share in AWEML. BAE Systems, Babcock Marine, and Rolls Royce are the three main contractors for the successor submarine. They are also the three Tier 1 suppliers in the wider Submarine Enterprise Performance Program (SEPP).²³²

US-based companies involved in the UK Trident program include Lockheed Martin, Jacob's Engineering, General Dynamics, and Electric Boat. Lockheed Martin is the lead contractor for the Trident missile system. The company also has a one-third share in AWE Management Limited (AWEML), which operates the UK nuclear warhead development and manufacturing facilities. Lockheed Martin UK maintains components of the Trident missile system at the Clyde Naval Base. AWEML, Lockheed Martin UK, and Babcock Marine are partners in a new joint venture that will be responsible for nuclear warhead and Strategic Weapon System activities at the Clyde Naval Base. Lockheed Martin manages Sandia National Laboratory, in the US, which has designed and produced "non-nuclear" components of the UK Trident warhead.

Jacob's Engineering has a one-third share in AWEML. General Dynamics produces support systems for Trident, including the Fire Control System. Electric Boat assisted BAE Systems with the Astute programme and will give it support with the successor submarine.

INTERNATIONAL LAW

In 2006 the UK government claimed that its plan to replace Trident was consistent with the nuclear Non-Proliferation Treaty (NPT) because “the NPT recognizes the UK’s status (along with the US, France, Russia and China) as a nuclear weapon state.” It also argued that the Treaty does not set a timetable for nuclear disarmament and does not specifically prohibit the updating of nuclear capabilities.²³³

This implies that the UK government thinks it can continue indefinitely to retain and modernize its nuclear forces. Its current plan is not to keep nuclear weapons for a short period of a few years, pending multilateral progress on disarmament, but to introduce a new system that can remain in service until the 2060s.

The former president of the International Court of Justice (ICJ), H.E. Judge Mohammed Bedjaoui, pointed out that when the Court said, in its 1996 Advisory Opinion, that nuclear weapon states have an obligation to bring to a conclusion negotiations on nuclear disarmament under article VI of the NPT, this “is nothing more nor less than actually to bring about concrete nuclear disarmament.”²³⁴ He added that the nuclear weapon states should “not betray the legitimate trust which the non-nuclear states could reasonably have invested in the hope that the promised negotiations would lead swiftly to an agreement on nuclear disarmament.”²³⁵ The UK government’s plan to retain nuclear weapons for the long term is not consistent with negotiating in good faith to achieve disarmament.

Bedjaoui, says that the ICJ’s failure to reach a conclusion in Point 2(E) of their Advisory Opinion, on the threat or use of nuclear weapons in an extreme circumstance of self defence, was influenced by suggestions that nations might develop low-yield, “clean” and “reduced-effect” nuclear weapons. He said: “The Court was unable to expunge completely and soundly this pseudo-scientific chiaroscuro which, thus distilled, finally managed to seep into some interstices of its reasoning.”²³⁶

In 2010 Bedjaoui was asked for his view on the legality of a nuclear weapon system that deploys over 100 warheads, each with a yield of 100 kilotons (like the UK Trident force). He concluded:

Even in an extreme circumstance of self-defence, in which the very survival of a State would be at stake, the use of a 100 kt nuclear warhead (regardless of whether it was targeted to land accurately on or above a military target) would always fail the tests of controllability, discrimination, civilian immunity, and neutral rights and would thus be unlawful....

The modernization, updating or renewal of such a nuclear weapon system would also be a material breach of the NPT obligations, particularly the unequivocal undertaking by the nuclear-weapon states to ‘accomplish the total elimination of their nucle-

ar arsenals leading to nuclear disarmament’ and the fundamental Article VI obligation to negotiate in good faith on cessation of the arms race and on nuclear disarmament, with the understanding that these negotiations must be pursued in good faith and brought to conclusion in a timely manner.²³⁷

Trident was not designed to launch one warhead against one target. The system is designed around a scenario when all of the missiles on a submarine are launched almost simultaneously. In the earlier Polaris system the UK submarine on patrol had to be able to launch its missiles at intervals of 20 seconds.²³⁸ This suggests that a UK Trident submarine, armed with eight missiles, will be able to launch all of its missiles in less than three minutes.

In 1998 the Scottish Campaign for Nuclear Disarmament estimated that a UK attack with 48 100-kiloton warheads on command bunkers in and around Moscow would result in 3 million fatalities in the short term. There would also be widespread long-term environmental damage, because the warheads would be detonated on the surface and not in the air.²³⁹

The change announced in 2010, from 48 to 40 warheads per submarine, would reduce these figures. On the other hand, the UK always has two nuclear-armed submarines and often three. An attack with all of the warheads on three submarines, against similar targets, could result in 7 million short-term fatalities. The number of casualties would be higher if the warheads were deliberately targeted to maximize civilian damage.

In the light of Bedjaoui’s view of the illegality of an attack with a single 100-kiloton warhead, an attack involving many such warheads would be a breach of international law.

In November 2006 Phillipe Sands QC and Helen Law gave advice on the legality of the maintenance and replacement of the UK Trident system. They said:

If the position of the UK is that a nuclear deterrent remains necessary whilst there is the unascertainable risk of a future threat developing, this amounts to a *de facto* acceptance that the UK will never fully disarm. In our opinion, this can only negate the good faith with which the UK is required to negotiate [to achieve nuclear disarmament under Article VI of the NPT].²⁴⁰

The Mk4A warhead modification program and the upgrade of all elements of the Trident system are likely to enhance the targeting capability of Trident. Sands and Law argue that upgrades of this nature would be likely to increase the circumstances in which the UK’s nuclear weapons would be used and that this would be contrary to the UK’s obligation to pursue a diminishing role for nuclear weapons, as set out at the 2000 NPT Review Conference and reaffirmed at the 2010 NPT Review Conference.

Lord Murray, formerly the senior government law officer in Scotland, has questioned whether the upgrad-

ing of Trident can be reconciled with the UK's obligations to pursue negotiations on disarmament in good faith. He has also said that the deployment of Trident on continuous patrol, in the absence of an imminent danger to Britain, could be seen as "a continuing threat of unrestricted use against others" and as such would be contrary to international law.²⁴¹

The UK's modernization plans are closely bound up with its special nuclear relationship with the US. The transfer of nuclear weapon design information, warhead components, and fissile material from the US to the UK is contrary to the spirit of the NPT and sets an example which is inconsistent with the purpose of the Treaty.

DISCOURSE AND TRANSPARENCY

The UK government has disclosed some of its plans for modernization, but there have been important limits to its transparency. It has tried to keep the Mk4A warhead modification program out of the limelight. The upgrading of AWE is presented as if it were disconnected from the development of a successor warhead. Blair's government argued that it was only planning to replace the submarine platform. It tried to censor an official's speech when it revealed that they would replace the warhead and missile as well.²⁴²

Each decision point has been presented as only a small step on the way. The government told MPs in March 2007 that parliament was only endorsing the concept phase of the programme for a successor submarine. When the next package of work was approved, in May 2011, MPs were told that the important Main Gate decision was still five years away. In July 2005 the government published the cost of the three years of its plan to modernize AWE. The full extent and cost of the programme have never been revealed.

Blair's government presented its case for modernization in the December 2006 White Paper and used this document to persuade parliament to back their proposal. The White Paper gave the misleading impression that status was not an important consideration. It said: "We maintain our nuclear forces as a means of deterring acts of aggression against our vital interests and not for reasons of status."²⁴³ The status argument has been deliberately played-down in official publications because of its implications for proliferation. The former UK Disarmament Ambassador, David Boucher, described as "pernicious" the notion that nuclear weapons give Britain a seat at the top table.²⁴⁴

Tony Blair contradicted the White Paper in his memoirs. He wrote: "I could see clearly the force of the commonsense and practical arguments against Trident, yet in the final analysis I thought giving it up too

big a downgrading of our status as a nation, and in an uncertain world, too big a risk for our defence."²⁴⁵ John McTernan, a former special adviser to the Blair government, put the case more bluntly: "If we didn't have Trident we'd be Belgium. Some people would find that a comfortable place to be. I wouldn't. If Britain is going to be a major power, Britain should have the kinds of weapons a major power has."²⁴⁶ In 2011 Admiral Lord Boyce, a former Chief of the Defence Staff, wrote that unilateral disarmament would undermine the UK's ability to remain a strong player on the world stage.²⁴⁷

Dr. Nick Ritchie has suggested that possession of nuclear weapons is tied up with aspects of Britain's identity as a nation, including how the country sees itself as a responsible, interventionist major power.²⁴⁸ One aspect of this identity is the special relationship which Britain feels it has with the US.²⁴⁹ Another is the sense that Britain should be above France and Germany in the pecking order of European states.

Bernard Jenkins MP argues that the UK should retain nuclear weapons to keep its place at the top table in nuclear disarmament negotiations.²⁵⁰ However the UK's ability to play an active role in these talks is crippled by its dependence on US support for its nuclear programme.

Britain's role is not to question its key ally, but to support it. Frank Miller said that the main benefit that the US derives from assisting AWE is that the UK stands alongside the US in the dock when they are accused by other nations during discussions on disarmament.²⁵¹

The 2006 White Paper said that no state had the intent and capability to threaten British vital interests with nuclear weapons. The 2010 National Security Strategy placed nuclear threats to the UK in the lower, second tier, of risks. In a situation where there is no identifiable threat, and where the status argument can only be whispered, UK governments have sought to justify their modernization programmes on the grounds that nuclear weapons are an insurance policy in an uncertain world.

In a key speech on Trident, Blair said that "the one certain thing about our world today is its uncertainty."²⁵² Supporters of British nuclear weapons have marshaled positive changes in world politics to justify Trident. Lord Robertson says that the fall of the Berlin Wall and the Arab Spring show how events cannot be foreseen, and that in such an unpredictable world Britain must have nuclear weapons.²⁵³

General Sir Hugh Beach challenges this reliance on uncertainty, arguing that "in no other area of military provision is the justification of a general insurance against the unforeseen accepted."²⁵⁴ He describes the government's rationale as "'just-in-case' posited on a most unlikely concatenation of circumstances."²⁵⁵ Ritchie points out that we can't predict the future, but

THE UK'S MODERNIZATION PLANS ARE CLOSELY BOUND UP WITH ITS SPECIAL NUCLEAR RELATIONSHIP WITH THE US.

we can “outline robust parameters and undertake a detailed analysis” of the specific threats presented in Blair’s White Paper.²⁵⁶

The first scenario in the White Paper is a re-emerging threat from Russia or China. Professor Michael Clarke says that we were lucky to have survived the Cold War without nuclear destruction.²⁵⁷ Ritchie points out that we should reassess the real risks that we ran of nuclear war by miscalculation and argues that British nuclear weapons were only a peripheral concern for the Soviet Union.²⁵⁸

The second scenario is of an emerging nuclear state. The White Paper says that the UK should not allow itself to be subject to nuclear blackmail from such a state. Beach counters this by giving examples of how nuclear threats have been ineffective.²⁵⁹ Ritchie points out that a British threat to use nuclear weapons in this situation would probably not be credible.²⁶⁰

The third scenario is state-sponsored nuclear terrorism. But intelligence agencies are not foolproof, as witnessed in Iraq. Assigning blame would always be a matter of disputable judgment and threatening nuclear attack in such a situation particularly problematic.

UK government decisions about nuclear weapons, since the 1960s, have focused on the argument that “now is not the time” to disarm. Sir Michael Quinlan, former permanent secretary at the MoD, said that each set of decision-makers, over several decades, produced “a set of rationales to clothe that gut decision.”²⁶¹ Blair wrote in his biography, “Imagine standing up in the House of Commons and saying I’ve decided to scrap it. We’re not going to say that, are we?”²⁶²

The White Paper rejected the argument that if Britain disarmed, then others would follow their example. It said, “There is no evidence or likelihood that others would follow the UK down a unilateralist route.”²⁶³ Lord Robertson said that there was no reciprocal response from other countries to the reduction in deployed UK warhead numbers which he announced in 1998—“there was no benign chain reaction.”²⁶⁴ He then criticized China for increasing its nuclear arsenal and Russia for modernizing its nuclear forces.

On the other hand, Professor Michael Clarke says that British disarmament could have a significant positive effect on others. He argues that if Britain were to scrap Trident this would be the most significant nuclear decision the world has ever seen.²⁶⁵ Professor William Walker points out that such a move would be unique because of Britain’s role in the early development of nuclear weapons and its position as one of the three custodians of the NPT.²⁶⁶ Walker adds that if Britain disarmed this would be far more dramatic than the examples of disarmament we have seen so far. These have been in the peculiar situations of the disintegration of the Soviet Union and the end of apartheid in South Africa. Clarke adds that, even if others don’t follow and we end up in an unstable scenario with more

nuclear-armed states, Britain would still be better off by not being one of them.

A major criticism of British nuclear weapons policy is that it sets a bad example for others. If Britain requires nuclear weapons as an insurance policy in an uncertain world, then every other nation in the world can say the same. In response, the government falls back on Britain’s position as a nuclear weapon state in the NPT.²⁶⁷ But this ignores the basic bargain of the Treaty—that the nuclear weapon states are obliged to genuinely seek to achieve disarmament.

Prime Minister Cameron describes the Trident force as an “independent nuclear deterrent.”²⁶⁸ Beach points out that most aspects of the system use American equipment and it is hard to imagine Britain launching a nuclear attack if the United States was opposed to such action.²⁶⁹

Dependence on American support is a significant driver for Britain’s modernization efforts. The Royal Navy is determined to buy the latest American equipment, so it is not left with the costs and problems of sustaining an obsolete system. One of the main goals of AWE’s research programme is to retain Britain’s unique access to the closely guarded secrets of the US nuclear laboratories. In return for this assistance, the United States expects that the UK would join any nuclear coalition of the willing.²⁷⁰ The US-UK nuclear exchange is based on the Mutual Defence Agreement, which is due for renewal in 2014.

John Woodcock, the Member of Parliament for the submarine town of Barrow, has been at the forefront of arguing for the successor submarine, because it creates jobs in his constituency. Similar arguments have been presented by Jackie Baillie, the Member of the Scottish Parliament for the area around Faslane. But, while the Clyde Naval Base supports thousands of jobs, the government has acknowledged that only 464 civilian posts at the site are directly related to Trident.²⁷¹ The Scottish Trade Unions Congress continues to oppose nuclear weapons and has called for a programme of diversification to enable these workers to be redeployed on other projects, such as the construction of marine energy facilities.

The government uses safety and surety as arguments to support the modernization of British nuclear forces. For example, Liam Fox pointed out that the PWR₃ reactor on the successor submarine would incorporate “the latest safety technologies”. However these improvements would not be made if the UK was planning to dismantle its nuclear arsenal in the near future. The reduced risk of an accident is outweighed by the increased risk of the deliberate use of nuclear weapons if there is no progress in tackling the conjoined issues of proliferation and disarmament.

The Liberal Democrat party raised nuclear weapons as a significant issue in the 2010 general election. They challenged the view of the Conservative and Labour

parties, that Britain should build a new system with Submarine Launched Ballistic Missiles, and said that the UK should look for a cheaper alternative. Their range of options included having no nuclear weapons at all, although this was played down in their campaign. The election resulted in a Conservative / Liberal Democrat government. The coalition is based on a joint agreement. With regard to Trident, the agreement says the parties “will maintain Britain’s nuclear deterrent, and have agreed that the renewal of Trident should be scrutinised to ensure value for money. Liberal Democrats will continue to make the case for alternatives.”²⁷²

In May 2011 the government announced that Armed Forces Minister Nick Harvey, a Liberal Democrat MP, would lead a study into alternatives. This study will consider whether British nuclear forces must be submarine-based, if they are submarine-based whether they could deploy cruise rather than ballistic missiles, and if there has to be one submarine on patrol at all times.²⁷³

Speaking to the Liberal Democrat conference in September 2011, Mr. Harvey said that the study was looking at dual-use submarines, which could be deployed in a nuclear or conventional role.²⁷⁴ This could involve either Astute-class submarines or the proposed new successor submarine.²⁷⁵

The alternatives study has revived the issue of whether the UK has to keep one nuclear-armed submarine at sea at all times. The government position is that the UK has to have an assured second-strike capability and that this is best provided by Continuous At Sea Deterrence (CASD). An unlikely critic of this approach was Sir Michael Quinlan, for over thirty years the primary advocate of British nuclear deterrence. Shortly before his death he wrote:

The case for having a boat at sea used to centre, in my long-ago DUS(P) days, on the argument that in the Cold War setting we must maintain this ultimate level of insurance against the admittedly-remote hypothesis of super-power bolt from the blue. That hypothesis has surely evaporated. Can we not now assume, for any realistic scenario, that we would have some warning.²⁷⁶

Supporters of CASD say that if there was no submarine at sea, then decision-making in a crisis would be more difficult. Deploying a nuclear submarine might heighten tension at a crucial time. Quinlan said he was skeptical of this argument and he didn’t think it was worth the extra cost, of having four submarines rather than three. He also suggested that, in a crisis, the UK might want to deliberately deploy a submarine as a means of sending a signal to the opponent.

Harvey’s report on alternatives will be completed in late 2012, fifty years after the Cuban missile crisis. This coincidence of timing will provide an opportunity to highlight the real risks from flawed theories of deterrence operating in the real world of human fallibility and error. It may also help to focus minds on whether

Britain needs today, and for the next 50 years, to keep one submarine on patrol at all times, waiting for a bolt-from-the-blue strike from a Soviet Union which long ago ceased to exist. Ending this posture would not only be a significant step in itself, but it could also be a way to unravel the UK’s plan to modernize its nuclear forces, because this plan is based on the requirement to keep a submarine at sea at all times.²⁷⁷

Philip Hammond, the current Defence Minister, has said that Harvey’s report will remain a closely guarded secret.²⁷⁸ But, in order to comply with the 2000 and 2010 NPT Review Conferences, the UK should be more transparent about this investigation and about all aspects of its modernization programme.

The Trident force operates from Faslane in Scotland. In March 2007 a majority of the MPs at Westminster who represented Scottish constituencies opposed the government’s plan to modernize British nuclear forces. In June 2007 the Scottish Parliament passed a motion which called on the UK government not to go ahead with this plan. The Scottish National Party (SNP), which is strongly opposed to Trident, has formed the Scottish government since May 2007. In May 2011 it won a majority in the Scottish Parliament.

The Scottish government will hold a referendum on Scottish independence in Autumn 2014. First Minister Alex Salmond has stressed that one of the main advantages of independence is that it would mean an end to nuclear weapons in Scotland.²⁷⁹ Officials in the MoD have admitted that it would not be feasible to move the nuclear weapons depot from Coulport to another site.²⁸⁰ A detailed review by Scottish CND of the alternatives found that none of the sites in England and Wales that were considered for Polaris in 1963 are viable today and that locating the UK nuclear force in the US or France would be very difficult because of the Non-Proliferation Treaty.²⁸¹ A senior official in the MoD told the *Telegraph* said that Scotland voting “yes” in the referendum would be a “unbelievable nightmare” for Trident.²⁸²

Some commentators have suggested that an independent Scotland would be forced to do a deal and that Trident would stay in Faslane.²⁸³ First Minister Salmond was asked in the Scottish Parliament whether this was a possibility. He replied: “It is inconceivable that an independent nation of 5.25 million people would tolerate the continued presence of weapons of mass destruction on its soil.”²⁸⁴ Opposition to nuclear weapons has consistently been stronger in Scotland than in England since the deployment of US Polaris submarines to the Holy Loch in 1961. Civic Scotland, including the churches and trade unions, has a long tradition of supporting nuclear disarmament. As Admiral Lord West, former First Sea Lord, has suggested, Scottish independence would be likely to lead to unilateral nuclear disarmament.²⁸⁵

Opinion polls suggest that the majority of Scots may not vote for independence in 2014. However, the

growing movement in this direction must raise serious question within the MoD of the viability of its plan to base nuclear weapons at Faslane until 2060. The perfect storm of the Scottish question and the economic crisis means that the UK nuclear weapons programme is more fragile today than at any time in its 50 year history, since the first British atomic test in October 1952.

NOTES

1. Strategic Defence and Security Review 2010, para 3.11. These figures were repeated by Liam Fox, Hansard, 28 June 2011.
2. The UK has purchased three W76 components—the Arming, Fuzing and Firing System, Gas Transfer System and Neutron Generator—from the US. Hansard, 4 December 2009. The UK Trident warhead contains EDC37, a British explosive, rather than the American equivalent, PBX9501.
3. John Ainslie, “UK nuclear tests 1974-1991,” November 2011. <http://banthebomb.org/ne/images/stories/pdfs/uktests.pdf>.
4. Minutes of the MOD Trident Group, 7 August 1980, The National Archives (TNA) DEFE 24-2125 e79.
5. John Ainslie, “UK nuclear tests 1974-1991,” *op. cit.*
6. Reply by George Robertson to question from Roseanna Cunningham, Hansard, 19 March 1998.
7. The Future of the United Kingdom’s Nuclear Deterrent, December 2006, Cm 6994, para 4-9.
8. Strategic Defence and Security Review 2010, para 3.10f.
9. “The program for implementing the SDSR warhead reductions has commenced: at least one of the Vanguard Class ballistic missile submarine (SSBN) now carried a maximum of 40 nuclear warheads.” Liam Fox, Hansard, 29 June 2011 Col 51WS.
10. Strategic Defence and Security Review 2010, para 3.10f.
11. Operational selection policy OPS11, Nuclear Weapons Policy 1967-1998, November 2005, www.nationalarchives.gov.
12. AWE Local Liaison Committee Minutes, 28 February 2002, www.tridentreplacement.net.
13. Rear Admiral Stephen Johnson, head of the Strategic Systems Program, said that HMS Victorious had fired a D5 missile over a range of 5,000 miles from Florida to off the coast of Africa on 24 May 2009, in testimony to the Senate Armed Services Committee on 3 June 2009.
14. Strategic Defence and Security Review 2010.
15. “The point has been reached where it is certain that the United Kingdom will need to procure significant quantities of highly enriched uranium, weapons grade plutonium and tritium from the US Department of Energy, at various rates from about 1985 for some ten years, in order to implement our future nuclear deterrent proposals”. Letter from Margaret Thatcher to Ronald Reagan, 10 September 1981, TNA DEFE 25-435 e48-1.
16. In 1981 it was assumed that HEU would be purchased from the US because this was cheaper than building a new “Destiny” enrichment facility in the UK. Special Nuclear Materials—Background Note (for MISC 7), November 1981 TNA DEFE 24-2123. In 1987 the Defence Committee was told that final enrichment of HEU was carried out in the US. Progress of the Trident Programme, House of Commons Defence Committee report, HC 422, 1987/88 page 22.
17. Progress of the Trident Programme, House of Commons Defence Committee report, HC 422, 1987/88 Q57.
18. John Ainslie, “Special Nuclear Materials for the UK Trident Programme,” <http://banthebomb.org/ne/images/stories/pdfs/tridentsnm.pdf>. This includes an analysis of the figures published in *Plutonium and Aldermaston: a historical account*, MOD 2000.
19. *Plutonium and Aldermaston: a historical account*, MoD, 2000, available through the Federation of American Scientists website, <http://www.fas.org/news/uk/000414-uk2.htm>.
20. For most of the period from 1969 to 1985 the UK military plutonium stockpile was around 2 tonnes. If each of the current warheads contains 4 kg of plutonium then the total amount in the current stockpile (less than 225 weapons) is less than 1 tonne, leaving 2.2 tonnes as a reserve. Much of this will have been in the form of pits for WE-177 and Chevaline warheads.
21. *Historical accounting for UK Defence Highly Enriched Uranium: A report by the Ministry of Defence on the role of historical accounting for Highly Enriched Uranium for the United Kingdom’s Defence Nuclear programmes*, MoD, March 2006, <http://www.mod.uk/NR/rdonlyres/DDDBEE8B-F36D-457E-B472-C6C2877EE804/0/HistoricalAccountingForDefenceHighlyEnrichedUranium.pdf>.
22. There are major gaps in its history of the British programme. The complex relationship with the US is mentioned in just one sentence. There is no reference to a known barter transaction with the US in 1964-9 and no explanation of how the UK obtained HEU for the Trident programme.
23. *Historical accounting for UK defence Highly Enriched Uranium, op. cit.*
24. In February 1957 the plan was to produce 4910 kg of HEU at Capenhurst between 1958/9 and 1961/2. Cost estimates for plutonium and uranium 235 for the years 1958-63, Note by the Technical Policy Branch, Risley, February 1957, TNA AB16-3878 e12. There was a requirement for 3463 kg of HEU for Green Grass and Red Snow warheads between 1957/8 and 1961/2, TNA AB43-92 e46, 4 May 1964. In 1996 the Stockholm International Peace Research Institute (SIPRI) estimated that Capenhurst had produced 3.8-4.9 tonnes of HEU, almost all of this between 1959 and 1961: <http://nuclearweaponarchive.org/UK/UKFacility.html>.
25. The official account of the HEU stockpile says that the two sources of HEU for the UK military programme were the Capenhurst plant (until 1962) and the United States. *Historical accounting for UK defence Highly Enriched Uranium, op. cit.* 7.5 tonnes were obtained from the US between 1964 and 1969 in exchange for plutonium. *Plutonium and Aldermaston: a historical account, op. cit.* This implies that the UK procured the remaining 14-15 tonnes of HEU from the US between 1970 and 2002.
26. “Within MOD irradiated fuel the proportion of fissile materials is significant”, Nuclear Liabilities Management Strategy, MoD, September 2011, p. 24.
27. British and American nuclear submarine reactors require HEU which is enriched to at least military grade.
28. The MoD said that Vulcan would be scaled down or closed after 2015, BBC, 2 November 2011. Rolls Royce told John Thurso MP that they would retain a workforce of around the current size beyond 2030, John O’Groat Journal, 16 November 2011.
29. Trident Value for Money – C4 Infrastructure, obtained under the Freedom of Information Act by Greenpeace.
30. Letter from George W Bush to Tony Blair, 7 December 2006.
31. MoD procurement activities were restructured in 2007. MoD project Poo221E was listed as “Mk4A Refurbishment Programme” under the old structure (Defence Procurement Agency), and “Nuclear Weapons Mk4A” under the new structure (Defence Equipment and Support). Excel spreadsheet accessed on the MoD website in 2007 but no longer online.
32. Defence Nuclear Environment and Safety Board Assurance reports for 2006, 2007 and 2008.
33. Defence Nuclear Environment and Safety Board 2006 Assurance report. This says that the Safety Justification Plan for the warhead modification was due to be submitted in early 2007.
34. Nuclear Weapon Regulator Annual report 2004-2005 DNSB/06/05, released under the Freedom of Information Act.
35. In 2006 Angus Robertson MP asked what discussions the MoD had held with the US on the Mk4A Reentry Body. Defence Minister John Reid replied, “officials from the Ministry of Defence regularly discuss a range of nuclear matters with their US counterparts under the auspices of the 1958 Mutual Defence Agreement,” Hansard, 2 May 2006, Column 1353W. In 2002 Lewis Moodie MP gave a similar reply to a question from Lynne Jones MP about W76-1, Hansard 6 February 2002, Column 997W.
36. Hansard 18 December 2006.
37. Vacancy for a Warhead Electrical Engineer as advertised on planetrecruit.com and beechwoodrecruit.com in 2007. In the description of this position on the Aldermaston website the words “Mk4A AF&F” were omitted. A similar position was advertised on the Aldermaston website in June 2009. This included the abbreviation “AF&F” but not “Mk4A”.
38. *Guardian*, 14 March 2007 and Hansard, 28 March 2007.
39. Hansard, 4 December 2009.
40. A key Measure of Effectiveness for C4/Mk4, when it was original-

- ly developed, was a target with a vulnerability number (VNTK) of 27Po. A target of this type would be destroyed by blast overpressure of around 150 psi, which is far less than required to destroy a hardened target. C4 achieved sufficient accuracy to be effective against 27Po. This Measure of Effectiveness for C4/Mk4 was used again in 1994. Joint DoD/DoE Trident Mk4/Mk5 Reentry Body Alternate Warhead Phase 2 Feasibility Study Report, January 1994, p. 9–14.
41. MC2912, the AF&F in the Mk4 RV, has three fuzing systems: Airburst Radar with 3 range options (prime), contact fuze (backup) and G-started timer (prime or backup). Survey of Weapon Developments and Technology, Sandia National Laboratory, February 1998, p. 485.
 42. Joint DoD/DoE Trident Mk4/Mk5 Reentry Body Alternate Warhead Phase 2 Feasibility Study Report, January 1994.
 43. Joint DoD/DoE Trident Mk4/Mk5 Reentry Body Alternate Warhead Phase 2 Feasibility Study Report, January 1994, Appendix B p 8. A near-surface burst detonates the warhead before it reaches the ground, but at a height where the fireball will touch the surface.
 44. A redacted chart shows the effectiveness of D5/Mk4A against a range of targets up to VNTK 46L8 (SS-11) with a comment “This represents a set of targets likely to be eligible for the Mk4A”, Alternate Warhead Study, pp. 9–17.
 45. Rear Admiral P Nanos, Director of Strategic Systems Programs, US Navy, “Strategic Systems Upgrade” in the Submarine Review April 1997. In 1997 the US Navy was planning a two-stage upgrade of the AF&F, with a fuse modification that would be in production by 2001 followed by the development of a replacement AF&F; Stockpile Stewardship and Management Plan: First Annual Update, DOE, October 1997, obtained under FOIA by Hans Kristensen.
 46. Joint DoD/DoE Trident Mk4/Mk5 Reentry Body Alternate Warhead Phase 2 Feasibility Study Report, January 1994; Stockpile Stewardship and Management Plan: First Annual Update, DOE, October 1997, obtained under FOIA by Hans Kristensen; Survey of Weapon Developments and Technology, Sandia National Laboratory, February 1998; 1999 DOE Stockpile Stewardship master plan quoted in Greg Mello, “That Old Designing Fever,” *Bulletin of Atomic Scientists*, January/February 2000.
 47. MC4708 Thermal Battery Assembly, www.sandia.gov.
 48. The Mk4A AF&F uses CMOS7r processors in the Permafrost Integrated Circuit, which has been described as “the brains of the W76-1”, <http://www.sandia.gov/LabNews/LN07-23-04/labnews07-23-04.pdf>, http://isandtcolloq.gsfc.nasa.gov/spring2002/presentations/knoll_4-30-02.pdf, <http://www.sandia.gov/LabNews/LN07-23-04/labnews07-23-04.pdf>.
 49. <http://www.sandia.gov/LabNews/LN04-20-01/labnews04-20-01.pdf>
 50. Letter from Des Browne to Nick Harvey, 2007.
 51. Defence Nuclear Environment and Safety Board 2008 Assurance Report, para 37.
 52. Sandia Lab Accomplishments, March 2011, http://www.sandia.gov/LabNews/labs-accomplish/2011/lab_accomp-2011.pdf; reported by Hans Kristensen in the Federation of American Scientists Blog on 1 April, <http://www.fas.org/blog/ssp/2011/04/britishw76-1.php>.
 53. Justification for Critical Decision 1, SNL Weapons Evaluation Test Laboratory at Pantex, Amarillo, Texas, http://www.arcplanning.com/projects/archive/screen-pdf/19712.801_wetl.pdf.
 54. High Energy Density Physics, National Nuclear Security Administration, April 2001, Appendix G—United Kingdom Statement on High Energy Density Physics. One of the two goals of the Nuclear Warhead Capability Sustainment Programme is to keep the existing warhead in service over an “extended fixed period”. MoD Screening Decision Form (MoD Form No 1923) for the Nuclear Warhead Capability Sustainment Programme, 2007.
 55. AWEML’s management contract was extended to 2025. AWE’s annual report said “The contract now covers the expected life cycle of the Trident system”. Annual report 2002, AWE. The 2006 White Paper said that the existing warhead was expected to remain in service until some point in the 2020s: Future of the United Kingdom’s Strategic Nuclear Deterrent, December 2006.
 56. Trident Value for Money Review, Note by the Ministry of Defence, obtained under the Freedom of Information Act by Greenpeace.
 57. Strategic Defence and Security Review 2010.
 58. John Ainslie, “Fogbank,” February 2008, www.banthebomb.org/newbombs/fogbank%20material.doc.
 59. Hansard 4 December 2009.
 60. The Acorn GTS was originally due to enter service in 1998, as part of Alteration 371 to the W76-0 warhead, but its completion was delayed by a few years. LANL Reflections, December 2002.
 61. “Processing of the replacement tritium reservoir” at Coulport was an issue in the Nuclear Weapons Regulator Annual Report 2004-05, DNSB/06/05.
 62. Independent Analysis Tritium R&D Facility Consolidation, October 2008, http://www.complexttransformationspeis.com/RM_508%20-%20TechSource%202008g.pdf.
 63. In 2000 AWE were conducting trials to extend the life of EDC37 from 10 years to 14 years.
 64. Between 1978 and 1980 the MOD used the term “successor warhead” for the replacement for Chevaline, i.e. Trident. They are reapplying same phrase today for the future warhead.
 65. “It would be premature to abandon a minimum capability to design and produce a successor to Trident should this prove necessary”: Strategic Defence Review, 1998.
 66. Discussion on Key Elements and Enablers of the UK Version of a Responsive Infrastructure, Heather Pragnell, A collection of papers from the 2007 PONI conference, Center for Strategic and International Studies, 2008, p. 73. NWCSF was based on proposals which were endorsed by the Defence Management Board (nuclear) in November 2002 and by Cabinet committee in January 2004. The description of these proposals was redacted in MoD Screening Decision Form (MoD Form No 1923) for the Nuclear Warhead Capability Sustainment Programme, 2007.
 67. MoD Screening Decision Form (MoD Form No 1923) for the Nuclear Warhead Capability Sustainment Programme, 2007.
 68. “Our research and development work splits into two main but inter-related areas. The first is the requirement to maintain the current Trident stockpile. The second is to develop our overall warhead design and assurance capabilities, including the ability to provide a new warhead lest our government should ever need it as a successor to Trident. Most of our research is conducted into this capability area”. Clive Marsh, Chief Scientist AWE, <http://www.youtube.com/watch?v=gT8qCFkblv4>.
 69. Discussion on Key Elements and Enablers, p. 73.
 70. Annual Report 2002, AWE, p. 2.
 71. *The Future of the United Kingdom’s Nuclear Deterrent*, December 2006, Cm 6994, p. 31.
 72. Speech by David Gould, Chief Operating Officer, Defence Equipment and Support, to the Future Deterrent Industry Day at Abbey Wood, Bristol, 29 June 2007.
 73. *The United Kingdom’s Future Nuclear Deterrent: The Submarine Initial Gate Parliamentary Report*, May 2011, p. 9.
 74. The 2006 White Paper said the warhead decision would be taken by the next parliament (2010–2015): *The Future of the United Kingdom’s Nuclear Deterrent*, December 2006, Cm 6994, p. 31. However in May 2011 this was put back to the subsequent parliament (2015–2020): *The United Kingdom’s Future Nuclear Deterrent: The Submarine Initial Gate Parliamentary Report*, May 2011, p. 9.
 75. Hansard, 19 November 2007, Column 483W.
 76. Written answer by Des Browne to question from Nick Harvey, Hansard, 19 November 2007, Column 483W.
 77. Project on Nuclear Issues (PONI) interview with Franklin Miller KGB, Special Advisor to President George W Bush & Senior Director for Defense Policy and Arms Control, <http://csis.org/program/us-uk-nuclear-cooperation-after-50-years>.
 78. Jeffrey Lewis, “High Surety Warhead,” *Arms Control Wonk*, 23 August 2007, <http://lewis.armscontrolwonk.com/archive/1619/high-surety-warhead>.
 79. Future Nuclear Deterrent Industry Day, Nuclear Warhead Context, Nick Bennet—DG Strat Tech, 29 June 2007. Reply by Des Browne to question from Nick Harvey, Hansard, 28 November 2007.
 80. “Re-entry Systems (Options): Options are now being considered by SWPT and AWE for the maintenance of nuclear warhead capability for current and future SSBNs. When variability of ISD for any successor warhead is factored in, a quite complex picture emerges in which continuing research and development of warhead technologies and features is a central theme. DNSR has

