ASSURING DESTRUCTION FOREVER: 2020 EDITION

Reaching Critical Will

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Abbreviation list

ABM Treaty: Anti-Ballistic Missile Treaty

ACA: Arms Control Association

ALBM: Air-launched ballistic missile

ASMPA: Air-Sol Moyenne Portée-Améliorée (France)

AWE: Atomic Weapons Establishment (United Kingdom)

BARC: Bhabha Atomic Research Centre (India)

BJP: Bharatiya Janta Party (India)

BMD: Ballistic "missile defence"

CCTV: China Central Television

CEA: Le Commissariat à L'énergie Atomique et aux énergies Renouvelables (France)

CESTA: Centre d'Études Scientifiques et Techniques d'Aquitaine (France)

CEND: Creating the conditions for nuclear disarmament

CD: United Nations Conference on Disarmament

CND: Campaign for Nuclear Disarmament

CNS: Capenhurst Nuclear Services (United Kingdom)

CMCs: Common Missile Compartments (United Kingdom)

CRS: Congressional Research Service (United States)

CTBT: Comprehensive Test Ban Treaty

CTBTO: Comprehensive Test Ban Treaty Organisation

DAM: Direction des Applications Militaires (France)

DAMS: Dépôts-Ateliers de Munitions Spéciales (France)

DCA: Dual-capable aircraft

DCNS: Direction des Constructions Navales (France)

DNE: Defence Nuclear Enterprise (United Kingdom)

DNO: Defence Nuclear Organisation (United Kingdom)

DoD Department of Defense

DOE: Department of Energy

DPRK: Democratic People's Republic of Korea

DRDO: Defence Research and Development Organisation (India)

EASR: Environmental Authorisations Scotland Regulations

FCO: Foreign and Commonwealth Office (United Kingdom)

FANu: Force Aéronavale Nucléaire (France)

FAS: The Federation of American Scientists

FAS: Forces Aériennes Stratégiques (France)

FMCT: Fissile material cut-off treaty

FNS: Les Forces Nucléaires Stratégiques (France)

GDP: Gaseous diffusion plant

GDP: Gross domestic product

GNI: Gross national income

HEU: Highly enriched uranium

HSTDV: Hypersonic technology demonstrator vehicle

IAC: Investment Approval Committee (United Kingdom)

IAF: Israeli Air Force

IAEA: International Atomic Energy Agency

IAEC: Israel Atomic Energy Commission

ICBM: Intercontinental Ballistic Missile

ICJ International Court of Justice

INF Treaty: Intermediate-Range Nuclear Forces Treaty

INSTEX: Instrument in Support of Trade Exchanges

IPFM: International Panel on Fissile Materials

IPPR: Institute for Public Policy Research

JCPOA :Joint Comprehensive Plan of Action

KCNA: Korean Central News Agency

Kts: Kilotons

LEED: Leverage to Enhance Effective Diplomacy Act

LEP: Life-extension programme

LEU: Low-enriched uranium

LOC: Line of control

LRSO: Long Range Stand Off

MIRV: Multiple independently targetable re-entry vehicles

MIT: Moscow Institute of Thermal Technology (Russia)

MND: Ministry of National Defense (Republic of Korea)

MoD: Ministry of Defence

MRBM: Medium-range ballistic missile

MTCR: Missile Technology Control Regime

NATO: North Atlantic Treaty Organisation

NAO: National Audit Office (United Kingdom)

NCA: National Command Authority (Pakistan)

NFU: No-first-use

NGO: Non-governmental organisation

NNRC: Shimon Peres Negev Nuclear Research Center (Israel)

NPR: Nuclear Posture Review (United States)

NPT: Non-Proliferation Treaty

NSQEP: Nuclear Suitably Qualified and Experienced Personnel (United Kingdom)

NWCSP: Nuclear Warhead Capability Sustainment Programme (United Kingdom)

ONR: Office for Nuclear Regulation (United Kingdom)

PAEC: Pakistan Atomic Energy Commission

PAROS: Prevention of an arms race in outer space

PLA: People's Liberation Army (China)

PLAAF: People's Liberation Army Air Force (China)

PLAN: People's Liberation Army Navy (China)

PLARF: People's Liberation Army Rocket Force (China)

PML: Pakistan Muslim League

PPL: Pakistan People's Party

RES: Réacteur d'essais

ROK: Republic of Korea

SDA: Submarine Delivery Agency (United Kingdom)

SEPA: Scottish Environment Protection Agency

SIPRI: Stockholm International Peace Research Institute

SNRC: Soreq Nuclear Research Center (Israel)

SWU: Separate work units

SLBM: Submarine-launched ballistic missiles

SNLE-3G: Sous-Marin Nucléaire Lanceur d'Engins de 3rd Génération

SPD: Strategic Plans Division (Pakistan)

SSP: Strategic Systems Program (United States)

SSBN: Ballistic missile submarines

START: Strategic Arms Reduction Treaty

TNO: Tête nucléaire océanique (France)

TPNW: Treaty on the Prohibition of Nuclear Weapons

UNA: United Nations Association

UNGA: UN General Assembly

UNODA: United Nations Office for Disarmament Affairs

UNSC: UN Security Council

UK: United Kingdom

US: United States

USD: US dollars

WHO: World Health Organisation

WMDFZ: Weapons of mass destruction free zone

Introduction

Ray Acheson

It's May 2020. Almost seventy-five years since a US president sitting in Washington, DC decided to drop two atomic bombs on the people of Japan—one on the city of Hiroshima, the other on Nagasaki. Thus began the nuclear age, marked with the construction of multiple "doomsday machines" programmed for unwinnable wars and global conflagration; astonishing wastes of human and financial resources; bullish, masculinised conflicts among states that deploy violence here and there while dancing around their potential for planet-ending acts; and the relentless peddling of all this as completely, totally, and undeniably rational.

But it is not rational. And the continued investment by certain governments in not just the maintenance but also the "modernisation"—the upgrading, updating, and life-extending—of nuclear weapons is absurd, dangerous, and immoral. Fortunately, during the COVID-19 crisis, people are starting to take notice of where all of the money—in many cases, taxpayers' money—has gone; of why their governments cannot provide basic protective equipment and medical supplies and services during a global pandemic. And even more fortunately, there is something we can do to get rid of the threat of nuclear weapons and release trillions of dollars to deal with real, rather than imagined, crises of security, safety, and stability: we can divest, and we can disarm.

Seventy-five years of apocalyptic potential

For seventy-five years, the world has lived under the threat of radioactive blast and firestorm, the effects of which are immediately devastating and punishingly intergenerational.[1] For seventy five years, from production to testing and use to storage of radioactive waste, nuclear weapon activities have contaminated land and water—and will continue to do so for thousands of years more.[2] For seventy-five years, a very few governments—nine, at current count—have decided to invest trillions of dollars into these instruments of death and destruction. For seventy-five years, corporations like Lockheed Martin, Boeing, and Bechtel have reaped incredible profits from government contracts for bombs and bombers. Certain academics, politicians, and bureaucrats have risen through the ranks of think tanks or government administrations in positions bankrolled by the nuclear profiteers, spinning theories of "nuclear deterrence" and "strategic stability" to justify this massive, unconscionable investment in technologies of massive violence.

It's been seventy-five years. Will we reach one hundred if we continue on like this? Can we survive a century with nuclear weapons? Can we survive a century of wasted money and ingenuity; a century of tensions between human beings armed to the death with the capacity to destroy entire cities, countries, the world, in moments; a century of living with this existential threat while another, that of climate change, promises even more damage and uncertainty ahead?

The question of can we, though, is not as relevant as should we. Should we just keep going, the way the nuclear war mongers want? They say we'll be fine. Better than if we were to disarm, they argue. Eliminating nuclear weapons will "destabilise" international relations, they assert. It will mean another global conflict, invasions and occupations, "dogs and cats living together."[3]

Preparing for major apocalypse in the midst of a "minor" one

Right now, we are in the midst of a global pandemic for which no governments were sufficiently prepared. We do not have enough basic equipment like ventilators and protection for health care workers. Capitalist economies are tanking as the majority of workers have been ordered to stay at home to prevent the virus from spreading even more rampantly than it has already. Millions of people have lost or will lose their jobs. Hundreds of thousands have and will lose their lives.

But don't worry: the nuclear-armed states can still launch their nuclear weapons! US Strategic Command has said that the coronavirus has had "no impact" on the ability of the United States to launch its nuclear weapons.[4] "Right now across the command, we are working to make sure that our ICBMs remain on alert and our critical command and control capabilities stay viable," say those in charge of the US doomsday machine.[5]

While nuclear weapon forces in all nuclear-armed states are likely to be affected by the pandemic and may have to delay or reduce active deployments or other activities they deem necessary for the effectiveness of their "deterrence" doctrines,[6] the fact is that there are still approximately 13,410 nuclear weapons in the world.[7] While this is significantly less than the 70,000+ kicking around in the 1980s, it is still more than enough to destroy our planet many, many times over.

While we can celebrate the 80 per cent decrease in stockpiles, we also have to recognise that reductions of nuclear weapons tapered off in the 1990s, only to be replaced, as a recent joint activist statement has noted, "by a lavishly-funded new race to develop novel and diversified abilities to unleash nuclear violence."[8] Some proponents of nuclear weapon modernisation argue that these investments are necessary to keep nuclear arsenals "safe" and "reliable". But existing warheads in the US are already certified annually to be safe and reliable;[9] furthermore, the plans outlined for most nuclear-armed states—as explored in this study—make it clear that they are pursuing new nuclear weapons and capabilities, not simply "securing" existing weapons.