- good visibility of and engagement with the ReS(O) programme.” Defence Nuclear Environment and Safety Board 2009 Assurance report.
81. Nicola S Cox and Duncan R Farr, “How Much Science Is Enough?” A collection of papers from the 2009 PONI Conference Series, Center for Strategic and International Studies, 2010, p. 52.
 82. “At AWE, this portfolio of experience is spread across the Trident, Capability and Successor Directorates.” “How Much Science Is Enough?” *op. cit.*, p. 53.
 83. On the basis of this approach, the analysis identified the warhead capabilities at AWE which were most important. The conclusion of Cox and Farr’s paper was that cuts at AWE should focus on discrete areas. Across the board reductions would be less efficient. “How Much Science Is Enough?” *op. cit.*, p. 57–60.
 84. AWE’s capacity to carry out certain tasks was at a low ebb in the late 1990s. In some areas they retained the ability to specify work, but not to carry it out themselves. Owen Price, “Must Life Extension Compromise Responsiveness?” A collection of papers from the 2005 PONI conference series, Center for Strategic and International Studies, 2006, p. 113f.
 85. Owen Price, *op. cit.*, p. 120. A key aim of the Technology Division at AWE is to improve systems engineering and warhead integration skills—“How Much Science is Enough?” *op. cit.*, p. 51.
 86. The Senior Systems Engineer was to “lead a team of AWE engineers on long-term overseas secondment for the purposes of AWE systems integration capability development” and “to support the development of a warhead-to-weapon system integration.” The Deputy Team Leader for Weapon Integration was to “implement a strategy to transfer systems integration capability from the overseas team to the core UK programme.” The Senior Systems Engineer was to be based at the “suppliers facility,” which is probably the Systems Engineering facility at Sandia National Laboratory. Jobs advertised at awe.co.uk, accessed in June 2006.
 87. US Air Force Research, Development Test and Evaluation FY2012 BA 5, PE 060422F Nuclear Weapon Support.
 88. One task in the AF&F project, to be carried out in FY2011, was to “document enveloping requirements to support Navy, Air Force and UK applications,” US Navy Research, Development, Test & Evaluation budget FY2012, BA7 PE 0101221N Strategic Sub & Wpn Supt, February 2011. The UK successor warhead will probably be designed to fit into the US Mk5 Re-entry Vehicle.
 89. US Navy Research Development Test and Evaluation budget FY2010, BA-7, PE 0101221N Strategic Sub & Weapons System Support, May 2009.
 90. “Development of the Integrated AF&F demonstrators ... to TRL4 and TRL5” Vacancy for Arms Fusing and Firing (AF&F) Mechanical Design Engineer, accessed 25 April 2011. Technical Readiness Level 4 (TRL 4) is testing in a laboratory and TRL 5 is testing in a relevant environment.
 91. Vacancy for Electrical/Electronic Design Engineer, accessed 25 April 2011.
 92. Vacancy for Senior Digital Electronics Research and Development Engineer, accessed 25 April 2011.
 93. Vacancy for Formal Methods and Software Engineer, accessed 15 May 2008.
 94. Vacancies for Firing Unit Mechanical Designer and Electronics Engineer, accessed 25 April 2011.
 95. Vacancy for Pulsed Energy Component Scientist, accessed 31 October 2010.
 96. “Liaise with overseas colleagues ... longer-term secondment overseas may be required to support collaborative activities” Vacancy for Senior Digital Electronics Research and Development Engineer, accessed 25 April 2011.
 97. SNL vacancy for Weapons Systems Engineer, accessed 10 July 2011. The scope of this post includes “support arming, fusing, and firing (AF&F) architecture development”. The employee is expected to “participate in advanced architecture studies in collaboration with the Department of Defence and the United Kingdom Atomic Weapons Establishment”.
 98. AWE vacancy for Design Engineer—Gas Transfer, accessed 12 November 2007.
 99. AWE vacancy for Hydrogen Storage Engineer—Gas Transfer, accessed 11 July 2008.
 100. AWE vacancies for Pressure Vessel Engineer—Gas Transfer (12 November 2007), Joining Engineer—Gas Transfer (12 November 2007), Senior Pressure Vessel Engineer—Gas Transfer (12 November 2007).
 101. Fiscal Year 2009 Program Implementation Plan, Directed Stockpile Work, Research and Development Program, National Nuclear Security Administration (NNSA), Revision 3, 26 August 2009, p. 26.
 102. AWE vacancies for Mechanical—Design Engineer (25 April 2011), High Voltage Test Equipment Engineer (13 June 2006), Electro-Explosives Specialist (21 October 2006), Neutron Tube Design Team Leader (22 July 2006), Thin Film Specialist (22 July 2006).
 103. AWE vacancy for vacuum tube materials scientist, accessed 8 May 2008.
 104. Owen Price, *op. cit.*
 105. Jeffrey Lewis, www.armscontrolwonk.com. “A common high-surety warhead for the Mk12A/W78 and Mk5/W88”, US Air Force Research, Development Test and Evaluation FY2012 BA 5, PE 060422F Nuclear Weapon Support.
 106. Vacancies for Mechanical Design and Integration Engineer and Arms Fusing and Firing (AF&F) Mechanical Design Engineer, accessed 25 April 2011.
 107. Vacancies for Electro-Mechanical Engineer, accessed 31 October 2010, and Electro-Mechanical Device Analyst, accessed 21 April 2007. Strong-links are also AF&F components.
 108. Fiscal Year 2009 Program Implementation Plan, Directed Stockpile Work, Research and Development Program, NNSA, Revision 3, 26 August 2009, p. 25.
 109. “KCP supports the Enhanced Surety subprogram of the Engineering Campaign through participation in specific component maturation efforts in support of Enhanced Collaboration with work with the United Kingdom,” NNSA FY2010 budget, p. 487.
 110. NNSA FY2012 budget, Weapons Activities, Engineering, Enhanced Surety. In November 2011 AWE was advertising for a manager who would “act as the UK Point of Contact for a specific US collaboration”. This post would be accountable to the Team Leader Surety Integration and Technology Division. Post for Major Task Manager advertised on the AWE careers website, 13 November 2011.
 111. “Development and certification of Multi-Point Safety options for the next insertion opportunity will continue ... with some continued effort through the enhanced collaborations with the United Kingdom”: NNSA budget FY 2012, p. 98. “Los Alamos National Laboratory and Lawrence Livermore National Laboratory will continue to develop multi-point safety options working in collaboration with the United Kingdom”: NNSA Budget FY2010, p. 105. In 2009 “parametric material studies” were carried out on Multi-Point Safety at LANL and LLNL through collaboration with the United Kingdom to bracket technologies: NNSA Budget FY 2011, p. 103.
 112. “In principle increased nuclear safety can be achieved by designing a WH [warhead] to be Multi-Point Safe (MPS). Whilst theoretically possible, physical or technical impracticality has prevented MRS being achieved in current WH designs. It shall be a design objective for nuclear WHs to be MRS.” JSP 538 Regulation of the Nuclear Weapons Programme, MOD, March 2005, Annex F Nuclear Weapon Safety Principles and Safety Criteria, p. 10.
 113. FY2012 Stockpile Stewardship and Management Plan, report to Congress, NNSA, 15 April 2011, p. 25.
 114. Beryllium components of the Trident warhead are manufactured in Bay 2 of building A90 in Aldermaston.
 115. A “very secure high explosive” was considered for a replacement for WE177, UK Nuclear Weapons Programme, 30 May 1977, TNA PREM 16-1181 e80. A study was recommended into the “potential military and political value of TATB if large weapons could be used” for a replacement for WE177, WE177 studies, 30 August 1977, TNA DEFE 70-783 e1.
 116. Statement of Rear Admiral Terry Benedict, Director Strategic Systems Programs, Subcommittee on Strategic Forces of the Senate Armed Services Committee, 6 April 2011, <http://armed-services.senate.gov/statemnt/2011/04%20April/Benedict%2004-06-11.pdf>.
 117. Letter from George W Bush to Tony Blair, 7 December 2006.
 118. 36 missiles were ordered prior to FY2010 and 24 in each year from FY2010 to FY2012. FY2012 budget Weapons Procurement, Navy/BA-1 Ballistic Missiles, 1250 Trident II modifications, February 2011.
 119. The Future of the United Kingdom’s Nuclear Deterrent, Cm 6994, MOD/FCO, December 2006.

120. http://www.draper.com/profile_boost_guidance.html
121. A solid-state Interferometric Fiber Optic Gyroscope (IFOG) will replace the current mechanical gyro, an Alternate Pendulous Integrating Gyroscopic Assembly (Alt PIGA) that will replace the current PIGA accelerometer. Charles Stark Draper Laboratory and the E2V Corporation have designed a new stellar camera. www.akama.com/company/The_Charles_Stark_Draper_Laboratory_Inc_a27463334185.html; A simulation-based Integration Approach for the First Trident Mk6 Life Extension Guidance System, presentation to the AIAA Missile Sciences Conference, Monterey, 18–20 November 2008.
122. Explorations, Winter 2004 and Spring 2006, Draper Laboratory.
123. Explorations, Spring 2006, Draper Laboratory.
124. Explorations, Spring 2006, Draper Laboratory.
125. A simulation-based Integration Approach for the First Trident Mk6 Life Extension Guidance System, presentation to the AIAA Missile Sciences Conference, Monterey, 18–20 November 2008.
126. “Since the development of MK1, Draper has significantly improved the reliability and accuracy of the follow-on systems, continuing today with the development of the MARK 6 MOD 1 system.” Mk6 Mod 1 is an alternative name for Mk6LE, see www.draper.com/Documents/Flier_Strategic.pdf.
127. http://www.archive.org/stream/departmentofdefeo72004unit/departmentofdefeo72004unit_djvu.txt. Both the new flight electronics and the Mk6LE guidance unit use new radiation-hardened computer parts.
128. Written answer by Adam Ingram to question from Angus Robertson, Hansard, 18 June 2004.
129. Admiral JT Mitchell, SSPO, testimony to Senate Committee on Armed Services, 11 May 1993, quoted in Hans Kristensen, “Proliferation of WMD and US Nuclear Strategy,” BASIC, 1998.
130. Statement of Rear Admiral Terry Benedict, Director Strategic Systems Programs, Subcommittee on Strategic Forces of the Senate Armed Services Committee, 6 April 2011, <http://armed-services.senate.gov/statemnt/2011/04%20April/Benedict%2004-06-11.pdf>.
131. Solicitation N0003005G0068Nj09 Mk98 Mod 8/9 Concept Exploration, 26 July 2006, www.fbodaily.com.
132. Solicitation N00030-07-G-0044X793, Mk6 LE 344 update 26 August 2009, www.fbodaily.com; Mk98 Mod 9 is part of the SSP Shipboard Integration (SSI) increment 4.
133. Justification and approval for use of other than full and open completion, contract N00030-08-C-041, SSP, www.fbodaily.com. The Shipboard Data System is SSI Increment 2.
134. Request for Information N00030-06-I-0055, 10 October 2006, www.fbodaily.com.
135. Class justification and approval for use of other than full and open competition, SSP, 11 September 2009, www.fbodaily.com.
136. Draft request for proposal (DRFP) N00030-10-R-0018, SSP, 24 June 2009, www.fbodaily.com.
137. Draft request for proposal (DRFP) N00030-10-R-0018, SSP, 24 June 2009, www.fbodaily.com; the first navigation upgrade is SSI increment 4.
138. Draft request for proposal (DRFP) N00030-10-R-0018, SSP, 24 June 2009, www.fbodaily.com; the second navigation upgrade is SSI increment 8.
139. FY2012 budget, Navy RDT&E, BA 5 Development & Demonstration, PE 0604503N SSN-688 and Trident Modernization.
140. Safety regulator’s advice on the selection of the propulsion plant in support of the future deterrent review note, DNSR/22/11/2, 4 November 2009, Defence Board report (09)62 Successor Submarine Project. The section quoted had been redacted but was accidentally released on the House of Commons website.
141. Successor Submarine Project—Review Note, Hd DUW and Hd FSM, 23 July 2009, Defence Board report (09)62 Successor Submarine Project.
142. *The United Kingdom’s Future Nuclear Deterrent: The Submarine Initial Gate Parliamentary Report*, May 2011.
143. Successor Submarine Project—Update, DER Capability, 24 November 2009, Defence Board report (09)62 Successor Submarine Project.
144. Statement by Steve Ludham, President of Nuclear Business at Rolls Royce, “The Future of the UK’s Strategic Nuclear Deterrent: the Manufacturing and Skills Base,” House of Commons Defence Committee, HC 59, 12 December 2006. Evidence, p. 8.
145. Rear Admiral Andrew Mathews Director General Submarines, “Showing the US the way?” 17 January 2008.
146. Natural circulation was first introduced in the S5G reactor on USS Narwhal. As a result this was the quietest submarine in the US Navy. A derivative of S5G is installed on US Ohio Class (Trident) submarines.
147. FY2012 budget, Navy RDT&E BA 4 Advanced Component Development and Prototypes, PE 0603561N, Advanced submarine system development.
148. FY2012 budget, Navy RDT&E, BA 4 Advanced Component Development and Prototypes, PE 0603561N, Advanced Submarine System Development.
149. “We will also reduce the number of operational missiles on the Vanguard class submarines to no more than eight,” Hansard 19 October 2010 Col 801; “We can reduce the number of operational launch tubes on those new submarines from 12 to eight”—statement by Prime Minister David Cameron, Hansard 19 October 2010, Col 801.
150. *The United Kingdom’s Future Nuclear Deterrent: The Submarine Initial Gate Parliamentary Report*, May 2011.
151. Statement of Rear Admiral Terry Benedict, Director Strategic Systems Programs, Subcommittee on Strategic Forces of the Senate Armed Services Committee, 6 April 2011, <http://armed-services.senate.gov/statemnt/2011/04%20April/Benedict%2004-06-11.pdf>.
152. *The United Kingdom’s Future Nuclear Deterrent: The Submarine Initial Gate Parliamentary Report*, May 2011.
153. A joint Navy-Air Force ballistic missile. DoDBuzz, 21 October 2011, <http://www.dodbuzz.com/2011/10/21/a-joint-navy-air-force-ballistic-missile/>.
154. The future of the UK’s Strategic Nuclear Deterrent: Written evidence from the Ministry of Defence, HC 835 2005/06 Ev 5.
155. Recommendation for the AWE Burghfield Site, AWE, 3 December 2002. This also said, “There is insufficient space at Aldermaston alone to accommodate the new operational facilities in the Company’s Major Investment Schemes and those that would be required for any Successor Programme.” A list of requirements for the Aldermaston site in this report included “future facilities for a successor system”.
156. “[The MoD press statement] disassociates the funding from any decision on the future of Trident—this is required irrespective of decisions on a successor warhead”. However, in the absence of this funding, it might be reasonable to assume that intellectual and infrastructure capabilities future options would have been more limited or less credible.” Owen Price, *op. cit.*, p. 116.
157. MoD Screening Decision Form (MoD Form No 1923) for the Nuclear Warhead Capability Sustainment Programme, 2007.
158. Nick Bennet –DG Strat Tech, “Future Nuclear Deterrent Industry Day, Nuclear Warhead Context,” 29 June 2007.
159. “It is vital that the UK carries out a programme of work, both independently and collaboratively, which will enable us to contribute to joint US/UK objectives and access the much larger US programme in this area. In order to do this the UK must have both a programme of work, and the high calibre staff, which will enable us to remain a credible partner in this vital relationship.” “High Energy Density Physics,” NNSA, April 2001, Appendix G—UK Statement on High Energy Density Physics.
160. AWE annual report 2009/10, www.awe.co.uk/Contents/Publication/of874d3AWE_Annual_Review_2010_video_web.pdf.
161. “High Energy Density Physics,” *op. cit.*
162. Dr Daryl Lanberg, Chief Scientist AWE, “Warhead assurance under CTBT constraints,” PONI Fall Conference, 21 September 2010.
163. Project Hydrus and Pulsed Power at AWE, presentation by AWE.
164. *Ibid.*
165. “Flash radiography applied to weapon’s physics was pioneered at AWE,” Project Hydrus and Pulsed Power at AWE, presentation by AWE.
166. Demonstration of the Self-Magnetic-Pinch Diode as an X-ray Source for Flash Core-Punch Radiography, SNL, 2007. Similar experiments were continuing in 2009. Fiscal Year 2009 Program Implementation Plan, Directed Stockpile Work, Research and Development Program. NNSA, Revision 3, 26 August 2009, p. 37. RITS-6 is a testbed for pulsed power.
167. Treaty between the United Kingdom of Great Britain and Northern Ireland and the French Republic relating to Joint Radiography/Hydrodynamic Facilities, 2 November 2010 Cm 7975, www.official-documents.gov.uk/document/cm79/7975/7975.pdf

168. Modern Electron Accelerators for Radiography, Carl Ekdahl, LANL, 2004.
169. NTS [Nevada Test Site] activity descriptions in support of the directed stockpile work research and development—stockpile systems and stockpile services FY 2009 program implementation plan, available at <http://nnsa.energy.gov/sites/default/files/nnsa/foiareadingroom/RR00549.pdf>.
170. Reply by Bob Ainsworth to question from Norman Baker, Hansard 26 June 2008 Col 449W. The AWE Site Development Strategy Plan 2003 said that material science research would be consolidated at a small number of facilities at Aldermaston and Burghfield.
171. The remits of AWE vacancies include—develop new organic materials (Organic materials chemist), investigate novel materials (Inorganic materials chemist), strengthen capabilities in new product development (head of material science research), understand the synthesis of new materials (theoretical chemist), develop new replacement materials (NMR spectroscopist), and research alternative materials and processes (graduate scientist).
172. Dr Daryl Landeg, “Warhead assurance under CTBT constraints,” PONI 2010 Fall Conference, 21 September 2010. A teraflop is a trillion calculations per second.
173. Reply by Bob Ainsworth to question from Norman Baker, Hansard 26 June 2008 Col 449W; reply by Des Browne to question from Nick Harvey, Hansard 7 January 2008 Col 29W; and AWE Site Development Context Plan (SDCP08) 2005–15, April 2008.
174. “Enriched Uranium Facility Initial Gate Business Case,” para 1. Reference DES/NW/PSO/555/35. Ministry of Defence, 3 April 2007, quoted in Project Pegasus—AWE Aldermaston’s proposed Enriched Uranium Facility, Nuclear Information Service, 2010.
175. Ibid.
176. “Information exchange targets UPF,” BWX Tymes, February 2006, <http://bit.ly/7oSSy4>.
177. Y-12 SWEIS Chapter 1, www.y12sweis.com
178. “Enriched Uranium Facility Initial Gate Business Case,” *op. cit.*, para 1. AWE currently carries out the initial fabrication of HEU into reactor fuel for the Naval reactor program; <http://www.mod.uk/NR/rdonlyres/DDDBEE8B-F36D-457E-B472-C6C2877EE804/0/HistoricalAccountingForDefenceHighlyEnrichedUranium.pdf>.
179. Reply by Peter Luff to question from Caroline Lucas, Hansard, 27 January 2011, Column 476W.
180. AWE annual report 2009/10, http://www.awe.co.uk/Contents/Publication/of874d3AWE_Annual_Review_2010_video_web.pdf.
181. Project Mensa: High Level Nuclear Design Philosophy.
182. Design and Access statement Project Mensa, AWE, Submitted to West Berkshire Council as part of the planning application for Project Mensa.
183. The floor space for Mensa is 26,573 sq m and this will replace a current facility of 30,000 sq m.
184. Reply by Peter Luff to question from Caroline Lucas, Hansard, 27 January 2011, Column 476W.
185. Reply by Peter Luff to question from Caroline Lucas, Hansard, 22 November 2011, Column 272W.
186. Reply by Peter Luff to question from Caroline Lucas, Hansard, 22 November 2011, Column 272W.
187. The Future of the United Kingdom’s Nuclear Deterrent, December 2006, Cm 6994.
188. Strategic Defence and Security Review, 2010, para 3.15.
189. Reply by Liam Fox Hansard 3 November 2010 Col 855W.
190. Nuclear submarine infrastructure—scope to minimise future costs, DES-SM LoD-Infra-01/03, 7 July 2010, obtained under the Freedom of Information Act by Greenpeace.
191. <http://www.derby.gov.uk/NR/rdonlyres/FDF000CB-355B-461E-9C03-2E34C8C77BoF/0/100901360CommitteeReport.pdf>; This planning application had originally been approved in November 2008 and was resubmitted with minor changes.
192. The current fuel manufacture plant is scheduled for decommissioning in 2017; A review by the Health and Safety Executive’s Nuclear Installation Inspectorate of the strategy of Rolls Royce Marine Power Operations Ltd for the decommissioning of its nuclear sites, HSE, 2002.
193. Reply by Liam Fox Hansard 3 November 2010 Col 855W.
194. “The Future of the United Kingdom’s Nuclear Deterrent,” Cm 6994, MOD/FCO, December 2006, Table 7-1.
195. PWR3 has “a longer in-service life”; *The United Kingdom’s Future Nuclear Deterrent: The Submarine Initial Gate Parliamentary Report*, May 2011, para 3.1.
196. Ibid., para 3.1.
197. Navy SSBN(X) Ballistic Missile Submarine Program: Background and Issues for Congress, Ronald O’Rourke, Congressional Research Service, 22 April 2011, www.fas.org/sgp/crs/weapons/R41129.pdf.
198. Written answer by Bob Ainsworth, Hansard, 3 June 2008.
199. Written answers by Des Browne, Hansard, 30 October 2007, and by Bob Ainsworth, Hansard, 3 June 2008.
200. Written answer by Des Browne, Hansard, 30 October 2007.
201. *The Future of the United Kingdom’s Nuclear Deterrent*, December 2006, Cm 6994, para 5.12.
202. Ibid.
203. *The United Kingdom’s Future Nuclear Deterrent Capability*, National Audit Office, Report by the Comptroller and Auditor General, HC 115, Session 2007/8, 5 November 2008, p. 6.
204. *The United Kingdom’s Future Nuclear Deterrent: The Submarine Initial Gate Parliamentary Report*, May 2011.
205. *The Future of the United Kingdom’s Nuclear Deterrent*, Cm 6994, MOD/FCO, December 2006.
206. The December 2006 White Paper said the annual in-service costs would be equivalent to 5–6 % of the Defence Budget. The MoD said that this would be £1.5 billion in a Memorandum from MoD to the Defence Committee, 19 February 2007, published in *The Future of the UK’s Strategic Nuclear Deterrent: the White Paper*, 9th report from the House of Commons Defence Committee 2006/7, 27 February 2007.
207. The outturn figure was used to illustrate that less than 15% of the total expenditure would be incurred before the Main Gate decision. *The United Kingdom’s Future Nuclear Deterrent: The Submarine Initial Gate Parliamentary Report*, May 2011.
208. Reply by Peter Luff to question from Caroline Lucas, Hansard 22 November 2011, Column 272W.
209. Written Answer by Des Brown, Hansard, 11 December 2007.
210. Total AWE costs for 2005/6 to 2007/8 were £2024: Written Answer by Liam Fox, Hansard, 15 November 2010, Column 563W. As £1.1 billion was additional funding, the routine costs of AWE in 2005/6–2007/8 were around £300 million per year. Total AWE costs from 2008/9 to 2010/11 were projected to be £2580 million: Written Answer by Liam Fox, Hansard, 3 June 2010, Column 78W. Total AWE costs from 2010/11 to 2012/13 were projected to be £1 billion per year: Written Answer by Liam Fox, Hansard, 26 October 2010, Column 204W.
211. When asked how much the government was spending on the Mk4A refurbishment project, Dr Fox replied, “The AWE costs associated with the Mk4A modification form part of the Nuclear Warhead Capability Sustainment Programme, which cannot be distinguished from the AWE management and operation costs.” Hansard, 11 November 2010, Column 450W.
212. Written Answer by Liam Fox, Hansard, 22 October 2010, Column 884W.
213. Polly Curtis, “School building programme scraped in latest round of cuts,” *The Guardian*, 5 July 2011, www.guardian.co.uk/education/2010/jul/05/school-building-programme-budget-cuts.
214. *The Building Schools for the Future Programme: Renewing the secondary school estate*, National Audit Office, 12 February 2009, www.nao.org.uk/publications/0809/schools_for_the_future.aspx, p. 25.
215. Richard Johnstone, “Lords reject benefit cuts for disabled people,” *PublicFinance*, 12 January 2012, www.publicfinance.co.uk/news/2012/01/lords-reject-benefit-cuts-for-disabled-people/.
216. *Economic and fiscal outlook*, Office for Budget Responsibility, Cm 8218, Presented to Parliament by the Economic Secretary to the Treasury by Command of Her Majesty, November 2011, http://cdn.budgetresponsibility.independent.gov.uk/Autumn2011EFO_web_version138469072346.pdf.
217. “Public sector job losses to add to gloomy employment outlook,” TUC, 16 January 2012, www.tuc.org.uk/economy/tuc-20481-fo.cfm.
218. Nick Mann, “Public sector job losses will hit poorest areas hardest,” *PublicFinance*, 17 January 2012, www.publicfinance.co.uk/news/2012/01/public-sector-job-losses-will-hit-poorest-areas-hardest/.
219. “Public service pension overhaul urged by Hutton report,” *BBC*, 10 March 2011, www.bbc.co.uk/news/business-12687489.

220. "The £38 billion was the difference between what the Department had planned to procure and what the department would have in resources if you assumed flat real growth between 2010 and 2020": Liam Fox, evidence to the Defence Committee, 9 March 2011, www.publications.parliament.uk/pa/cm201012/cmselect/cmdfence/c761-ii/c76101.htm.
221. "It's £42 billion if you include the deterrent": Ibid.
222. 2011/12—£336m, 2012/13—£669m, 2013/14—£1355m, 2014/15—£2059; <http://www.publications.parliament.uk/pa/cm201012/cmselect/cmdfence/1635/163506.htm#a11>.
223. Richard Norton-Taylor, "Army to shrink to smallest size since Boer war while reservists' role bolstered," *The Guardian*, 17 July 2011, www.guardian.co.uk/uk/2011/jul/17/army-shake-up-reduce-size.
224. "Threat to 2,000 Ministry of Defence jobs at Abbey Wood," *BBC*, 12 May 2011, www.bbc.co.uk/news/uk-england-bristol-13361089.
225. Sean Rayment, "Ministry of Defence faces £2 billion more cuts," *The Telegraph*, 21 January 2012, www.telegraph.co.uk/news/uknews/defence/9029791/Ministry-of-Defence-faces-2-billion-more-cuts.html.
226. Malcolm Chalmers, "Looking into the Black Hole: Is the UK Defence Budget Crisis Really Over?" RUSI, September 2011.
227. Strategic Defence and Security Review, September 2010.
228. Ibid.
229. Ibid.
230. "Overall the PWR₃ Derived Submarine will not only deliver a safer, but also a more capable submarine than the PWR₂ Adapt Astute. The dominant sacrifices between the options are therefore in cost and in schedule risk." Safety regulators' advice on the selection of the propulsion plan in support of the future deterrent review note, Andrew McFarlane, Head of the Defence Nuclear Safety Regulator, November 2009, Defence Board report (09)62, obtained by Scottish CND under the Freedom of Information Act.
231. PWR₃ has "lower through-life maintenance costs": *The United Kingdom's Future Nuclear Deterrent: The Submarine Initial Gate Parliamentary Report*, May 2011, para 3.1.
232. Ibid., para 4.2
233. *The Future of the United Kingdom's Nuclear Deterrent*, op. cit., para 2–9.
234. HS Judge Mohammed Bedjaoui, "Good Faith, International Law and the Elimination of Nuclear Weapons," in Rebecca Johnson and Angie Zelter (eds.), *Trident and International Law: Scotland's Obligations*, Luath Press, 2011, p. 64.
235. Ibid., p. 72–73.
236. Ibid., p. 63.
237. HS Judge Mohammed Bedjaoui, "Postscript," in Rebecca Johnson and Angie Zelter (eds.), *Trident and International Law: Scotland's Obligations*, Luath Press, 2011, pp. 90–91.
238. Naval Staff Requirement (NSR) 7959, 1972 TNA DEFE24-1081 e31. NSR 7959 set out the requirement for an upgrade to Polaris and was the foundation for the Chevaline system.
239. John Ainslie, *Trident: Britain's Weapon of Mass Destruction*, Scottish CND, 1998.
240. Phillipe Sands QC and Helen Law, "The United Kingdom's Nuclear Deterrent: Current and Future Issues of Legality," in Rebecca Johnson and Angie Zelter (eds.), *Trident and International Law: Scotland's Obligations*, Luath Press, 2011, p. 146.
241. Note by Lord Murray for a Scottish Government Summit on a Future Without Nuclear Weapons, 22 October 2007. Lord Murray is a former Lord Advocate, the senior Government law officer in Scotland, and also a former Judge on the High Court of Judiciary and Court of Session.
242. Speech by David Gould, Chief Operating Officer, Defence Equipment and Support, to the Future Deterrent Industry Day at Abbey Wood, Bristol on 29 June 2007. The phrase "including the warhead and missile" was redacted from the speech when it was first released to the Scottish Campaign for Nuclear Disarmament. It was only disclosed following a review under the Freedom of Information Act. The MoD argued that Gould had been mistaken.
243. *The Future of the United Kingdom's Nuclear Deterrent*, op. cit., p. 20.
244. Defence Committee, Examination of witnesses, 21 March 2006, www.publications.parliament.uk/pa/cm200506/cmselect/cmdfence/986/6032104.htm.
245. Tony Blair, *A Journey*, September 2010.
246. "Who Needs Trident," *BBC Scotland*, 23 February 2011.
247. Submission to the BASIC Trident Commission from Admiral Lord Boyce, Chief of Defence Staff 2001/03, 2011.
248. Dr Nick Ritchie "Trident and British Identity: Letting go of nuclear weapons," Bradford Disarmament Research Centre, September 2008.
249. Ibid.
250. "Unilateral disarmament would ensure that the UK has no influence or leverage over international nuclear disarmament by removing the UK from future disarmament negotiations." Submission to the BASIC Trident Commission from Bernard Jenkins MP.
251. "Carrying the burden of NATO's nuclear deterrent—it's an intellectual burden, it's a policy burden, it's an international burden, it's being the only guy at the CD with a nuclear deterrent because the Chinese and the Russians sit there with the Third World and say what a terrible thing nuclear weapons are and what a terrible thing space arms are, and so who's in the dock?—It's always useful to have someone else in the dock with you." Frank Miller interviewed by the Project on Nuclear Issues, <http://csis.org/program/us-uk-nuclear-cooperation-after-50-years>.
252. Speech by Tony Blair, 4 December 2006, http://news.bbc.co.uk/1/hi/uk_politics/6207584.stm.
253. Lord Robertson, presentation to Trident debate, submitted to the BASIC Trident commission.
254. Submission to BASIC Trident Commission from General Sir Hugh Beach, Master General of Ordnance 1977/81, 2011.
255. Ibid.
256. Dr Nick Ritchie, op. cit.
257. Presentation by Professor Michael Clarke, Director of the Royal United Services Institute, in the "Trident: Should we keep it?" Debate, Edinburgh, 23 June 2011.
258. Dr Nick Ritchie, op. cit.
259. "Berlin blockade, Korean war, Yom Kippur war and Taiwan," Submission to BASIC Trident Commission from General Sir Hugh Beach, Master General of Ordnance 1977/81, 2011.
260. Dr Nick Ritchie, op. cit.
261. Lord Hennessy, Inaugural Michael Quinlan lecture, House of Lords, 2 February 2011, quoting a statement by Quinlan to himself, <http://www.parliament.uk/documents/lords-information-office/2011%20Lord%20Hennessy%20Robing%20Room%20Lecture%20.pdf>.
262. Tony Blair, op. cit.
263. *The Future of the United Kingdom's Nuclear Deterrent*, op. cit., p. 20.
264. Lord Robertson, presentation to Trident debate, submitted to the BASIC Trident commission.
265. Presentation by Professor Michael Clarke, op. cit.
266. Presentation by Professor William Walker at Trident and International Law: Scotland's Obligations conference, Scottish Parliament, 12 February 2011.
267. *The Future of the United Kingdom's Nuclear Deterrent*, op. cit., p. 20.
268. Hansard 18 May 2011 Column 338.
269. Submission to BASIC Trident Commission from General Sir Hugh Beach, Master General of Ordnance 1977/81, 2011.
270. In 1992 Nick Witney, Director of Nuclear Policy at the MoD, discussed this issue with Michael Quinlan. Witney wrote that he had been told by a US official that if America was going to threaten nuclear action against Saddam Hussein then this official would urge the President to make sure that other Western nuclear powers (ie Britain and France) were involved. Tanya Ogilvie-White, *On Nuclear Deterrence: The Correspondence of Sir Michael Quinlan*, IISS, 2011, p. 255.
271. In 2009 there were 147 civilians working for the MOD, 392 working for Babcock Marine and 72 working for Lockheed Martin UK Strategic Systems, giving a total of 464 civilians at the Clyde Naval Base whose jobs were directly reliant on Trident. Reply by Bob Ainsworth to a question from Katy Clark, Hansard, 14 October 2009, Column 962W.
272. "The Coalition: our programme for government," p. 17, www.cabinetoffice.gov.uk/sites/default/files/resources/coalition_programme_for_government.pdf.
273. Trident Alternatives Study—Terms of Reference; <http://www.acronym.org.uk/uk/index.htm>.
274. "If we had dual use of submarines for tactical purposes as well as for the nuclear deterrent, then if at any point in the future a future government concluded they could scale down the nuclear deter-

- rent there would be other valid uses to which the submarines could be put and you wouldn't be tearing up that vast amount of expenditure. You would just be putting assets to different uses" Nick Harvey, quoted in Joel Shenton, "Dual-use nuclear subs a 'game-changer,'" Defence Management, 21 September 2011, www.defencemanagement.com/news_story.asp?id=17502.
275. "Whether it's the dual use of an Astute or an adapted Astute submarine or if that's too expensive – which it might prove to be – dual use of the planned successor in similar ways to what the Americans have done, it's a game-changer." Nick Harvey, quoted in Joel Shenton, *op. cit.*
276. Letter from Michael Quinlan to Patrick Turner, MOD policy director, 18 June 2006, quoted in Tanya Ogilvie-White, *op. cit.*, p. 257.
277. One of the assumptions in the 2010 Value for Money Review was that the force would be required to sustain "continuous at sea deterrent patrols": "Trident Value for Money Review," Note by the Ministry of Defence, obtained under the Freedom of Information Act by Greenpeace.
278. "In looking at alternative systems and posture, the review draws upon highly classified technical, intelligence and policy information covering extremely sensitive national security issues. There are, therefore, no plans to publish either the report or the information it draws upon" Philip Hammond, reply to question from Jeremy Corbyn, Hansard, 21 November 2011, column 34W.
279. Alex Salmond told the SNP conference in October 2011 that giving Scotland more powers, short of full independence, would not be enough: "All good, all necessary, but not good enough. Trident missiles would still be on the Clyde, we could still be forced to spill blood in illegal wars, such as Iraq, and we would still be excluded from the councils of Europe and the world." SNP conference report, *BBC*, 22 October 2011.
280. "Berths would not be a problem—there are docks on the south coast that could be used without too much fuss. But there simply isn't anywhere else where we can do what we do at Cullport, and without that, there is no deterrent." James Kirkup, "Nuclear subs will stay in Scotland, Royal Navy chiefs decide," *The Telegraph*, 26 January 2012, www.telegraph.co.uk/news/uknews/defence/9043092/Nuclear-subs-will-stay-in-Scotland-Royal-Navy-chiefs-decide.html.
281. If the UK nuclear force was based in the US or France then the UK would have to build new unique facilities rather than using those of the host country, because the weapons would have to remain under UK control at all times. John Ainslie, *Trident—Nowhere to Go*, Scottish CND, January 2012.
282. James Kirkup, *op. cit.*
283. Kerry Gill, "Trident missiles would have to stay in Scotland," *Express.co.uk*, 28 January 2012, www.express.co.uk/posts/view/298468.
284. Alex Salmond speaking in the Scottish Parliament, 25 January 2012.
285. Admiral West speaking on Radio 4 as quoted in the *Daily Record*, 30 December 2011.

UNITED STATES

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Two decades after the end of the Cold War, the United States continues to deploy nuclear forces of extraordinary size and power. Thousands of nuclear weapons remain available for use, with enough ready for launch in minutes to destroy any country on earth, at the same time doing irreparable harm to the global environment. These weapons have been maintained since the middle of the twentieth century by a vast complex of laboratories, factories, and test facilities spread across the United States. This complex, although significantly smaller now than it was when it produced and maintained tens of thousands of nuclear weapons amidst a frenzied Cold War arms competition, is being modernized to provide the capacity to maintain existing nuclear weapons and to build new ones into the middle of the twenty-first century.

The President now in office has proclaimed his commitment to nuclear disarmament, but also has made far more concrete policy and budget commitments to the array of institutions that sustain and are sustained by a large and essentially permanent nuclear arsenal. In the broader political realm, crude fear-based narratives dominate mass media discourse about issues of war, peace, and the military, while discourses within the fora of government and amongst the organizations that seek to influence them is limited to adjustments at the margins. All this takes place within a status quo vigorously defended by constellations of large organizations grown extraordinarily wealthy and powerful in a polity where wealth and power have grown increasingly polarized. The military-industrial complex remains one of the most significant such constellations, with economic power equal to any other and a level of legitimacy that surpasses most in a political landscape where most institutions both public and private are widely seen as corrupt. There is little in the way of a disarmament “movement”. The nascent political movements emerging in the climate of economic crisis and a formal politics deadlocked by an oligarchy riven by internal divisions have focused mainly on issues of economic unfairness and the erosion of formal democracy. War and peace issues so far constitute only a relatively minor strand in these stirrings, and disarmament *per se* is seldom mentioned.

At the same time, the rhetoric of indebtedness and the agenda of austerity being pushed by significant elements of the ruling corporate oligarchy have engen-

dered a public discourse about spending, including military spending, that has grown increasingly incoherent. Some of the factions pushing hardest for steep cuts in government spending also are working to exempt the military from their effects. An explicit programme of austerity and economic stagnation for all but an increasingly insular top-tier economy of powerful large organizations and their more privileged inhabitants, however, is difficult to package and sell to an increasingly restive population. In this atmosphere, predicting outcomes becomes more difficult, particularly in areas like nuclear weapons spending where much of the real negotiating and decision-making goes on outside the public eye. Some nuclear weapons programmes may be viewed by those with meaningful influence over the relevant decisions as redundant, and hence easier to sacrifice than other military priorities viewed as having more immediate relevance to maintaining a status quo favourable to incumbent elites both abroad and at home. There is little sign, however, that reductions in nuclear weapons spending or changes in policy direction are likely to have a significant effect on the character of the US nuclear arsenal in the near term.

Ultimately, some of the same collisions of forces that might make cuts in US nuclear weapons spending more possible also are manifestations of a society and polity growing both less stable and more authoritarian. These remind us that the character of governments in extreme circumstances can change a great deal, and that nuclear weapons are unsafe in any hands.

STATUS OF US NUCLEAR FORCES

In 2010, the United States released information about the size of its nuclear arsenal, stating that as of the end of 2009 it had an active stockpile of 5113 nuclear weapons.¹ This number includes both “active” and “inactive” warheads, with the “active” category including “strategic and nonstrategic weapons maintained in an operational, ready-for-use configuration, warheads that must be ready for possible deployment within a short timeframe, and logistics spares.”² In addition, the US has “several thousand” nuclear weapons listed as “retired.”³ Independent experts estimate that the US has approximately 3500 such “retired” warheads.⁴ An unknown percentage of these “retired” warheads have not been released by the Department of Defense for

dismantlement, but instead are being held in “managed retirement” status, which requires that they be maintained “in such a way that they could be reactivated should a catastrophic failure in the stockpile necessitate such action.”⁵ Dismantlement rates have ranged from about 250 to 650 annually in recent years.⁶

The United States currently reports 1790 “strategic” nuclear weapons as “deployed” on intercontinental ballistic missiles, submarine-launched ballistic missiles, and heavy bombers.⁷ The definition of “deployed” used by the United States is that agreed to with Russia in the 2010 Strategic Arms Reduction Treaty (START). This does not count warheads that are in the stockpile that could be carried by delivery systems not defined as deployed. This is of particular importance, for example, in regard to nuclear-capable heavy bombers. Each deployed bomber is tallied as one countable only warhead, but could carry many more. Hans Kristensen and Robert Norris, generally considered to provide the most authoritative independent account US nuclear force levels in their annual “Nuclear Notebook” series in the *Bulletin of Atomic Scientists*, estimate that the 60 strategic bomber aircraft that they estimate the US currently assigns to nuclear missions could carry a total of 1136 nuclear bombs and cruise missiles.⁸ Kristensen and Norris estimate that the US stockpile includes 760 non-strategic weapons with about 200 nuclear bombs actively deployed, most of them at air bases in NATO countries in Europe.⁹

Delivery systems

The United States deploys its nuclear weapons via a “triad” of delivery systems: land based intercontinental ballistic missiles (ICBMs), submarine-launched ballistic missiles (SLBMs), and both heavy bombers and other strike aircraft. The US currently deploys 448 Minuteman III ICBMs in underground silos in the central United States, carrying either a single 300 kiloton (kt) W87 warhead or one to three 335 kt W78 warheads. Trident D5 SLBMs are carried aboard 14 Trident submarines, each with 24 launch tubes. Twelve of these submarines currently are operational and two are undergoing maintenance and refitting. The December 2011 US START data release listed 249 Trident SLBMs as deployed, meaning the missiles were in launch tubes in submarines, an average of just over 20 missiles per boat. Each missile is estimated to carry four warheads, either the 100 kt W76 or the more modern 455 kt W88 (the latter accounting for about a third of deployed SLBM warheads).¹⁰

The US has two long-range heavy bombers assigned to nuclear missions—the B-2 stealth bomber and the venerable B-52H, the latest version of a design that has been in service since the 1950s. The 2010 Nuclear Posture Review stated that 76 B-52H bombers and 18 B-2 bombers can be equipped with nuclear weapons.¹¹ Kristensen and Norris estimate that 16 B-2s and 44

B-52s are assigned to nuclear missions. Three types of nuclear gravity bombs are carried by the B-2: the 10 to 360 kt variable yield B61-7; the 400 kt B61-11 (a modification developed during the 1990’s to add some earth-penetrating capability); and the 1.2 megaton B83 (also with variable yield). B-52s carry the B61-7, B83, and air-launched cruise missiles armed with 5 to 150 kt W80-1 warheads.¹²

Non-strategic B61-3, 4, and 10 bombs can be delivered by US F-15 and F-16 strike aircraft and by nuclear-certified NATO F-16s and P-200 Tornados. The non-strategic B61s have variable yields ranging from 0.3 to 170 kt. There are about 400 in the active stockpile, with approximately 180 estimated to be deployed at NATO bases in Europe.¹³ Navy nuclear-armed Tomahawk cruise missiles carrying W80 5–150 kt warheads, previously retained in non-deployed status, are now slated for retirement.¹⁴

Fissile materials

The United States has produced approximately 850 tons of highly enriched uranium (HEU). Most was made for use in nuclear weapons; the rest has been used or stockpiled for naval nuclear reactor fuel. Some HEU from nuclear weapons that were decommissioned as the arsenal declined from massive Cold War levels also has been earmarked for use in naval reactor fuel. Approximately 260 tons of HEU is either in nuclear weapons or available for nuclear weapons use. Approximately 100 tons has been made into naval reactor fuel and 130 tons of HEU is designated for future use in naval reactors. 180 tons has been used in reactor fuel and nuclear tests or has been transferred to other countries. 174 tons of excess HEU has been designated for down-blending to low-enriched nuclear reactor fuel.¹⁵

The US in 1994 had approximately 100 tons of plutonium: 85 tons weapon-grade and fifteen tons non-weapon-grade. 38 tons either are in nuclear weapons or are designated for nuclear weapons use. All of the non-weapon-grade plutonium and 47 tons of weapon-grade plutonium has been declared to be excess.¹⁶ Much of the weapons grade plutonium is either still in decommissioned nuclear weapons or is in plutonium pits stored at the National Nuclear Security Administration’s Pantex facility in Texas. Much of the excess plutonium, including plutonium from nuclear weapons, is slated to be converted into mixed oxide commercial nuclear reactor fuel, under a US-Russia agreement for plutonium disposition.¹⁷ Conversion of plutonium to plutonium oxide conducted at the Los Alamos National Laboratory in New Mexico and fuel fabrication at the Savannah River plant in South Carolina.

MODERNIZATION

The government of the United States officially is committed to modernizing its nuclear bombs and war-

heads; the submarines, missiles, and aircraft that carry them; and the laboratories and plants that design, maintain, and manufacture nuclear weapons. US policy and budget documents all manifest an intent to keep some thousands of nuclear weapons in active service for the foreseeable future, together with the capability to bring stored weapons back into service and to design and manufacture new weapons should they be desired.

Continuing modernization of the US nuclear arsenal since the end of the Cold War has been driven by several different dynamics. There is the presumption, which prevails until definitively negated and until US nuclear targeting plans requiring large numbers of weapons change, that the United States will keep a large nuclear arsenal for many decades to come.¹⁸ Second is the still-considerable economic and political power of the immense nuclear weapons complex and associated elements of the aerospace-military-industrial complex, a national web of institutions that continues to deploy an array of ideological and institutional techniques to sustain their flow of tax dollars. Finally, there have been repeated efforts by particular administrations and by factions within the military-industrial-congressional complex to develop nuclear weapons with additional capabilities, such as earth penetrators and weapons offering more accurate, low-yield options. Conflict in the mainstream over nuclear weapons policy has been limited for the most part to this last area, the development and deployment of weapons that can be characterized as “new weapons.” There has been a strong consensus in the US political class—regardless of which party has held the Presidency or the Congressional majority—for maintaining a large arsenal deliverable via a “triad” of land-based missiles, submarine launched missiles, and aircraft, and for modernizing the facilities needed to do so, with some debate over what this actually requires. This consensus has shown little change since the end of the Cold War.

The course of nuclear weapons modernization efforts in the post-Cold War period reflects both institutional power and policy inertia tending to support continued arsenal modernization. It also reflects the tensions over development of new weapons systems that might be perceived as particularly provocative. Recognizably new weapons concepts, when publicly proposed, usually have been defeated, sometimes with Congressional language explicitly limiting particular research efforts. Since the first Iraq war, elements in the military had been seeking nuclear weapons with new capabilities, particularly low-yield and earth-penetrating weapons with increased capability to destroy underground structures with reduced collateral damage. Congress, however, prohibited research on very low-yield nuclear weapons in 1993 and proved resistant to development of nuclear weapons that were unambiguously “new” throughout the 1990s. Congress loosened these restrictions, however, during the frenzied

military buildup following the 11 September 2001 attacks, with the Bush administration pushing the development of new weapons such as a “robust nuclear earth penetrator”. Despite authorizing expanded research, Congress remained resistant to allowing distinctively “new” bombs and warheads to advance beyond feasibility studies and the early design stage.¹⁹

The Bush administration also pushed for advances in delivery systems that would increase nuclear weapons capabilities during this period. The Navy, for example, conducted an “enhanced effectiveness” (E2) programme to increase the accuracy of the Mark IV reentry vehicle deployed on many Trident SLBMs. The programme was labeled explicitly as having the potential for new nuclear weapons capabilities: “Enhanced Effectiveness provides increased capabilities articulated in the NPR, such as prompt accurate strike, defeat of critical targets and selective nuclear options.”²⁰ Although never developed past the flight test phase, “[t]he E2 warhead could possibly have provided Trident missiles with the accuracy to strike within 10 meters of their intended, stationary targets.”²¹

There has been one “modification” with what is generally conceded to be a new capability, the B61-12, which added limited earth-penetrating capability to the venerable and versatile B61 bomb design. A number of incremental upgrades in both warheads and delivery systems, however, have gone largely unchallenged. Modernization of the command and control, surveillance, targeting, and communications infrastructure associated with nuclear weapons deployment and use, along with research on nuclear weapons effects, has continued throughout the post-Cold War period (although at a slower pace), seldom being a subject of public discussion.

Bomb and warhead modernization

The National Nuclear Security Administration (NNSA) calls its projects for sustaining and modernizing the types of nuclear bombs and warheads currently in the active stockpile “life extension programs (LEPs).” These are for the B83 and B61 series bombs, the W76 and W88 SLBM warheads, the W78 and W87 land-based ICBM warheads, and the W80 cruise missile warhead.²² One LEP, for the W87 Minuteman missile warhead, was completed in 2004.²³

The US currently has an official policy of making no “new” nuclear weapons and of not adding “new” military capabilities to existing ones. The 2010 Nuclear Posture Review Report declared, “The United States will not develop new nuclear warheads. Life Extension Programs (LEPs) will use only nuclear components based on previously tested designs, and will not support new military missions or provide for new military capabilities.”²⁴

There has been considerable controversy during the post-Cold War period, however, about what constitutes a “new” weapon or a “new” capability. As noted above,

the US in the late 1990s produced a modified B61-11 bomb that added earth-penetrating capability.²⁵ Incremental upgrades made in the course of life-extensions and less extensive refurbishment actions also can provide bombs and warheads with new capabilities. Developments in arming, firing, and fusing systems, for example, can make nuclear weapons more effective for destroying hardened or underground targets by adding ground bursts capability and greater accuracy. Upgrades to the fusing system that controls the height of burst for the W76 will improve hard target destruction capability when combined with the highly accurate Trident D5 submarine launched ballistic missile.²⁶ The W76 LEP incorporates upgraded arming, fusing, and firing assemblies is slated to be completed by 2018.²⁷ Approximately 1200 W76 warheads are expected to be refurbished.²⁸ The B83 bomb also was modified in a previous refurbishment to “provide new MC required heights of burst.”²⁹

The NNSA is in the early stages of perhaps its most extensive refurbishment program so far, covering the B61 series of bombs. The 2010 Nuclear Posture Review calls for a “full scope B-61 (nuclear bomb) Life Extension Program to ensure its functionality with the F-35 and to include making surety—safety, security, and use control—enhancements to maintain confidence in the B-61.” The F-35 will be a modern, stealthy strike aircraft, and equipping it with nuclear weapons will provide more advanced non-strategic nuclear delivery options. Further, NNSA is planning to replace all currently deployed bombs in the B61 series (with the exception of the high yield, earth-penetrating B61-11) with a single new design with a maximum yield of 50KT. The new design also will add a guided tail kit adapted from one already used in modern conventional bombs. Plans call for the new bomb, designated the B61-12, to be deliverable via both air and ground burst, and to be compatible with both current US and NATO nuclear-qualified aircraft and the F-35.³⁰ Despite US claims that its modernization programmes will add no new military capabilities, the new B61 bomb, if built, will allow the targeting of a wide range of targets with more accurate, lower yield nuclear weapons. As Hans Kristensen of the Federation of American Scientists observes,

Increasing the accuracy of the B61 has important implications for NATO’s nuclear posture and for nuclear targeting in general. In Europe, the new guided tail kit would increase the targeting capability of the nuclear weapons assigned to NATO by giving them a target kill capability similar to that of the high-yield B61-7, a weapon that is not currently deployed in Europe. This would broaden the range of targets that can be held at risk, including some capability against underground facilities. In addition, delivery from new stealthy F-35 aircraft will provide additional military advantages such as improved penetration and survivability.³¹

Kristensen also notes that the B61 replacement will achieve many of the goals of the low-yield nuclear weapons initiatives that Congress had limited or refused to fund during the Clinton and Bush administrations: Mixing precision with lower-yield options that reduce collateral damage in nuclear strikes were precisely the scenarios that triggered opposition to PLYWD and mini-nukes proposal in the 1990s. Warplanners and adversaries could see such nuclear weapons as more useable allowing some targets that previously would not have been attacked because of too much collateral damage to be attacked anyway. This could lead to a broadening of the nuclear bomber mission, open new facilities to nuclear targeting, reinvigorate a planning culture that sees nuclear weapons as useable, and potentially lower the nuclear threshold in a conflict.³²

Another major LEP effort for the W78 ICBM warhead is in the early planning stages. This LEP will look at options that will produce either a warhead or some warhead components that could be used on both ICBMs and SLBMs. The LEP for the W88 SLBM warhead, the most modern nuclear weapon in the active stockpile, is expected to begin in the latter half of this decade. Work on a replacement arming, firing, and fusing system will start earlier, in order to determine whether a common option can be developed for the W78 and the W88.³³ The W80 cruise missile warhead is slated to get its LEP in the 2020s, although the schedule and nature of the W80 refurbishment may be affected by the outcome of a Defense Department study on new stand-off missile options.³⁴

Delivery system modernization

The United States is both continuing incremental upgrades in its existing missiles and aircraft and starting planning and design of the next generation of nuclear-armed missiles, aircraft, and missile submarines.

The US aircraft that are equipped to deliver nuclear weapons also are used for conventional missions, in a context of combat operations that have been ongoing for two decades, since the first Iraq war. These aircraft undergo continuing rounds of refurbishment and modernization. B-52 bombers are undergoing a “comprehensive program” begun in the 2005 fiscal year “to ensure B-52 viability to perform current and future war-time missions to include datalinks, navigation, sensors, weapons, and electronic warfare (EW) and training capabilities.”³⁵ The B-2 stealth bomber is being extensively modernized to allow it “to continue operations around the world in more advanced threat environments,”³⁶ with upgrades to its radar, data and communications, and defensive systems.³⁷ The dual-capable F-16 and F-15 strike aircraft that can carry nonstrategic B61 bombs also are undergoing constant rounds of modernization to incorporate available upgrades in avionics, communications, and other technologies.³⁸

The Minuteman III land based ICBM is undergoing an extensive overhaul to extend its operational life through 2030. In March 2011 the Commander of the US Strategic Command said that “the Air Force is currently in a multi-year program to refurbish or modernize practically every inch of the Minuteman III—from the top of the nose cone to the bottom of the first stage nozzles.”³⁹ Modernization efforts include upgrades to silos, missile command centers, guidance and reentry vehicle technologies, and targeting systems. The modernization effort also will complete the retirement of the W62 warhead (170 KT yield) from the Minuteman force and its replacement on some of Minuteman missiles by the more modern 300KT W87, originally deployed on the now-decommissioned Peacekeeper missiles.⁴⁰

The Trident D5 SLBM also is being refurbished, with an LEP that will modernize guidance systems and missile electronics and that will also build additional D5 missiles.⁴¹ Like the Minuteman modernization effort, virtually every component of the Trident missiles will be updated.⁴² The Ohio class submarines that carry the Trident missiles also are undergoing cycles of refurbishment and modernization to maintain them for several more decades, with the current plan being to phase them out and replace them with a new ballistic missile submarine beginning at the end of the 2020s.⁴³ Work now underway includes upgrades in sonar communications, and other shipboard electronics.⁴⁴ In addition, over the last decade the Navy completed the conversion of four of the earlier Ohio class submarines built to carry the C4 Trident I missile to carry the larger Trident II D5.⁴⁵ All 14 US ballistic missile submarines now carry the D5, an upgrade over the C4 in range, payload, and accuracy.

The United States currently is in various stages of development of the next generation of nuclear-armed planes, missiles, and submarines, with the planning and deployment horizon for the new systems extending well into the middle of the century. The Obama administration announced long-term commitments to delivery system modernization, including the development of follow-on systems to replace those of Cold War vintage, in the 2010 Nuclear Posture Review and in reports to Congress released in the context of the Senate ratification process of New START. Although these commitments were made less than two years ago, the US is in the throes of an ongoing budget impasse resulting in one extraordinary temporary procedural device after another postponing decisions on the most controversial spending matters. This in turn is a manifestation of the broader climate of economic uncertainty, of austerity programmes being imposed by financial elites on populations in both Europe and North America, and of stark divisions within the US political classes. At this writing, all of this casts some doubt regarding the extent to which the spending levels committed to by the Obama administration will be sustained in the coming budget year and after. The Obama administra-

tion’s budget request for the 2013 fiscal year, submitted in February 2012, proposes to accomplish some reductions from planned spending by delaying or stretching out programmes.⁴⁶

The Nuclear Posture Review stated that the Navy had been directed to begin development of a replacement for the Ohio class ballistic missile submarines, with the first of the existing ballistic missile submarines expected to be retired at the end of the 2020s. According to the NPR, the number of ballistic missile submarines may be reduced from 14 to 12 later in this decade, pending further review.⁴⁷ As currently envisioned, the Ohio class boats will be replaced by 12 new submarines with 16 launch tubes each. The first of the new submarines were originally slated to go into service in 2029, with 12 new boats deployed and the Ohio class submarines retired by 2040. The FY2013 budget request proposes delaying delivery of the new boats by two years.⁴⁸ The launch tubes will be designed to fit the life extended Trident D5 missile, so that both types of submarines can use the same missile during the transition.⁴⁹ Work also is ramping up on development of new naval reactors to power the next generation submarines, with the NNSA’s Naval Reactor program requesting increased funding.⁵⁰ The US and the United Kingdom are cooperating on the development of their next-generation ballistic missile submarines, in particular in development of a modular Common Missile Compartment for missiles with the characteristics of the Trident D5, capable of being used by both the next generation of UK boats (expected to carry eight missiles each) as well as in the US Navy 16 missile design.⁵¹ At this writing, however, plans for the Ohio SSBN replacement appear to be in flux, with some consideration being given to reducing the number of submarines acquired, perhaps by increasing the number of launch tubes on each boat.⁵²

The Air Force conducted an Analysis of Alternatives for the Land Based Strategic Deterrent in the early 2000s, deciding at that time to modernize the Minuteman to extend its service life to 2030. A new analysis of alternatives for a possible Minuteman III replacement is slated to start in 2012.⁵³ The military also is looking for ways to reduce costs of both modernization of existing systems and of acquiring new ones by developing components that can be used on both land and submarine-based missiles.⁵⁴

The F-35 Joint Strike Fighter already is in production, with nuclear-armed versions eventually expected to replace nuclear capable F-15s and F-16s. The F-35 programme, however, has been plagued by delays and cost overruns, so modernization of F-15s and F-16s will be extended to bridge the gap until the new aircraft is deployed.⁵⁵ If both the nuclear capable F-35 and the B61-12 bomb go forward as planned, the US will deploy more accurate low-yield non-strategic nuclear weapons, delivered by a new generation of stealth strike aircraft. The military also is in the early stages of selecting options

for new nuclear-armed long-range bombers and for the stand-off nuclear weapons they would carry. According to a report prepared in late 2010 in support of the Obama administration's New START ratification effort, "The long-range strike study, which is also considering related investments in electronic attack, intelligence, surveillance and reconnaissance, air- and sea-delivered cruise missiles, and prompt global strike, will be completed in time to inform the President's budget submission for FY 2012."⁵⁶ This study will be examining conventional as well as nuclear long-range strike options.

The 2010 Nuclear Posture Review stated that a study was in progress to examine alternatives for a new long-range bomber and a possible replacement for the air launched cruise missile.⁵⁷ The commitment to build a new long-range stealth bomber was reiterated in a January 2012 top-level Defense Department policy guidance document, *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense*.⁵⁸ The Air Force in its FY2012 funding request budgeted almost \$900 million over the next five years for research and development to replace the air-launched cruise missile.⁵⁹

The US also has been engaged for more than a decade in efforts aimed at taking advantage of improvements in the accuracy of long range missiles and re-entry vehicles to develop the means to deliver non-nuclear weapons anywhere on earth in short order. These programmes, referred to as Prompt Global Strike, have explored adding non-nuclear payloads to Minuteman ICBMs and Trident SLBMs, as well as placing payloads on other rocket boosters in a variety of basing scenarios. The Obama administration reportedly is considering an additional option that would place conventionally armed intermediate range ballistic missiles on attack submarines.⁶⁰ Using ICBMs and SLBMs poses dangers of conventional "Prompt Global Strike" launches being mistaken by other nuclear-armed states for a nuclear attack, so Congress has been reluctant to proceed with

The Obama administration appears committed to continuing the Prompt Global Strike effort, seeing it as a way to add previously unavailable options for strategic strike—some of which may fall outside the existing arms control framework. Principal Deputy Under Secretary of Defense for Policy, Dr. James N. Miller, told a House committee in March 2011, after New START had been concluded, that

The 2010 NPR noted the potential value of CPGS [Conventional Prompt Global Strike] capabilities to defeat time-urgent regional threats. DoD is exploring in particular the potential of conventionally-armed, long range missile systems that fly a non-ballistic trajectory such as boost-glide systems. Such systems could "steer around" other countries to avoid over-flight and have flight trajectories distinguishable from an ICBM or submarine launched ballistic missile (SLBM). As we made clear during the New START Treaty negotiations, we would not consider such non-nuclear systems, which do not otherwise meet the definitions of the New START Treaty, to be "new kinds of strategic offense arms" for the purposes of the Treaty.⁶²

Prompt Global Strike (PGS) systems, if developed and deployed, add a volatile new element to the nuclear balance, raising the possibility that a range of targets previously only vulnerable to nuclear-armed long range missiles could be destroyed with non-nuclear weapons. Further, missile and reentry system technologies developed nominally for conventional weapons delivery could be applied to nuclear weapons, either via incremental upgrades to nuclear systems or, should the US choose to change its policy regarding their use, via deployment of nuclear weapons on new long-range systems once developed. Current iterations of the Air Force Common Aero Vehicle boost-glide concept, for example, dubbed the Hypersonic Technology Vehicle, continue to be developed and tested.⁶³ In its early phas-

THE US HAS BEEN ENGAGED FOR MORE THAN A DECADE IN EFFORTS AIMED AT TAKING ADVANTAGE OF IMPROVEMENTS IN THE ACCURACY OF LONG RANGE MISSILES AND RE-ENTRY VEHICLES TO DEVELOP THE MEANS TO DELIVER NON-NUCLEAR WEAPONS ANYWHERE ON EARTH IN SHORT ORDER.

deployment on existing systems, particularly on ballistic missile submarines, as opposed to land-based systems that at least in theory could be located so as to reduce the dangers of a conventional launch being mistaken for a nuclear one. Congress has attempted to consolidate these programmes into a single research effort and has reduced total funding. Nonetheless, several different reentry vehicle technologies, including SLBM reentry vehicle systems with accuracy upgrades and boost-glide vehicles stemming from a long-running Air Force "Common Aero Vehicle" project intended to allow both great range and maneuverability, have proceeded to the flight-testing phase.⁶¹

es the Common Aero Vehicle was conceived as a system that could deliver either conventional or nuclear weapons, although after the late 1990s the programme was limited to exploration of potential non-nuclear payloads.⁶⁴ The "Prompt Global Strike" programmes essentially are the extension of efforts stretching back into the Cold War to push reentry vehicle capabilities to the limits of available technology.⁶⁵ Although funding for conventional strike PGS has declined since its peak in the Bush years, it remains a source of technologies that could yield new strategic weapons capabilities both conventional and nuclear.

Finally, US Strategic Command is continuing a long-running project to integrate nuclear and conventional strike planning, together with missile defences and the full range of surveillance, warning, and command and control systems.⁶⁶ The US also is modernizing the command and control systems that link the President to nuclear forces and command networks.⁶⁷

RESEARCH, TESTING, AND PRODUCTION

In addition to modernizing warheads and delivery systems, the US is refurbishing and upgrading many of the facilities where nuclear weapons are designed, tested, and manufactured. These activities are most visible at the government owned-contractor operated complex of laboratories and plants that conduct nuclear weapons research and development and that produce nuclear bombs and warheads. The planes, missiles, and submarines that carry nuclear weapons are manufactured by large private aerospace contractors, often with components scattered across networks of sub-contractors, so facility modernization is funded less directly by the federal government. In some areas, however, the government is taking more active steps to assure that industrial capacity for nuclear weapons systems will be sustained, particularly where the pace of acquisitions has slowed considerably compared to the rapid, large scale cycles of strategic weapons production characteristic of the Cold War era.

The work of designing, building, and maintaining US nuclear bombs and warheads is done at eight sites in seven states. The laboratories at Los Alamos, New Mexico and Livermore, California do weapons research and design and a variety of tasks to keep existing nuclear weapons ready to go. The Los Alamos National Laboratory also makes the plutonium “pits” that are the atomic trigger for thermonuclear weapons. The Sandia laboratories, in Albuquerque, New Mexico and Livermore, California, do engineering work on nuclear weapons and design and manufacture nonnuclear components. All three laboratories also conduct non-nuclear military research. The Nevada Test Site, where over a thousand nuclear weapons were exploded in the atmosphere and underground before the 1992 testing moratorium, continues to be used for underground experiments called “subcritical” tests that do not have a significant nuclear yield. The Test Site, now called the Nevada National Security Site, also houses facilities for other kinds of nuclear weapons experiments, including those requiring large open air non-nuclear explosions. These tests further develop nuclear weapons knowledge and help to keep the Test Site ready to resume full-scale nuclear testing if desired.

The remaining parts for nuclear weapons are manufactured at plants across the country. The Y-12 plant in Tennessee makes uranium parts and other components, including the secondaries that provide the fuel

for the thermonuclear blast triggered by the explosion of the plutonium primary in most modern nuclear weapons. The Kansas City plant in Missouri makes and tests non-nuclear components. South Carolina’s Savannah River facility extracts tritium, a radioactive isotope of hydrogen used to increase nuclear weapons yield, and fills the tritium containers for nuclear weapons. The Pantex plant in Amarillo, Texas assembles, modifies, and dismantles nuclear weapons, and also makes high explosive components.⁶⁸

Over the last decade and a half, the Department of Energy has built billions of dollars worth of new experimental facilities across the nuclear weapons complex, expanding its capacity to conduct nuclear weapons research without full scale nuclear explosive testing. The National Ignition Facility (NIF) at the Lawrence Livermore National Laboratory in California was completed in 2009. The NIF is a laser driven fusion machine the size of a football stadium, designed to create very brief, contained thermonuclear explosions. The NIF and smaller high-power laser arrays at other DOE facilities are used for a wide range of applications, from training weapons designers in nuclear weapons science to nuclear weapons effects testing. The Dual Axis Radiographic Hydrotest Facility (DARHT) began operating in 2008. This facility at the Los Alamos National Laboratory in New Mexico joined already existing facilities where mockups of primaries or “pits,” the first stage of a thermonuclear weapon, are imploded while very fast photographic or x-ray images are generated, thus allowing scientists to “see” inside the implosion. Further experiments exploring the extreme conditions created in a nuclear weapon explosion are studied using various types of “pulsed power,” in which a large amount of energy is stored up and then released very quickly in a small space. The energy source can be chemical high explosives or stored electrical energy. Pulsed power facilities at both DOE and Department of Defense laboratories are used to explore nuclear weapons function and effects and directed energy weapons concepts.

The data streams from these and other experimental facilities, along with that from “subcritical” tests, which implode nuclear materials but have no measurable nuclear yield and the archived data from over 1000 past US nuclear tests, will be integrated via the Advanced Simulation and Computing Program. This multi-billion dollar supercomputing programme reaches beyond the weapons laboratories, seeking to incorporate the nation’s leading universities into an effort to attract and train yet another generation of nuclear weapons designers.