The US government has been quick to reassure that the coronavirus pandemic will not affect its nuclear weapon investments.[10] The current US president's latest budget proposal, released earlier this year, called for an increase of nearly 20 per cent in spending on nuclear weapons while cutting funds for the Center for Disease Control, World Health Organisation, and other public health agencies.[11] BAE Systems, Boeing, General Dynamics, Lockheed Martin, Northrop Grumman, Raytheon, and all other major weapons producers have all indicated they are "open for business". While many have instituted work-from-home policies for certain employees, they have all assured the Pentagon that they will continue to operate throughout the crisis.

In the United Kingdom, the government has so far indicated it is also full-steam-ahead with its nuclear weapon modernisation programme. Estimated to cost about £205 billion, the efforts to replace the UK's Trident nuclear weapon system has already suffered from cost overruns.[12] Furthermore, as the chapter on the United Kingdom in this publication notes, when it comes to accounting for other potential costs, "Environmental considerations and risks become externalities that are neither considered nor identified, with no analysis of remediation requirements or responses to climate change impact, accidents, or the protection of civilian populations."

Even without the detonation of a nuclear bomb, accidentally or on purpose, these weapons are costing lives. The International Campaign to Abolish Nuclear Weapons (ICAN) has calculated annual nuclear weapon spending in three countries and compared it to the costs of meeting immediate health care needs during the coronavirus pandemic.[13] In France, for example, which spends approximately €4.5 billion a year right now on its nuclear weapon programme, the government could redirect those funds to pay for 100,000 hospital beds for intensive care units, 10,000 ventilators, and the salaries of French nurses and 10,000 doctors. In each of the nuclear-armed states, the money spent on nuclear weapons has directly impacted the resources available to deal with the pandemic.

Past nuclear weapon activities also have direct impact on populations now facing the pandemic. Survivors of exposure to radiation from nuclear weapon use, testing, production, and waste are at greater risk from COVID-19. Exposed populations "are disproportionately from Indigenous communities, communities of color, low-income, or rural communities, and often face significant barriers to receiving adequate health care even in the best of times."[14]

The imperatives of divestment and disarmament

Thus since the beginning of the pandemic, activists have been demanding an end to nuclear weapon modernisation and a redirection of resources.[15] Former Navy Commanders, members of parliament, academics, and activists have urged the UK government to redirect the billions of pounds spent on the operation and modernisation of the Trident nuclear weapon system towards responding to the pandemic instead,[16] while US advocates have called for the government to reduce its "bloated nuclear arsenal and invest in more urgent security priorities" such as "preventing or mitigating any future mass outbreak of disease."[17] US activists have also demanded that stimulus packages include equitable health care access for communities harmed by nuclear weapon activities.[18]

But it is not just during the COVID-19 pandemic that we need to be concerned with nuclear weapon maintenance, modernisation, or use. This is a pandemic we live with every day, to the point where it has become completely normal for the vast majority of people in the world. Out of sight, out of mind. Missile tests don't even make the news. Nuclear weapon tests, such as those most recently by the Democratic People's Republic of Korea (DPRK), grab the headlines for a moment—but the fact that those most vocally condemning the DPRK's actions possess far larger nuclear arsenals themselves is virtually never discussed outside of antinuclear activist circles.

We cannot wait until a nuclear weapon is used again before we pay attention and act to end the threat of nuclear war. We don't have to.

In 2017, the majority of the world's countries negotiated and adopted the Treaty on the Prohibition of Nuclear Weapons. It outlaws the possession, use, threat of use, and development of nuclear weapons. It closes existing legal gaps in international law, provides for nuclear disarmament, and categorically rejects the idea nuclear weapons provide security or stability.

Among other things, this treaty precludes nuclear weapon modernisation, and bans any assistance—material or otherwise—with such programmes. This follows the letter and spirit of the nuclear Non-Proliferation Treaty (NPT), which obligates nuclear-armed states both to nuclear disarmament and to ceasing the nuclear arms race. None of the nuclear-armed governments are in compliance with either treaty. It is here, on the basis of international law and all of the commitments and actions to which these governments have voluntarily subscribed over the past fifty years, that we can demand an end to nuclear weapons.

It is also on the basis of public health, environmental protection, and of morality and human rights, that we can demand nuclear weapon divestment and disarmament. It is past time to unleash the funds and the forces of human ingenuity to more productive, positive, progressive ends: towards a Green New Deal and a Red Deal.[19] Towards health care, housing, education, food, decarceration and prison abolition, migration, and more. Towards international relations and transnational cooperation based on peace, equity, justice, and solidarity, instead of weapons and war.

About this publication

This report is an update of a study that Reaching Critical Will initiated in 2012, funded by the Ministry of Foreign Affairs of Austria. Updates have been made each year since there was a nuclear Non-Proliferation Treaty (NPT) meeting.[20] While the 2020 NPT Review Conference, scheduled for April–May 2020, has been postponed due to COVID-19, we are publishing a 2020 edition of the report to show the investments being made in nuclear weapons at a time of a global health crisis. Depending on when the Review Conference is convened, we may issue an updated edition if necessary. We also encourage readers to view our 2020 NPT briefing book, which sets out information about the history and status of the NPT while also highlighting and explaining some of the main issues to be addressed by states parties at the Review Conference.

Each chapter has been prepared by experts on national nuclear weapon programmes. Each goes through the current status of nuclear weapon forces; modernisation programmes and plans; the costs of these programmes; the countries' positions on international nuclear weapon law and policy; and public discourse related to nuclear weapons.

This study is for activists, researchers, and governments. It is meant to provide a strong and up-to-date evidence base to improve public understanding about nuclear weapons modernisation activities and their costs. We hope it is useful in preparing for the next NPT Review Conference, but also more broadly for challenging the rhetoric of the nuclear-armed states by exposing the reality of their nuclear weapon programmes and plans. This report demonstrates that concrete action is needed 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 activists 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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Explosion © code404, Pixabay

Executive summary


"A-Day" First atomic bomb explosion at Bikini in the Marshall Islands 1 July 1946 © Science in HD, Unsplash

China

Hui Zhang

Current status

There are various estimates of the size of China's nuclear arsenal. The Federation of American Scientists (FAS) estimated in 2019 that China has a total stockpile of approximately 290 nuclear warheads for delivery by about 180–190 land-based ballistic missiles, 48 sea-based ballistic missiles, and bombers.[1]

Based on Chinese publications and Western governmental and non-governmental estimates, this author estimates that in 2020 China has a total inventory of approximately 360±50 nuclear warheads, including approximately 280±50 nuclear warheads for delivery by approximately 175±24 land-based nuclear ballistic missiles (of which approximately 132±19 can reach the continental United States), approximately 80 warheads for its submarine-launched ballistic missiles (SLBMs), bombers, and retired warheads. This stockpile is likely to grow further over the next decade as additional nuclear capable missiles become operational. In particular, the number of China's ICBMs have increased significantly since 2015, driven mainly by expansion in US missile defence programmes as many Chinese believe. China's arsenal may be somewhat larger than France's but is smaller than the US and Russia.

Modernisation

Since 2015 China has shown it is quickly modernising its nuclear force through adding more and "better" intercontinental ballistic missiles (ICBMs) and multiple independently targetable re-entry vehicles (MIRVs).

China's ongoing nuclear weapons modernisation aims to increase the survivability, reliability, safety, and permeating ability of its small nuclear arsenal and thereby assure a limited, reliable, and effective counterattack capability in order to "deter" a first nuclear strike. Hu Side, the former president of Chinese Academy of Engineering Physics emphasised, "China's nuclear modernisation [is conducted] under the guideline of China's nuclear policy, maintaining the principle of counterattack in self-defense and avoiding [an] arms race."[2]

Economics

It is difficult to estimate the cost of China's nuclear weapon force. Chinese experts of nuclear weapons believe China invests at a very low level for its nuclear weapon programmes.[3] China's officially announced military budget of 1.19 trillion yuan (US $177.5 billion) for 2019 is an increase of 7.5 per cent over the 2018 budget of US $167.4 billion.[4] This accounted for less than two per cent of its gross domestic product (GDP) and about one fourth of the US military budget of 2019.

However, some foreign analysts suspect that the Chinese official data misrepresent the real Chinese military spending. For instance, the Stockholm International Peace Research Institute (SIPRI) estimated that total Chinese military spending in 2018 was about US $250 billion, about 1.5 times that of China's official figure in 2018.[5]

International law and doctrine

Since its first nuclear explosion in 1964, China has maintained what it calls a "minimum deterrent" and a no-first use (NFU) pledge, both of which it says are aimed at avoiding a costly nuclear arms race.

China signed the Comprehensive Test Ban Treaty (CTBT) in 1996 but has not yet ratified it. It has stated that it supports negotiating "a non-discriminatory, multilateral and internationally effectively verifiable fissile materials cut-off treaty (FMCT) under the framework of the Conference on Disarmament (CD) on the basis of the Shannon Mandate as early as possible. China opposes any attempt, even in disguised form, to start the negotiation of the FMCT out of the framework of the CD."[6] China's official policy has long called for "the complete prohibition and thorough destruction of nuclear weapons," which was reiterated in its 2010 White Paper on Defense.[7] Furthermore, the White Paper stated that 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."