The NNSA also has an array of facilities to test other aspects of nuclear weapons functions, such as the forces and stresses nuclear weapons would be subjected to during delivery to their targets, ranging from the effects of radiation and lightning to rapid acceleration and deceleration. NNSA plans to modernize many of these fa-

cilities in the near future and to consolidate them at the Sandia laboratory in Albuquerque, New Mexico, where many already are located. NNSA expects an increased work load for these facilities from the life extension program for the B61 bomb series, a significant redesign and modification project.⁶⁹

This vast array of nuclear weapons testing and simulation facilities has allowed the continuing modernization of US nuclear weapons, sometimes adding new capabilities to existing systems. General James Cartwright, then Commander of U.S. Strategic Command, described the possibilities:

[I]f my modeling and simulation really understands the environment in which that weapon will go to, I can do things with it that allow me to stay within the law which says that I have to leave the current warhead configuration as it is, but that I can take my 1966 Mustang, which is when most of these assets were made available to me, and I could put seatbelts, airbags, antilock brakes, GPS in it. I could do a whole bunch of things that would fundamentally change the characteristic of that stockpile.⁷⁰

A key element in US plans for its nuclear arsenal is the capacity to design and manufacture significant numbers of nuclear weapons. US nuclear weapons policy documents portray the ability to reverse reductions in the nuclear arsenal as a precondition for any such reduction. According to the 2010 Obama administration Nuclear Posture Review,

[I]mplementation of the Stockpile Stewardship Program and the nuclear infrastructure investments recommended in the NPR will allow the United States to shift away from retaining large numbers of non-deployed warheads as a hedge against technical or geopolitical surprise, allowing major reductions in the nuclear stockpile. These investments are essential to facilitating reductions while sustaining deterrence under New START and beyond.⁷¹

In addition to expanding its suite of testing and simulation facilities, for which the first round of major post-Cold War projects is largely complete, the NNSA is modernizing its facilities for the manufacture of nuclear bombs and warheads and their components. Nuclear weapons research and production is being consolidated at eight major NNSA weapons complex sites, down from fifteen at the end of the Cold War.⁷² Plants built to produce immense Cold War nuclear stockpiles are being replaced by a combination of new facilities and new manufacturing lines and equipment relocated to refurbished nuclear facilities. The modernized complex is expected to be capable of sustaining an arsenal of 3000–3500 weapons, including reserves and spares.⁷³ As key new facilities such as those for uranium and plutonium component manufacture will become opera-

tional only in the 2020s, US plans envision sustaining thousands of nuclear weapons into the middle of this century.⁷⁴

NNSA asserts that the entire complex of modernized research, production, and testing facilities will be needed for the foreseeable future, and that further reductions in arsenal size would not result in cost savings or significant scaling back of activities in the weapons complex:

After achieving a capability-based infrastructure, smaller total stockpiles than prescribed by post-NPR implementation strategies would not lead to a smaller, less costly infrastructure.... Once the number of warheads falls below a specific level, the costs just to maintain the required capabilities dominate. This is because most facilities, operations, and critical skills must exist, be maintained, and be exercised to remain viable.⁷⁵

NNSA has long asserted that the highest priority large projects in production complex modernization are for plutonium operations at Los Alamos and for uranium operations at the Y-12 plant in Tennessee. The PF-4 facility at Los Alamos (part of the laboratory's main plutonium facility) is being refurbished and con-

figured for production of up to 80 plutonium pits per year by 2022. Los Alamos has been preparing an adjacent site for construction of a large new nuclear facility, the Chemistry and Metallurgy Research Replacement Nuclear Facility (CMRR-NF). The CMRR-NF, if built, would provide new facilities for plutonium research and analytical operations in support of pit production and maintenance. At Y-12, NNSA plans to replace facilities for production and dismantlement of enriched uranium components with a new consolidated Uranium Processing Facility (UPF), also with a goal of achieving operational status by 2022. Consolidation and replacement of additional manufacturing functions necessary for the production of nuclear weapons secondaries at Y-12 is planned for the late 2020s.⁷⁶ NNSA also is replacing its main facility in Kansas City, Missouri for the manufacture of non-nuclear components with a new plant, the newly constructed building to be constructed and leased via a public-private partnership involving the federal government, a Kansas City local public development authority, and a private company.⁷⁷

Both the CMRR-NF and the UPF will cost billions of dollars and take a decade or more to complete. The UPF is estimated to cost between \$4.2 billion and \$6.5 billion.⁷⁸ For CMRR, originally estimated to cost \$375 million, the latest cost projection is \$3.7 billion to \$5.9 billion.⁷⁹ The project's cost has increased both because the NNSA has expanded its scale and scope and because of difficulties posed by seismic risks at the project site. The CMRR-NF has been slowed by redesigns

THE MODERNIZED COMPLEX IS EXPECTED TO BE CAPABLE OF SUSTAINING AN ARSENAL OF 3000-3500 WEAPONS, INCLUDING RESERVES AND SPARES.

necessitated in part by seismic issues, and also by local opposition including litigation challenging its environmental review process.⁸⁰ In December Congress cut \$100 million from a \$270 million appropriation for the CMRR and prohibited construction work in the coming fiscal year.⁸¹ The February 2012 Budget Request for fiscal year 2013 proposes deferring construction of the CMRR for at least five years while examining other alternatives.⁸² The decision to cut current CMRR funding already has sparked opposition in Congress, with Michael Turner, Chair of the Strategic Forces Subcommittee of the House Armed Services Committee, introducing legislation requiring construction of the CMRR and fulfillment of other funding commitments made by the Obama administration in connection with ratification of New START.⁸³ Nonetheless the CMRR-NF, a problematic project with large and rapidly escalating costs that likely is not essential to sustaining the current nuclear arsenal, is among the major US nuclear weapons projects most likely to be eliminated.

US nuclear weapons delivery systems also continue to be flight tested, entailing a separate array of test ranges and ground facilities. Both ICBMs and SLBMs are flight tested several times per year.⁸⁴ Field and flight testing facilities being refurbished or modernized include the Western missile range with launch facilities at Vandenberg Air Force Base in California (ICBM and SLBM flight tests, Prompt Global Strike flight tests), the Eastern range with launch facilities at Cape Canaveral, Florida (SLBM flight tests), the Kwajalein test site (downrange from Vandenberg), and the Tonopah Test Site in Nevada (bomb flight and drop tests).⁸⁵

The military is undertaking additional efforts to assure that technical and industrial capacities that are either maintained by military contractors or that are scattered across the military and NNSA laboratory systems are sustained over the long term. This includes a campaign to sustain the industrial base for solid rocket motors,⁸⁶ needed for ICBMs and SLBMs (as well as for other rocket and missile applications), and an effort to sustain a wide range of nuclear weapons effects testing capabilities.⁸⁷ The primary function of the nuclear weapons effects facilities is to assure that US military hardware, from electronics used by conventional forces to missile defence systems and nuclear weapons, can operate in an environment where nuclear explosions are occurring. These facilities also can be used to study certain effects of nuclear weapons on adversary facilities and systems.

MODERNIZATION AND DISARMAMENT COMMITMENTS

The nuclear Non-Proliferation Treaty (NPT) entered into force in 1970. Article VI committed member nuclear weapons states, including the United States, to “negotiation in good faith on effective measures relating to cessation of the nuclear arms race at an early date.”

In 1996, the International Court of Justice ruled that article VI requires the signatory nuclear weapons states not only to negotiate, but to achieve disarmament.

More than two decades after the end of the Cold War and four decades after the US signed and ratified the NPT, the United States and Russia retain nuclear arsenals large enough to end civilization in short order. Six other states have enough nuclear weapons to inflict severe damage not only on their own regions but on the global environment. After fairly rapid rounds of reductions from the immense “overkill” arsenals of the Cold War era, the pace of reductions has slowed considerably. Discontent among non-nuclear weapons states with lack of disarmament progress nearly led to an impasse at the 1995 NPT Review and Extension Conference, with the Treaty only being extended indefinitely in exchange for further commitments on the part of the nuclear weapons states regarding concrete steps on disarmament. In their efforts to obtain the Treaty’s indefinite extension, the nuclear weapons states that are parties to the NPT, including the United States, agreed to a non-binding package of “Principles and Objectives” for non-proliferation and disarmament. These included the conclusion no later than 1996 of negotiation of a Comprehensive Test Ban Treaty (CTBT) banning nuclear explosive testing and “the determined pursuit by the nuclear-weapon States of systematic and progressive efforts to reduce nuclear weapons globally, with the ultimate goals of eliminating those weapons, and by all States of general and complete disarmament under strict and effective international control.”⁸⁸ Also adopted was a call for universal adherence to the treaty and progress towards establishment of a Middle East zone free of weapons of mass destruction (WMD).

Between 1995 and 2000, however, the United States and the other nuclear weapons states showed little progress on disarmament. The CTBT, centerpiece of the tacit bargain underlying the 1995 NPT extension, was rejected by the US Senate in 1999. The US continued to modernize its arsenal, pursuing what appeared at least to potential adversaries to be weapons with new capabilities, such as the B61-12 earth penetrating bomb. In 1998 India and Pakistan, neither parties to the NPT, engaged in a dramatic round of nuclear testing, demonstrating the fragility of the non-proliferation regime and the possibility of dangerous new regional arms races if the NPT collapsed. There had been no progress towards discussion of a WMD free zone in the Middle East, or of what to do about Israel’s undeclared nuclear arsenal.

At the 2000 NPT Review Conference, the non-nuclear weapons states pushed through a more comprehensive list of “practical steps” towards fulfillment of the NPT article VI disarmament obligation. The key commitments over which the US government could exercise the most control included ratification of the CTBT; the principle of irreversibility as applied to nuclear

disarmament and related arms control and reduction measures; an “unequivocal undertaking” to accomplish the total elimination of their nuclear arsenals; full implementation of the START II and START III treaties then under consideration by the US and Russia; “preserving and strengthening the Treaty on the Limitation of Anti-Ballistic Missile Systems as a cornerstone of strategic stability and as a basis for further reductions of strategic offensive weapons”; concrete measures to reduce the operational status of nuclear weapons (i.e. de-alerting); and a diminishing role for nuclear weapons in security policies.⁸⁹ The US government views these as political, rather than legal, commitments. There are good arguments, however, that while such commitments may not constitute new binding obligations, they do provide legal criteria for assessing compliance with existing ones.⁹⁰

Over a decade later, the United States has shown some paper progress, but behind the words and even the treaties there is little evidence of substantive, “good faith” commitment to nuclear disarmament. The United States still has not ratified the CTBT. Both the Bush and Obama administrations have completed nuclear arms control treaties with the Russians and had them duly approved by the Senate. Neither the Bush-era 2002 Strategic Offensive Reductions Treaty nor New START fundamentally change the character of nuclear weapons deployments. Both allow a “triad” long-range missiles launched from land or submarines as well as bombs and cruise missiles on long-range bombers. Neither placed new limits on shorter range “non-strategic” nuclear-armed air or missile systems.⁹¹ Each country still is allowed to deploy thousands of nuclear weapons, with no limits on the number of weapons that can be held in reserve, or on the productive capacity to build yet more.

Meanwhile, the US announced its withdrawal from the Anti-Ballistic Missile Treaty in December 2001, effective six months later.⁹² Continuing US development and deployment of ballistic missile defence systems remains an impediment to disarmament progress, with Russia threatening to place short-range missiles on its Western borders and to withdraw from New START if the US goes ahead with plans for deployment of anti-ballistic missile systems in Eastern Europe.⁹³

There is a more disturbing long-term trend as well, relevant to the commitments in the 2000 NPT Review Conference Final Document for an “unequivocal undertaking” to eliminate nuclear arsenals and the “principle of irreversibility to apply to nuclear disarmament, nuclear and other related arms control and reduction measures.”⁹⁴ To a certain degree there is a reciprocal relationship between these two commitments, particularly where modernization of nuclear weapons infrastructure is concerned. Endless modernization of the research laboratories and factories necessary to design and produce nuclear weapons is inherently incompat-

ible with any “principle of irreversibility” in regard to disarmament. Doing so with the express intention of being able to re-arm, 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.

Current US nuclear weapons policies state that the US “must maintain a basic set of production, scientific, and engineering capabilities” that will be “responsive to changing world demands” and be capable of sustaining the existing stockpile while producing up to 80 nuclear weapons per year.⁹⁵ “NNSA’s ‘capability-based’ plan for modernization provides sustainment of essential capabilities by retaining in a state of readiness the minimum facilities, equipment and critically skilled individuals needed to design, develop, manufacture, maintain, surveil and assess the nuclear weapons stockpile.”⁹⁶ The 2010 Nuclear Posture Review portrayed the capability to produce new weapons to be put in place by the current round of modernization efforts as a “modest capacity” to “surge production in the event of significant geopolitical ‘surprise.’”⁹⁷ Current plans for modernizing infrastructure call for the capacity to maintain support for “total stockpiles up to a range of approximately 3,000 to 3,500 active, logistic spare, and reserve warheads.”⁹⁸ Further, according to US nuclear weapons complex planners, even reductions in arsenal size “would not lead to a smaller, less costly infrastructure.” In their view, “[t]his is because most facilities, operations, and critical skills must exist, be maintained, and be exercised to remain viable.”⁹⁹ The current plan seems to be to keep for the foreseeable future a full suite of nuclear weapons facilities with capabilities expressly designed to make arms reductions reversible, tending to make any commitment to disarmament appear more equivocal than not.

Another disturbing trend in the post-Cold War period has been the use by the nuclear weapons establishment, associated elements of the broader military-industrial complex, and their advocates in Congress of debate over arms control treaties as an opportunity to extract new commitments for facilities and funding. The late 1990s debate over ratification of the Comprehensive Test Ban Treaty resulted in solidified funding prospects for the first round of nuclear weapons facilities upgrades, purportedly to provide the “Stockpile Stewardship” program with the capabilities needed to maintain the arsenal without underground tests. More than a decade later, the United States has billions of dollars worth of new facilities like the Dual Axis Radio-graphic Hydrotest Facility at Los Alamos and the National Ignition Facility at Livermore, and makes much large annual nuclear weapons expenditures—but still has not ratified the Comprehensive Test Ban Treaty.¹⁰⁰ In 2010, the Obama administration engaged in something that came to resemble a bidding process in its

efforts to obtain Senate consent to ratification of New START, adding billions of dollars in promised spending for the nuclear weapons research and production complex and for nuclear weapons delivery systems over the course of the year, as well as political commitments to assure that the Treaty would not disturb the onward march of missile defense and “prompt global strike” development.¹⁰¹

Bob Corker, Republican Senator from Tennessee (home of Oak Ridge National Laboratory and the Y-12 plant) stated the trade-off clearly: “I saw this entire process as an opportunity to push for long overdue investments in modernization of our existing nuclear arsenal and made clear I could not support the treaty’s ratification without it.”¹⁰² Following ratification he pronounced himself well satisfied with the result, declaring that “the New START treaty could easily be called the ‘Nuclear Modernization and Missile Defense Act of 2010.’”¹⁰³

IN THE UNITED STATES, NUCLEAR WEAPONS MODERNIZATION OVER THE LAST TWO DECADES HAS BEEN INTEGRALLY LINKED TO MOVEMENT TOWARDS A NUCLEAR NON-PROLIFERATION POLICY INCREASINGLY BASED ON THE THREAT OF OVERWHELMING MILITARY FORCE.

Regarding the diminishing of the role of nuclear weapons in security policies, the US declaratory nuclear weapons use policy has been moderated somewhat, with the Obama administration stating in the 2010 Nuclear Posture Review that “the United States will not use or threaten to use nuclear weapons against non-nuclear weapons states that are party to the Nuclear Non-Proliferation Treaty (NPT) and in compliance with their nuclear non-proliferation obligations.”¹⁰⁴ The NPR also declared, however, that the US will not rule out use of nuclear weapons “in deterring a conventional or CBW [chemical or biological weapons] attack against the United States or its allies and partners” by “states that possess nuclear weapons and states not in compliance with their nuclear non-proliferation obligations.”¹⁰⁵ So far the change in declaratory policy has had little discernable effect on US nuclear weapons policies or deployments. As shown above, modernization plans for US nuclear weapons that appear to add capabilities intended to make nuclear weapons more feasible in small scale conflicts and against non-nuclear-armed states continue to move forward (perhaps the most important current programme in this regard is the effort to replace existing B-61 bombs with a more accurate model with relatively lower yields, designed to be delivered by a new generation of stealth attack aircraft). It remains to be seen whether a follow-on review of US nuclear weapons policies and war plans now in progress, intended to implement the broad policy prescriptions of the Nuclear Posture Review and to examine the possibility of further reductions, will result in more concrete changes in programmes and policies.¹⁰⁶

The Bush administration’s decision to respond to the 11 September 2001 attacks on New York and Washington—committed by small armed bands employing a spectacular form of irregular warfare—with a massive arms buildup and a world-wide campaign of conventional wars and covert action launched the United States on an upward curve of intensifying militarism. The centerpiece of the Bush “Long War” was the invasion and occupation of Iraq, for which the politically decisive justification was the prevention of nuclear proliferation, with Bush administration officials from the President on down intoning the fearful trope that we could not wait for a “smoking gun” that could prove to be a “mushroom cloud.”¹⁰⁷

In the United States, nuclear weapons modernization over the last two decades has been integrally linked to movement towards a nuclear non-proliferation policy increasingly based on the threat of overwhelming military force. From the 1991 Gulf War on, a significant driver of nuclear weapons research has been the desire to develop accurate, low yield nuclear weapons and earth penetrating nuclear weapons that could destroy hardened targets with a single strike, making use of nuclear weapons more politically feasible as a “counterproliferation” tool. As an anonymous Pentagon staffer told the Washington Post in 2000, the goal at the time was to develop “a deep penetrator that could hold at risk a rogue state’s deeply buried weapons or Saddam Hussein’s bunker without torching Baghdad.”¹⁰⁸ This was during the Clinton years; the Bush administration both continued efforts to develop low yield and earth penetrating nuclear weapons and promulgated a policy of integrating nuclear and conventional forces and war planning.

One result of this ongoing, publicly visible effort to develop more useable nuclear weapons has been that “counterproliferation” crises are now frequently accompanied by rumours that the United States is considering the use of nuclear weapons against the alleged proliferator, giving rise to a climate of nuclear threat against states that have no nuclear weapons.¹⁰⁹ And whether or not nuclear weapons are likely to be employed, an approach to nuclear weapons proliferation that leans heavily on military threats, particularly on the part of a state that has just fought a war flimsily justified as necessary to prevent the spread of nuclear weapons, runs counter to the principles underlying the NPT and of the post-World War II international legal order. The NPT preamble also states that its goals are to be achieved “in accordance with the Charter of the United Nations,” and that “States must refrain in their international relations from the threat or use of force against the territorial integrity or political independence of any State...”

Under the Obama administration, not much has changed yet beyond the rhetoric. US nuclear non-pro-

liferation strategy continues to lean far more heavily on military threats than diplomacy. The latest and most worrisome instance of this is the escalating campaign of force posturing and covert action against an Iranian government that has neither attacked the United States nor been proven to have an active nuclear weapons programme.¹⁰⁰ This, of course, assumes that the main purpose of US attempts to pressure and destabilize the Iranian government is to stop what it truly believes to be a nuclear weapons programme, an assumption that also rests more on the assertions of the US government than on independently verifiable evidence. What also should go without saying and yet time and time again cannot: no country has the right to declare threats to peace and to its interests that lie in the future, far outside any reasonable concept of present or imminent attack, by conducting a war of aggression. As the Nuremberg Judgment, a bedrock document of the Post World War II legal order, declared,

War is essentially an evil thing. Its consequences are not confined to the belligerent states alone, but affect the whole world. To initiate a war of aggression, therefore, is not only an international crime; it is the supreme international crime differing only from other war crimes in that it contains within itself the accumulated evil of the whole.¹⁰¹

The country with the most powerful military one way or another will play a decisive role in the process of nuclear disarmament. A long-term policy of the world's most powerful state to prevent nuclear weapons proliferation by world-wide deployment of powerful military forces ultimately backed by nuclear weapons, a policy that in the view of much of the world has in practice been used as a stalking horse for hegemonic power politics, is far more likely to perpetuate arms racing than to end it. So long as the policy and practice of the world's dominant military power is to reduce its nuclear arsenal only to the extent that it can develop other weapons that allow it to project force in similar ways, prospects for reaching the goal of nuclear disarmament are unlikely to improve. The current administration on this point too has shown little sign of departing from the policies of its predecessors. Assuring a military audience that the President's policies constitute no decisive break from the past, Vice President Joe Biden stated that

Capabilities like an adaptive missile defense shield, conventional warheads with worldwide reach, and others that we are developing enable us to reduce the role of nuclear weapons, as other nuclear powers join us in drawing down. With these modern capabilities, even with deep nuclear reductions, we will remain undeniably strong. As we've said many times, the spread of nuclear weapons is the greatest threat facing our country. That is why we are working both to stop their proliferation and eventually to eliminate them. Until that day comes, though, we

will do everything necessary to maintain our arsenal."¹⁰²

The adequacy and good faith of disarmament progress must be assessed in light of both the threat nuclear weapons pose in general and the place of the particular state in the global order of things. The United States sits at the apex of the global war and weapons system, not only the country with the most modern and sophisticated armed forces, of which nuclear forces remain an integral part, but home to the world's leading arms merchants and the country whose armed forces have been involved in more wars than any other over the last half century. Yet US political and military elites have shown a marked lack of urgency regarding nuclear disarmament, showing far more concern about the possible dangers posed by nuclear weapons that don't yet exist than about the thousands that still sit poised at the ready. The pace and scale of the arms reductions they have been willing to contemplate will do little to reduce the danger US nuclear weapons and weapons policies pose to the world over the next one to two decades. During this period, the current crisis of the global economic system and its attendant political dislocations, of a severity and duration unprecedented in the nuclear age, is likely to reach its peak. In the absence of a significant change in direction by the United States, nuclear disarmament likely will remain a dream so distant as to have little relevance for the near term prospects of humanity.

US NUCLEAR WEAPONS CONTRACTORS

US nuclear weapons, the associated systems for fighting nuclear wars, and the factories and laboratories to design, produce, and maintain it all are owned, managed, and operated by an interlocking network of public agencies and private corporations. These in turn are part of a military-industrial-political complex of unprecedented size and power, a social phenomenon still so new and large that it remains incompletely understood. Key actors within this vast array of institutions will play pivotal roles in the unfolding of the political crises emerging out of the deepening, intractable global economic crisis and its interaction with novel challenges of global scope, including the effects of societies encountering resource limits and the collapse of important elements of our ecosystems.

In the US today, wealth has become concentrated in the largest corporations and an ownership class largely comprised of the upper echelons of those same organizations, and there are virtually no legal limits on the use of money to influence elections and government decisions. In this milieu, the organizations that constitute the military-industrial complex are likely to play a decisive role in decisions about US military policy, including nuclear weapons matters, for the foreseeable future. And with the United States sitting at the apex

of the global system of military production and trade, deploying forces and selling weapons in conflict zones world-wide, these same powerful interests likely will play a part in the future of nuclear disarmament more significant than that of any government. Governments represent particular constellations of interests within states during the course of their rule. Few constellations of interests in the post-World War II era have approached the enduring power of the US military-industrial complex.

The Fiscal Year 2012 US military budget, including nuclear weapons spending, totaled about \$650 billion, down slightly from the previous year.¹³ If we add in other armed security programmes, internal and external, the intelligence agencies, and the costs of past military activities from veterans' health care to interest costs, the total annual US spending on "security" is over trillion dollars a year.¹⁴ Even using the smaller figure, US military spending continues to dwarf that of all other states, constituting about 43% of the global total.¹⁵ Since 2001 real US military spending has grown 81.5%, compared to 32.5% for the rest of the world.¹⁶ In announcing a new Defense Strategic Guidance at the Pentagon in January 2012, President Obama emphasized that the current plan, at least, is for US military spending to continue to increase for the next decade:

Over the next 10 years, the growth in the defense budget will slow, but the fact of the matter is this: It will still grow, because we have global responsibilities that demand our leadership. In fact, the defense budget will still be larger than it was toward the end of the Bush administration. And I firmly believe, and I think the American people understand, that we can keep our military strong and our nation secure with a defense budget that continues to be larger than roughly the next 10 countries combined.¹⁷

The United States also is the world's largest arms dealer. US arms accounted for over a third of 2010 arms transfers, and over half of the new arms transfer agreements in 2010, with Russia a distant second with less than half the total of US transactions in both categories.¹⁸ Four of the five top arms manufacturers in the world—Lockheed, Boeing, Northrup-Grumman, and General Dynamics—are US companies,¹⁹ and all are significant contractors for US nuclear weapons work as well. In shifting combinations of prime and sub-contractors, joint ventures, and partnerships, these firms and other US engineering, research, construction, and manufacturing companies both cooperate and compete in selling weapons systems and a broad array of services to the US nuclear weapons complex and the nuclear arms of the military. Some of the largest US public university systems also provide research and management services, adding as well a certain gloss of

scientific neutrality and public interest commitment.

Most National Nuclear Security Administration facilities are government-owned enterprises managed by consortiums of private corporations or corporations and universities. The two main nuclear bomb and war-head design laboratories, the Lawrence Livermore Laboratory in California and the Los Alamos Laboratory in New Mexico, were managed by the University of California for most of their history, but were substantially privatized over the last decade. Los Alamos currently is managed by Los Alamos National Security, LLC, a joint enterprise of Bechtel National, the University of California, the Babcock and Wilcox Company, and the Washington Division of URS. Babcock and Wilcox is a diversified energy equipment and engineering company and a major player in the nuclear power industry. B&W also is a principal supplier of technology and engineering services for Navy shipboard nuclear reactors. URS is a multinational engineering, construction services, and military contractor, which extended its reach in the nuclear weapons arena with its 2002 acquisition of EG&G, a major US military contractor with a nuclear weapons history stretching back to the 1940s, including managing

operations at the Nevada Test Site. Bechtel was present at the creation of the modern US military-industrial complex, and today has contracts in areas ranging from missile range management to chemical weapons disposition. Bechtel also is a major player in the nuclear power industry, building and refurbishing nuclear power plants.²⁰

The Livermore National Laboratory is now managed by Lawrence Livermore National Security, LLC, which includes Bechtel National, the University of California, Babcock and Wilcox, URS, and Battelle. Founded as a non-profit research laboratory, Battelle still has a non-profit corporate form, but has developed into a very large, diversified research and management services firm selling its services mainly to government and to large corporations. It does work in field ranging from health services and environmental planning and compliance to aerospace technology development.²¹ In addition to its work for NNSA, Battelle has contracts for the military and the Department of Homeland Security, with its current "national security-related" work totaling about \$1.6 billion annually.²²

The Sandia National Laboratories are operated by Sandia Corporation, a subsidiary of Lockheed Martin, the world's largest arms maker. Sandia's principal facilities are in Albuquerque, New Mexico and across the street from the Livermore National Laboratory in California. The Sandia labs perform a wide range of nuclear weapons research, testing, and engineering functions, and also manufacture radiation-hardened electronic components for nuclear weapons. Sandia also oper-

THE FISCAL YEAR 2012 US MILITARY BUDGET, INCLUDING NUCLEAR WEAPONS SPENDING, TOTALED ABOUT \$650 BILLION

ates the Tonapah Test range, where aircraft-delivered nuclear weapons are flight and drop tested.¹²³

The Y-12 plant, which is the primary site for the manufacture of the bomb and warhead components requiring uranium, is managed by Babcock & Wilcox Technical Services Y-12, a joint enterprise of B&W and Bechtel National. The Pantex plant, where nuclear weapons are assembled and disassembled, is run by Babcock & Wilcox Technical Services Pantex, an LLC that also includes Bechtel National and Honeywell. Honeywell is another top-20 arms maker globally (14th in 2009), and also a diversified industrial and manufacturing company working in industries from petrochemicals to automobile components to consumer products packaging.¹²⁴ The Kansas City plant, where non-nuclear components are manufactured, also is managed by Honeywell.¹²⁵

The Nevada Test Site, used for a variety of military testing using hazardous materials in addition to nuclear weapons-related tests, is managed by National Security Technologies, LLC, a joint venture of Northrop Grumman, AECOM, CH2M Hill, and Nuclear Fuel Services. Nuclear Fuel Services, a subsidiary of Babcock and Wilcox, is the main supplier of nuclear reactor fuel for the Navy. It also downblends highly enriched uranium originally produced for nuclear weapons to a form suitable for commercial reactor fuel. AECOM, a Fortune 500 company, is a diversified global engineering, construction, and technical services firm. It also is a major contractor for the Department of Defense, providing world wide airfield engineering services to the Air Force and logistics and base support functions to

THE NUCLEAR WEAPONS AND NUCLEAR POWER INDUSTRIES IN THE US ALSO HAVE BEEN INTERTWINED SINCE THEIR INCEPTION. SEVERAL OF THE MAIN CONTRACTORS FOR THE US NUCLEAR WEAPONS RESEARCH AND PRODUCTION COMPLEX ALSO ARE MAJOR COMMERCIAL NUCLEAR ENERGY COMPANIES.

other services at foreign bases and deployments, particularly in the Middle East. CH2M Hill also is a broad-spectrum engineering and construction company with a long-time specialization in wastewater systems and in environmental cleanup, an area where it has done extensive work for the US nuclear weapons complex.¹²⁶

The Savannah River, South Carolina plant is the main site for tritium operations. The Department of Energy also plans to construct a plant there for the conversion of plutonium for use in mixed-oxide nuclear reactor fuel. Savannah River is operated by Savannah River Nuclear Solutions, LLC, a joint enterprise of Honeywell, Fluor Corporation, and Newport News Nuclear, Inc., a subsidiary of Huntington Ingalls Industries. Huntington Ingalls is a major military shipbuilder, building and maintaining both nuclear and non-nuclear vessels for the Navy. Fluor is another big military contractor and diversified engineering, construction, and project management firm, providing logistical support for US

foreign military operations and bases, and working on projects from the new span of the San Francisco-Oakland Bay Bridge to tar sands petroleum production.¹²⁷

Many of the nuclear weapons site contractors also provide environmental cleanup and remediation services to the Department of Energy for the sites they manage or for closed facilities of the larger Cold War nuclear weapons complex. The large engineering firms, such as Bechtel, Fluor, and CH2M Hill, for example, all do significant amounts of environmental remediation work for DOE.

The nuclear weapons and nuclear power industries in the US also have been intertwined since their inception. Several of the main contractors for the US nuclear weapons research and production complex also are major commercial nuclear energy companies. Bechtel is a leading nuclear construction and engineering firm, building or providing support services for a significant share of the 104 nuclear power reactors in the US and doing additional nuclear work abroad. Fluor also has built a number of nuclear power plants and provides maintenance and engineering services for many more. Babcock and Wilcox is a long-time designer and manufacturer of major commercial nuclear power plant components. The US nuclear weapons laboratories and production plants also have been and continue to be major centers of commercial nuclear power research. The nuclear weapons industry provides the large nuclear companies with a significant research and industrial base, together with a reliable income stream when the prospects for nuclear power dim (in particular when major

nuclear accidents bring the dangers of the technology back to public consciousness). B&W and Bechtel, for example, are partners in developing small modular nuclear reactors as an alternative

to large nuclear plants, drawing on both company's extensive history in the industry and in particular on B&W's experience in naval nuclear reactors. Part of the current plan for encouraging the development of small modular reactors is for the US government to jump start demand by considering them for use to provide power for government facilities such as Department of Energy sites and Department of Defense installations.¹²⁸

The delivery systems for US nuclear weapons are made and maintained by agglomerations of corporate contractors and subcontractors. Webs of subcontractors for particular systems often are scattered across many states and congressional districts, a proven way to cement support in a political system in which military spending has been one of the few forms of government industrial policy capable of gaining any consistent consensus.

The prime contractors for all systems are one or another of the US-based companies that constitute four

of the top five arms makers in the world: Lockheed Martin, Boeing, Northrup Grumman, and General Dynamics. Boeing is the prime contractor for the B-52 bomber, the Minuteman III ICBM, the air launched cruise missile, and the F-15E strike aircraft (originally made by McDonnell Douglas prior to its merger with Boeing). Lockheed Martin is the prime contractor for the Trident D-5 SLBM, the F-16, and the F-35, the strike aircraft expected eventually to replace both the F-16 and F-15E in carrying non-strategic B61 nuclear bombs. Northrup Grumman is the prime contractor for the B-2 Stealth Bomber, and General Dynamics is the prime for the Ohio class ballistic missile submarines.¹²⁹

All of the dominant arms makers have large and diverse military portfolios, albeit with different emphases. As the world's largest arms maker, Lockheed Martin's various business units make a wide range of weapons and military systems, from combat ground vehicles, ships and aircraft to missiles and missile defense systems. As noted earlier, a Lockheed Martin subsidiary also manages the Sandia Laboratory, which does nuclear weapons system engineering and makes non-nuclear components of nuclear weapons systems. Northrup Grumman also has a broad base in military contracting, but is strongest in aerospace, including manned and unmanned aircraft, missiles, satellites, and missile defense systems. Boeing is mainly an aerospace company, producing and maintaining aircraft, missiles, rockets, and missile defense systems, satellites, and a wide range of associated weapons, electronics, and communications systems. As one of the world's largest producers of commercial aircraft, it has a higher proportion of non-military sales than the other top arms makers. General Dynamics is the main US ship-builder for submarines, builds surface combat ships, makes ground combat vehicles and a variety of ordnance, and has a civilian aerospace business specializing in business jets.¹³⁰

The major contractors subcontract on each others programmes, and also employ layer upon layer of further subcontractors, reaching deep into the fabric of American economic, cultural, and political life. A short sampling of institutions that engage in smaller but still significant amounts of military work suggests the breadth and depth of this phenomenon. General Electric (GE), one of the leading manufacturers of both commercial and military aircraft engines in the world. Although no longer a leading nuclear weapons contractor, it makes the engines for the B-2 bomber. GE ranks number six on the list of America's largest 500 corporations.¹³¹ It manufactures a broad range of goods ranging from consumer products like digital cameras and refrigerators to turbines for electrical generating plants. It has a large financial subunit, GE Capital, and owns NBC, one of the major US broadcasting networks.¹³² International Business Machines (IBM), a perennial power in the computer industry, and number 18 on the

Fortune 500 list, has provided the nuclear weapons laboratories with several generations of supercomputers, central to their efforts to continue nuclear weapons research and design in a post-nuclear testing regime.¹³³ The Universities of California and Texas, two of the country's largest public university systems, are part of management teams for the principal nuclear weapons design laboratories. University involvement in nuclear weapons contracting brings with it a distinctive set of concerns. The association of public universities with nuclear weapons research and production institutions helps buttress claims to scientific neutrality and of a dedication to the general public good. Military funding of university research, in turn, can have a profound effect on research agendas, on what questions will and will not be answered, across a wide range of disciplines.¹³⁴

Many of the companies that also are large defense contractors have grown along with the American empire, the dominant global economic, political, and military force of the last century, in a way that makes their character and effects hard to disentangle from the shape modernity has taken. The big construction and engineering firms like Bechtel that build the production complexes of the nuclear establishment also built large portions of the global metropole, including key elements of its global resource extraction systems and supply chains from petrochemical infrastructure in the Middle East to airports and port facilities world wide. The immense resources poured into cutting edge weapons and the sophisticated infrastructure that is used to design, deploy, and coordinate them in the field have enabled the leading military contractors in many instances to become major players in civilian business areas such as communications and computing technologies. As US elites have come to preside over an economically polarized nation within an even more stratified world, the militarization of "homeland security" has created new opportunities for the military contractors to exercise their "core competences" and sell their wares. IBM, Lockheed Martin, and General Dynamics, for example, also are top ten Homeland Security contractors.¹³⁵ And in a time of economic stagnation, the largest US military contractors, having amassed large cash reserves, are simultaneously hedging against budget cuts and expanding the range of their economic and social power by moving into other industries, such as health care, that offer the promise of rent-like returns.¹³⁶

The nuclear technology complex overlaps the military-industrial complex, but also has an identity in its own right. Its influence over all things nuclear, from nuclear weapons policy to public perceptions about the virtues and dangers of nuclear technologies and the effects of radiation, remains under analyzed. Our lack of adequate understanding on this front may be particularly acute in the realm of nuclear non-proliferation policy, where the same enterprises may have interests

in promoting both nuclear technologies and military technologies purportedly deployed to suppress their spread. The only certainty is that in the United States, as in every nuclear weapon state, decisions about nuclear matters remain among the least democratic, often decisively influenced by processes that lie concealed behind layers of propaganda and secrecy.