However, China did not participate in the negotiation of the Treaty on the Prohibition of Nuclear Weapons (TPNW) and has said it will not sign or ratify it.

Recently, the US government under President Trump demanded that China agree to join in arms control restraints before it will agree to extend the New Strategic Arms Reduction Treaty (New START). Beijing has rejected such a request.

Public discourse

Beijing has made its nuclear policies clear by issuing defence white papers since 1998, but China has kept information about its stocks of fissile materials and nuclear weapons secret. The Chinese public gets information about its nuclear force posture mainly through Western publications. While some scholars and security analysts in China frequently 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. The voices against China's nuclear weapon programme have been very weak in China. However, concerns about the safety of nuclear facilities, in particular in the wake of Japan's Fukushima nuclear energy disaster in March 2011, are increasing along with the emergence of antinuclear movement in some local communities within China.[8]

Democratic People's Republic of Korea (DPRK)

Ko YouKyoung

Current status

The Democratic People's Republic of Korea (DPRK) has been conducting nuclear test explosions since 2006 and is expected to have a current arsenal of around 35 assembled nuclear warheads.[9] While the Democratic People's Republic of Korea (DPRK) has rarely disclosed information about its nuclear programme, there is a growing body of data provided externally by experts and intelligence agencies based on official DPRK statements, information provided during negotiations, and satellite imagery. Occasionally, the DPRK has invited foreign scientists and inspectors to visit its nuclear facilities to demonstrate its capabilities. The DPRK has also announced the results of successfully conducted nuclear and missile tests.

The DPRK has tested a nuclear explosive device six times between 2006 to 2017. One source assessed that "after the six nuclear tests—including two with moderate yields and one with a high yield—there is no longer any doubt that the DPRK can build powerful nuclear explosive devices designed for different yields."[10] The DPRK has a large and diverse arsenal of land-based ballistic missiles and has tested submarine-launched ballistic missiles. In one assessment, the parts of this arsenal that are confirmed to be operational are close-range ballistic missiles, short-range ballistic missiles, and two of its three medium-range ballistic missiles. One of two intermediate-range ballistic missiles may be close to operational status, and one ICBM may have a limited operational capability, while as many as four are in development.

Economics

There is little data on the cost of the DPRK's nuclear and missile programmes. In December 2012, an official from the Republic of Korea's (ROK) Ministry of National Defense told reporters that it estimated the DPRK spent US $1.74 billion on missile development and US $1.1–1.5 billion on nuclear development for a total of US $2.8–3.2 billion.[11] Other unconfirmed media reports put South Korean estimates of the DPRK's nuclear programme at US $1–3 billion, with the higher number combining nuclear and missile development.

Critics have denounced the DPRK government for investing in a nuclear and missile programme at the expense of the national economy and public welfare. They contend that the DPRK should instead divert its resources toward feeding its people and providing clean water and medical supplies. But some also maintain that economic sanctions should remain in place until the complete, verifiable, and irreversible dismantlement of the DPRK's nuclear programme.[12] Alternatively, some humanitarian and civil society groups argue that the United States and the DPRK should formally end the Korean War with a peace agreement to help facilitate a shift in the government's investments.[13]

International law and doctrine

According to the UN Office for Disarmament Affairs (UNODA), the DPRK is categorised as a state party to disarmament treaties of 1925 Geneva Protocol (1988), Antarctic Treaty (1987), Biological Weapons Convention (1987), Convention on Environmental Modification Techniques (1894), Outer Space Treaty (2009), and the NPT (1985)—though the DPRK says it withdrew from the NPT in 2003.[14] The DPRK is not a party to the Comprehensive Nuclear-Test-Ban Treaty (CTBT). It is also not party to the Treaty on the Prohibition of Nuclear Weapons (TPNW), though it voted in favour of the resolution in October 2016 to convene negotiations in 2017 on a "legally binding instrument to prohibit nuclear weapons, leading towards their total elimination".[15]

The DPRK presents itself as a country that is in principle in favour of global denuclearisation, but legally entitled and practically "forced" to develop nuclear weapons for self-defence due to the ongoing state of war with a nuclear-armed state, the United States. It does not consider itself to be party to any binding agreement generally limiting its nuclear programme. It notably considers that it lawfully withdrew from the NPT in 2003, although according to UNODA, "States parties to the Treaty continue to express divergent views regarding the status of the DPRK under the NPT."

A longer history of the DPRK's withdrawal from the NPT; the Six Party talks, responses from the international community and current status of dialogue with the United States and the ROK is included in the complete chapter on the DPRK.

Public discourse

To people in the Korean peninsula and the region, public discourse on the DPRK's nuclear weapons has been focused on how to achieve denuclearisation along with a peace regime on the peninsula. There have been various and diverse public discourses from different perspectives for over 75 years as the armistice regime has been maintained without political settlement to replace it into a peace agreement.

According to the Asan Report in July 2018, 71.8 per cent of South Koreans rated the US-DPRK summit as positive. As perceptions on the prospect for the denuclearisation of the DRPK improved, 62.6 per cent of South Koreans were optimistic about DPRK's implementation of the agreement.

In the United States, the public discourse on DPRK's nuclear weapons is dominated by those who advocate resuming large-scale military exercises and maintaining sanctions as leverage to denuclearise the DPRK. Increasingly however, experts and civil society groups are challenging this conventional view.

France

Hans M. Kristensen

Current status

As of early 2020, France possessed a stockpile of an estimated 290 nuclear warheads. Approximately 200 of these warheads are deployed or operationally available for deployment on short notice. This includes about 160 warheads on two of the three deployable submarines and up to 40 cruise missiles on bomber bases. The third submarine might take longer to ready and the cruise missiles for the Charles De Gaulle aircraft carrier are stored on land. France's nuclear posture is based on two types of delivery vehicles: aircraft and ballistic missiles.

France has recently completed fielding a new class of ballistic missile submarines and aircraft. A modified ballistic missile with a new warhead is being back-fitted onto the submarines. A new class of ballistic missile submarines and a new air-launched cruise missile are in development.

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.

France is not increasing its nuclear forces, nor does it show any indication that it intends to reduce them in the near term. Instead, France continues to reaffirm the importance of nuclear weapons and the 2017 *Defence and National Security Strategic Review* concluded that maintaining the nuclear deterrent "over the long term" is essential.[16]

Economics

Assessing the total cost and breakdown costs of French nuclear forces is difficult. The French Ministry of Defense says France allocated at least US $4.9 billion (€4.5 billion) to nuclear forces in 2019,[17] an increase of more than 10 per cent compared with €4 billion in 2018.[18] But the total apparently does not include all costs.[19] The increase is part of an "exceptional increase"[20] of military spending in response to what is seen as a deteriorating security environment in Europe and elsewhere. In total, the French government says it will spend €25 billion (US $28 billion) on its nuclear forces in the five-year period between 2019 and 2023.[21]

International law and doctrine

France continues to reaffirm the importance of nuclear weapons and the 2017 Defence and National Security Strategic Review concluded that maintaining the nuclear deterrent "over the long term" is essential. In February 2020, French President Macron delivered a speech outlining his vision for France's nuclear "deterrence" strategy.[22] In it, he stressed the role of nuclear weapons within European security policy that was widely seen as offering a wider role for France's nuclear weapons in the security of the rest of the continent,[23] including the suggestion that other countries could participate in French nuclear deterrence exercises and war games. Macron's speech dismissed calls for nuclear abolition as an "ethical debate" that lacks "realism in the strategic context".

France is a state party to the nuclear Non-Proliferation Treaty (NPT) having ratified the Treaty in 1992.[24] France signed the Comprehensive Test Ban Treaty (CTBT) in 1996 and ratified it jointly with the United Kingdom in 1998.[25] This brought to an end more than three decades of destructive and controversial nuclear weapon testing that involved a total of 210 tests, almost 200 of which took place in the South Pacific.[26] It also stressed for many years the importance of negotiating a Fissile Material Cut-off Treaty (FMCT) within the United Nations' Conference on Disarmament.

France did not participate in the negotiations of the Treaty on the Prohibition of Nuclear Weapons (TPNW) and has indicated it does not intend to accede to it.

Public discourse

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. 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 NPT to pursue nuclear reductions, its rejection of additional reductions and its ongoing modernisation of its nuclear forces might be seen as being out of sync with those obligations.

Recent polling shows strong opposition to nuclear weapons amongst adults aged 20 to 35, referred to as "millennials". For example, a 2019 poll, commissioned by the International Committee of the Red Cross (ICRC), found that 81 per cent of French millennials think that it is never acceptable to use nuclear weapons in wars or any armed conflict, and 80 per cent agreed that the existence of nuclear weapons is a threat to humanity.

India

M.V. Ramana

Current status

India is estimated to have 130–140 nuclear warheads.[27] It is also developing a range of delivery vehicles, including land- and sea-based missiles, bombers, and nuclear-powered and nuclear-armed 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 3.2 ± 1.1 tons of HEU as of the end of 2014.[28] With regard to plutonium, India is estimated to have a stockpile of 0.69±0.14 tons of weapon-grade plutonium as of the end of 2019.[29] 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 of the end of 2014, between around 7.7±4.1 tons of reactor grade plutonium, of which about 0.4 tons are under IAEA safeguards.[30]

Modernisation

The primary focus of modernisation has been on increasing the diversity, range, and sophistication of nuclear delivery vehicles. This includes aircraft, land-based missiles and submarine-launched missiles. The longest range missile in the Indian arsenal is the three-stage, 5,000 kilometer range Agni V, which is fired from what is described as a canister rather than a fixed concrete launch pad.[31] The canister design allows for missiles to be launched quickly and for the missile to be transported by trucks on roads, hence making it harder to locate. Agni-V was successfully tested in December 2018 and is supposed to be inducted into the Indian army in 2020.[32] India has also developed a cruise missile, which is described as nuclear capable, with a range of over 1000 km called Nirbhay, which had its first successful test in November 2017 after several failures, and subsequently successfully tested again in April 2019.[33]

India has been developing two submarine-launched ballistic missiles (SLBM), the K-15 and the K-4. K-15, which is also termed the B-5 or the Sagarika, is a nuclear-capable SLBM with a range of 750 kilometres and was reportedly tested thrice by users from a submarine that was "positioned nearly 20-meter deep in the sea, about 10-km off the" eastern coast of India in August 2018.[34] Since then, the missile has reportedly been deployed on India's nuclear-powered and nuclear-armed submarine, the Arihant, that was described as having gone on a "deterrent patrol" in 2018.[35] The Arihant's four launch tubes will reportedly be capable of carrying 12 K-15s.[36] In addition to Arihant, a second nuclear-powered submarine, variously called Arighat and Aridhaman, is reportedly under construction and expected to be commissioned in 2020–2021, and this will be followed by two more.[37]

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. According to the Stockholm International Peace Research Institute (SIPRI) database on military expenditures, India spent Rs. 4547 billion, or 66.6 billion constant 2017 US dollars (USD) in 2018, up from Rs. 3107 billion (54.2 billion USD) in 2014. Between 2014 and 2018, India was the world's second-largest importer of major arms and accounted for 9.5 per cent of the global total.[38] Traditionally, the majority of its imports came from Russia but in recent years the share of imports from Israel, the US, and France have been increasing. The current government seeks to increase exports of weapons, promote the privatisation of public sector companies involved in the defence sector, and increase provision of contracts to private companies, either singly or as public-private partnerships, to manufacture defence equipment.

International law and doctrine

India has not signed either the nuclear Non-Proliferation Treaty (NPT) or Comprehensive Test Ban Treaty (CTBT). This is in line with the Indian government's historical focus in arms control diplomacy, namely 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.

According to India's official nuclear policy, India has a policy of no-first use of nuclear weapons. But there have been signs that this commitment might not be reliable.[39] In 2019 the current defence minister Rajnath Singh reiterated that the no first use policy might change in the future, a statement that was particularly relevant because it was made during a period of heightened tension in Kashmir.[40]

Public discourse

The expansion and modernisation of nuclear weapons has been accompanied by claims about India becoming a powerful nuclear state. Many official announcements about the achievement of any new capability will be accompanied by a statement about how India has reached some exclusive set of countries with that particular capability. While Pakistan is the traditional target of the media, there has been an increased focus on being able to attack China, although this is usually phrased as being able to 'defend against' China.[41]

Israel

Sharon Dolev

Israel neither confirms nor denies the existence of its nuclear programme since the late 1960s, yet it has been widely assumed that Israel possesses nuclear weapons.[42]

Current status

Estimates about the size of the arsenal are based on the informed speculation and unconfirmed revelations dating back to 1986.[43] Experts and analysts estimate that Israel's current nuclear force ranges from 60 to over 400 weapons[44] with 80 warheads being the most cited figure. Israel has a nuclear triad made up of its Dolphin submarines, modified aircraft, and nuclear-tipped Jericho missiles. It is assumed that Israel has deployed between 50 to 100 ballistic missiles[45] capable of carrying nuclear warheads.[46] It is also believed[47] that on 6 December 2019, Israel conducted a test launch of what is assumed to be a Jericho-IV missile with a range of "thousands of kilometers"[48].

Israel's 200 F-16 Falcons, with a range of 2500km and F-15 Eagles (Boeing) have long been the backbone of the Israeli Air Force (IAF). The former is recently being replaced by the new Lockheed-Martin F-35I. All three models are used to carry nuclear weapons by NATO or the US Air Force.

As of January 2016, Israel's fleet includes five Dolphin-class submarines built in Germany.[49] One more submarine should become operational by the end of 2020.[50] Estimates[51] are that these submarines are part of Israel's "second strike" capability[52], probably using Popeye, Harpoon or Gabriel missiles.

There are two main nuclear facilities in Israel: The Shimon Peres Negev Nuclear Research Center (NNRC), located near Dimona, operating since the 1960s. The reactor's capacity was initialy 24 MWt, and now it is believed to be between 40–70 MWt[53] or even 150 MWt.[54]

The Israeli Atomic Energy Commission (IAEC), secretly created in 1952,[55] oversees Israel's nuclear activities.[56] Responsibility for the IAEC falls under the prime minister's office and it reports directly to him.

Economics

The Stockholm International Peace Research Institute (SIPRI) estimates Israel's total military spending for 2018 at B 15.88 USD[57] And the 2011 Global Zero report[58] estimated that 11.53 per cent of military spending allocates to nuclear weapons. compiling this information, we arrive at an estimate of B 1.839 USD for 2018.

International law and doctrine

Israel is not a party to any of the major arms control related treaties and therefore, argues that it is not bound by them. The policy of ambiguity has shaped Israel's behaviour in the international arena. Israel is a member state of International Atomic Energy Agency (IAEA) since 1957[59] and signed several conventions concerning civilian and humanitarian aspects of nuclear research and use.[60] Israel abstained from participating in all humanitarian conferences preceding to the negotiations towards the Treaty on the Prohibition of Nuclear Weapons (TPNW),[61] voted against the UN General Assembly to commence the negotiations in 2017, and voted against the adoption of the treaty.[62]

A weapons of mass destruction free zone (WMDFZ) was first proposed in the Middle east by Egypt in 1990 with backing from Iran. In 1995, the NPT Review and Extension Conference with a specific resolution calling for the establishment of a WMDFZ in the Middle East. This resolution linked the indefinite extension of the NPT to commitments to create such a zone.[63] At the 2010 NPT Review Conference, states parties agreed to practical steps to progress toward establishing the WMDFZ. A subsequent conference was convened In November 2012. In 2018, UN General Assembly First Committee adopted a resolution, submitted by the Arab states, to convene a regional conference on the zone by the end of 2019, outside of the NPT process.

The first conference on the zone was convened at the UN Headquarters in New York in November 2019, with the presence of all twenty-two-member states of the Arab League, Iran, four nuclear-armed states (China, France, Russia, and the United Kingdom), relevant international institutions, a handful of civil society organisations and the absence of Israel and the US.[64]

Public discourse

While ambiguity outside Israel mainly covers the question of possession, the ambiguity inside Israel has a different magnitude. There is some limited discussion in academic circles amongst a small group of academics and think tanks, usually comprised of those who used to be part of the security system, and a steadily growing number of discussions in the media, though the focus is usually on Iran's nuclear programme and not Israel's.

On 29 August 2018, Prime Minister Binyamin Netanyahu stood outside the Dimona reactor[65] and said to the media that any country that threatens to destroy Israel risks meeting a similar fate.[66] This kind of direct threat, along with reports on missile tests[67] and "slips of the tongue" by Israeli officials,[68] are seen outside of Israel as nuclear threats and as "maintaining deterrence," but all this seems to be unseen or less understood by the Israeli media and, as a result, by the Israeli public.

Pakistan

Zia Mian

Current status

As of the start of 2020, Pakistan was believed to have around 150-160 nuclear weapons, an almost ten-fold increase from the year 2000. This arsenal is projected to grow to perhaps 250 weapons by 2025. Pakistan has a number of short-range, medium, and longer-range road-mobile ballistic missiles as well as ground-launched, air-launched, and sea-launched cruise missiles in various stages of development that are capable of delivering a nuclear warhead. It is estimated that Pakistan could have a stockpile of 3.6 tonnes of weapon-grade highly enriched uranium (HEU) and almost 350 kilograms of plutonium as of 2020. It continues to block talks on a fissile material cut-off treaty at the United Nations Conference on Disarmament (CD).

Modernisation

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. As of 2020, it has four plutonium-production reactors in operation. Pakistan's arsenal has moved from aircraft-delivered nuclear bombs to include nuclear-armed ballistic and ground and air launched cruise missiles and from liquid-fueled to solid-fueled medium-range missiles. It has been testing a sea-launched cruise missile to be deployed on submarines.

Economics

There is almost no reliable information about the funding and environmental consequences 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. 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 and the country continues to rely on extensive bilateral and international economic aid.

Environment

Local communities have raised concerns about health and environmental effects from uranium mining, radioactive waste disposal, and nuclear weapons testing but there is a lack of detailed technical information due to secrecy on the part of the government and independent confirmation of the claims.

International law and doctrine

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 recognise no legal obligation to restrain or end its nuclear weapons and missile programme. Pakistan has blocked negotiations of a fissile material cut-off treaty at the CD. While the government has said it supports negotiation of a nuclear weapons convention, Pakistan did not join the talks in 2017 on the Treaty for the Prohibition of Nuclear Weapons.