ECONOMICS AND DISCOURSE

In late 2010, in order to cement support for New START in the Senate, the Obama administration made a commitment to increase spending for nuclear weapons research, production, and testing and for the maintenance and modernization of nuclear weapons delivery systems.¹³⁷ At the time of the Fiscal Year 2012 President's Budget Request submitted to Congress in early February 2011, the administration anticipated spending approximately \$88 billion for bombs and warheads and supporting infrastructure and about \$125 billion for delivery systems over a ten year period.¹³⁸

By late 2011, however, the budget process was in a shambles. The austerity campaign engaged in with varying degrees of enthusiasm by virtually all elements of the US corporate and political classes had run out of control. Every faction wanted to cut something, but divisions among the oligarchs prevented agreement on what to cut. There also was a strong bloc in Congress determined to prevent any significant increases in taxes on the wealthy or corporations, making significant increases in revenue virtually impossible. The magnitude of the cuts in public spending being bandied about had grown so large that programmes favored by genuinely powerful interests such as the military services and contractors faced a greater than usual chance of reductions. The solution was the design of arcane procedural measures to diffuse political responsibility for the impasse while postponing decisions that might affect any set of interests having real power. This left the political front men of all factions (not to mention the entire political system) further discredited, but averted for the moment measures that might interfere with large organization wealth extraction strategies dependent on the use of federal government power to tax and spend.

If implemented, these measures could reduce future projected military spending, but would not significantly cut into the vast increase in the magnitude of military spending that has occurred over the past decade.¹³⁹ Further, the round of military spending reductions mandated by the "sequester" provisions of the August 2011 Budget Control Act do not take effect, if at all, until January 2013. They could be reversed by legislative action at any time, and Congressional advocates of the military-industrial complex have announced their determination to do so.¹⁴⁰

As austerity campaigning took hold of the mainstream political discourse over the course of 2011, there

was some speculation, encouraged in part by occasional comments from official sources, that the Obama administration was, and perhaps still is, contemplating more structurally significant cuts US nuclear forces, such as the elimination of one of the three legs of the nuclear triad. This speculation was given further support by the initiation of an internal review of nuclear weapons policies and plans, including the operational war and targeting plans that ultimately determine what the military sees as its requirements for numbers and types of nuclear weapons and delivery systems.¹⁴¹ Information leaked about the review suggested the administration was contemplating options as low as 400 warheads. Such cuts, however, apparently were being discussed in the context of reductions that might be negotiated with Russia.¹⁴² Further, the leaks regarding the Obama administration's nuclear review may have been based on a RAND working paper that examined a range of arsenal sizes, but did so in hypothetical combinations with other strategic systems such as prompt global strike weapons and missile defenses.¹⁴³

Public comments regarding possible reductions in nuclear forces by military and civilian officials, however, have been in the context of achieving cost savings over the long run via decisions not to replace existing nuclear weapons delivery systems or by reducing numbers of platforms, e.g. by cutting the number of new ballistic missile submarines to be acquired. These comments typically have been accompanied by reiteration of commitments to retain all current types of delivery systems, likely until the end of their service lives.¹⁴⁴ The likelihood that the nuclear policy reviews currently in progress will make few near-term changes in US nuclear forces was reinforced by the announcement in late January 2012 that the 2013 military budget will make no significant cuts that would affect current US nuclear weapons systems. For FY 2013 and after, the Obama administration is proposing a pre-sequester budget plan in which military spending would dip less than one percent the first year, and then resume its steady growth thereafter.¹⁴⁵ The Defense Department in late January issued an overview document titled "Defense Budget Priorities and Choices" outlining the major programme decisions informing the spending levels. That document announced a continued commitment to all three legs of the nuclear "triad": land-based ICBMs, SLBMs, and strategic bombers. It also reaffirmed plans for a new long-range bomber. The only apparent cost-cutting measure affecting nuclear weapons programmes was a two year delay in the planned replacement of the Ohio class ballistic missile submarines.¹⁴⁶

The "Defense Budget Priorities and Choices" document also gave new life to a submarine-launched conventional prompt global strike weapon, listing as a priority "[d]esign of a conventional prompt strike option from submarines." In response to questions on the programme, Chairman of the Joint Chiefs of Staff General

Martin Dempsey suggested to reporters that concepts currently contemplated involved missiles that would move at a speed and with a trajectory that would make them distinguishable from a ballistic missile, thus solving problems of nuclear ambiguity that previously had concerned Congress enough to limit “prompt global strike” weapons launched from ballistic missile submarines.¹⁴⁷ Eliminating the danger of confusion that a launch might be nuclear, however, does not mitigate the impact on the global strategic balance of new kinds of powerful, accurate conventional weapons that can be launched from stealthy undersea platforms and which would be capable of hitting any country on earth far more quickly than existing conventional delivery systems such as cruise missiles and aircraft.

In sum, the Obama administration appears for the near term to be remaining on the course of modernization of nuclear weapons systems and of the facilities that build and maintain them that it committed to in the context of its effort to obtain Senate consent to New START. There may be further changes at the margins to control costs, particularly for programmes such as major systems acquisitions and construction projects where costs are prone to spiral out of control. Pushing back the schedule for replacement ballistic missile submarine acquisition was one such change; the moratorium on construction of the CMRR-NF at Los Alamos (perhaps also the facility most vulnerable to cancellation) is another. But the broader modernization thrust remains, with little in the way of changes that might reduce the diversity of capabilities and destructive capacity of the US arsenal on the planning horizon before the current delivery systems begin to be replaced—or not—in the 2030s. There is no reason to expect significant disarmament initiatives from Congress, where pro-nuclear weapons factions remain strong, particularly on the committees with the most influence on relevant parts of the federal budget.¹⁴⁸

In the broader populace, there is little debate about US nuclear weapons policies or spending. Thirty years on from the outpouring of disarmament sentiment that brought a million people out to protest in Central Park, little is left in the way of a disarmament movement in the United States. What remains is a scattering of organizations, some more towards the “arms control” end of the spectrum that always were part of the political mainstream and some that are institutionalized remnants of movements past. The former always have pursued a remedial and incrementalist politics. Most who work in the latter have come to believe that they have no choice. This dynamic reflects far broader changes in the US economic, social, and political environment, affecting how social change work is done

across the board, and even whether work on issues of general public concern is perceived and described as working for social change.

What public discussion there is about US nuclear weapons policy is dominated by specialists. Actual nuclear disarmament is conceived as a distant, aspirational goal. There is very little debate, discussion, or serious analysis of what kinds of strategies for social, economic, or political change would be necessary to accomplish it. In the absence of a movement to a convincing vision of the path to nuclear disarmament or the political power to support it, most disarmament-related advocacy is reactive. US arms control and disarmament groups focus mainly on preventing the expansion of nuclear weapons capabilities and budgets, or on taking advantage of what are perceived as opportunities for incremental progress. The common denominator is that the limits to the disarmament agenda are set by what is thought to be achievable in government fora without challenging anything fundamental about the existing order of things, or the role of US military forces in sustaining it.

IN SUM, THE OBAMA ADMINISTRATION APPEARS FOR THE NEAR TERM TO BE REMAINING ON THE COURSE OF MODERNIZATION OF NUCLEAR WEAPONS SYSTEMS AND OF THE FACILITIES THAT BUILD AND MAINTAIN THEM THAT IT COMMITTED TO IN THE CONTEXT OF ITS EFFORT TO OBTAIN SENATE CONSENT TO NEW START.

In the post Cold War era, challenges to the rationale for deployment of US military forces have remained episodic and marginal. There have been significant upsurges of anti-war sentiment occasioned by particular wars, but none have yet coalesced into sustained opposition to the immense permanent military establishment that is a central characteristic of the US economy and polity. In mainstream, Washington, DC-focused arms control and disarmament discourse, “the mission” of the military largely remains in brackets, with debate limited to how it can be achieved most inexpensively and with the least risk. In this context, nuclear weapons are portrayed as less useful and more risky than other weapons, offering less bang for the buck because their fearsome destructiveness limits the circumstances in which they can be used. Elimination of nuclear weapons is framed as a good thing to the extent that the goals of those who have the power to set US military and foreign policy can be achieved without them. What those goals are and who has the power to set them also remains largely outside the frame.¹⁴⁹

Viewed within this conventional advocacy frame the current austerity campaign by corporate and political elites offers an additional opportunity to advance this narrative. The argument runs that maintaining nuclear weapons over the long run, and particularly building expensive replacements for existing delivery systems, is

likely to require cuts in conventional forces in a climate where, for the first time in over a decade, the military might not be able to get virtually everything it asks for.

Arguments of this kind may rein in nuclear weapons spending to some degree, perhaps even reducing the number of new delivery platforms acquired or delaying or eliminating construction of some new weapons facilities. The main focus of many arms control advocates at this writing seems to be reducing the number of ballistic missile submarines to be acquired (after the Ohio class submarines reach the end of their service life about two decades from now) from twelve to eight, and possibly delaying acquisition of ICBMs and new nuclear-capable bombers.¹⁵⁰

Demanding more than incremental reductions in the near term is marginalized in a professionalized arms control and disarmament discourse as unrealistic. An alternative “realism” might give more weight to the urgency of reducing arsenals to levels where they no longer can inflict fatal damage on humanity and the ecosphere on a time scale relevant to the deepening crises we face, crises that bear some significant resemblances to those that brought great power wars in the past. This broader realism might also encompass the relationship of the current impasse in disarmament progress to the equally urgent task of war prevention, a task complicated by the repeated use of “non-proliferation” as a stalking horse for geopolitical agendas. Is the danger of great power war on the rise once more in a world of ascending and declining great powers competing for disappearing resources and pursuing ecologically unsustainable growth paths? Amidst the deepest economic crisis of the nuclear age, what constellations of organizations within states benefit from sustained high-tech militarism, and have interests they see as justifying high risk confrontations that could lead to catastrophe? Such questions remain largely outside US arms control and disarmament discourse. Even most disarmament advocates apparently are willing to accept elite assurances that a technocratically managed, interdependent global economy has eliminated the possibility of great power war (just as they assured us it eliminated the business cycle), or perhaps also believe, on some unexamined level, that nuclear deterrence works. Little else explains the pervasive lack of urgency regarding disarmament amongst most who make arms control their occupation.

Reductions in numbers of delivery systems and warheads at some indeterminate future time would be a good thing. It has no necessary relationship, however, to significant progress towards bringing the US nuclear arsenal below the level where it represents an existential threat to humanity. There is no reason to believe that budgetary concerns will override a determination on the part of elites who actually have a say in the matter to keep a “superpower” nuclear arsenal. Post-Soviet Russia suffered an economic decline virtually unprec-

edented in a modern industrialized country in the absence of major war, and yet its elites chose to hold on to a nuclear arsenal of civilization-destroying size. If one believes that nuclear weapons might in fact be used, nuclear weapons are a relatively cheap way to retain or acquire the ability to destroy an adversary who may be able to field larger or more technologically capable conventional forces.

Like many other countries, the United States, has been sliding deeper into political crisis the longer the global economic crisis has dragged on. Here, as in much of the world, wealth has become concentrated in huge organizations that constitute the top tier of an increasingly divided economy and society. The military-industrial complex and other constellations of corporations, in alliance with government organizations with aligned interests, dominate politics at every level from the local to the national. The US is a country where democracy has long been in decline, eroded by the effects of this concentration of wealth in a political system where money has free play, and by 60 years of national security state ideologies used to justify not only high-tech militarism but a slow, steady stifling of civil society.¹⁵¹ The rule of law no longer applies to those at the top, and anything beyond the mildest forms of dissent outside channels safely controlled by one or another form of legalized corruption is hemmed in by heavily militarized police. As the 2006 Weapons of Mass Destruction Commission, headed by Hans Blix, put it in its report, “Governments possessing nuclear weapons can act responsibly or recklessly. Governments may also change over time.”¹⁵²

From the perspective of incumbent elites struggling to sustain the status quo against challenges within and without amidst deepening crisis, the sense of a world out of control on many fronts provides ideological justification for their habitual version of “caution”: remain vigilant, and well-armed. There is little sign that the oligarchs who control the United States, a country that no longer can claim outstanding performance in any social endeavor other than the deployment of high-tech violence, will choose a different course. Having been successful in restricting meaningful access to the political system to the wealthy and powerful, it is also unlikely that change will be forced upon them, in the absence of social movements on a scale far greater than any on the visible political horizon. In the 1960s Pakistan’s foreign minister Zulfikar Ali Bhutto became a symbol of the determination of national elites to acquire nuclear weapons regardless of the consequences for their people with his statement that should India get nuclear weapons, “[e]ven if Pakistanis have to eat grass we will make the bomb.”¹⁵³ In Prague in 2009, President Obama, like many presidents before him, stated a belief that nuclear disarmament might be a good idea on some distant day, but reaffirmed a promise that every time has proved to be the concrete reality:

“As long as these weapons exist, the United States will maintain a safe, secure and effective arsenal to deter any adversary.”¹⁵⁴ Unless there are profound changes in the structure of US politics, economics, and society, it is likely that many millions of Americans will be eating grass long before the US stops striving for global military dominance, much less begins moving towards nuclear disarmament.

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MODERNIZATION AND ...

INTERNATIONAL LAW

JOHN BURROUGHS

Cessation of the nuclear arms race at an early date is one of the principal if often forgotten objectives of the 1968 nuclear Non-Proliferation Treaty (NPT). Decades later, NPT states parties made commitments to a diminishing role for nuclear weapons in security policies and to the principle of irreversible disarmament. Those and other obligations and commitments and related doctrines create a rich set of standards for assessment of modernization of nuclear forces and infrastructure. Below, the relevant obligations and commitments are set out first. Then they are analyzed and the question of their application to non-NPT states is addressed. An assessment follows of quantitative modernization, qualitative modernization, and modernization enabling long-term maintenance of nuclear forces. A central theme is that modernization erodes the trust and cooperation required for fulfillment of the fundamental nuclear disarmament obligation. The conclusion examines challenges posed by the current state of international law and institutions in the nuclear weapons sphere, and urges development of an institutional capability adequate to the task of monitoring cessation of the nuclear arms race and achievement of the global elimination of nuclear weapons.

OBLIGATIONS AND COMMITMENTS DIRECTLY RELATING TO MODERNIZATION

Nuclear Non-Proliferation Treaty (NPT), article VI

Each of the Parties to the Treaty undertakes to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date.

1995 NPT Review and Extension Conference, Principles and Objectives for Nuclear Non-Proliferation and Disarmament

4. The achievement of the following measures is important in the full realization and effective implementation of article VI, including the program of action as reflected below: (a) The completion by the Conference on Disarmament of the negotiations on a universal and internationally and effectively verifiable Comprehensive Nuclear-Test Ban Treaty no later than 1996. Pending the entry into force of a Comprehensive Test-Ban

Treaty, the nuclear weapon States should exercise utmost restraint; (b) The immediate commencement and early conclusion of negotiations on a non-discriminatory and universally applicable convention banning the production of fissile material for nuclear weapons or other nuclear explosive devices, in accordance with the statement of the Special Coordinator of the Conference on Disarmament and the mandate contained therein.

Comprehensive Nuclear-Test-Ban Treaty, preambular paragraphs 5 and 6

Recognizing that the cessation of all nuclear weapon test explosions and all other nuclear explosions, by constraining the development and qualitative improvement of nuclear weapons and ending the development of advanced new types of nuclear weapons, constitutes an effective measure of nuclear disarmament and non-proliferation in all its aspects,

Further recognizing that an end to all such nuclear explosions will thus constitute a meaningful step in the realization of a systematic process to achieve nuclear disarmament.

2000 NPT Review Conference Final Document, Practical Step 9(d) and (e)

Concrete agreed measures to further reduce the operational status of nuclear weapons systems.

A diminishing role for nuclear weapons in security policies to minimize the risk that these weapons ever be used and to facilitate the process of their total elimination.

2010 NPT Review Conference Final Document, Action Plan on nuclear disarmament

I(b)(4): The Conference recognizes the legitimate interests of non-nuclear-weapon States in the constraining by the nuclear-weapon States of the development and qualitative improvement of nuclear weapons and ending the development of advanced new types of nuclear weapons.

Action 1: All States parties commit to pursue policies that are fully compatible with the Treaty and the objective of achieving a world without nuclear weapons.

Action 11: Pending the entry into force of the Comprehensive Nuclear-Test-Ban Treaty, all States commit to refrain from nuclear-weapon test explosions or any other nuclear explosions, the use of new nuclear

weapons technologies and from any action that would defeat the object and purpose of that Treaty, and all existing moratoriums on nuclear-weapon test explosions should be maintained.

OBLIGATIONS AND COMMITMENTS RELATING TO NUCLEAR DISARMAMENT

Nuclear Non-Proliferation Treaty (NPT), article VI

Each of the Parties to the Treaty undertakes to pursue negotiations in good faith on effective measures relating to ... nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control.

Advisory Opinion, International Court of Justice, para. 105(2)F

There exists an obligation to pursue in good faith and bring to a conclusion negotiations leading to nuclear disarmament in all its aspects under strict and effective international control.

2000 NPT Review Conference Final Document, Practical Step 6

An unequivocal undertaking by the nuclear-weapon States to accomplish the total elimination of their nuclear arsenals leading to nuclear disarmament to which all States parties are committed under Article VI.

2000 NPT Review Conference Final Document, Practical Step 5

The principle of irreversibility to apply to nuclear disarmament, nuclear and other related arms control and reduction measures.

2010 NPT Review Conference Final Document, Action Plan on Nuclear Disarmament

Action 1: All States parties commit to pursue policies that are fully compatible with the Treaty and the objective of achieving a world without nuclear weapons.

ANALYSIS OF OBLIGATIONS AND COMMITMENTS DIRECTLY RELATING TO MODERNIZATION

Cessation of the nuclear arms race

It is too little noticed that the NPT envisages that the “cessation of the nuclear arms race” is to be achieved at an “early date” through good-faith negotiations. As Mohamed I. Shaker conveys in his three-volume study of the origin and early implementation of the NPT, this means that the quantitative build-up, and qualitative improvement, of nuclear arsenals is to be ended prior to negotiations on their elimination.¹

The principal means of cessation of the nuclear arms race were universally understood at the time as a ban on nuclear testing, a ban on production of fissile materials for nuclear weapons, and strategic nuclear arms limitations negotiations, capping build-ups, between the United States and the Soviet Union. At least from the standpoint of many non-nuclear weapon states, a further element was cessation of manufacture of nuclear weapons.² Additionally, many non-nuclear weapon states specifically referred to ending the qualitative improvement of nuclear warheads and their delivery systems.

The NPT preamble recalls the determination to negotiate a ban on all nuclear test explosions expressed in the 1963 Limited Test Ban Treaty. And, at its first session after the NPT was opened for signature on 1 July 1968, the Eighteen Nation Disarmament Committee (ENDC), the predecessor to today’s Conference on Disarmament, the United States and the Soviet Union, as co-chairs, proposed an agenda under a heading taken from article VI:

1. Further effective measures relating to the cessation of nuclear arms race at an early date and to nuclear disarmament. Under this heading members may wish to discuss measures dealing with the *cessation of testing*, the *non-use of nuclear weapons*, the *cessation of production of fissionable materials for weapons use*, the *cessation of manufacture of weapons* and reduction and subsequent elimination of nuclear stockpiles, nuclear-free zones, etc.³

An agenda proposed later that year by non-nuclear weapon states also featured elements relating to cessation of the nuclear arms race, with the addition of prevention of further development and improvement of nuclear arms, listed as the first item:

- (a) *the prevention of the further development and improvement of nuclear weapons and their delivery vehicles;*
- (b) *the conclusion of a comprehensive test ban treaty, as an important step in the field of nuclear disarmament, and as a matter of high priority;*
- (c) *reaching agreement on the immediate cessation of the production of fissile materials for weapons purposes and the stoppage of the manufacture of nuclear weapons;*
- (d) *the reduction and subsequent elimination of all stockpiles of nuclear weapons and their delivery systems.*⁴

If bans on testing and production of fissile materials for weapons had been adopted soon after the NPT was signed, they would have helped to prevent the development, build-up, and spread of nuclear forces to the incredible level and extent the world is now working to unwind. The Comprehensive Nuclear-Test-Ban Treaty (CTBT) has long been understood to prevent, or at least to constrain, qualitative arms racing. A fissile materials cut-off treaty (FMCT) would prevent quantitative arms

acing based on production of new materials. However, unless widened in scope, it would not prevent acquisition of additional weapons based on use of stockpiled existing materials, as is unfortunately possible now on a large scale for the older nuclear powers. Cessation of manufacture of nuclear weapons as such so far has not been pursued through proposed agreements. Nor have limitations on qualitative development and improvement of nuclear arsenals. Verification of measures prohibiting development and manufacture would be highly intrusive, comparable to that required for reduction and elimination of nuclear arsenals.

NPT member states have an obligation to pursue negotiations on cessation of the nuclear arms race at an early date, and that obligation must be fulfilled in good faith. As further discussed below, pending achievement of cessation of the nuclear arms race, to show good faith they must not take actions undermining that objective. This prong of article VI therefore generally enjoins states to refrain from both quantitative build-up and qualitative improvement of their nuclear arsenals.

That conclusion is reinforced by the unanimously adopted Final Document of the General Assembly's first special session on disarmament, held in 1978, whose provisions apply to all UN member states including those not party to the NPT. It provides, *inter alia*:

39. *Qualitative and quantitative disarmament measures are both important for halting the arms race. Efforts to that end must include negotiations on the limitation and cessation of the qualitative improvement of armaments, especially weapons of mass destruction and the development of new means of warfare*

47. *Nuclear weapons pose the greatest danger to mankind and to the survival of civilization. It is essential to halt and reverse the nuclear arms race in all its aspects in order to avert the danger of war involving nuclear weapons. ...*

50. *The achievement of nuclear disarmament will require urgent negotiation of agreements at appropriate stages and with adequate measures of verification satisfactory to the States concerned for:*
(a) *Cessation of the qualitative improvement and development of nuclear-weapon systems;*
(b) *Cessation of the production of all types of nuclear weapons and their means of delivery, and of the production of fissionable material for weapons purposes.*⁵

Test ban treaty

Under Article 18 of the Vienna Convention on the Law of Treaties, signatories to the CTBT are required to refrain from actions contrary to its object and purpose. Signatory states possessing nuclear weapons are the United States, United Kingdom, France, Russia, China, and Israel. In addition, NPT member states have com-

mitted under action 11 of the 2010 NPT Final Document to refrain from any action that would defeat the object and purpose of the CTBT. It can be argued, moreover, that in light of its wide ratification, the general practice of non-testing since the CTBT was signed in 1996, General Assembly and Security Council resolutions, and other international statements, at least a "political norm" of no testing has emerged applicable to non-signatory states outside the NPT, India and Pakistan.⁶

Do some modernization activities contravene the object and purpose of the CTBT because they contribute to the development and qualitative improvement of nuclear weapons? The "object" of the Treaty would seem to be the end of nuclear testing. As for the purpose, the broader aim of the Treaty, the last preambular paragraph indicates there are several. It reads: "*Affirming* the purpose of attracting the adherence of all States to this Treaty and its objective to *contribute effectively* to the prevention of the proliferation of nuclear weapons in all its aspects, to the process of nuclear disarmament and therefore to the enhancement of international peace and security."⁷ Among the purposes therefore is to contribute to "the process of nuclear disarmament". Earlier preambular paragraphs "recognize" that an end to nuclear explosions is a "meaningful step" in the process of nuclear disarmament because it will "constrain the development and qualitative improvement of nuclear weapons."⁸

The language, however, is quite qualified. The word "recognize" indicates a statement of fact rather than an aim, the word "constrains" is well short of expressing an expectation of termination, and "to contribute effectively" is a limited aim. It accordingly would seem a bridge too far to argue that, in general, modernization activities that develop and improve nuclear weapons are contrary to the CTBT's object and purpose. Finally, especially regarding security matters, states typically argue that they are restricted by what they have specifically agreed to, and no more. Even in this light, at least planned laser fusion experiments involving miniature nuclear explosions are vulnerable to the criticism that they contravene the CTBT's prohibition of nuclear explosive testing and its object and purpose.⁹

If on its own the CTBT does not give rise to a general commitment or obligation to refrain from qualitative modernization of nuclear weapons, nonetheless its preambular language does complement and reinforce other obligations and commitments, notably the NPT obligation regarding cessation of the nuclear arms race at an early date.

A new element in the 2010 NPT commitment regarding the CTBT is refraining from "the use of new nuclear weapons technologies". Its meaning is unclear. It may be a general declaration referring to new nuclear warheads. In context, though, it would appear to refer to technologies that would circumvent the ban on nuclear explosive testing or otherwise defeat the object and

purpose of the treaty. It would seem to apply, for example, to laser fusion facilities as well as to various means of simulating and analyzing nuclear explosions. However, given that such technologies have been employed or have been in development in nuclear weapons states for many years, whether they would come under the commitment is questionable given the qualifier “new,” unless their development post-dates the 2010 conference. There does not seem to have been any in-depth consideration of this element; rather, it was simply inserted at the request of a non-nuclear weapon state.

NPT conference commitments

The 1995 NPT Review and Extension Conference made strong commitments to negotiation of a CTBT and an FMCT, and those commitments were subsequently reaffirmed and developed by the 2000 and 2010 NPT Review Conferences.¹⁰ Both measures are understood to be key elements of cessation of the nuclear arms race under Article VI. All three conferences also made commitments to the reduction and elimination of nuclear arsenals. As quantitative build-up of arsenals by NPT nuclear weapon states had ended, that aspect of cessation of the nuclear arms race no longer received attention and the nuclear disarmament prong of article VI came to the fore.¹¹

Regarding qualitative modernization, the Practical Steps adopted by the 2000 NPT Review Conference, reaffirmed by the 2010 Review Conference, contain commitments to reduce the role of nuclear weapons in security postures on both policy and operational levels. Those commitments have been incorporated in a long string of General Assembly resolutions adopted by overwhelming majorities.¹² A natural corollary is that nuclear weapons will not be improved to give them additional military capabilities and make them more suitable for new missions. The 2010 NPT Final Document also “recognizes” the “legitimate interest” of non-nuclear weapon states in “constraining” the development of nuclear weapons. While not definitive due to the unwillingness of NPT nuclear weapon states to go further, these provisions support the contention that qualitative modernization adding to military capabilities undermines good-faith achievement of the article VI objective of cessation of the nuclear arms race.

In 2005, the US State Department argued that given the fact that all of the NPT nuclear weapon states “have continued to modernize their nuclear weapons stockpiles during the period in which the NPT has been in effect ... it would be a novel and unfounded interpretation of the NPT to argue that such modernization is problematic under the NPT.”¹³ In general, a practice of non-compliance, however long-lasting, does not demonstrate compliance. Moreover, from the beginning non-nuclear weapon states have insisted that the NPT bargain requires the achievement of a CTBT, which was long, if over-optimistically, regarded as tantamount

to ending qualitative nuclear arms racing. The Final Document of the 1975 NPT Review Conference reflects this view, stating that the “Conference expresses the view that the conclusion of a treaty banning all nuclear weapons tests is one of the most important measures to halt the nuclear arms race.”¹⁴ And as noted earlier, after the NPT was signed non-nuclear weapon states placed prevention of development and improvement of nuclear arms at the top of their proposed agenda for negotiations in the ENDC.

Perhaps most significantly, in the aftermath of the disintegration of the Soviet Union, the NPT conferences of 1995, 2000, and 2010 have established more symmetry, in principle at least, between the obligation of non-nuclear weapon states not to acquire nuclear weapons and the obligation of NPT nuclear weapon states to enter into a process of eliminating their arsenals including through the reduction of the role of nuclear weapons.¹⁵ Modernization improving military capabilities and projecting retention of nuclear forces for many decades into the future is inherently incompatible with such a process, as is shown more fully by consideration of the nuclear disarmament prong of article VI.

ANALYSIS OF OBLIGATIONS AND COMMITMENTS RELATING TO NUCLEAR DISARMAMENT

NPT article VI, the ICJ statement of the disarmament obligation, and the unequivocal undertaking

The two principal aims of article VI are cessation of the nuclear arms and the elimination of nuclear weapons. The latter aim is made crystal clear in the preamble to the NPT, which refers to “the liquidation of all [States’] existing stockpiles, and the elimination from national arsenals of nuclear weapons and the means of their delivery pursuant to a Treaty on general and complete disarmament under strict and effective international control.”

In the 1950s and 1960s, a treaty on general and complete disarmament had been envisioned as a) the limitation and reduction of armed forces and conventional armaments; b) prohibition of nuclear weapons and weapons of mass destruction of every type; and c) establishment of effective international control through a control organ.¹⁶ Subsequent to the negotiation of the NPT, the practice of states was to negotiate separate conventions on prohibition and elimination of distinct types of weapons, notably on biological weapons, chemical weapons, antipersonnel landmines, and cluster munitions, with an implementing agency in the case of chemical weapons. Such matters are considered by the UN General Assembly under the rubric of “general and complete disarmament”.

In light of this practice, article VI should now be understood as requiring, not negotiation of a treaty on

elimination of WMD and limitation of conventional arms, but rather negotiation of a treaty on the prohibition and elimination of nuclear weapons—a Nuclear Weapons Convention—comparable to the Chemical Weapons Convention and Biological and Toxin Weapons Convention.¹⁷ Such a reading of article VI is supported by article 31 of the Vienna Convention on the Law of Treaties, which provides for application and interpretation of treaties in light of practice and agreement subsequent to their adoption.

The 1996 International Court of Justice advisory opinion on nuclear weapons also supports this reading of article VI. With all justices concurring, the Court concluded that article VI and other international law requires that states “pursue in good faith and bring to a conclusion negotiations leading to nuclear disarmament in all its aspects under strict and effective international control.”¹⁸ Thus the Court did not make the obligation of complete nuclear disarmament dependent upon achievement of general and complete disarmament, which in any case is being pursued, notably through the treaties on biological and chemical weapons. Relying on an international law distinction between obligations of conduct and result, the Court held that with respect to nuclear weapons, both conduct (negotiation) and result (“nuclear disarmament in all its aspects”) are required. The result element arises from article VI itself, the NPT preamble, which clearly identifies the sought after result, as well as the long history of UN efforts related to nuclear disarmament, starting with the first resolution adopted by the General Assembly.¹⁹

In the 2000 Final Document, NPT state parties effectively endorsed the understanding of article VI as requiring the achievement of complete nuclear disarmament, adopting the “unequivocal undertaking by the nuclear-weapon States to *accomplish* the total elimination of their nuclear arsenals leading to nuclear disarmament to which all States parties are committed under Article VI.”²⁰ This provision has considerable legal weight; it represents the practice and agreement of states bearing directly and specifically upon the interpretation of article VI.²¹

The implication for modernization of nuclear arsenals is straightforward. If implemented at all, it must not be done in a way which interferes with accomplishing the result of elimination of nuclear weapons required by the nuclear disarmament obligation. This implication is generally recognized in the commitment set forth in the 2010 NPT Final Document: “All States parties commit to pursue policies that are *fully compatible* with the Treaty and *the objective of achieving a world without nuclear weapons.*”²²

The implication also follows from the fundamental principle of good faith governing compliance with treaty obligations set forth in article 26 of the Vienna Convention on the Law of Treaties. Good faith requires abiding by agreements in a manner true to their pur-

poses and working sincerely and cooperatively to attain agreed objectives.²³ Acts at cross-purposes with the achievement of agreed objectives are incompatible with good faith.²⁴ While such acts may in theory be reversible, they undermine the development of the trust necessary to achievement of objectives. As the ICJ stated: “One of the basic principles governing the creation and performance of legal obligations, whatever their source, is the principle of good faith. Trust and confidence are inherent in international co-operation, in particular in an age when this co-operation in many fields is becoming increasingly essential.”²⁵ The need for trust is especially pronounced when it comes to security matters and even more so with respect to a process of global nuclear disarmament.²⁶

Thus in the NPT context, states Judge Mohammed Bedjaoui, former President of the International Court of Justice, good faith proscribes “every initiative the effect of which would be to render impossible the conclusion of the contemplated disarmament treaty” eliminating nuclear weapons globally pursuant to article VI.²⁷ In Australia’s argument to the ICJ in 1995, then Foreign Minister Gareth Evans put the matter more specifically. He said that to implement the nuclear disarmament obligation, states possessing nuclear weapons “cannot add to, improve or test them.”²⁸

The NPT principle of irreversibility

The principle of irreversibility has its origins in the formation of policy concerning disposal of fissile materials from dismantled warheads. The policy adopted between the United States and Russia is that such materials should be processed to render them effectively unusable again in warheads, for example by “down-blending” highly enriched uranium and using it as nuclear reactor fuel, or mixing plutonium with highly radioactive nuclear waste and burying it underground. The principle was similarly applied to delivery systems: missiles and bombers removed from deployment were verifiably destroyed under the Intermediate-Range Nuclear Forces and START agreements. As is readily understood, the aim is to make arms control measures, and the elimination of nuclear weapons, not sham but effective, so that items subject to arms control and disarmament cannot be employed for rearmament.

The principle of irreversibility connects tightly to good faith implementation of the nuclear disarmament obligation. Its adoption by the 2000 and 2010 Review Conferences represents an interpretation and application of article VI identifying a key legal criterion for assessment of compliance.²⁹ The principle has also been repeatedly affirmed by General Assembly resolutions adopted by overwhelming majorities.³⁰ Modernization of nuclear weapons infrastructures for the purpose, declared or unspoken, of making a build-up of nuclear forces possible, circumvents the principle of irreversibility,³¹ and undermines the achievement of the

objective of disarmament in violation of the principle of good faith.

STATES NOT PARTY TO THE NPT

It is often assumed that because India, Israel, and Pakistan never joined the NPT, they are not subject to any international law disarmament obligation.³² As previously noted, in matters of security, states are especially insistent that they are not bound by any obligation to which they have not expressly agreed. Moreover, because they are subject to constitutional processes of approval, treaties typically have the advantage of greater buy-in from entire political systems. Nonetheless, there are multiple reasons to believe that in principle all states are bound by a customary international law nuclear disarmament obligation. At an absolute minimum, they are subject to a “political norm” enjoining nuclear disarmament.³³

To begin with, the NPT has nearly universal adherence, and article VI applies to all parties to that Treaty, not only the nuclear weapon states acknowledged by the Treaty. Extensive adherence to treaty obligations is a strong indicator of the existence of a customary international law obligation.