Public discourse

The government has sought to create a positive public image of the nuclear weapons programme, often by linking it to national pride and identity. Pakistan's major political parties support the nuclear weapons programme. The central thrust of most public debate about Pakistan's nuclear weapons is the struggle with India, especially over the disputed territory and status of the people of Kashmir, which continues to be the focus of concern and a driver of possible conflict that could escalate into conventional war and into nuclear war.

Russia

Pavel Podvig

Current status

According to the most recent New Strategic Arms Reduction Treaty (New START) data exchange, in September 2019 Russia had 513 operationally deployed strategic launchers that carried 1,426 nuclear warheads.[69] 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 2019, Russia was estimated to have about 1,600 deployed warheads in its strategic arsenal. The total number of warheads associated with strategic launchers is estimated to be about 2,700.[70] 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 1,800 non-strategic warheads that could be considered operational and another 2,000 awaiting dismantlement.

The Strategic Rocket Forces of the strategic triad has historically been the largest component of the Soviet and Russian strategic forces. As of early 2020, it includes about 320 operationally deployed ballistic missiles of five different types that carry up to 1,180 warheads.[71]

As of the beginning of 2020, Russia's strategic submarine force included six Project 667BDRM (Delta IV) submarines; one submarine of the older Project 667BDR (Delta III) class; and three new Project 955 Borey submarines. A new submarine of the Project 955A Borey-A class, a moderate upgrade of the Project 955, will enter service in 2020. It is estimated to have 66 heavy bombers.

At the end of 2019 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.

Modernisation

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 maintains and modernises the strategic triad of land-based intercontinental missiles, submarines with sea-launched ballistic missiles, and long-range bombers. The modernisation programme also includes a number of non-traditional delivery systems, such as a hypersonic glider vehicle, a nuclear-powered cruise missile, and an underwater nuclear-powered vehicle. 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-defence missiles.

Economics

Modernisation of the strategic forces is part of the broader rearmament programme. The 2011–2020 State Armament Program allocated 20 trillion rubles (about US $600 billion at the exchange rate at the time) for various military systems. About 10 per cent of the total funds allocated for rearmament, or 1.9 trillion rubles, was spent on the modernisation of the strategic forces. The current State Armament Program, signed into law in 2017, covers the period from 2018 to 2027. The difficult process to approve the new programme illustrates that financial constraints could affect the scale of strategic modernisation. The Russian economy is heavily dependent on export of natural resources, so a fall in oil and gas prices has already forced the government to reconsider its spending priorities.

International law and doctrine

The issues relating to the legitimacy of nuclear weapons under international law are rarely discussed in Russia. Although official documents and statements do not question Russia's right to possess nuclear weapons, they also recognise its responsibilities as a nuclear-armed state party to the nuclear Non-Proliferation Treaty (NPT). The National Security Strategy approved in 2015 recognises the goal of building a world free of nuclear weapons as part of overall progress toward "strategic stability" with equal security for all.[72]

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. 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 centralised storage facilities on its national territory.[73] However, Russia has been reluctant to discuss legally binding measures related to its non-strategic 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. More than half of the population consider nuclear weapons to be the main guarantee of the security of the country and about 30 per cent of respondents believe that nuclear weapons play an important, although not a decisive, role.[74]

Public discussion of issues relating to nuclear weapons rarely questions the role of these weapons in Russia's national security. The strategic modernisation programme described above is also rarely criticised, despite its potentially very substantial cost. In general, public opinion in Russia tends to view favourably the efforts to support the military industry and introduce modern equipment to the armed forces. Government policy and public attitudes combine to ensure that the strategic modernisation efforts undertaken by the Russian government will continue as a high priority programme that is unlikely to be affected by budgetary pressures.

United Kingdom

Janet Fenton

Current status

The United Kingdom has 120 operationally available nuclear warheads as part of a larger stockpile of around 180. There are four Vanguard class submarines which carry eight ICBM missiles and 40 warheads, each with a yield of 100 kilotons. The warheads are manufactured and serviced in England and transported by road to and from the atomic weapon storage facility at Coulport and the submarines are based close by at Faslane on the Gare Loch in Scotland.[75]

Modernisation

The new Dreadnought class submarines will be built by BAE at Barrow-in-Furness in Cumbria. As with the Trident system, the UK will have access to United States' D5 missiles from a common pool, which are currently being upgraded along with other key parts of the system. In a context of close collaboration between British and American nuclear weapon labs, the warheads will be manufactured in the UK with improved accuracy in delivery, meaning that the same number of destinations can probably be targeted with a reduced number of missiles.[76]

The modernisation programme is critically affected by cost over-runs, delays to the building of infrastructure, difficulties in recruiting submariners and scientific staff, bottlenecks in dock space, faulty engineering, and inadequate project oversight. The new submarine class is unlikely to the ready to replace the current fleet when the Vanguard boats reach their already extended projected lifetime.[77]

Economics

Non-governmental estimates for the lifetime costs of the replacement programme range from £172 billion to £205 billion. Actual costs are obscured by complex budgeting arrangements and there persists an overall lack of transparency on the part of the government.[78] The economic challenge to the replacement programme is intensified by the reality of the era of austerity and the COVID-19 emergency, which has highlighted human needs as a priority but shows that government spending plans can change dramatically when required.

International law and doctrine

The UK argues for the lawfulness of its nuclear weapon system on the basis that it is a recognised nuclear weapon state within the NPT and has ceased the production of new fissile material, although it has in fact a huge stockpile of separated plutonium. It also relies on the 1996 International Court of Justice (ICJ) Advisory Opinion as rejecting the argument that nuclear weapons use would necessarily be unlawful in all circumstances.[79] Despite a separate legal system in Scotland and opposition to UK nuclear weapons policy, it has not so far been possible to test the legality of the nuclear weapons under UK jurisdiction and based in Scotland on the fundamental international humanitarian law principles of controllability, discrimination, and civilian immunity.

Public discourse

The ruling Conservative Party, and the opposition Labour party, are both supportive of the Trident replacement programme. Within the Scottish parliament the ruling Scottish National Party (SNP) and the Greens are strongly opposed to nuclear weapons, while the Scottish Labour Party is opposed to the replacement programme. This reflects the widespread and longstanding public rejection of weapons of mass destruction and their deployment from Scotland itself. Significant movement in the UK position could be brought about by the following: international developments, especially the impacts of the Treaty on the Prohibition of Nuclear Weapons (TPNW); the election of a UK government open to disarmament; by a major nuclear accident in the UK; through an independent Scottish government effectively disarming the whole UK by having nuclear weapons removed from Scotland; or by major economic shocks that cripple the modernisation programme. The COVID-19 pandemic is forcing the UK to be more open to thinking the "unthinkable" and they may have to consider an alternative to their current patriarchal and imperialistic position of power.

United States

Greg Mello and Trish Williams-Mello

Current status

The US nuclear weapons programme is relatively transparent. As outlined by the Federation of American Scientists, the US Department of Defense maintained an estimated stockpile of 3,800 nuclear warheads for delivery by 800 ballistic missiles and aircraft.[80] Most of the warheads in the stockpile are stored for potential upload onto missiles and aircraft as necessary. Many are destined for retirement. The FAS estimated that approximately 1,750 warheads are currently deployed, of which roughly 1,300 strategic warheads are deployed on ballistic missiles and another 300 at strategic bomber bases in the United States. An additional 150 tactical bombs are deployed at air bases in Europe.

Modernisation

There have been a number of changes in the US nuclear modernisation programme since the April 2019 edition of *Assuring Destruction Forever.* These are not so much changes in scope but in speed.

First, accelerated, massive hiring is occurring across the nuclear weapons enterprise.[81]

Second, parallel investments in warhead core ("pit") factories have begun, to front-load production in the 2020s to support new-warhead (W87-1) production.[82]

Third, accelerated and early-to-need development of a new submarine warhead (W93) is beginning, budgeted at US $53 million for FY2021 with first production in 2034 (see Table 1), a two-year advancement at both ends of the development period.[83]

Fourth, an unusually early—years-ahead—sole-source contract has been awarded for the Long Range Stand Off (LRSO) cruise missile.[84]

Fifth, unprecedented near-term spending increases for FY21 have been requested to enable these accelerations as discussed below, despite the US $8 billion already available in unspent prior appropriations.[85]

Two programmes were completed since the April 2018 edition of this report. The W76-1 submarine warhead upgrade was completed in late 2018, extending this warhead's life by a planned 30 years while dramatically increasing its accuracy.[86] Some W76 warheads were easily and cheaply converted to low-yield W76-2s in early 2019. These low-yield warheads began deployment in December 2019.[87]

Economics

For FY2019, the most recent year for which an independent estimate is available, the Congressional Budget Office (CBO) assessed annual then-current spending on US nuclear weapons at $33.6 billion—US $21.8 billion in DoD and US $11.8 billion in Department of Energy (DOE).[88] This figure does not include the development of naval reactors for nuclear weapons platforms (US $1.8 billion, in DOE) or warhead-associated DOE environmental expenses of US $6 billion in that year. If included, these would raise the total to US $41.4 billion.[89] By way of comparison, this is larger than the *total* military spending in all but nine other countries.[90]

Costs are increasing rapidly. That same CBO ten-year estimate showed US $42 billion in unanticipated cost growth over the front decade in comparison to its 2017 ten-year estimate—5.3 per cent/year above inflation. Most of the unanticipated growth came from "new modernisation programmes" added since 2017 and "more concrete plans for nuclear command-and-control systems."[91]

The Trump Administration is now requesting US $44.5 billion for nuclear weapons in FY2021,[92] not including US $1.7 billion for naval reactors and US $5.0 billion for environmental cleanup, or US $51.2 billion in all. The request includes US $15.6 billion for warheads—a 25 per cent increase over FY2020 and a 40 per cent increase over FY2019—as well as US $28.9 billion for nuclear weapons in DoD, a 32 per cent increase over two years. Some US $14.8 billion in DoD research and development costs are requested.[93] In 2017, CBO had estimated FY2021 nuclear weapon costs would be about US $40 billion, so the FY2021 request represents about US $5 billion (11 per cent) in unanticipated cost growth in FY2021 since then.[94]

International law and doctrine

The US is a party to the nuclear Non-Proliferation Treaty (NPT). Since 2018, the US government has been promoting an initiative it calls Creating the Conditions for Nuclear Disarmament (CEND).[95] This approach, which focuses on the measures other countries need to take in order for the US to feel "secure" enough to engage in nuclear disarmament, undermines past NPT commitments and other nuclear weapon governance agreements.

The US has not signed or ratified the Treaty on the Prohibition of Nuclear Weapons. It has repeatedly said that will "never" support the Treaty and that it does not consider itself bound by it through customary international law.[96] The US has actively lobbied its allies and other countries to not support the negotiation of the Treaty or to ratify it after its adoption in 2017.[97]

The US has signed but not ratified the Comprehensive Nuclear Test Ban Treaty (CTBT). Comments from the current US administration have given rise to concerns that the US may resume testing, though officials have said the US intends to abide by its explosive nuclear testing moratorium (it has continued to engage in ever-more-sophisticated subcritical testing since the CTBT's adoption in 1996).[98]

The US announced its withdrawal from the Anti-Ballistic Missile Treaty in 2001. On 2 August 2019, the US completed its withdrawal from the Intermediate-Range Nuclear Forces (INF) Treaty. It blamed its withdrawal on Russia.[99]

The New Strategic Reduction Arms Reduction Treaty (New START) is the only remaining treaty that places limits on US and Russian nuclear weapon deployments. It is set to expire in February 2021. The US government has said it is interested in pursuing "tripartite" nuclear arms control with Russia and China rather than a bilateral agreement,[100] which China does not see as reasonable given its much smaller arsenal size.

On 8 May 2018, the US government announced its withdrawal from the Joint Comprehensive Plan of Action (JCPOA) with Iran and other states.

Public discourse

At present there is no significant public or congressional opposition to any major US nuclear weapons modernisation programme.

Acceptable narratives in US public discourse on nuclear issues largely flow directly and indirectly from government sources—"newsmakers"—which news outlets favour. Narratives from other sources, if present at all, come primarily from certain academics, think tanks, and government – or party-aligned NGOs and are typically reactive, and secondary or *pro forma*.

In other words, most "public" discourse about nuclear weapons comes directly or indirectly from government. Government is in turn largely captive of the "unwarranted influence" of the "military-industrial complex."[101]

Recent polls reveal that Americans overall don't know or care much[102] about nuclear weapons, and harbor contradictory ideas about them.[103] They do clearly support further mutual stockpile reductions with Russia,[104] and if asked do express a wish to rid the world of nuclear weapons.[105] Recent polling once again affirms support for arms control objectives.[106]

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Nuclear weapon detonation © AlexAntropov86, Pixabay

China

Hui Zhang

Since its first nuclear explosion in 1964, China has maintained what it calls a "minimum deterrent" and a no-first use (NFU) pledge, both of which it says are aimed at avoiding a costly nuclear arms race. As its 2019 White Paper on Defense states:

> China is always committed to a nuclear policy of no first use of nuclear weapons at any time and under any circumstances, and not using or threatening to use nuclear weapons against non-nuclear-weapon states or nuclear-weapon-free zones unconditionally. China advocates the ultimate complete prohibition and thorough destruction of nuclear weapons. China does not engage in any nuclear arms race with any other country and keeps its nuclear capabilities at the minimum level required for national security. China pursues a nuclear strategy of self-defense, the goal of which is to maintain national strategic security by deterring other countries from using or threatening to use nuclear weapons against China.[1]

While some western experts and scholars are suspicious of China's NFU pledge, China's nuclear force posture is in line with an NFU policy. Specifically, it has a smaller arsenal with a lower alert status than what is generally considered to be required for a first-use option. The PLA Rocket Force, which is the military unit in control of China's strategic missile forces, conducts war planning and training under the assumption that China will absorb a first nuclear blow and use its nuclear forces only to retaliate.[2] There is currently no evidence China will change its long-standing NFU nuclear doctrine, which has been consistently embraced by top Chinese leaders from Mao Zedong to the present. China's nuclear force posture is determined primarily by its strategy, not financial or technological constraints.[3]

In 1978, Deng Xiaoping provided the guidance for the future development of China's nuclear force. He emphasised 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] Since the 1980s, the Chinese government says it has been pursuing its nuclear force structure as a "lean and effective" nuclear deterrent.

For China, the "minimum acceptable" nuclear force is one that will survive a first nuclear strike and overcome a missile defense system to reach its designated targets. The number of the "minimum" nuclear warheads to reach a target would be relatively constant. However, the total number of warheads required to support an effective nuclear force is changeable, depending on a number of factors, including estimates about the survivability of Chinese missiles and their ability to permeate missile defence systems. China's officials have never declared the specific number of weapons needed for its "minimum" nuclear force.

China's ongoing nuclear weapons modernisation aims to increase the survivability, reliability, safety, and permeating ability of its small nuclear arsenal and thereby assure a limited, reliable, and effective counterattack capability in order to "deter" a first nuclear strike. Hu Side, the former president of Chinese Academy of Engineering Physics (the Chinese Los Alamos) emphasised, "China's nuclear modernisation [is conducted] under the guideline of China's nuclear policy, maintaining the principle of counterattack in self-defense and avoiding [an] arms race."[5]

Since 2015 China has shown it is quickly modernising its nuclear force through adding more and "better" intercontinental ballistic missiles (ICBMs) and multiple independently targetable reentry vehicles (MIRVs). In December 2015, in a major military reform of the People's Liberation Army (PLA), the Second Artillery Force was renamed as the PLA Rocket Force (PLARF), thus upgrading its status from an independent branch to the level of full service. At the inauguration ceremony for the PLARF in December 2015 Chinese leader Xi Jinping emphasised the PLA Rocket Force as "China's core force for strategic deterrence, a strategic buttress for China's position as a major power, and an important cornerstone for defending national security." Xi also called on the Rocket Force to "enhance nuclear deterrence and counter-strike capacity which is credible and reliable, medium- and long-range precision strike ability, as well as strategic check-and-balance capacity to build a strong and modern Rocket Force."[6]

Some western officials and scholars have often expressed growing concerns about Chinese nuclear buildup and, in particular, that Beijing has been pursuing nuclear parity with the United States (US) and Russia after the New START arms control agreement was signed in 2010.[7] But China says that its nuclear force and modernisation activities are determined mainly by its "minimum deterrence" and NFU nuclear policy.

Rusted out radiation warning sign
© Ilja Nedilko, Unsplash

Further, any expansion of the Chinese nuclear arsenal would still be constrained by its inventory of fissile material, which at present would not support an arsenal of more than 1,000 warheads.[8] By comparison, the US and Russia each possess a total over 6,000 warheads.

Under the guidance of its self-defence nuclear strategy, China will continue to modernise its nuclear force in order to maintain a reliable second-strike retaliatory capability. China's nuclear weapon modernisation has been responsive to the advances of military capabilities of other countries, particularly the United States. As Hu Side emphasised, "The sole purpose for Chinese maintaining a limited nuclear counterattack force is to deter a potential nuclear strike. However, the development of US missile defense and the long-rang strike capability with high accuracy to target mobile missiles is in practice to decrease the effectiveness of Chinese nuclear deterrence. Thus, it surely leads to Chinese attention."[9]

Current status

There are various estimates of the size of China's nuclear arsenal. The Federation of American Scientists (FAS) estimated in 2019 that China has a total stockpile of approximately 290 nuclear warheads for delivery by about 180–190 land-based ballistic missiles, 48 sea-based ballistic missiles, and bombers.[10] Based on Chinese publications and Western governmental and non-governmental estimates, this author estimates that in 2020 China has a total inventory of approximately 360±50 nuclear warheads, including approximately 280±50 nuclear warheads for delivery by approximately 175±24 land-based nuclear ballistic missiles (of which approximately 132±19 can reach the continental United States), approximately 80 warheads for its submarine-launched ballistic missiles (SLBMs), bombers, and retired warheads (see table 1)[11]. This stockpile is likely to grow further over the next decade as additional nuclear capable missiles become operational. In particular, the number of China's ICBMs have increased significantly since 2015, driven mainly by expansion in US missile defence programmes as many Chinese believe. China's arsenal may be somewhat larger than France's, but is smaller than the US and Russia.