Second, disarmament, and nuclear disarmament in particular, has been an aim of the United Nations since its beginning. Articles 11 and 26 of the UN Charter contemplate work on disarmament by the General Assembly and the Security Council. The first General Assembly resolution sought to set in motion the elimination of nuclear and other weapons of mass destruction.³⁴ Then resolutions of the General Assembly called for the elimination of nuclear weapons and other WMD through general and complete disarmament. In 1978, the Final Document of the General Assembly special session made nuclear weapons the top priority for disarmament negotiations.³⁵

Third, the obligation of elimination of nuclear weapons and other WMD is rooted—as the term ‘weapons of mass destruction’ itself conveys—in their incompatibility with international humanitarian law forbidding indiscriminate attacks, the prohibitions of crimes against humanity and genocide, and what the ICJ called “elementary considerations of humanity.”³⁶ Law based in such elementary considerations applies universally, regardless of particularities of treaty adherence. No one would argue that a state is not subject to the prohibition of genocide because it is not a party to the Genocide Convention. Nor does the persistent objector doctrine, permitting states to avoid the application of rules of customary international law to which they consistently declare their non-consent, apply to such fundamental rules. If law forbidding employment of nuclear weapons applies universally, and it does, that is a powerful reason for the nuclear disarmament obligation to apply universally.³⁷

The International Court of Justice stated the disarmament obligation in a way open to its universal application: “There exists an obligation”³⁸ That this was deliberate was confirmed by Judge Bedjaoui, then President of the Court, in his separate declaration: “[I]t is not unreasonable to think that, considering the at least formal unanimity in this field, this twofold obligation to negotiate in good faith and achieve the desired result has now, 50 years on, acquired a *customary character*.”³⁹ The first two factors referred to above clearly shaped the Court’s approach. Regarding the widespread adherence to the NPT and the participation of all member states of the United Nations in disarmament deliberations, the Court stated:

100. This twofold obligation to pursue and to conclude negotiations formally concerns the 182 States parties to the Treaty on the Non-Proliferation of Nuclear Weapons, or, in other words, the *vast majority of the international community*.

Virtually the whole of this community appears moreover to have been involved when resolutions of the United Nations General Assembly concerning nuclear disarmament have repeatedly been unanimously adopted. Indeed, any realistic search for general and complete disarmament, especially nuclear disarmament, necessitates the co-operation of all States.

101. Even the very first General Assembly resolution, unanimously adopted on 24 January 1946 at the London session, set up a commission whose terms of reference included making specific proposals for, among other things, “the elimination from national armaments of atomic weapons and of all other major weapons adaptable to mass destruction”. In a large number of subsequent resolutions, the General Assembly has reaffirmed the need for nuclear disarmament. Thus, in resolution 808 A (IX) of 4 November 1954, which was likewise unanimously adopted, it concluded “that a further effort should be made to reach agreement on comprehensive and co-ordinated proposals to be embodied in a draft international disarmament convention providing for: ... (b) The total prohibition of the use and manufacture of nuclear weapons and weapons of mass destruction of every type, together with the conversion of existing stocks of nuclear weapons for peaceful purposes.”

The same conviction has been expressed outside the United Nations context in various instruments.⁴⁰

India and Pakistan each vote for the annual General Assembly resolution on follow-up to the ICJ opinion.⁴¹ Its first operative paragraph welcomes the ICJ statement of the disarmament obligation, and the second calls for early commencement of multilateral negotiations leading to a convention prohibiting and eliminating nuclear weapons. The votes provide some evidence that the two countries accept that the nuclear disarmament obligation applies to them, and they have not stated otherwise.

Finally, Security Council resolution 1887, issued in 2009 by the first ever head of state-attended session exclusively addressing nuclear non-proliferation and disarmament, contains a call on non-NPT states to join in the article VI nuclear disarmament “endeavor”. While falling short of a legally-binding directive, a “call” from the Council is more than a suggestion. The resolution also calls on states outside the NPT to join it as non-nuclear weapon states, a standard provision in UN and NPT documents, and a preambular paragraph reaffirms “that proliferation of weapons of mass destruction, and their means of delivery, constitutes a threat to international peace and security.”

At least with respect to India and Pakistan, the call to join in nuclear disarmament, new for the Security Council, is probably the more operationally pertinent paragraph. But both provisions of the resolution, as well as calls in NPT Review Conference outcome documents for states outside the NPT to join as non-nuclear weapon states, at a minimum support an international expectation that non-NPT states not engage in

MODERNIZATION OF NUCLEAR WEAPONS INFRASTRUCTURE IN ORDER TO ENABLE POSSIBLE FUTURE BUILD-UP OF ARSENALS IS CONTRARY TO THE PRINCIPLE OF IRREVERSIBLE DISARMAMENT.

arms racing. That expectation was directly stated by the Security Council shortly after India and Pakistan conducted nuclear tests in 1998. In resolution 1172 the Council called upon them “to stop their nuclear weapon development programmes, to refrain from weaponization or from the deployment of nuclear weapons, to cease development of ballistic missiles capable of delivering nuclear weapons and any further production of fissile material for nuclear weapons.”

In summary, while it may not readily be accepted by non-NPT states, there is a strong case that they are subject to a universal nuclear disarmament obligation and the subsidiary obligation of cessation of the nuclear arms race. Their conduct should certainly be assessed under at least the same standards applicable to NPT nuclear weapon states—if not more restrictive ones, given the persistent calls for them to join the NPT as non-nuclear weapon states—whether the standards are considered legal or political in nature.

ASSESSMENT OF MODERNIZATION UNDER INTERNATIONAL LAW STANDARDS

Other contributions in this collection provide detailed information and analysis on particular states’ modernization programmes. It is not possible here to apply the above discussed international law standards to each country. However, relevant issues are summarized below with respect to quantitative moderniza-

tion, qualitative modernization improving military capabilities, and modernization to enable long-term maintenance of existing capabilities. The central contention is that modernization depletes the fund of trust needed for cooperation in disarmament.⁴² The converse is also true; a failure to forge ahead with arms control and disarmament measures, modest or far-reaching, encourages modernization as a hedge against feared actions of other states.⁴³

Quantitative modernization

Increases in the size of nuclear arsenals and the amount of fissile material dedicated to weapons purposes is not currently a concern with respect to the United States, United Kingdom, France, and Russia. But they are a critical concern with respect to India and Pakistan, as well as to China at least with respect to its arsenal. The refusal on the part of Pakistan to enter into negotiations on an FMCT (with China and India perhaps taking advantage of Pakistan’s overt position) is contrary to the universal obligation of good-faith pursuit of negotiations leading to nuclear disarmament and the subsidiary obligation of good-faith negotiation of cessation of the nuclear arms race. More generally, increases in arsenal size and in fissile materials stocks are actions contrary to good faith because they undermine achievement of cessation of the nuclear arms race and disarmament.⁴⁴

Modernization of nuclear weapons infrastructure in order to enable possible future build-up of arsenals is contrary to the principle of irreversible disarmament. In the United States, the building of new facilities has been expressly justified as providing a surge capability. This not only violates the irreversibility principle, it is contrary to the principle of good faith; it erodes the trust needed for the enterprise of global nuclear disarmament.

Qualitative modernization improving military capabilities

An end to such qualitative modernization was envisaged in the article VI prong of cessation of the nuclear race at an early date, and the CTBT was understood as a principal means for achieving this objective. More than four decades after the NPT was signed, the failure to date of NPT nuclear weapon states United States and China to ratify the CTBT demonstrates a lack of good faith with respect to achieving the objective of cessation of the nuclear arms race. The failure of India, Pakistan, and Israel so far to sign and/or ratify the treaty is subject to similar criticism.

Upgrades and replacements of nuclear warheads and delivery systems that improve military capabilities are counter to the NPT commitment to diminishing the role of nuclear weapons, demonstrate a lack of

good faith with respect to achievement of cessation of the nuclear arms race, and are incompatible with good-faith achievement of the objective of disarmament through a cooperative global enterprise. In the United States, the projected development of the B61-12 bomb with enhanced targeting capabilities, to be carried by a new aircraft, the F-35, with stealth capabilities, illustrates qualitative modernization arising from replacement of existing delivery systems and bombs/warheads.⁴⁵ Another example is the French deployment in 2010 of the submarine-launched M51 missile with increased range, accuracy, and payload capacity compared to the M45 missile it replaced.⁴⁶

A very troubling dynamic arises from the relationship of nuclear forces, maintained through ongoing modernization, to other military capabilities. In the context of missile defence deployments, cyberware capabilities, development of non-nuclear long-range strike capabilities, possible space-based systems, and the like, existing nuclear weapons may become objectively more threatening because at least in theory they have more potential for effective use in preemptive strikes. The 2000 NPT Final Document recognized the connection between missile defences and disarmament, calling in the Practical Steps for “preserving and strengthening the [Anti-Ballistic Missile] Treaty as a cornerstone of strategic stability and as a basis for further reductions of strategic offensive weapons.” While the ABM Treaty is now history due to US withdrawal from the Treaty under the Bush administration, the principle remains valid. Assessment of modernization of nuclear forces must thus consider those forces within a state’s overall military posture. And, as the United Nations and NPT negotiators recognized in placing nuclear disarmament in the context of general and complete disarmament, the good-faith pursuit of nuclear disarmament must also encompass as necessary related strategic systems.

Modernization enabling long-term maintenance of nuclear forces

States with nuclear weapons have plans and budgets for replacement of delivery systems and warheads stretching several decades into the future. This tends to be portrayed not as adding to military capabilities, but simply as maintaining an existing and benign ‘nuclear deterrent’. In practice, whether currently intended or not by governments, military capabilities will be enhanced, directly and also indirectly due to the combination of nuclear forces with other strategic systems.

Assume for purposes of discussion, however, modernization programmes that serve only to perpetuate existing capabilities for the indefinite future. One can imagine that they would simply be terminated when a collective decision to eliminate nuclear forces is made. Such a view ignores the practical reality of the programmes’ reinforcement of anti-disarmament el-

ements within each country. It also ignores the likely prospect of arms racing centered on infrastructures if not the forces themselves, which in turn undermines prospects for cooperation in disarmament. Generally, whether or not competition ensues, the intent of the modernizing states to comply with the disarmament obligation is thrown into doubt, with adverse effects on the non-proliferation regime, and erosion of the trust needed for the nuclear disarmament enterprise.

CONCLUSION

The application of international law to modernization, especially qualitative modernization, faces multiple challenges. To begin with, while in the NPT context nuclear weapon states have endorsed in principle the CTBT, FMCT, and capping and reducing nuclear arsenals, they have resisted specific commitments with respect to qualitative modernization. Thus the 2010 NPT Review Conference could only record the “legitimate interest” of non-nuclear weapon states in “constraining” development and improvement of nuclear arsenals.

Second, absent an overall, verified, program of elimination of nuclear forces, it is difficult to envisage how verification of a complete halt to both qualitative and quantitative modernization would be accomplished. Nonetheless, compliance with existing standards should be assessed to the extent possible, and those standards should be made more precise.

Most importantly, there is no international institutional mechanism for assessment of nuclear weapons programmes and the state of their compliance with international law with respect to cessation of the nuclear arms race and nuclear disarmament. Nor is there any international mechanism for enforcement of compliance. In the NPT review process and in the General Assembly First Committee, a few states devote at most several sentences to general statements on the subject of modernization. No ad hoc official international expert groups have examined the subject. NPT states parties not only do not have any institutional capability for assessment and enforcement of compliance with article VI, they have not developed such a capability with respect to non-proliferation. That is handled by the International Atomic Energy Agency, a wholly distinct body whose Board of Governors has a restricted membership, and the Security Council.

The establishment of adequate institutional capability to monitor nuclear weapons matters would help develop reliable information and a shared understanding of applicable standards, and thus the trust needed for a workable process of global disarmament.⁴⁷ It would counteract the tendency of states, especially powerful ones, to treat international law and institutions as manipulable for their own ends, rather than as global public goods whose integrity should be preserved.

Notwithstanding those challenges, international law bearing on modernization is reasonably well developed. It is a normative code that the ‘invisible college’ of non-governmental analysts exemplified by the authors in this collection,⁴⁸ as well as disarmament experts and advocates within and without governments around the world, can and should draw upon in working for an end to modernization and a beginning of global disarmament.

NOTES

- Mohamed I. Shaker, *The Nuclear Non-Proliferation Treaty: Origin and Implementation, 1959–1979* (London: Oceana Publications, 1980) (hereafter, “Shaker”), vol. 2, pp. 572–580, 583–585.
- In the NPT preamble, cessation of the manufacture of nuclear weapons appears in a paragraph concerning a treaty on general and complete disarmament, which tends to support the view that it is not an element of cessation of the nuclear arms race. However, a fissile materials cut-off treaty was seen at the time as contributing or even equivalent to cessation of the nuclear arms race because it would end production of nuclear warheads. See Shaker, vol. 2, at pp. 584–585. See also *id.* at p. 577 (statement of Cyprus in First Committee of the General Assembly includes cessation of manufacture under halting the nuclear arms race). The history of negotiation of the NPT and statements soon after it was adopted are not conclusive, but indicates that nuclear weapons states viewed cessation of the manufacture of nuclear weapons as an element of a final stage of elimination of nuclear weapons, while many non-nuclear weapon states viewed it as an element of cessation of the nuclear arms race.
- Conference of the Eighteen-Nation Committee on Disarmament, *Final Record of the Three Hundred and Nineteenth Meeting*, Verbatim Record, ¶ 93, Aug. 15, 1968, ENDC/PV. 390 (emphasis added), cited in Shaker, vol. 2, p. 579.
- Final Document of the Conference of Non-Nuclear-Weapon States (A/CONF.35/10, 1 Oct. 1968), Resolution C, p. 8 (emphasis added), cited in Shaker, vol. 2, p. 580.
- Final Document of the Tenth Special Session of the General Assembly, adopted by A/RES/S-10/2, 30 June 1978, adopted without a vote (emphasis added).
- George Bunn, “The Status of Norms Against Nuclear Testing,” *The Nonproliferation Review* (Winter 1999) (hereafter, “Bunn”), pp. 20–32.
- Emphasis added.
- Emphasis added.
- See Nicole Deller, Arjun Makhijani, John Burroughs, eds., *Rule of Power or Rule of Law? An Assessment of U.S. Policies and Actions Regarding Security-Related Treaties* (New York: The Apex Press, 2003) (hereafter, “*Rule of Power or Rule of Law*”), pp. 54–57.
- For background on the NPT review process and the NPT itself, see Charles J. Moxley, Jr., John Burroughs, and Jonathan Granoff, “Nuclear Weapons and Compliance with International Humanitarian Law and the Nuclear Non-Proliferation Treaty,” 34 *Fordham International Law Journal*, April 2011, no. 4, www.lcnp.org/wcourt/Fordhamfinaljoint.pdf (hereafter, “Moxley”), pp. 595, 680–683; and Michael Spies and John Burroughs, eds., *Nuclear Disorder or Cooperative Security? U.S. Weapons of Terror, the Global Proliferation Crisis, and Paths to Peace*, Lawyers Committee on Nuclear Policy, Western States Legal Foundation, Reaching Critical Will of the Women’s International League for Peace and Freedom, 2007, wmdreport.org/ndcs/online (hereafter, “*Nuclear Disorder or Cooperative Security*”) pp. 27–34, 57–76.
- In a declaration dated 6 April 1995, France, Russia, the United Kingdom and the United States among other things welcomed “the fact that the nuclear arms race has ceased.” NPT/Conf.1995/20, 19 April 1995, Annex. Perhaps the declarants had in mind quantitative arms racing; qualitative arms racing demonstrably has not ceased.
- E.g.*, A/RES/66/45, “United action towards the total elimination of nuclear weapons,” 2 December 2011, adopted by a vote of 169 to 1 (DPRK), with 11 abstentions, operative paragraphs 10 and 11; A/RES/65/71, “Decreasing the operational readiness of nuclear weapons systems,” 8 December 2010, adopted by a vote of 157 to 3 with 22 abstentions.
- U.S. Department of State, Bureau of Arms Control, “Article VI of the Non-Proliferation Treaty,” 10 February 2005, cited in *Nuclear Disorder or Cooperative Security*, p. 65.
- Shaker, vol. 2, p. 631.
- See *Rule of Power or Rule of Law*, pp. 39–40.
- See, *e.g.*, General Assembly Resolution 808 (IX) A (1954).
- Regarding the extensive record of governmental and civil society support in the UN context for a Nuclear Weapons Convention, see *Good Faith Negotiations Leading to the Total Elimination of Nuclear Weapons: Request for an Advisory Opinion from the International Court of Justice*, International Association of Lawyers Against Nuclear Arms and International Human Rights Clinic at Harvard Law School, 2009, www.lcnp.org/disarmament/2009.07.ICJbooklet.pdf, pp. 23–25.
- Legality of Threat or Use of Nuclear Weapons*, Advisory Opinion of 8 July 2006, I.C.J. Reports 1996, p. 226 (hereafter, “Nuclear Weapons Advisory Opinion”), at ¶ 105(2)F.
- A/Res/1(1), 24 January 1946, “Establishment of a Commission to Deal with the Problems Raised by the Discovery of Atomic Energy.”
- Emphasis added.
- See Article 31 of the Vienna Convention on the Law of Treaties (VCLT); see also Moxley, p. 686 and note 290 and sources cited therein.
- Emphasis added.
- See Moxley at p. 687 and sources cited therein.
- Cf. *Report of the International Law Commission Covering its 16th Session, 727th Meeting*, 20 May 1964: Pursuant to the VCLT Article 26 obligation that every treaty in force must be performed by the parties in good faith, the duty of the parties is “not only to observe the letter of the law but also to abstain from acts which would inevitably affect their ability to perform...”
- Nuclear Weapons Advisory Opinion, at ¶ 102.
- See Judge Mohammed Bedjaoui, “Good Faith, International Law, and Elimination of Nuclear Weapons,” Keynote Address, 1 May 2008, www.lcnp.org/disarmament/2008MayoeventBedjaoui.pdf, pp. 24–29.
- Ibid.*, p. 22.
- Verbatim Record of Proceedings Before the ICJ, 30 October 1995, www.icj-cij.org/docket/files/95/5925.pdf (hereafter, “Evans”), p. 53.
- Pursuant to VCLT Article 31. See Moxley at p. 686 and note 290 and sources cited therein.
- E.g.*, A/RES/66/45, 2 December 2011. Its operative paragraph 5 “[e]mphasizes the importance of applying the principles of irreversibility, verifiability and transparency in relation to the process of nuclear disarmament and non-proliferation.”
- See Jacqueline Cabasso, “Irreversibility and Verification,” NGO Presentation to the NPT Review Conference Preparatory Committee, April 2002, www.reachingcriticalwill.org/legal/npt/NGOpres02/11.pdf. Cf. Ian Anthony, *Irreversibility in Nuclear Disarmament: Political, Societal, Legal and military-Technical Aspects* (Swiss Confederation and Stockholm International Peace Research Institute, September 2011), p. 9; David Cliff, Hassan Elbahtimy, and Andreas Persbo, *Irreversibility in Nuclear Disarmament: Practical steps against nuclear rearmaments* (Swiss Confederation and Stockholm International Peace Research Institute, September 2011), pp. 11–13.
- As for the Democratic People’s Republic of Korea (DPRK), if it is considered to have withdrawn from the NPT, the discussion regarding non-NPT states applies all the more powerfully to it. The DPRK also is subject to stringent Security Council resolutions requiring the dismantlement of its nuclear weapons programme.
- On the concept of political norm, see Bunn.
- A/Res/1(1), 24 January 1946.
- Final Document of the Tenth Special Session of the General Assembly, adopted by A/RES/S-10/2, 30 June 1978, ¶ 45.
- Nuclear Weapons Advisory Opinion, at ¶ 79.
- While not specifically addressing the question of states outside the NPT, Gareth Evans captured the thrust of this reasoning in Australia’s argument to the ICJ. He stated: “It is therefore illegal, in our submission, to acquire, develop, test, possess, or otherwise use or threaten to use nuclear weapons. § The right of States

- to self-defence cannot be invoked to justify such actions. The right to self-defence is not unlimited. It is subject to fundamental principles of humanity. Self-defence is not a justification for genocide, for ordering that there shall be no enemy survivors in combat or for indiscriminate attacks on the civilian population. Nor is it a justification for the use of nuclear weapons. § This prohibition under customary international law must apply equally to nuclear-weapon States and non-nuclear-weapon States. It is in the nature of rules of customary international law that they apply to all States alike. If humanity and the dictates of conscience demand the prohibition of such weapons for some States, it must demand the same prohibition for all States.” Evans, p. 52.
38. Nuclear Weapons Advisory Opinion, at ¶ 105(2)F: “There exists an obligation to pursue in good faith and bring to a conclusion negotiations leading to nuclear disarmament in all its aspects under strict and effective international control.”
 39. Declaration of President Bedjaoui, *Legality of Threat or Use of Nuclear Weapons*, Advisory Opinion of 8 July 2006, I.C.J. Reports 1996, p. 268, at ¶ 23.
 40. Nuclear Weapons Advisory Opinion, at ¶¶ 100-101 (emphasis supplied).
 41. See, e.g., A/RES/66/46, 2 December 2011.
 42. I am indebted to Robert Zuber, director of Global Action to Prevent War, for his insights regarding the role of trust. For a discussion in another context, see Robert Zuber and Ana Carolina Barry Laso, “Trust but Verify: Building Cultures of Support for the Responsibility to Protect Norm,” *Global Responsibility to Protect 3* (2011), pp. 286–300.
 43. As Robert Socolow, member of the *Bulletin of the Atomic Scientists* Science and Security Board, and professor of Mechanical and Aerospace Engineering, Princeton University, observed: “Obstacles to a world free of nuclear weapons remain. Among these are disagreements between the United States and Russia about the utility and purposes of missile defense, as well as insufficient transparency, planning, and cooperation among the nine nuclear weapons states to support a continuing drawdown. The resulting distrust leads nearly all nuclear weapons states to hedge their bets by modernizing their nuclear arsenals. While governments claim they are only ensuring the safety of their warheads through replacement of bomb components and launch systems, as the deliberate process of arms reduction proceeds, such developments appear to other states to be signs of substantial military build-ups.” *Bulletin of the Atomic Scientists* press release, “Doomsday Clock Moves 1 minute closer to midnight,” 10 January 2012 (emphasis added).
 44. Arguably, a factor to be weighed in the assessment of good faith as to both quantitative and qualitative modernization is the purpose of a state’s actions. If such actions are aimed solely at preserving a second-strike capability in view of enhanced preemptive capabilities of other powers, that is less provocative than efforts aimed at building up “war-fighting” capabilities of various kinds. Cf. the first preambular paragraph of the NPT, which refers to the “need to make every effort to avert the danger of a [nuclear] war”.
 45. Hans Kristensen, “B61 LEP: Increasing NATO Nuclear Capability and Precision Low-Yield Strikes,” *Federation of American Scientists*, 15 June 2011, www.fas.org/blog/ssp/2011/06/b61-12.php. Similarly, “life-extension” for the W76 submarine-based warhead added to the capability to hit hard targets. See Greg Mello, “That Old Designing Fever,” *Bulletin of the Atomic Scientists*, January/February 2000, Vol. 56, No. 1, pp. 51–57.
 46. See Hans M. Kristensen’s contribution to this collection.
 47. A first step to an international monitoring capability may have been taken by the 2010 NPT Review Conference. The action plan on nuclear disarmament set forth in the Final Document provides: “Action 21. As a confidence-building measure, all the nuclear-weapon States are encouraged to agree as soon as possible on a standard reporting form and to determine appropriate reporting intervals for the purpose of voluntarily providing standard information without prejudice to national security. The Secretary-General of the United Nations is invited to establish a publicly accessible repository, which shall include the information provided by the nuclear-weapon States.” Also needed are adequate disarmament infrastructures at the national level. See Randy Rydell, “The United Nations and a Humanitarian Approach to Nuclear Disarmament,” *Nuclear Abolition Forum* (No. 1, 2011), www.abolitionforum.org/site/wp-content/uploads/2012/01/NAF-First-issue.online-version.pdf, pp. 25–35, at p. 30.
 48. In a famous article, Oscar Schachter described the “professional community of international lawyers” as an “invisible college dedicated to a common intellectual enterprise”. “The Invisible College of International Lawyers,” *72 Northwestern University Law Review*, 1977, pp. 217–226.

DIVESTMENT FOR DISARMAMENT

CHALLENGING THE FINANCING OF NUCLEAR WEAPONS COMPANIES

TIM WRIGHT

In recent years, the “vision of a world without nuclear weapons” has gained near-universal acceptance among governments. Yet all nine nuclear-armed nations continue to inject billions of dollars a year into programmes to upgrade and modernize their nuclear forces—with the clear intention of retaining these illegal, immoral, and inhumane weapons for many decades to come. What can be done to halt this great diversion of public wealth into instrument of mass destruction? How can we transform the oft-stated “vision” of nuclear abolition into reality?

In order to ban the use and possession of nuclear weapons by all states, we must effectively challenge the modernization of nuclear arsenals. Groups and individuals are doing this by protesting at factories and laboratories where nuclear weapons are designed and manufactured, raising community awareness, initiating legal actions to bar construction of new nuclear weapons facilities, and lobbying elected representatives to reject budgetary requests for work on nuclear weapons. Some campaigners are also employing economic means—boycotts and divestment—to challenge the nuclear weapons complex.

In four of the nine nations that possess nuclear arms—the United States, Britain, France and India—private companies are heavily involved in the design, manufacture, modernization, and maintenance of nuclear warheads, their delivery vehicles (missiles, submarines and bombers), and related infrastructure. Elsewhere in the world, nuclear weapons modernization is carried out primarily or exclusively by government-owned entities, making boycott and divestment campaigns more difficult to pursue.

Boycotting is a method that targets unethical companies directly. A well-known example of a nuclear weapons boycott is the campaign initiated in the 1980s by Infact—now called Corporate Accountability International—against General Electric, which had been majorly involved in nuclear bomb making since the Manhattan Project.¹ The boycott ultimately succeeded in forcing the conglomerate to abandon its nuclear weapons enterprise. It had been particularly vulnerable because, unlike most other makers of nuclear weapons, it sold consumer goods. Boycotts can also be

applied more generally, as in the case of the boycott of all French products in the 1990s, which helped to bring an end to nuclear testing in the South Pacific.

Divestment is different from boycotting in that it focuses on financial institutions—banks, asset managers, insurance companies and pension funds—that invest in nuclear weapons companies, either by providing capital loans or through the ownership of bonds or shares. A notable example of divestment is the decision in 2004 by the Norwegian government pension fund—one of the largest sovereign wealth funds in the world—to sell off major shareholdings in several nuclear weapons companies.² Two government entities in New Zealand, the Accident Compensation Fund and the Government Pension Fund, have also divested from nuclear weapons stocks in response to public pressure.³ A growing number of commercial banks are similarly adopting policies that proscribe investments in nuclear arms.

Divestment campaigns have been especially effective in countries that do not possess nuclear weapons, as the public is more likely to be surprised and angered by revelations that their financial institutions are investing in the makers of nuclear weapons. However, divestment can also be effective in nuclear-armed states, particularly at a local level. For example, students have been known to influence the investment decisions of their university boards, and large church groups have taken steps to ensure that their funds are not invested in the nuclear arms industry.

Divestment helps to establish, or reinforce, the illegitimacy of the nuclear weapons industry by building understanding and acceptance of the illegality of these weapons and drawing attention to the catastrophic humanitarian and environmental harm they cause. The ultimate aim of divestment is to force nuclear weapons companies to withdraw from the industry, fearing financial losses or damage to their reputation.

Where the manufacture of nuclear weapons accounts for only a small proportion of a company’s overall turnover, it will be more likely to assess whether the profits from such work are outweighed by the damage caused to the company as a whole—as in the case of the General Electric boycott. Similarly, companies that

sell consumer wares will be more concerned about potential damage to their brand than companies engaged only in armaments production. Therefore, certain nuclear weapons companies will be more vulnerable than others to divestment campaigns.

It is crucial to understand that vested interests in nuclear arms production are a major impediment to disarmament. The nuclear weapons industry is booming, with more than US\$100 billion spent on nuclear weapons programmes globally in 2011,⁴ much of which went to private military contractors. These companies employ lobbyists to patrol the corridors of power

IT IS CRUCIAL TO UNDERSTAND THAT VESTED INTERESTS IN NUCLEAR ARMS PRODUCTION ARE A MAJOR IMPEDIMENT TO DISARMAMENT.

in search of the next big deal. If companies choose to withdraw from the industry because of the commercial harm caused to them by divestment, decision makers will feel less pressure to continue investing in nuclear weapons modernization programmes.

Simon O'Connor, an economic adviser to the Australian Conservation Foundation, explains the practical benefits of divestment as follows: "Divestment sends the strongest signal that the activities of a company are not acceptable. Although it is rare that a share price will be materially impacted upon by a divestment decision of a single investor, the divestment can send a strong signal to the board of the company that its activities will not be tolerated, and can catalyse change within the business. It also sends a strong signal to other investors that the company is engaged in activities that are unacceptable."⁵

A significant advantage of the divestment approach is that it can be put to use almost anywhere. In today's globalized economy, many thousands of individuals and institutions around the world are directly or indirectly—and, more often than not, unwittingly—involved in financing nuclear weapons companies. Any person with a bank account or pension fund has the power to choose not to invest in nuclear arms producers, and can encourage friends, family members, and colleagues to withdraw their money from banks that refuse to divest from such companies. Divestment is a mechanism with which we can harness the widespread and overwhelming public opposition to nuclear weapons to achieve tangible results.

COMPANIES INVOLVED

US companies

Most companies involved in nuclear weapons work are based in the United States, which is estimated to spend in excess of US\$60 billion a year maintaining and upgrading its nuclear arsenal⁶—twice the amount it spends on foreign aid. It has the most active and am-

bitious nuclear weapons modernization programme of any country, involving the complete overhaul of its nuclear missiles, submarines, and bombers, and the construction of three new nuclear weapons factories. The following ten companies, among others, are heavily involved in the US nuclear weapons industry:

Alliant Techsystems, or ATK, which produces rocket propulsion systems for Trident II submarine-launched ballistic missiles and Minuteman III intercontinental ballistic missiles.⁷

Babcock & Wilcox, which supplies the US government with nuclear components for its defence pro-

grammes and operates the Pantex plant of the National Nuclear Security Administration, where it modernizes nuclear warheads.⁸

Bechtel, which manages the Los Alamos and Lawrence Livermore national laboratories, where nuclear weapons are researched, designed, and developed, and the "safety and reliability" of the current US nuclear stockpile is monitored.⁹

Boeing, which maintains the Minuteman III intercontinental ballistic missiles in the US arsenal, being responsible for guidance, flight controls, weapons systems testing and engineering.¹⁰

GenCorp, which is involved in the design, development, and production of land- and sea-based nuclear ballistic missile systems. It is currently producing propulsion systems for Minuteman III and D5 Trident nuclear missiles.¹¹

General Dynamics, which provides maintenance, engineering, and technical support for US nuclear-armed submarines. It built the *Ohio*-class submarines for the US navy, many of which are equipped with Trident nuclear missiles.¹²

Honeywell International, which produces approximately 85 percent of the non-nuclear components for US nuclear weapons, and is involved in simulated nuclear testing and the life-extension programme for the US navy's Trident II nuclear missiles.¹³

Jacobs Engineering, which owns a one-third share in the United Kingdom's Atomic Weapons Establishment, where it designs, manufactures, and maintains British nuclear warheads.¹⁴

Lockheed Martin, which is involved in the production and maintenance of nuclear weapons for both the United States and the United Kingdom, being responsible for the construction of submarine-launched Trident II D5 nuclear missiles.¹⁵

Northrop Grumman, which leads a joint project responsible for producing and maintaining the Minuteman III nuclear missiles, roughly 500 of which form the core of the US nuclear arsenal.¹⁶

UK companies

Many British companies are also involved in nuclear weapons work—maintaining the existing fleet of *Vanguard*-class Trident nuclear-armed submarines or developing the proposed new fleet of nuclear-armed submarines. Although a final decision has yet to be made on whether to renew Trident, considerable work is already underway, with the Department of Defence having made sizeable financial outlays.¹⁷ Some British companies are also involved in the French nuclear weapons programme. Major nuclear weapons companies in the United Kingdom include:

Babcock International, which is involved in developing the new class of nuclear-armed submarine and maintaining the country's existing fleet of submarines.¹⁸

BAE Systems, which is part of a joint venture that is producing nuclear missiles for the French air force, and is also involved in developing Britain's proposed new nuclear-armed submarines.¹⁹

Redhall Group, which carries out mechanical and electrical engineering activities at the Atomic Weapons Establishment in Aldermaston and Burghfield.²⁰

Rolls-Royce, which is part of the joint venture to develop the new class of nuclear-armed submarine, and also maintains the existing fleet of submarines.²¹

Serco Group, which owns a one-third share in the joint venture that runs the Atomic Weapons Establishment, and is responsible for designing, manufacturing and maintaining nuclear warheads.²²

Other companies

Several other companies are involved in nuclear weapons work, mostly for France. These include:

EADS (European Aeronautic Defence and Space Company), a Dutch company that produces and maintains submarine-launched nuclear missiles for the French navy, and is part of a joint venture responsible for building new nuclear missiles for the French air force.²³

Finmeccanica, an Italian company that holds a one-quarter share in MBDA, the joint venture building nuclear missile for the French air force. The missiles are capable of being launched from the *Mirage 2000N* fighter plane and the new *Rafale* fighter plane.²⁴

Safran, a French company that is part of a joint venture to build the new M51 submarine-launched missiles for the French navy, which can each deliver multiple nuclear warheads. Its subsidiaries provide the propulsion and navigation systems for these missiles.²⁵

Thales, a French company that is also involved in the contract to build M51 nuclear missiles for the new French submarines, with an estimated value of €3 billion. EADS's subsidiary Astrium is the lead contractor, whereas Thales is a main subcontractor.²⁶

At least one company, **Larsen & Toubro**, is heavily involved in the Indian nuclear weapons programme.

L&T is responsible for designing and constructing five nuclear-armed submarines for the Indian navy, each of which is equipped with a dozen K-15 ballistic missiles. The company has also tested a launch system for India's nuclear missiles.²⁷

INVESTMENT POLICIES

Many financial institutions apply ethical standards, such as the UN Principles for Responsible Investment,²⁸ when deciding how to invest their funds. These standards take into account environmental, social, and corporate governance factors. Investing in companies that manufacture and modernize nuclear weapons constitutes a grave breach of ethical investment norms, as nuclear weapons are illegal to use²⁹ and cause catastrophic and prolonged humanitarian and environmental harm.

Some financial institutions, in addition to maintaining general ethical investment or sustainability policies, have defence policies expressly stating that they will not invest in nuclear armaments.³⁰ However, these policies on nuclear weapons investments typically fall short of imposing a blanket ban on the financing of nuclear weapons companies. For example, some banks only rule out providing loans that are specifically intended for nuclear weapons work, while permitting loans to nuclear arms makers for general corporate purposes.