Table 1: China's nuclear force, 2020

TYPE WARHEADS	NATO DESIGNATION	LAUNCHER NUMBERS	YEAR DEPLOYED	RANGE (KILOMETERS)	WARHEAD X YIELD (KILOMETERS)	WARHEAD NUMBERS
Land-based ballistic missiles						
DF-4	CSS-3	3	1980	5,500+	1 x 3,300	6
DF-5A	CSS-4 Mod2	9	1990s	13,000	1 x 4,000-5,000	9
DF-5B	CSS-4 Mod3	9	2015	13,000	3-4 x 200-300?	27-36
DF-21	CSS-5 Mods2/6?	18/?	2000/2016	2,150	1 x 200-300?	36-72
DF-26		20-30	2015	5000+?	1 x 200-300?	20-30
DF-31	CSS-10 Mod 1	4	2006	7,200	1 x 200-300?	4
DF-31A	CSS-10 Mod 2	48-72	2007	11,200	1 x 200-300?	48-72
DF-31AG	?	20-30	2017	11,200	1 x 200-300?	20-30
DF-41	CSS-X-20	20-24	2019?	12,000+	3 x 200-300?	60-72
Subtotal:175/(151-199)						*281/(230-331)*
Submarine-Launched ballistic missiles						
JL-2	CSS-NX-4	48	2014	7,000+	1 x 200-300?	48
Bombers						
H-6K?	B-6	20?	1965/2009	3,100+	1 x 200-300?	20
Total:243/(219-267)						*~349/(298-399)*

The author estimates that the more than 10 additional warheads include the retired JL-1s, for a total inventory of approximately 360±50 nuclear warheads.

Land-based missiles

China's nuclear weapons modernisation has focused on improving the survivability of its land-based strategic missiles by developing mobile missiles and increasing the ability to overcome missile defences by MIRVing its ICBMs. As shown in Table 2, this author estimates that as of 2020 China has approximately 175±24 nuclear-capable land-based missiles that can deliver approximately 280±50 nuclear warheads. In particular, approximately 132±19 ICBMs with about 202±28 warheads can reach the continental US.

China continues phasing out its old liquid-fueled missiles. It is estimated that China has approximately six DF-4 ICBMs as of 2020. The DF-4 is a two-stage, transportable, liquid-fueled ICBM. It is expected to be retired within a few years. China has around three brigades to operate approximately 18 liquid-fueled, silo-based DF-5s ICBMs—assuming half of the silos assigned for the DF-5A and MIRVed DF-5Bs. The DF-5B ICBM was first officially displayed at a September 2015 military parade in Beijing, and the official parade commentators affirmed the DF-5B is capable of carrying multiple warheads. Some Chinese accounts mentioned each DF-5B ICBM could carry up to eight warheads.[12] It is estimated that approximately 27-36 warheads could be delivered by nine DF-5B ICBMs assuming there are 3-4 warheads for each missile. The DF-5As are expected to be replaced by the MIRVed DF-5B or DF-5C. On 21 January 2017, it was reported that China tested a new variant of the missile, the DF-5C, that is equipped with 10 MIRVs[13].

One focus of China's nuclear weapon modernisation programme over last two decades has been the development of solid-fueled, road-mobile ICBMs. China started to field the solid-fueled, road-mobile DF-31 ICBMs in 2006. The three-stage solid propellant ballistic missile has a range of about 7,200km. One major mission of the DF31 was to replace the DF-4s. It is estimated only about eight DF-31missiles had ever been deployed, and are now being phased out. It is estimated that about four DF-31 ICBMs could have been deployed and are expected to be retired in a few years. Since 2007 China has deployed a significant number of DF-31A ICBMs, an improved version of DF-31, with a range of over 11,200km. It is estimated that China operates about four DF-31A brigades. This author estimates China could have about 48-72 DF-31A ICBMs, dependent on how many launchers each brigade has. It is assumed each of the DF31/31A ICBM has a single warhead.

During the PLA's 90th anniversary parade in 2017, DF-31AG ICBMs—which are an improved version of the DF-31A—were first showcased. The new missile uses an improved transporter-erector-launcher to increase its mobility and survivability. Once again, 16 DF-31AG were displayed during the 2019 national day military parade. Chinese official media stated those 16 DF-31AG ICBMs were from two brigades,[14] which means China has at least two brigades to operate the new missiles. This author estimate China could have equipped the new brigades with about 20-30 DF-31AG ICBMs by 2020, and more could be deployed in coming years.

The latest generation of the Dongfeng series strategic missiles—the DF-41, a new MIRV-capable, road-mobile ICBM—was displayed during the China National Day military parade on 1 October 2019.[15] The new DF-41 ICBM also uses the improved transporter-erector-launcher with greater mobility. It is estimated to have an operational range over 12,000 km which is able to cover all of the continental US. It has been reported each DF-41 ICBM can carry 6 to 10 warheads.[16] A Chinese military expert also emphasised on China Central Television (CCTV) that each DF-41 ICBM can carry 6 or 10 warheads.[17] Chinese official media stated the 16 DF-41ICBMs displayed in the military parade were from two brigades, which means China has at least two brigades to operate the new missiles. This author estimates that China could have equipped the new brigades with about 20-24 DF-41 ICBMs that can deliver approximately 60-72 warheads, assuming there are three warheads for each missile.

The PLARF is also enhancing its "regional nuclear deterrent". The DF-21A, a two-stage, solid-propellant, single-warhead medium-range ballistic missile (MRBM), had been the major system in this area. It is being replaced by new variants including the DF-26 IRBM. It is estimated that several DF21A brigades have been reduced to one or two brigades with about 36-72 missiles each.

The most significant development for the regional deterrence is the deployment of a significant number of DF-26 IRBMs since 2016.[18] The DF-26 is a road-mobile, two-stage solid-fueled IRBM with a range of over 4,000km. The DF-26 IRBM was first publicly displayed at the country's military parade on 3 September 2015 in celebration of the 70th anniversary of Japan's surrender at the end of World War II. Sixteen DF-26 IRBMs were also shown during the China National Day military parade on 1 October 2019. Official commentary during the parade described the missile as possessing both nuclear and conventional capabilities as well as conventional strikes against naval targets. The official media also emphasised those 16 DF-26 missiles were from two brigades,[19] which means China has at least two brigades to operate the new missiles. More missiles can be expected to be fielded and the US Pentagon stated in 2019 that 80 DF-26s have been deployed.[20] While some reports state that the DF26 is MIRV-capable, there is no evidence to confirm this so far. It is believed the DF-26 has three versions including nuclear, conventional, and anti-ship. If about one third of those deployed DF-26 are assigned for nuclear mission, about 20-30 DF-26 could be deployed by 2020, and more could be delivered to fully equip those new brigades.

Submarine-launched ballistic missiles

The People's Liberation Army Navy (PLAN) has recently sped up modernising its sea-based strategic force. China's 2011 Defense White Paper states that "The PLA Navy endeavours to accelerate the modernisation of its integrated combat forces, enhance its capabilities in strategic deterrence and counterattack, and develops its capabilities in conducting operations in distant waters and in countering non-traditional security threats."[21]

In 2014, the first of the second-generation ballistic missile submarines (SSBN), the Type 094 Jin-class entered service, replacing its ageing Xia-class SSBN (Type-092) commissioned in early 1980. A 2019 US Defense Department (DOD) report states China has constructed six Type 094 Jin-class SSBNs, and that four are operational. The DoD report emphasises that "China's four operational JIN-class SSBNs represent China's first credible, sea-based nuclear deterrent."[22]

Each Jin-class SSBN can carry 12 JL-2 submarine-launched ballistic missile (SLBMs) with a much longer range of over 7000km than that of JL-1 SLMBs assigned for the Jin-class SSBN. Twelve JL-2 SLBMs were displayed during the China National Day military parade on 1 October 2019. It is estimated China has 48 warheads for the SLBMs assuming each missile has a single warhead.[23]

The 2019 DOD report states,"China's next-generation Type 096 SSBN reportedly will be armed with the follow-on JL3 SLBM, which will likely begin construction in the early-2020s." It is reported China conducted four flight tests of JL-3 missiles between 2018 and 2019.[24] The JL-3 SLBM could be "MIRVed" with about 3-6 warheads. The JL-3 missile is reported to have a great range to cover US territory, while operating from Chinese coastal waters. The Type 096 SSBN is expected to be much quieter and more difficult to track. Given that China has significantly enhanced its land-based nuclear force, it is expected that China will speed up the modernisation of its sea-based strategic force to secure a second-strike force in the coming years.

Bombers

China's air-based nuclear force is the weakest leg of its deterrent triad. The PLA Air Force (PLAAF) has been pursuing enhancements to its strategic deterrence by upgrading its H-6 bomber series and developing next generation bombers. It is estimated China could have a small inventory of about 20 gravity bombs.[25] China's small arsenal of strategic bombers mainly has symbolic meaning and a minor "deterrent" effect.

The H-6K, a more modern version of the Chinese H-6 bomb series was first seen in a military parade on 3 September 2015 celebrating the 70th anniversary of Japan's surrender at the end of World War II. The 2019 DOD report emphasises that "since at least 2016, Chinese media have been referring to the H-6K as a dual nuclear-conventional bomber." The most up-to-date version, the H-6N bomber, was showcased during the China National Day military parade on 1 October 2019. It has a much longer combat range. [26] The PLA air force is currently developing the next generation bomber, the H-20, a new nuclear-capable strategic stealth bomber with much longer range. It is expected to enter service as early as 2025. Meanwhile, since 2016 China has been testing a new air-launched ballistic missile (ALBM) designated by the US intelligence community as CH-AS-X-13.[27] The 2019 US DOD report states that once deployed and integrated, this nuclear ALBM would "for the first time, provide China with a viable nuclear 'triad' of delivery systems dispersed across land, sea, and air forces".[28]

Tactical nuclear weapons

There have been rumors for many years that China has tactical nuclear weapons. However, the deployment of tactical nuclear weapons is not consistent with China's no-first-use policy. From the beginning of China's nuclear weapons programme, Mao Zedong and following generations of leaders have viewed nuclear weapons as strategic tools to deter the use of nuclear weapons against China, not as war-fighting tools. While China mastered the design of a neutron bomb in the 1980s, China did not manufacture and deploy it because its defensive nuclear strategy did not require it.[29] In practice, there is no evidence to show China deploys any kind of tactical nuclear weapons.