Their distinction between so-called direct and indirect financing does not stand up to scrutiny.³¹ All nuclear weapons companies are engaged in a diversity of enterprises, many of which are non-nuclear in nature. (For example, Boeing builds commercial jetliners.) To the author's knowledge, none of these companies source direct finance from banks and other financial institutions solely for the purpose of producing nuclear weapons. Instead, they raise money through corporate loans, syndicated loans, bond issues, share placements, and share ownership. This money is allocated in whatever way the company sees fit. It is of little consequence whether the financier or investor did or did not intend for the money to be used for nuclear weapons production (absent a specific mechanism to prevent the money from being used for that purpose).

In short, nuclear weapons companies raise finance for "general corporate purposes," and a proportion of these funds are invariably used to produce nuclear weapons. If banks and other financial institutions wish to avoid facilitating the build-up and modernization of nuclear arsenals, they must adopt more stringent policies that exclude the financing of nuclear weapons companies altogether. The existing policies of some financial institutions have little if any practical effect given that nuclear weapons companies do not seek finance from banks and other financial institutions specifically for nuclear weapons work.

A few large banks do, however, appear to exclude all major nuclear weapons companies entirely from their investment universe. For example, Rabobank, which is based in the Netherlands, does not invest in any of the 20 nuclear weapons companies mentioned above.³² Its policy states: “From a moral point of view, Rabobank should refrain from facilitating the armaments industry, unless the player is a company that only supplies non-controversial or armaments-related products. Rabobank currently deems the following armaments to be controversial: cluster munitions, anti-personnel mines, nuclear, biological and chemical weapons.”³³

Similarly, PGGM, a leading Dutch pension administrator with over €109 billion of pension assets for more than 2.3 million participants, does not appear to invest in any of the 20 nuclear weapons companies.³⁴ It has a policy of excluding companies from investment “if they are involved in the manufacturing or trading of weapons of which the use will cause violation of fundamental human rights.”³⁵ The fund states: “Any company with a substantial involvement in the manufacturing or trading of [weapons of mass destruction] will be directly excluded from our investments.”³⁶ Other financial institutions should follow the lead of PGGM and Rabobank.

In countries where public sentiment against nuclear weapons is particularly strong, banks, pension funds and other financial institutions that refuse to divest from nuclear weapons producers could well find that their customers start searching for more ethical alternatives. While most of the large mainstream financial institutions have not yet adopted policies screening nuclear weapons producers, there are many smaller, ethically minded financial institutions around the world that not only avoid providing money to the nuclear weapons industry, but refuse to invest in armaments altogether. Typically, these institutions fund companies that make a positive contribution to society, for example, through the development of renewable energy sources or community-based projects.

Thus, divestment from nuclear weapons producers can be viewed as part of a broader social and economic agenda involving the redirection of wealth away from the manufacture of weapons and the waging of war and towards socially useful enterprises. Despite our leaders’ repeated pledges to disarm, the nine nuclear-armed nations continue to spend in excess of US\$100 billion every year maintaining and modernizing their nuclear forces—diverting public resources away from dealing with the many scourges that afflict the world. Although it may at times seem difficult to influence how our governments allocate money, we each have the power to determine how our own money is invested. We can challenge our banks and pension funds to do the right thing, and seek alternatives if they refuse to listen.

WHY DIVEST?

There is a strong legal basis for divesting from nuclear weapons companies. Any use of nuclear weapons would be a grave breach of international humanitarian law, which prohibits the use of weapons that are incapable of distinguishing between civilians and combatants, inflict superfluous injury and unnecessary suffering, have uncontrollable effects, and cause widespread, long-term, and severe harm to the environment.³⁷

Under international law, not only is it illegal to use nuclear weapons, the *threat* of use is also forbidden.³⁸ Threats include specific signals of intent to use nuclear weapons if certain demands are not met, as well as general policies declaring the readiness to resort to nuclear weapons when vital interests are at stake. The doctrine of nuclear deterrence—which involves the threat of using nuclear weapons—is therefore contrary to international law. A primary purpose of nuclear weapons modernization programmes is to ensure that the threat of use is “credible”.

The vast majority of nations have made a legal undertaking never to manufacture or acquire nuclear weapons,³⁹ and the International Court of Justice—the highest authority on general questions of international law—has affirmed that there exists a universal obligation, based in the nuclear Non-Proliferation Treaty (NPT) and customary law, to accomplish the complete elimination of nuclear weapons through good-faith negotiations.⁴⁰ According to international law scholar John Burroughs, “It cannot be lawful to continue indefinitely to possess weapons that are unlawful to use or threaten to use, are already banned for most states and are subject to an obligation of elimination.”⁴¹

He explains that “[g]ood faith means abiding by agreements in a manner true to their purposes and working sincerely and cooperatively to attain agreed objectives”. The modernization of nuclear forces “undermines or renders impossible achievement of the objective of global elimination of nuclear arsenals”, as it “stimulates qualitative nuclear arms racing, instead of marginalization of nuclear forces as they are reduced and eliminated”.⁴² Even if the only aim of modernization were to maintain existing military capabilities, “[t]he long time frame for planning and executing such modernization, on the order of several decades, and the substantial spending involved, erodes the credibility of arms control and disarmament commitments and measures.”⁴³

In addition to the legal imperative to divest from nuclear arms makers, there is also a strong ethical argument. In 2010 the parties to the NPT acknowledged “the catastrophic humanitarian consequences of any use of nuclear weapons”,⁴⁴ and in 2011 national Red Cross and Red Crescent societies adopted a landmark resolution stressing “the incalculable human suffering that can be expected to result from any use of nuclear weapons, the

lack of any adequate humanitarian response capacity and the absolute imperative to prevent such use”.⁴⁵ A single nuclear bomb dropped on a large city could kill more than a million people in an instant. The lingering effects of radiation on human beings cause suffering and death many years after the explosion.

The nuclear weapons industry is the most illegitimate of all industries. It threatens every one of us. Yet mainstream financial institutions across the world continue to invest in companies that participate in this grossly immoral, earth-endangering industry. It is up to civil society to act to stop this complicity. It is time for a global divestment campaign to challenge the build-up and modernization of the world’s most destructive weapons. Such a campaign will be vital to the success of a genuine, total ban on these ultimate instruments of terror.

NOTES

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POLITICAL WILL

CIVIL SOCIETY, SOCIAL MOVEMENTS, AND DISARMAMENT IN THE 21ST CENTURY

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“What might bring the demise of the nuclear industry, or the breakup of the nuclear-military-industrial complex? In order to bring about a substantial change in the motion and direction of massive systems of production, such as electric light-and-power systems, a counterforce of comparable magnitude becomes imperative. Changes in circumstances comparable to those that cause the demise of organisms well adapted to, even shaping, their environment need to occur. To counter large technological systems, forces analogous to those that killed off the dinosaurs are needed. Like the dinosaurs, some technological systems have embedded in them characteristics that were taken on in times past, characteristics suited for past environments but not for the present. Because these characteristics are often embedded in the hardware of a technological system, they are especially long-lived. These anachronistic characteristics persist despite incremental changes in the environment that favour different characteristics. Only an overpowering change in environmental circumstances can kill off the new dinosaurs.” — Thomas P. Hughes¹

The kinds of questions posed by historians and critics of where our economic development path has led are notably absent from the everyday discourses of arms control and disarmament. Equally striking is the contrast between the pervasive lack of urgency on nuclear disarmament matters, both inside and outside of governments, and the rapidly accelerating pace of events of in the wider world. For the first time in the nuclear age, we are seeing a world in deepening economic crisis with no end in sight, amidst a dynamic of declining and ascending great powers of a scale and character comparable to the events that brought the great power wars of the last century. Yet in the halls of the international disarmament fora and professionalized single-issue NGOs that focus on disarmament affairs, few seem to consider any of this particularly relevant to their discussions.

The terrain upon which nuclear disarmament discourse rests is like a conference centre built on the shoulders of an awakening volcano, now being rocked by an intensifying series of tremors. There is economic

decline and political paralysis in core capitalist states that include several of the original nuclear powers, and rapid growth and starkly uneven development in post colonial and post-Communist states, several also nuclear-armed. We have seen a nuclear power catastrophe that has raised fundamental questions about the civilian applications of nuclear technology just when its advocates once more were attempting to portray its expansion as inevitable. The implications of this disaster for renewed awareness of the dangers posed by nuclear technologies are only beginning to unfold. There have been earthquakes literal and metaphorical, but none powerful enough yet to interrupt the sterile rearrangement of technical and legal proposals that substitute for meaningful progress, or the endless reiteration of aspirational catchphrases that substitute for what must be done to create the “political will” that could make meaningful disarmament progress possible. Public responses sparked directly or indirectly by the consequences of the financial cataclysm that has shaken the foundations of the global economic system have begun to emerge in many places, but so far war, militarism, and the misdirection of resources from human needs remains at most a minor thread in the new discussion. Disarmament goes largely unmentioned.

Two decades after the end of the Cold War, nuclear arsenals of civilization-destroying capacity still exist. Most disarmament advocates nonetheless treat nuclear arsenals and the immense, wealthy institutions that sustain them as if they were an anachronistic aberration, a survival from a past order of things that has no integral role in the present. In support of this view, disarmament professionals point to the fact that nuclear arsenals, while still objectively very large, are much smaller than they were during the Cold War, and also cite pronouncements of political and military leaders in the nuclear weapons states that might be read to suggest a consensus on the need for nuclear disarmament.

With a consensus on nuclear disarmament presumed and the arsenals of the two states that possess most of the world’s nuclear weapons trending downwards (however gradually), the focus of disarmament work remains largely procedural and technical, fo-

cused on legal and diplomatic measures and on means for their verification. Despite the glacial pace of disarmament progress after the immediate post Cold War period, the possibility that nuclear disarmament may have plateaued at current levels, and that this has happened for structurally significant reasons, receives little discussion. The question of how to create the “political will” necessary for disarmament, and of whether doing so might require forms of social action focused somewhere besides fora dominated by governments and professionalized, single-issue NGOs, is seldom asked, much less seriously addressed.

As the articles in this volume show, all of the nuclear weapons states are modernizing their nuclear arsenals, and some are continuing to expand them. It appears likely that smaller but still potentially world-destroying nuclear arsenals have been normalized, and are an integral part of the political and economic architecture of the global system as it now exists. Despite social and political changes of a magnitude that from the perspective of the Cold War times might have been expected to make nuclear disarmament possible, the nuclear dinosaurs appear to have adapted successfully to their new environment. The task now is to imagine conditions in which humanity can outlive them, and the means to bring those conditions about.

I believe that at present we lack adequate conceptual tools for thinking about both the dangers posed by nuclear weapons, and the kind of movements we would need to eliminate those dangers, so I can offer only some preliminary cuts through a vast and complicated terrain.

My intention here is to raise some questions about how to think about disarmament and the dangers posed by nuclear weapons anew—or perhaps, even before that, to make an argument for the necessity of doing so. I hope to spark discussion among people who care enough about nuclear disarmament to devote significant time and attention to it, but who find themselves in a time and place far removed from anything that could be called a “disarmament movement,” enmeshed in professionalized NGOs and single-issue, ameliorative forms of advocacy that seem less and less relevant in a crisis-ridden world.

FROM APOCALYPSE NOW TO APOCALYPSE REPRESSED: INTERROGATING THE PAST TO RETRIEVE THE PRESENT

“If ‘the hand-mill gives you society with the feudal lord; the steam-mill, society with the industrial capitalist,’ what are we given by those Satanic mills which are now at work, grinding out the means of human extermination? I have reached this point of thought more than once before, but have turned my head away in despair. Now, when I look at it directly, I know that the category which we need is that of ‘exterminism.’” — Edward Thompson²

In 1980, as the blocs congealed around the United States and the Soviet Union began their last great round of Cold War confrontation, Edward Thompson cautioned his colleagues on the Left that the nuclear arms race of that time had developed a singular dynamic not reducible to traditional competition among great powers, struggle among classes, or forms of militarism driven by capitalism and imperialist competition. “What,” asked Thompson,

if the object [of analysis] is irrational? What if events are being willed by no single causative historical logic (‘the increasingly aggressive military posture of world imperialism,’ etc.)—a logic which then may be analyzed in terms of origins, intentions, or goals, contradictions or conjunctures—but are simply the product of messy inertia? This inertia may have drifted down to us as a collocation of fragmented forces (political and military formations, ideological imperatives, weapons technologies): or, rather, as two antagonistic collocations of such fragments, interlocked by their oppositions? What we endure in the present is historically-formed, and to that degree subject to rational analysis: but it exists now as a critical mass on the point of irrational detonation.³

Thompson saw an arms race that had developed its own motive power, independent of the deep ideological divide between the Cold War antagonists but also reinforcing it. As the confrontation of nuclear-armed high-tech militaries spiraled onward for decades, it also placed its imprint on every aspect of the competitors, spawning leading industrial sectors, forms of culture, and forms of rule. The vast scale and scope of the arms race could not, Thompson thought, be explained by mere arms profiteering in the West or by “rational” reactions by the USSR to the Western arms buildup. Superpower elites, locked in a decades long confrontation, also had come to depend on it: “At a certain point,” he argued, “the ruling groups come to *need* perpetual war crisis, to legitimate their rule, their privileges, and priorities; to silence dissent; to exercise social discipline; and to divert attention from the manifest irrationality of the operation. They have become so habituated to this mode that they know no other way to govern.”⁴ The social impact the institutional machinery of high-tech arms racing had become so deep and pervasive that it was plausible to take the position that “the USA and the USSR do not *have* military-industrial complexes: they *are* such complexes.”⁵

One could not understand the nuclear arms race and the dangers it posed, Thompson argued, without looking to particular dynamics created by the new military technologies and the distinctive institutions that had developed around them. The immense institutions of the aerospace-nuclear establishment had, in his view, developed an autonomous internal dynamic of their own, still ill-understood but also not reducible to the economic interests and political power of the

arms makers. But Thompson viewed the Cold War, and particularly the “second Cold War” of the 1980s, as a confrontation where ideology even more than the technological and military aspects had become unmoored from any material great power conflict. “It is ideology,” he wrote, “even more than military-industrial pressures, which is the driving motor of Cold War II.... It is as if—as in the last climax of European imperialisms which led on into World War One, or as in the moment when Nazism triumphed in Germany—ideology has broken free from the existential socio-economic matrix within which it was nurtured and is no longer subject to any controls of rational self-interest.”⁶ All of this, thought Thompson, manifested a world in which the polarization between the United States and Soviet Union, and to a lesser extent the USSR-US-China triangle, constituted the “central human fracture” and the “fulcrum upon which power turns” of the era. “This is the field-of-force which engenders armies, diplomacies and ideologies, which imposes client relationships upon lesser powers and exports arms and militarisms to the periphery.”⁷

Thompson believed that the response to the Cold War confrontation needed to work both in parallel and across borders to democratize the economy and politics, while at the same time attempting to disengage subordinate states from the dynamic of the Cold War bloc system. Thompson believed that alliances with liberation movements in the post-colonial world were important, both to prevent their integration into one bloc or another and to prevent the militarization of post-colonial and post-revolutionary states. But he saw “the fracture through the heart of Europe” as being “the central locus of the opposed exterminist thrusts,” and the goal of European disarmament politics as “a counter thrust, a logic of process leading towards the dissolution of both blocs” and “the demystification of exterminism’s ideological mythology,” allowing the states and peoples of Eastern and Western Europe to regain control of their political fate.⁸ It was essential that resistance to each country’s part in the Cold War confrontation and nuclear arms racing come not from outside, “but only from within the resistance of peoples *inside each bloc*.”⁹

But so long as resistance was confined to internal, national politics, it might, Thompson thought, be able to slow the race towards catastrophe, but it would be unable to force any genuine change of course. At the same time, movements that could be portrayed by ruling elites as aiding the “enemy” cause would only reinforce the Cold War dynamic, allowing rulers on each side, in alliance with powerful military-industrial national security state complexes, to reassert ideological control and to police their respective territories. What was needed was an internationalism that rejected the ideologies of both blocs, focusing on the “imperatives of human ecological survival” and subordinating for

the moment political differences—for example, between those who were anti-capitalist and those who were not—about what a different and genuinely better future might look like. If these movements could “swing those blocs off collision-course,” Thompson believed, the blocs themselves would begin to erode, opening up the space in which a broader politics, and prospects for deeper change, in both blocs and the wider world, might open up once more.¹⁰

Thompson’s view that broad coalitions were needed to thaw the frozen politics of the Cold War confrontation did not imply, however, that a peace politics could afford to ignore the deeper social structures supporting militarism and driving conflicts among. Rather, Thompson and the wing of the peace movement he helped build tried to develop a critique with an appeal outside and beyond the orthodoxies of both East and West, seeking to disseminate truths officially unmentionable both sides of the Cold War divide:

Peace is more than the absence of war. A lasting peace only can be obtained by overcoming the various political, economic, and social causes of aggression and violence in international relations as well as in the internal affairs of states. A comprehensive democratization of states and societies would create conditions favorable to this aim. Such democratization includes the existence of a critical public which has the capacity to exercise effective control over all aspects of military and security policy.... The economic systems in East and West urgently need democratization. Social needs such as housing or work in safe and human conditions have become more important in defining economic priorities. In the West a primary task is to ensure that people are no longer marginalized by massive unemployment. In the East, decentralization of the economy is an essential task in order to make the economy more efficient and responsive to the needs of the people.¹¹

Regardless of one’s view of the role of the Western peace movements, it is evident that the collapse of one superpower protagonist, the Soviet Union, and the dissolution of the communist regimes across Eastern Europe brought with it the end of the particular nuclear danger of that time. But the elements of disarmament movements that were narrowly focused on the weapons technologies of the nuclear arms race and that saw the Cold War confrontation as its cause diminished rapidly as the Cold War wound down. Although a politics aimed at democratizing not only the politics of the East but the economics of the West may have informed and inspired core elements of Cold War disarmament movements, particularly in Europe, the broader coalitions Thompson thought imperative to counteract the Cold War exterminist dynamic failed to coalesce into a cohesive alternative political vision, instead dissolving into a political terrain of causes and identities. “Nothing is more discouraging,” wrote Thompson in 1990,

“than the failure of the Western peace movement and progressive forces to move into the spaces of opportunity which have opened; the failure to hasten on reciprocal process in the West to match the decomposition of Cold War ideological controls in the East.”¹² Those who sought to democratize the economy and to radicalize political democracy beyond plebiscitary choices among managerial elites were overwhelmed by the rising tide of neoliberal triumphalism.

FROM TERROR TO COMPLACENCY: THE UNEXAMINED AFTERLIFE OF COLD WAR NUCLEAR ARSENALS

“It is easy to believe that the nuclear age is different, that perhaps in the 1920s and 1930s people and nations raced toward air war because they were still naive about the dangers they faced or just insufficiently scared, but that nuclear energy compels a restraint and an anxiety impossible at an earlier time. The distinction has some validity, especially with regard to the United States, where the bomber’s benign properties were most widely assumed. But much evidence suggests that the fear of air war was nearly as powerful to an earlier generation as it is for today’s. Indeed, the generation between the world wars had, in the example of World War I, a more potent reminder of war’s irrationality than the nuclear generation possesses today. Their reminder had taken the real-life form of blood and death, but today, with World War II more than four decades in the past, people can be scared only by what they think may happen, not by what they vividly remember to have taken place. To regard the missile generation as the first to confront civilization’s destruction is immodest, self-indulgent, and self-defeating as well, for it leads to denial of an often instructive example and of the recognition of that heavy inheritance received from an earlier age.” — Michael S. Sherry¹³

“Where there is change, there will be struggle, by already privileged elements within societies, for control over its tempo and direction, and, above all, for the distribution of its costs and benefits. The problems of conflict and change today are essentially the same as those that confronted societies in the past; they are likely to be the same in the future.” — Sandra Halperin¹⁴

“The international atmosphere seemed calm. No foreign office expected trouble in June 1914, and public persons had been assassinated at frequent intervals for decades. In principle, nobody even minded a great power leaning heavily on a small and troublesome neighbor. Since then some five thousand books have been written to explain the apparently inexplicable: how, within a little more than five weeks of Sarajevo, Europe found itself at war.” — Eric Hobsbawm¹⁵

Having focused on the Cold War roots of the nuclear arms race largely to the exclusion of the relationship of high-technology militarism to other, perhaps more

deeply rooted social and economic dynamics, many of those who continued to work for disarmament believed that the Cold War’s end offered a significant opportunity for the elimination of nuclear arsenals. The Cold War had constituted an unprecedented division of the world into ideologically opposed blocs, accompanied by the development of equally unprecedented, permanently mobilized military-industrial establishments deploying destructive power of a scale and character that constituted a radical leap beyond anything that had gone before. There was a temptation to believe that because the extraordinary conflict had emerged together with these extraordinary weapons, the two seemingly distinctively intertwined and mutually reinforcing, that with the Cold War’s ending nuclear weapons no longer had relevance to any form of conflict. Many seemed to assume that not just *that* nuclear danger but *any* nuclear danger stemming from conflicts involving the already nuclear-armed states was a thing of the past. The threat nuclear arms continued to represent most often was represented as vestigial, a remnant of a *past* conflict, whose continued dangers were bound up in confrontations between the weapons systems themselves, rather than in the intentions and actions of elites of nuclear-armed states who might choose courses of action that resulted in wars in which nuclear weapons might be used. Much of the repertory of disarmament advocacy to this day consists of characterizing nuclear weapons as Cold War anachronisms, or as militarily useless, or both.

The immediate post-Cold War period did result in significant reductions in the number and variety of nuclear weapons, particularly those deployed by the two superpowers. Massive arsenals comprising in aggregate tens of thousands of nuclear weapons were reduced to thousands, and delivery systems to the vicinity of a thousand for each of the former Cold War adversaries. The initial waves of reductions were facilitated by the fragmentation the Soviet Union and precipitous economic decline of Russia, its nuclear-armed successor state, providing the US government and military (with domestic opposition as its main obstacle) with the opportunity to demobilize the most redundant, obsolescent, expensive, and in some instances most potentially provocative nuclear weapons systems.

That steep curve of declining stockpile numbers, however, has flattened, and shows little concrete sign of tending towards zero in the foreseeable future. We are now more than twenty years past the end of the Cold War—half the length of that era itself. The original superpower antagonists still deploy thousands of nuclear weapons, more than enough to end global civilization in a day. Six other countries deploy nuclear arsenals large enough to kill hundreds of millions and to do significant, long-lasting ecological damage. There appears little reason to believe that we are on an inexorable path towards elimination of nuclear arsenals. Rather, it

seems more likely that we are in the latter stages of the “normalization” of nuclear arsenals in a post Cold War context. Great power armed forces and their constellations of large-organization allies are busy doing other things than confronting each other’s nuclear arsenals. New kinds of permanent states of war have provided ideological rationales for national security states and immense military-industrial complexes, allowing these elements of Cold War elites to successfully sustain their wealth and power, while at the same time continuing to provide a model and a justification for similar elites to find a path to power and privilege in ascendant states.

Despite much aspirational rhetoric about disarmament from current and past political and military leaders, there is no path in view that will reduce nuclear arsenals below the level where wars involving nuclear-armed states could inflict catastrophic damage to humanity and the ecosphere in anything like the near term. To the contrary, it appears possible that barring other, far deeper changes in societies that have nuclear weapons establishments, the bottom limit for nuclear reductions may well be what their ruling elites perceive as an adequate “existential threat”—the certain ability to inflict catastrophic damage on those they see as their likely adversaries. And for elites who continue to entertain global ambitions, perhaps the damage that they believe they must be able to inflict to keep their ever-expanding “way of life” alive must be on a global scale. It may be that this is where the ultimately irrational logic of “deterrence “by threat of limitless violence converges with the irrational, limitless logic of capitalism (and perhaps of all totalizing modernist ideologies rooted in an unending effort to achieve control over nature and society by the perfection of technology). “For power left to itself can achieve nothing but more power, and violence administered for power’s (and not for law’s) sake turns into a destructive principle that will not stop until there is nothing left to violate.”¹⁶

Whatever war crises our global economic and political system generates in the next few decades we will have to face in a nuclear-armed world, barring some significant change of course. The political basis, the “political will,” for such a sea change is nowhere visible on the current political landscape. It is past time to consider once more the kinds of questions Thompson asked, to think anew about the character of the “nuclear danger” in our particular historical moment. What vast structures with an inertia of their own “may have drifted down to us as a collocation of fragmented forces (political and military formations, ideological imperatives, weapons technologies?)” What kinds of dynamics are at work today that might bring constellations of immense organizations deploying nuclear weapons into confrontations that could reach “a critical mass on the point of irrational detonation?”¹⁷

In the United States, the vast nuclear-military-industrial complex and national security state that Thomp-

son saw as a distinctive Cold War phenomenon persists. It has proved not to need an equal partner to legitimate endless arms development, global force projection, and a ceaseless search for overwhelming military dominance. After an interregnum of ideological disarray in the early 1990s, the organizations of the military-industrial complex and their allies cobbled together a new ideological narrative of terrorism and rogue states and a new kind of permanent war emergency. The 9/11 attacks coalesced and accelerated ideological, economic, and political programmes well underway in the late 1990s. These initiatives proved successful enough to bring US military spending up to and beyond average Cold War levels, to launch two wars, and to expand the already vast US permanent military presence in the oil producing regions of the Middle East and Southwest Asia. The US nuclear arsenal is smaller, but still of civilization-destroying size, the institutions they sustain and that sustain them modest only by comparison to their Cold War magnitude.

The role of nuclear weapons has changed, but the essential nature of the conflicts and potential conflicts of which they play a part has changed as well: from two status quo superpowers locked in ideological struggle on their boundaries and hinterlands to developing multi-polar great power contention—with a nuclear armed hegemonic state in economic decline, but still unmatched in military power. Yet there is little discussion of whether nuclear war was avoided during the Cold War not by luck, not by successful deterrence, not by the restraining effects of peace movements, but rather mainly because those who controlled the nuclear-armed states did not see their core interests threatened to a degree that impelled them to push war risk to, and over, the limit. The two superpowers were vast continental empires with internal hinterlands not yet fully developed, and both dominated large spheres of influence in which their interests, both economic and ideological, could be furthered. Both states, and the Soviet Union most of all, had recent memories of the carnage and devastation wrought by industrialized total warfare. Armed competition occurred mainly at the periphery of both systems without threatening either core. The collapse of the Soviet-centered system did not result from a death struggle with Western capitalism, but rather was mainly an internal affair. Large segments of the various East bloc national elites (and those in China as well) successfully preserved their privileged position by consolidating and privatizing or selling off the fruits of communist-era modernizing development, emerging as new power players inhabiting ascendant urban nodes of the global corporate capitalist metropole.

It is conceivable in this context that the existence of nuclear weapons added to, rather than reduced, the likelihood of great power war during the Cold War period. Material conflicts between competing elites remained

below the level of existential threat to either side, and the still-fresh memory of the horrors of World War II induced a degree of caution in the decision-makers. But nuclear weapons and the means to deliver them at global ranges raised the potential of a *coup de main*, destroying the adversary in one swift stroke. The appeal of this to some extreme elite elements, particularly in the United States, combined with the ideological confrontation in ways that intensified it and increased the inherent dangers of arms racing and of large, perpetually mobilized nuclear forces.

Globally, nuclear establishments and military-industrial complexes exist today in the context of (and, to a degree still inadequately understood, in the service of) an aggressive corporate capitalism that now encompasses virtually the entire planet. This particular phase of capitalism is intensely financialized at the core and export-driven in the regions of most rapid development, resulting in unevenly distributed growth and immense wealth disparities. That growth is of an unprecedented absolute magnitude, resulting as well in growing resource competition in a world in which the most easily exploited deposits of many key nonrenewable resources are nearing exhaustion and in which the disruption of existing ecosystems is threatening societal capacities to sustain production of traditional renewable resources, such as foodstuffs, while attempting to develop new ones, such as biofuels. The result is a kind of universal imperialism, with new nodes of the global capitalist metropole springing up in competition with one another within and across national boundaries. Heavily defended islands of new wealth remain immersed in a sea of poverty. Fortresses of old wealth in the core have seized control of increasing shares of national income amidst deteriorating 20th century conurbations inhabited by polyglot multitudes whose common ground appears to be a future of thwarted expectations.

It is in this broader global context that we need to view nuclear weapons, and also the integral relationship between nuclear weapons and nuclear power. Both are elements in and help to sustain a dominant global circulation of trade and investment devoted to the production of goods and services that only a fraction of the world's population can afford to buy. In this kind of world, weapons and military services will be a growth industry. And nuclear technology, with its potential for the ultimate in weaponry, provides one way for certain elites and sectors of the new middle classes to make a profitable place for themselves within the wave of corporate-capitalist globalization spanning the late 20th century, into the 21st.

The nuclear road provides elites in nuclear establishments with privileged access to their own country's resources, a development context that can be shielded from foreign competition, and forms of trade and industry that can be portrayed as increasing in importance as fossil fuels diminish. This is so whether the

intention to develop nuclear weapons is clear or is allowed to remain ambiguous. The powerful tools of nationalism and "national security" secrecy can be used to facilitate the extraction of wealth from the rest of society and prevent scrutiny of national nuclear enterprises that whether in first generation nuclear powers or post-colonial states have been rife with technical problems, corruption, and widespread, intractable environmental impacts. Nuclear technology, with its overtones of near-magical, limitless power (an image its purveyors energetically promote), casts a positive aura over other big, centralized high-tech development programmes that are profitable for elites, but have little or even negative value for much of the population in an ever more stratified world.¹⁸

Nuclear weapons and nuclear power are preeminent examples of the irrationality of the whole. Nuclear energy risks destroying society in order to power it; nuclear weapons risk destroying the people to save the state. Nuclear arsenals are tools in power struggles that only determine which fraction of global elites will be best positioned to exploit the rest of us, contests in which the few seek to profit while all bear the risk. Nonetheless, they have been celebrated by national regimes both capitalist and socialist, neo-imperialist and post-colonial, as crowning national achievements, and as supreme implements of productive and coercive power. Immense institutions and academic disciplines have been constructed to develop, deploy, and justify them, institutions which have ideological and political influence that appears to far exceed their economic and military-political role. Thus, the appeal of nuclear weapons to elites pursuing a range of political and economic development paths over the past half century suggests that nuclear abolition may require change that reaches even deeper than the institutions of global corporate capitalism.

The kind of "nuclear danger" facing us today is perhaps the inverse of that presented by the Cold War world E.P. Thompson portrayed, requiring a shift in focus for those who hope to reduce it, and to eliminate nuclear weapons. We no longer have a nuclear danger concentrated in one central conflict, its contours defined by the intertwining of an unprecedented technological and industrial arms race and an equally unprecedented ideological confrontation that divided the world. Instead, we now see nuclear weapons deployed in the more "normal" context of shifting constellations of immense corporate capitalist organizations, their interests aligning or conflicting with nation-states that deploy nuclear weapons. The prevailing opinion among those who are most visible in arms control and disarmament discourse appears to be that great power war and wars involving nuclear weapons are far less likely in this conjuncture than they were during the Cold War. Otherwise, the notion that nuclear weapons that do not exist (i.e. those that might come into the

possession of “rogue states” or “terrorists”) constitute a greater danger than thousands of nuclear weapons held at the ready by nuclear-armed states would appear absurd.¹⁹

There are two main sorts of arguments in circulation supporting the proposition that the danger today of large-scale wars among nuclear-armed states is vanishingly small. The first is that today’s “great powers” have become so economically interdependent that total wars among them would be against their interests. This notion, it should be noted, also had considerable popularity in the years immediately before World War I.²⁰ The second argument essentially is that nuclear deterrence works. One may wonder why this should be any more true now than it was during the Cold War, and why there is so little sense of urgency today about bringing nuclear arsenals down below the numbers where they can wreak catastrophic damage on humanity and the natural world.

THE POLITICAL ECONOMY OF NUCLEAR DANGER: BEYOND GUNS VS. BUTTER

“By the end of the twentieth century, the largest U.S. corporations, approximated by the Top 0.01%, have reached an unprecedented situation: their net profit share of national income hovers around record highs, and it seems that this share cannot be increased much further under the current political-economic regime.... Peering into the future, they realize that the only way to further increase their distributional power is to apply an even greater dose of violence. Yet, given the high level of force already being exerted, and given that the exertion of even greater force may bring about heightened resistance, capitalists are increasingly fearful of the backlash they are about to unleash.” — Shimshon Bichler and Jonathan Nitzan²¹

What discussion there is of the “political economy” of nuclear weapons complexes and disarmament largely is limited to the profit motives and money-driven political influence of military contractors and to the impact of the allocation of government spending to the military rather than to programmes that would provide for human needs. In this latter vein the current economic crisis, and the austerity campaigns that have been a central element of the economic policy response by Western elites, have been seized upon as an opportunity to attack nuclear weapons budgets as spending on useless or obsolete Cold War weapons. There also have been renewed efforts by disarmament groups to form alliances with NGOs working to defend social welfare programmes and workplace rights and protections, emphasizing “guns vs. butter” themes. So far, however, there has been little new analysis of the relationship of nuclear arsenals and institutions to

the broader constellations of economic power associated with particular states, or of the way that the current systemic economic crisis, the first of its kind in the nuclear age, might affect the risk of war involving use of nuclear weapons.

One place to start in untangling these strands is to consider whether money cut from military budgets would indeed be spent on the development of institutions, technologies, and practices that serve the needs of the vast majority of populations either within particular states or globally. Changes in government fiscal schemes on both the revenue and expenditure sides are far more likely to be used to support the asset values and income streams of the wealthy and powerful institutions that have the preeminent say in installing and influencing governments. This is particularly visible now in the sweeping austerity programmes being imposed in varying degrees on the populations of the countries of the old capitalist core, with the top tier corporate capitalist organizations taking the opportunity of global crisis to consolidate their control over economies while rolling back welfare state programmes and regulations. In this climate, people hard pressed to sustain their individual economic existence are unlikely to see disarmament as a pressing concern. People working in organizations focused on preserving existing public goods, social services, and workers’ rights likely understand this, whether that understanding has been articulated or not. Consequently, disarmament advocacy approaches that make simple “guns vs. butter” arguments for redirection of funds spent on the military to human needs are unlikely to succeed. It will be difficult to develop broad and effective coalitions without a deeper critique of the current conjuncture, a vision of an alternative path forward that reduces the demand for weapons and military services, and a strategy for advancing along that path.

The deeper structural trends, it should be noted, were in place long before the crash of 2007–2008. In 1994, Greg Albo saw the dominant global circuit of trade and investment as leading to

an unstable vicious circle of ‘competitive austerity’: each country reduces domestic demand and adopts an export-oriented strategy of dumping its surplus production, for which there are fewer consumers in its national economy given the decrease in workers’ living standards and productivity gains all going to the capitalists, in the world market.... So long as all countries continue to pursue export-oriented strategies, which is the conventional wisdom demanded by IMF, OECD, and G7 policies and the logic of neoliberal trade policies, there seems little reason not to conclude that ‘competitive austerity’ will continue to ratchet down the living standards in *both* the North and the South.²²

Almost two decades later, this regime of “competitive austerity” is deep in crisis, likely caused in large part

by the extremes of wealth and poverty and resulting economic stagnation it has engendered. Nonetheless, most of the major economic actors seem committed to an intensification of the “competitive austerity” approach. The resulting economic and political landscape is beginning to bear some uncomfortable resemblances to the conditions that brought on the great power wars of the last century, but this time with permanently mobilized, nuclear-armed great power militaries. Widely separated historical periods cannot be easily compared, but the differences between the two conjunctures do not necessarily point in the direction of less, rather than more danger of large-scale war. Contrary to the contention that “austerity” is likely to result in significant reductions in arms expenditure and changes in total force structures that could be honestly understood as “disarmament,” these conditions appear likely to favour the continuing power of military industrial complexes (again, in the absence of more fundamental changes in the character of global economics and politics). As leading high-tech economic sectors with significant organizational alliances in governments, arms makers and military services providers are well-situated politically to continue to draw on state funds amid circumstances in which many forms of profitable high-value added global trade are disrupted. And with conflict and the potential for conflict on the rise due both to the immiseration of populations by intensifying cycles of austerity and the rapid ascendance of new economic powers, military-industrial complexes will find it relatively easy to find and to justify a continuing market for their wares.

Wars among “great powers” in such circumstances arise not as part of a rational competitive scheme, but rather when the accumulating irrationalities of a global system of competition generates conflicts both within and among states that elites find insoluble. The kinds of regimes that singly or in combination generate war crises result not from the pursuit of economic ends by carefully chosen military means, but rather from national systems themselves locked in irresolvable domestic conflicts, their elites bereft of strategies that would allow them to contain dissent while protecting their own privilege (whose legitimacy must remain beyond question). It is, as at such times in the past that, again in Thompson’s formulation, “ideology has broken free from the existential socio-economic matrix within which it was nurtured and is no longer subject to any controls of rational self-interest.”²³

Further, long-entrenched elites, blinkered in such moments by ideologies whose content and function has become more and more a one-dimensional defence of a deteriorating status quo, typically lack the intellectual tools as well as the imagination to anticipate the likely consequences of war-making, which they have come to view as just one more tool of instrumental, top-down statecraft. Gabriel Kolko notes,

All wars in the past century began with men who initiated them substituting their delusions, in which domestic political interests and personal ambitions often played a great part, for realistic evaluations of the titanic demands and consequences that modern warfare invariably imposes.... They have been oblivious of surprises and have harbored false expectations; wars almost never conform to the convenient assumptions about how long conflicts will last and their decisive political consequences.²⁴

“Those who become leaders of states,” Kolko also observed, “are ultimately conformists on most crucial issues, and individuals who evaluate information in a rational manner—and therefore frequently criticize traditional premises—are weeded out early in their careers.” Today, the same elites who assured us that the business cycle had been conquered by new improved forms of economic rationality and management, making long, deep global economic crises virtually impossible, now maintain that the rise of new economic powers and the decline of the old can be “managed” without catastrophic conflict. They also continue to believe that immense high-tech militaries ultimately backed by world-destroying nuclear arsenals are a useful tool in the repertory of “management.”

All of these factors suggest that those who pursue the prevalent incremental approaches to disarmament in nuclear-armed states may be thinking too narrowly and too small. Eliminating concrete instances of nuclear weapons complexes is a good thing, but once again must be considered in a broader context. Paring away at arsenals and infrastructure while leaving the core institutions of high-tech nuclearized militarism and the interests they serve not only untouched but largely uncriticized, with nuclear disarmament generally proceeding at a glacial pace, may do little to reduce the threat that nuclear weapons pose. This is particularly true of approaches that take on the aspect of a kind of “peer review” for military establishments, bracketing the fundamental interests and purposes militaries serve while suggesting that military budgets are better spent on some mix of capabilities that has fewer nuclear weapons but perhaps more of the most modern and sophisticated conventional forces.²⁵

This kind of approach, again, implicitly assumes that the risk of war is very low among great powers over the time it is likely to take to reduce nuclear arsenals to the point where their threat no longer is significant. In this regard it is worth considering the fact that we have not seen total war mobilization by the leading industrial powers for over half a century. We have no idea, really, what it would look like in the current conjuncture, with immense high-tech economies operating at full capacity, many millions of people added to militaries and workforces, peacetime regulations of all kinds thrown aside and top-down planning and disciplinary structures of an entire new order imposed. World War

It completely transformed the technological and organizational character of all the leading states, even leaving aside the effects of the war's destruction. In a war crisis, what marginal progress there might have been in reducing the numbers of nuclear weapons and delivery systems could be quickly swept away. If the war plans of the contending powers demanded more nuclear weapons, more nuclear weapons would be built. If the peer review-style efforts of mainstream Western arms control advocates had indeed been on target and a moderately downsized nuclear arsenal could provide an adequate ultimate threat to work most effectively in combination with a fearsome array of high-tech "conventional" weaponry, perhaps no additional nuclear weapons would be deemed necessary. The possibility that available resources and over-burdened ecosystems would not easily sustain full-scale war mobilizations by the most powerful states might make a war crisis more dangerous rather than less, intensifying resource conflicts and domestic political unrest in ways that make ruling elites even more likely to take risks.

WHERE DOES POLITICAL WILL COME FROM? SOCIAL MOVEMENTS AND THE CRISIS OF THE NGOS

"The lowest and widest common denominator of anti-nuclearism has to be the collective moral sentiment against such life-threatening evil. But the vision of a collective and shared humanity that this arouses also has to be linked, at least in some informal and indirect sense, to a broader agenda for collective human progress in the twenty-first century. In this vital sense, it remains as true now as in the past, we must fight for more than peace. To fight successfully against nuclearism, we must fight against more than nuclearism. To fight successfully for a nuclear-free world, we have to be internationalists. And to deepen and strengthen our internationalism on this front, we will have to be internationalists on many other fronts." — Praful Bidwai and Achin Vanaik²⁶

When seeking to explain the perennial absence of disarmament progress in international negotiating fora, diplomats and NGO staffers alike often will cite the absence of "political will". How such political will might be created, however, is seldom seriously analyzed or discussed. In the context of interactions between the states themselves, this absence is unremarkable. States are assumed to come to the table with their "political will" largely predetermined, their diplomats acting within limits established by political processes within presumptively legitimate sovereign states. Successful rounds of diplomacy may yield confidence on a particular matter such as nuclear disarmament that prepares the ground for further progress, but the determination that further progress is desirable still occurs

within whatever political processes are decisive in the negotiating states.

Nuclear disarmament activists focus a great deal of attention on interactions among states and on the fora where they meet to negotiate (or to produce the endless appearance of negotiating) on disarmament matters. This is true not only of arms control groups with agendas largely delimited by the foreign policy goals of the states in which they are located, but of smaller NGOs dedicated to the speedy elimination of all nuclear arsenals. They do so despite the fact that international fora and interactions among states pose difficulties for social movements that ultimately have interests and goals that are not aligned with those of any state, as defined and expressed by the constellations of elites who control states.

The nature of international civil society remains problematic, in ways that pose some particular tensions for the role of international "civil society" actors in disarmament matters. The concept of civil society itself was developed in relation to the public sphere and mechanisms for the expression of public opinion and the formation of political will within nation states.²⁷ In the international arena, people and organizations who do not share common citizenship seek to influence decisions and actions of states and organizations of states whose constituent actors are governments. The actions and decisions that disarmament advocates seek to influence are core aspects of state function: the deployment of the highest levels of military force. There are good reasons why international publics, and publics not limited to those of nuclear weapons states, should have a voice in decisions about nuclear weapons and disarmament and arms control more generally. Nuclear weapons pose a threat to the future of all humanity and the ecosphere. The ways that states, and particularly the most powerful states, deploy armed force shapes the character of global society as a whole.

Nonetheless, there are reasons why a form of internationalism that seeks to directly affect interactions between states may be problematic for the development of effective movements that can help build a world in which elimination of nuclear weapons is possible. The first is that decisions about nuclear weapons policies—whether to acquire them, whether to continue to maintain and deploy them—are made within the polities of particular nation states, and direct pressure on the relevant governments can most easily be applied by domestic peace movements. But in addition, a nuclear weapons discourse focused on international fora and state interactions (such as treaties) tends to represent states as unitary actors. There are some sound reasons for this, including the fact that in many circumstances norms requiring respect for claims of national sovereignty can be invoked to defend the right to self-determination of populations as well. But in disarmament discourse, treating states as unitary actors also elides

the existence of particular constellations of organizations and interests within states that drive and benefit from pursuit of nuclear weapons, and more generally of a national technological capacity to build them.

Treating states as unitary actors manifesting the common interests of their populations is an important component of a non-proliferation and disarmament narrative that legitimizes the nuclear status quo. On the proliferation side, the pursuit of nuclear weapons is seen as a natural goal for states, because acquiring nuclear weapons is seen as a way to achieve military advantage over states without them, and then as a means of “deterring” the use of nuclear weapons by other states that possess them. The difficulty of eliminating nuclear arsenals once they exist is conceived as a technologically constructed version of the tragedy of the commons: each state’s search for greater security via acquisition of nuclear weapons leads to greater insecurity for all, but no nuclear armed state is likely to disarm unless its potential adversaries do so as well.²⁸ In the context of non-proliferation and disarmament discourse, officials of nuclear weapon states (dutifully echoed by many arms control and disarmament professionals) strive to portray the nuclear arsenals of the nuclear weapon states (at least those that are signatories of the nuclear Non-Proliferation Treaty) as the product of a long-ago original sin, regrettable in retrospect but exceeding hard to undo. This narrative is underscored by ritual denunciations of nuclear weapons by officials of nuclear-armed states as burdensome anachronisms that all hope one day to eliminate. This account of things neatly justifies the continued possession of nuclear weapons by those that have had them longest, while at the same legitimating the prevention of their acquisition by anyone else. It does nothing to explain what the stakes are for the relevant elites in nuclear weapon states that make them willing to risk the fate of their populations and of human civilization itself in a perpetual nuclear standoff, while being willing to risk very little of their own wealth and power to eliminate the dangers nuclear weapons pose.

Positing false collectivities, shared communities of interest where there are none, is a significant element of nationalist and militarist ideologies. Criticizing and breaking down such false collectivities is an essential part of peace and disarmament work. For the vast majority of us, nuclear weapons have never been “ours” in any meaningful sense. The decision to acquire them has, in every instance, been made in secret, and the institutions that have developed and expanded nuclear arsenals have everywhere been among the least transparent and subject to democratic control. The ideologies that justify militarism and the national security state in general are grounded in images of common “homelands” and “national interests” that must be defended at all costs, up to and including the risk of global annihilation. Nuclear deterrence ultimately rests on

the assumption that all inhabitants of nuclear weapons states (and even of states with the “benefit” of being under a superpower “nuclear umbrella”) have interests of a kind and magnitude that justify this dangerous gamble. In a world where both political and economic democracy is in short supply, nuclear weapons are tools in power struggles that mainly determine which fraction of global elites will be best positioned to exploit the rest of us.

Much of the work done by civil society at the international level has focused on developing mechanisms and tools to implement disarmament institutionally and technically once the requisite “political will” exists. While useful, it has not actually generated “political will”. Creating the political will for disarmament requires the construction of movements within states, particularly in states that deploy nuclear weapons or in which there are powerful elements that might wish to acquire them. Constructing movements capable of supporting the conditions for disarmament will vary depending on the role that nuclear weapons and nuclear technology plays in national economies, development discourses, and in the military and geopolitical strategies of particular national elites. As during the Cold War, the internationalist character of disarmament work will consist of finding common ground between the relevant movements in parallel on both sides of confrontations between states that involve nuclear weapons, including efforts by nuclear weapons states to prevent additional states from acquiring them. As E.P. Thompson noted, the prospects for success of such international efforts will be increased to the extent that they do not allow national elites to portray their domestic movements merely as allies of their adversaries. The task of constructing genuinely international and internationalist movements is, however, more daunting in the current conjuncture. States that possess nuclear weapons or that might be the targets of counterproliferation efforts vary far more in culture, development history, and place in the global order of things than did the countries on the two sides of the main Cold War divide, which often shared cultural and political ties only recently severed that aided international efforts on a people to people basis. The number and variety of confrontations that might emerge involving nuclear-armed states in the coming years and decades also may make the Cold War era seem both simple and stable by comparison.

The complexities of this kind of internationalism will be effaced in large part to the extent that international disarmament work remains both single-issue and focused at the upper institutional levels of both states and interstate fora. This leads to self-selection of the participants both in terms of organizations and individuals, with their commonality more a result of a screening and exclusion process imposed by the structure and location of the fora than by any au-

thetic commonality of interest among the disparate social forces international NGOs claim to represent. This can become a self-reinforcing spiral—leading to “movements” consisting mainly of clusters of NGO staff, experts, and academics that seem “international” due to the origins of their participants, but ultimately only represent tenuous constituencies in any particular country. The longer this separation from active social movements goes on, the more difficult it may be to mobilize movements within the key states to change their conduct.

On the level of everyday NGO practice, a variety of mutually reinforcing factors impede changes in work styles, much less deeper changes in approach. A number of commentators have criticized funding patterns resulting in a “foundation-NGO complex” that marginalizes voices calling for fundamental change in the distribution of wealth and power.²⁹ Campbell Craig and Jan Ruzicka recently dubbed the prosperous constellation of government organizations, academic institutions, think-tanks, and well-heeled arms control groups that cluster around the capitols of the Western nuclear weapon states the “nonproliferation complex”. They noted the success of the organizations of the “nonproliferation complex” since the Cold War in shifting attention away from the actual nuclear arsenals to those that don’t yet exist, and of the NGO elements in the complex at putting together “unthreatening programmes”—unthreatening, that is, to the continued existence of great power nuclear arsenals—“of startling cost and scope” occupying much of the publicly visible space in arms control and disarmament discourse.. “By conveying to the public in the West the message that the blame for the continuing nuclear danger lies elsewhere,” Craig and Ruzicka concluded, “the complex has cultivated the false belief that nuclear peace can be accomplished over the course of time without the need for unpleasant forms of political action, and without any sacrifice. In so doing, it has pushed to the fringes debate about what will actually have to be done if we don’t wish to live perpetually with the specter of nuclear war.”³⁰

A nuclear disarmament discourse in which discussion of the risk of great power war is pushed to the margins facilitates the slide towards a nearly exclusive focus on preventing the spread of nuclear weapons to “rogue states” and “terrorists”. It helps to legitimate an international status quo in which the continued brandishing of nuclear weapons by elites who control existing nuclear-armed states is tolerated, while the potential acquisition of nuclear weapons can be portrayed as so intolerable as to justify violation of what remains of international law, right up to the most fundamental norms against wars of aggression. Information about nuclear weapons and “intelligence” about the potential of various parties for their acquisition is arcane, largely secret, and highly susceptible to manipulation by gov-

ernments that can lay claim to having the technical means to acquire it. All of this contributes to a political climate in which accusations of nuclear weapons proliferation remain a tempting stalking horse for more mundane geopolitical agendas of great power elites.

Broader narratives that connect attacks by the foreign Other to nuclear fears further reinforce a general climate in which more militarized “security” is portrayed as the only path to safety. In the United States, even local disarmament groups, seeking ways to import a sense of urgency into local struggles against nuclear weapons facilities in a context in which the central dangers posed by existing nuclear arsenals have been suppressed and displaced, routinely invoke the risk of terrorist attack on well-defended nuclear weapons facilities deep in the North American hinterland, in places where no act of “terrorism” ever has occurred (at least since those perpetrated by foreign Others from across the Atlantic Ocean who invaded and dispossessed the original inhabitants).

The ability of an elite “nonproliferation complex” to dominate disarmament discourse, however, is only one manifestation of a broader professionalization of politics and erosion of a civil society rooted in face-to-face, human scale interactions and institutions.³¹ The oppositional political landscape in many parts of the global metropole, and particularly in the United States, is dominated by single-issue or single constituency organizations driven by professional staffs. The prevailing relationship between staff and constituency mirrors the relationship of mainstream professionals to their clients, with zealous advocacy of a particular interest taking precedence over all other concerns. All of this is reinforced not only by top-down funding but by professional norms that reward approaches that implicitly limit solutions to incremental, expert-driven adjustments to the status quo while stigmatizing any hint of analysis or action pointing towards fundamental social change as “impractical.”

The habits of mind and the nature of discourse in organizations and institutions suffused by the professional advocacy model in practice often proves incompatible with the kind of research, reflection, and discussion needed to form useful strategies for meaningful progress even on individual issues. A lack of incentives (and a broader political, economic, and career culture that provides many disincentives) to think systematically about the relationship among issues and the basic power structure of society blinds many single-issue advocates to both obstacles to progress and to what actually is necessary to build effective coalitions to overcome concentrated power and wealth. A lifetime spent proposing remedies for problems without being able to name their underlying causes largely excludes thinking more than superficially about who might be opposed to change and why, and what might be done about it. Where this mode of political action

prevails, there can be no setting of collective priorities, no meaningful discussion of the role any one issue and the particular reforms its advocates demand might play in movements for and transition to a significantly more fair, democratic, and ecologically sustainable society, no discussion across issues of sequencing or priorities.

The result of all this is a disarmament discourse in which there is little room for analysis and debate concerning the relationship between the goal of eliminating nuclear arsenals and what else might have to be changed to make that goal achievable. Governments, think tanks, and the more prestigious and visible NGOs clustered in power centres of the global metropole all are shackled one way or another to a global order of investment, production, and distribution that they prefer or feel compelled to represent as largely autonomous and unchangeable. For them, significant changes in the distribution of wealth and power are off the table. Mainstream arms control and disarmament discourse is delimited by a conceptual frame in which this is held to be not only true but self-evident. In this frame, the possibility that the entrenched inequities, pervasive absence of democracy, and ecological irrationality of the status quo might both pose insuperable obstacles to disarmament and increase the potential for wars between states already armed with nuclear weapons is exiled to the margins of thought.

One exception to this limited outlook has been work emanating from South Asia as India and Pakistan accelerated the development and deployment of nuclear arsenals in the late 1990s. The emergence of a new arms race sparked new thinking about the character of nuclear arsenals, the dangers they pose, and the reasons that ruling elites seek to develop nuclear technology and nuclear weapons. This included analysis of the relationship between the economic, ideological, and organizational strategies of nuclear institutions, together with discussion of the role that nuclear technology has played in the broader development agendas of South Asia's post-colonial elites.³² Some of this work is of a kind that has seldom been attempted with regard to the original nuclear weapons states. The growth of nuclear institutions in a development context that is both rapid and highly uneven has thrown into high relief the way relatively small fractions of societies both control the pursuit of nuclear technologies and are their primary beneficiaries. There are lessons that might be learned by considering earlier rounds of nuclear development in the light of more recent ones. So far, however, neither the emergence of new arms races nor resulting new thinking about nuclear institutions has had much effect on the nature and limits of the broader discourse about nuclear weapons, which continues to be dominated by ideas drawn from the familiar arms control and nonproliferation conceptual toolbox.

THE PATH FORWARD: REALISM FROM THE BOTTOM UP

"You cannot talk like sane men around a peace table while the atomic bomb itself is ticking beneath it. Do not treat the atomic bomb as a weapon of offense; do not treat it as an instrument of the police. Treat the bomb for what it is: the visible insanity of a civilization that has ceased to worship life and obey the laws of life." — Lewis Mumford³³

"Is this association of inordinate power and productivity with equally inordinate violence and destruction a purely accidental one?" — Lewis Mumford³⁴

The path to nuclear disarmament likely will not begin in negotiations among states, or even in the parliamentary and electoral processes of nuclear armed states. Decisions made in these venues that can be understood as firm, irreversible commitments to disarmament will come quite late in the journey, far down the road from where we are now. Once we approach the point where these decisions and negotiations truly become possible, it is quite likely that they no longer will be very difficult. The path to disarmament likely will require changes in the nuclear weapons states, and also in the global economic and political order, so profound that the reasons states threaten each other with nuclear weapons will have been eliminated.

This view encounters resistance from many disarmament advocates. One reason may be that it bears a disconcerting resemblance to one of the main tenets of the dominant arms control ideology, in which elimination of nuclear arsenals is represented as a desirable but always-distant goal. Those who rule nuclear-armed states frequently affirm their support for nuclear disarmament, but insist that they must retain their nuclear arsenals until "security issues" that threaten their "national interests" have been resolved. Ideologies that justify inequitable orders of things often contain a kernel of truth, displaced and reframed in a manner that can both reassure the privileged and convince the rest, at least to an extent sufficient, when combined some measure of coercion, to dull any impetus towards rebellion.³⁵ The prevailing ideologies of war and peace, international relations and disarmament, allow us to look anywhere for the causes of threats to peace and human survival but to the fundamental institutional arrangements of our economy and their relationship to the technologies, built world, and development path that they entail.

Here, that kernel of truth is that we live in a world still in many ways deeply divided and bristling with high-tech armaments. However, some perspectives which acknowledge this resemble each other, but in fact are directly opposed. One claims that the causes of war must be explored and revealed. The factions in society with a stake in the existing highly inequitable order of things must be named and opposed. Opposed

to this is a narrative that implicitly insists that we must accept the unfair and undemocratic nature of the existing order as given, and then uses the conflict and violence it systematically generates as an excuse to hold onto the entire apparatus of state violence which sustains that same order.

To say that progress toward nuclear disarmament requires progress towards eliminating the causes of war is not the same as saying that eliminating the causes of war is a *precondition* for nuclear disarmament. We do not have to wait until we have removed the causes of war to advocate for disarmament, or to develop the movements and social change strategies that make disarmament possible. Removing the causes of war and working for nuclear disarmament are part of the same larger project. Making the world more economically equitable lessens the danger of war. Giving all people a voice in the decisions that affect every sphere of their lives lessens the danger of war—and almost certainly increases the chances that economic life will become more fair as well. Moving towards a way of life that is consistent with the rhythms and limits of the ecosystems that sustain us likely reduces the dangers of war over the long term. Nuclear weapons and nuclear power are both leading instances of the irrationalities that result from a social world that has been constructed to concentrate power in the hands of tiny minorities, and to make it possible for them to maintain and defend their power.

But even many committed activists in the disarmament field turn away from these questions because their implications are so daunting. Meaningful progress towards nuclear disarmament may be impossible without removing, or at least sharply reducing, the likely causes of war characteristic of the development path we have taken. Chief among these are the vast inequities and drive for ever-increasing wealth and power that that has been built right into the institutional structures of the dominant form of modernity. The elites who control nuclear weapon states, already possessors of wealth on an unprecedented scale, use every means at their command to acquire yet more even amidst the deepest global economic crisis of the nuclear age, forging on inside their brightly lit office towers and luxury gated estates, impervious to the deepening poverty, hopelessness, and rage gathering outside. The prospect of great powers in transition, ascending and declining, combined with widespread political instability flowing both from stark inequality and from rapid, uneven development, threatens to bring the prospect of great power war back into the realm of undeniable possibility, eroding the officially “unthinkable” status of large scale nuclear warfare. An intensifying atmosphere of conflict and potential conflict may make disarmament a harder, not easier, sell within national, and national-ist, political discourses.

It is much easier to place all of this outside the problem, to assume that the special destructiveness of nu-

clear weapons assures that no one, really, ever will use them again in warfare intentionally, and that everyone, really, wants to get rid of them. Then one can turn back to searching for some formula, technical, legal, or diplomatic, which, once devised, will lead us inexorably to disarmament, and safety. This reflexive tendency to stay within the limits of the professional and institutional discourses as conventionally defined can be represented to others and oneself as the only “practical” choice. But in a world where the institutional machinery of both the economy and of governance most places is paralyzed or breaking down, the pragmatism of this choice hardly is self-evident.

There is not much left of a middle ground. The only alternative is to let all of this in, combining awareness of the fact that nuclear warfare risks ending us all, everything that was and could be, with the knowledge that people only can be willing to take such a risk in a society that has gone terribly wrong, that has built institutions within which people can become so far removed from the fundamentals of life on this planet as to be willing to gamble it all away. Nuclear weapons are our ultimate message to ourselves that our way of life, built on brute force, deception on a mass scale, and profligate waste, all driven by the endless race to accumulate things and power over others, must come to an end, one way or another.

There also is little time left on the planet’s ecological clock. Our current crisis is exacerbated by the approach of resource limits, most centrally for easily retrievable fossil fuels, and by ecological limits, most centrally in terms of human-induced climate change, but also in terms of widespread destruction of ecosystems that sustain many of the earth’s species as well as irreplaceable “ecological services” such as sources of fresh water.

The approach of these resource and ecological limits poses unprecedented challenges to a global economic system already in crisis. It has been contended by some analysts for a century that capitalism cannot survive without an ecological and social “outside,” a non-capitalist frontier available for relatively easy exploitation when the mechanisms of economic growth within the portions of the globe and of global society encompassed by the capitalist system grind to a halt. Today, both the so-called second world of the 20th century and most post-colonial regimes that had sought some different path have largely been incorporated into the global corporate capitalist circuit of production, investment, and trade. Despite ever more intensive commodification of the interactions and relationships of everyday life, the immense organizations that dominate the world are running out of geographical, technological, demographic, and social “fixes,” new arenas to exploit when they have exhausted the old. We need to find a way to mobilize social energies at a scale and pace previously devoted only to war to transform our built world and its workings to be ecologically sustainable.

The risks of this transition must be fairly shared, or the necessary transformation likely will be impossible. The chaos and violence resulting from incumbent elites attempting to defend existing inequities will be compounded by already unavoidable consequences of ecological decline, combined with the urgent need to shift resources into massive rebuilding or refitting everything from energy, transportation, and agricultural systems to buildings of all kinds. Further, much of the necessary transformation consists of moving away from the large-scale technologies and far-flung chains of production and distribution that incumbent elites have developed in large part as a means of cementing their power over resources and production, and hence their privileged access to wealth. The choice between retaining a global economy controlled by immense, unaccountable private institutions but somehow making it “greener,” and a radical restructuring and democratization of our economic and political systems likely is a false one, with only the latter leading to the survival of human civilization for the long term.³⁶

The process of nuclear disarmament is stuck because all global politics is stuck, unable to find peaceful means to resolve these fundamental dilemmas. Most of the world’s wealth and power has stopped at the top. The solutions on offer from elites for a global economic crisis causing widespread poverty and desperation are austerity measures designed to support the value of their assets and to further concentrate wealth and power in their own hands. One can hardly expect that in such a moment those same elites will seriously consider giving up their weapons, especially the most powerful means of destruction ever devised.

The political will to build the new international order we need, one in which disarmament will become possible, must be built from the bottom up. The path to nuclear disarmament, like the path towards progress on most things that really matter, runs in this moment through New York’s Zucotti Park and the Occupy encampments world-wide, through Cairo’s Tahrir Square and the centres of local resistance to India’s Kudankulam nuclear power project, through the growing opposition to US military outposts in South Korea and Japan, through all those places that the excluded and suppressed are gathering to find their voice and their power. It will not lead back to the halls of governments and the United Nations until much has changed. History has left the building for the streets and public squares; it is happening out beyond the security checkpoints in places where credentials are neither required nor accepted.

Movements sufficient to create the political will to eliminate the danger of nuclear weapons use, and finally the weapons themselves, will not arise from within the professional and institutional worlds of arms control and disarmament. Even the kind of debate and analysis needed to understand what must be done to create

the political conditions for disarmament have largely failed to take hold within disarmament discourses and institutions. It is a time for all of us who work not just for disarmament but for peace and justice to be looking outward: for allies, for hope, and for understanding of what must be done. Only by building a place where we can have the conversation about how to make another world possible, will we be able to start moving towards a world where nuclear weapons have no place.

NOTES

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18. For an extended version of this argument, including the strategies and alliances broader pursued by the nuclear industry in the context of the campaign for the recent US-India nuclear deal, see Andrew Lichterman and M.V. Ramana, “The U.S. India Nuclear Deal: Violating Norms, Terminating Futures,” in Ray Acheson, ed., *Beyond Arms Control: Challenges and Choices for Disarmament*, New York: Reaching Critical Will of the Women’s International League for Peace and Freedom, 2010, pp.58–70, also available at <http://www.reachingcriticalwill.org/resources/books/BAC/chapter5.pdf>.
19. A typical formulation, found on the White House web site, asserted that “the gravest danger to the American people is the threat of a terrorist attack with a nuclear weapon and the spread of nuclear weapons to dangerous regimes.” “The Agenda: Foreign Policy,” http://www.whitehouse.gov/agenda/foreign_policy, accessed 25 March 2009.
20. Eric Hobsbawm, *The Age of Empire: 1975–1914*, New York: Vintage Books, 1989, p.316, discussing this themed as raised by Norman Angell (author of *The Great Illusion*) and others.
21. Shimshon Bichler and Jonathan Nitzan, “The Asymptotes of Power,” February 2012, (Revised transcript of a presentation by Jonathan Nitzan, The 2nd Annual Conference of the Forum on Capital as Power, The Capitalist Mode of Power: Past, Present, Future, October 20–21, 2011, York University, Toronto), www.bnarchives.net, p.39.
22. Gregory Albo, “Competitive Austerity’ and the Impasse of Capitalist Employment Policy,” in R. Miliband and L. Panitch, eds.,

- Between Capitalism and Nationalism, Socialist Register 1994*, p.147; quoted in Sandra Halperin, *War and Social Change in Modern Europe: The Great Transformation Revisited*, Cambridge: Cambridge University Press, 2004, p.289.
23. E.P. Thompson, *The Heavy Dancers: Writings on War, Past and Future*, New York: Pantheon Books, 1985, p.44.
 24. Gabriel Kolko, *Another Century of War?*, New York: The New Press, 2002, pp. 89–90.
 25. The manner in which a recent legislative initiative proposing cuts in US nuclear weapons spending is illustrative. Its lead legislative sponsor, US Representative Edward Markey of Massachusetts, told the news media that “It’s better to cut unneeded submarines than Navy SEALs and better to cut nuclear bombers than unmanned drones...Which weapons are we going to be using in the 21st century?” Joel Rubin, an official of the Ploughshares Fund, a leading US arms control NGO, thought it important to emphasize that “This is not a road map to zero weapons.” “Lawmakers Seek \$100B in U.S. Nuke Spending Cuts,” *Global Security News-wire*, 8 February 2012.
 26. Praful Bidwai and Achin Vanaik, *New Nukes: India, Pakistan, and Global Nuclear Disarmament*, New York: Interlink Books, 2000, p.234.
 27. For a useful discussion of the application of the concepts of civil society and the public sphere at the international level, see Nancy Fraser, “Transnationalizing the Public Sphere: On the Legitimacy and Efficacy of Public Opinion in a Post-Westphalian World,” *Transversal*, multilingual web journal of the European Institute for Progressive Cultural Policies, 2007, <http://eipcp.net/transversal/0605/fraser/en>.
 28. On the incoherence of Western international relations theory discourse in regard to nuclear weapons, see Itty Abraham, *The Making of the Indian Atomic Bomb: Science, Secrecy, and the Postcolonial State*, London: Zed Books, 1998, pp.14-17.
 29. See, e.g., Joan Roelofs, *Foundations and Public Policy: The Mask of Pluralism*, Albany: State University of New York Press, 2003; and Incite! Women of Color Against Violence, *The Revolution Sill Not Be Funded: Beyond the Non-Profit Industrial Complex*, Cambridge, South End Press, 2007.
 30. Campbell Craig and Jan Ruzicka, “Who’s in, who’s out?” *London Review of Books*, 23 February 2012, pp.37–38.
 31. For an exploration of how this dynamic has played out in disarmament work see Andrew Lichterman, “Nuclear Disarmament, Civil Society, and Democracy” *Disarmament Forum*, 2010, No.4, <http://www.unidir.org/pdf/articles/pdf-art3022.pdf>.
 32. See, for example, Praful Bidwai and Achin Vanaik, *New Nukes: India, Pakistan, and Global Nuclear Disarmament*, New York: Interlink Books, 2000; Itty Abraham, *The Making of the Indian Atomic Bomb: Science, Secrecy, and the Postcolonial State*, London: Zed Books, 1998; M.V. Ramana and C. Rammanohar Reddy, eds., *Prisoners of the Nuclear Dream*, New Delhi: Orient Longman, 2003; Itty Abraham, ed., *South Asian Cultures of the Bomb: Atomic Public and the State in India and Pakistan*, Bloomington: Indiana University Press, 2009.
 33. Lewis Mumford, “Gentlemen: You Are Mad!” *The Saturday Review of Literature*, 2 March 1946.
 34. Lewis Mumford, *The Myth of the Machine: The Pentagon of Power*, New York: Harcourt Brace Javanovich, 1970, p. 257.
 35. “It is an often-taught and often-forgotten lesson that ideology is designed to promote the human dignity and clear conscience of a given class at the same time that it discredits their adversaries; indeed, these two operations are one and the same; and as a cultural or intellectual object ideology may be defined as just such a reversible structure, a complex of ideas which appears either systematic or functional depending on the side from which it is approached.” Fredric Jameson, *Marxism and Form*, Princeton: Princeton University Press, 1974, p. 380. “Coercion does not result as much in widespread hypocrisy as in a felt need to reconcile existing contradictions, to emphasize those aspects of one’s desires that can be made compatible with the influence of coercion at the expense of those that cannot. The kind of enforced coherence which emerges may be shallow, full of holes. To the extent that coercion plays a role in resolving difficulties of meaning and desire, social life is riddled with badly kept secrets and poorly concealed incongruities. People think less clearly; their ability to confront the problem of their own existence is lessened. The moment coercion fails, crises of meaning of various kinds are ready to break out. Or rather, such moments do not result from the failure of coercion, as an effect from a cause, they are the failure of coercion.” W.M. Reddy, *Money and Liberty in Modern Europe: A Critique of Historical Understanding*, Cambridge, England: Cambridge University Press, 1987, p.48.
 36. See, e.g., Naomi Klein, “Capitalism vs. the Climate,” *The Nation Magazine*, November 28, 2011, www.thenation.com/article/164497/capitalism-vs-climate; John Bellamy Foster, “Capitalism and the Accumulation of Catastrophe,” *Monthly Review*, Vol.63 No.7, December 2011, p.1.

Reaching Critical Will is a project of the Women's International League for Peace and Freedom (WILPF), the oldest women's peace organization in the world. Reaching Critical Will works to affect perceptions and policies on issues related to nuclear weapons, military spending, and the arms trade. We engage with governments at the United Nations, promoting transparency accountability, and dialogue; and with grassroots activists and the general public, bringing their concerns to the UN. Reaching Critical Will also works to foster greater understanding of the issues through critical analysis and by engaging citizens in strategic organizing and advocacy that builds momentum for nuclear abolition and the reduction of militarism in movements seeking social, economic, and environmental justice.

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