Fissile materials

It is believed that China stopped production of plutonium and highly enriched uranium (HEU) in 1987. All its previous military production facilities have been closed, converted, or are being decommissioned.[30]

China has produced HEU for weapons in two complexes: the Lanzhou gaseous diffusion plant (GDP) (Plant 504) and the Heping GDP (Plant 814). The Lanzhou GDP began operations in 1964 and ended HEU production in 1979. It has since shifted to making low-enriched uranium (LEU) for civilian power reactors and possibly for naval reactors. The plant was shut down on 31 December 2000 and demolished in 2017. The Lanzhou GDP produced an estimated 1.2 million separative work units (SWU).

The Heping GDP was a Third Line facility that began operating in 1970 and stopped production of HEU in 1987. Since then, it is believed to have produced enriched uranium products for non-weapon military or dual use purposes.Heping GDP is likely closed by 2019. It is estimated that the Heping GDP produced 2.2 million SWU.

Together, the Lanzhou and Heping gaseous diffusion plants therefore produced roughly 3.4 million SWU. Taking into account HEU and separative work consumed by research and naval reactors, tritium production reactors, used in nuclear tests, and lost in waste, the total amount of weapon-grade HEU in China's stockpile is estimated to be 14±3 tons.

China produced plutonium for weapons at two nuclear complexes, Jiuquan (Plant 404) and Guangyuan (Plant 821) Each has a single natural uranium-fueled, graphite-moderated, water-cooled production reactor with an original design power of 600 megawatts thermal. China also used its plutonium production reactors to produce tritium.

The Jiuquan reactor began operation in 1966 and stopped plutonium production in 1986. Decommissioning began after 1990. Based on new information, the Jiuquan reactor could have produced a total of about 2 tons of weapon-grade plutonium.

The second is the Guangyuan plutonium production complex, located at Guangyuan in Sichuan province (Plant 821). This was also a Third Line plant backing up the Jiuquan complex and also included a plutonium reactor and reprocessing facility. The reactor began operation in 1973 and stopped plutonium production in 1984. Decommissioning work began after 1990. The Guangyuan reactor could have produced a total of 1.4 tons of weapon-grade plutonium.

Together therefore, the Jiuquan and Guangyuan reactors could have produced a total of about 3.4 tons of weapon-grade plutonium. After considering China used its plutonium production reactors to produce tritium as well and allowing for uncertainties, the Jiuquan and Guangyuan reactors could have produced a total of about 3.2± 0.6 tons of weapon-grade plutonium.

Taking into account the amount of plutonium consumed in nuclear tests and lost in reprocessing and fabrication, China's current inventory of plutonium for weapons is estimated to be about 2.9±0.6 tons.

Economics

It is difficult to estimate the cost of China's nuclear weapon force. Chinese experts of nuclear weapons believe China invests at a very low level for its nuclear weapon programmes.[31] China's officially announced military budget of 1.19 trillion yuan (US $177.5 billion) for 2019 is an increase of 7.5 per cent over the 2018 budget of US $167.4 billion.[32] This accounted for less than two per cent of its gross domestic product (GDP) and about one fourth of the US military budget of 2019.

Beijing insists that it coordinates military modernisation with national economic development. As stated in its 2019 White Paper on defence, China is pursuing, the coordinated development of national defense and the economy. Following the principle of building the armed forces through diligence and thrift, China takes into consideration the development of the economy and the demands of national defense, decides on the appropriate scale and composition of defense expenditure, and manages and applies these funds in accordance with law.[33]

However, some foreign analysts suspect that the Chinese official data misrepresent the real Chinese military spending. For instance, the Stockholm International Peace Research Institute (SIPRI) estimated that total Chinese military spending in 2018 was about US $250 billion, about 1.5 times that of China's official figure in 2018.[34]

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 five per cent of its overall military expenditure for its nuclear weapon programme,[35] China would thus have spent between US $8.9 billion and US $13.4 billion on its nuclear programme in 2019.

International law and doctrine

China signed the Comprehensive Test Ban Treaty (CTBT) in 1996 but has not yet ratified it, partly because its ratification by the United States was rejected by the US Senate in 1999, which disincentised China to proceed with its own ratification. Some Chinese nuclear experts argue that the US should take a lead to ratify the Treaty. They further assert that if the US does not ratify the CTBT, it may send a signal to Chinese officials and experts that despite having conducted over 1,000 nuclear tests, the US still lacks confidence on having a safe and reliable arsenal in which case China, with only around 40 tests, may feel that more testing is required. This would make CTBT ratification less likely. Most likely, China would ratify the CTBT after the United States does so.

In practice, the CTBT will constrain China's nuclear modernisation more than other nuclear-armed states parties to the nuclear Non-Proliferation Treaty (NPT). It 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.

China officials have stated that, China supports the objectives and purposes of the Comprehensive Nuclear-Test-Ban Treaty (CTBT). Committed to promoting the early entry-into-force of the Treaty, China has honoured the commitment of moratorium on nuclear tests and made steady progress regarding domestic preparation for the implementation of the Treaty.[36]

Chinese officials have stated that, China supports negotiating a non-discriminatory, multilateral and internationally effectively verifiable fissile materials cut-off treaty (FMCT) under the framework of the Conference on Disarmament (CD) on the basis of the Shannon Mandate as early as possible. China opposes any attempt, even in disguised form, to start the negotiation of the FMCT out of the framework of the CD.[37]

Although Beijing supports the FMCT negotiations, its concerns about US missile defence and US development of outer space weapons could affect its position. Indeed, due to its concerns in this regard, China strongly indicated its preference to simultaneously address both the FMCT and a treaty on the prevention of an arms race in outer space (PAROS) during the early 2000s. In recent years, while China's position has not demanded simultaneous negotiations, it continues to promote a draft treaty on preventing space weaponisation along with Russia. If Beijing remains concerned about US missile defences and space weapon programmes, it might decide to build more ICBMs for maintaining its nuclear deterrence, which might require more plutonium and HEU to fuel those weapons. A calculation of this measure would undermine possible Chinese support for FMCT negotiations.

China's official policy has long called for the complete prohibition and thorough destruction of nuclear weapons, which was reiterated in its 2010 White Paper on Defense.[38] Furthermore, the White Paper stated that 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.

However, China did not participate in the negotiation of the Treaty on the Prohibition of Nuclear Weapons (TPNW) and has said it will not sign or ratify it. In a 2018 joint statement with the other NPT nuclear-armed states, China said it is opposed to the TPNW because it fails to address the key issues that must be overcome to achieve lasting global nuclear disarmament and contradicts and risks underming the NPT.[39]

Recently, the US government under President Trump administration is demanding that China agree to join in arms control restraints before it will agree to extend New START. Beijing has rejected such a request.

Beijing has long maintained 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.[40] However, Beijing does not state when China itself would participate in the process of nuclear reduction. Many Chinese analysts believe Beijing may wish to wait until the United States and Russia reduce their stockpiles to about 1,000 total warheads each. China may then need to reveal the size of its nuclear force as a way to create the necessary confidence for the United States and Russia to continue their reductions.

Beijing maintains that nuclear disarmament must abide by the principles of maintaining the global strategic balance and stability; and undiminished security for all.[41] It emphasises the deployment of the global missile defence system undermines both the strategic stability and nuclear disarmament efforts. China believes that effectively downplaying the role of nuclear weapons in national security policy will provide an important precondition and essential step to complete prohibition and total elimination nuclear weapons as well as that a No-First-Use commitment by nuclear weapon states is the most realistic step in this direction.[42]

Given the asymmetric nature of the arsenals of Russia and the US versus that of China, both in quantity and quality, Beijing believes the transparency of its own nuclear strategy and nuclear doctrine is more important than that of its force posture. Further, China contends that the opacity of its force posture can serve to enhance the deterrence effect of its small nuclear force, which is helpful for keeping strategic stability between the weaker player and the superpowers.

However, certain nuclear transparency measures, including stating nuclear strategic intentions and nuclear capabilities are necessary to maintain nuclear strategic stability among nuclear-armed states. As a responsible stakeholder and in order to defuse China threat theory, China should consider releasing more information about its nuclear weapon programme.

Public discourse

Beijing has made its nuclear policies clear by issuing defence white papers since 1998, but China has kept information about its stocks of fissile materials and nuclear weapons secret. The Chinese public gets information about its nuclear force posture mainly through western publications. While some scholars and security analysts in China frequently 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. The voices against China's nuclear weapon programme have been very weak in China. However, concerns about the safety of nuclear facilities, in particular in the wake of Japan s Fukushima nuclear energy disaster in March 2011, are increasing along with the emergence of antinuclear movement in some local communities within China.[43]

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Democratic People's Republic of Korea (DPRK)

Ko YouKyoung[1]

The Democratic People's Republic of Korea (DPRK) has been conducting nuclear test explosions since 2006 and is expected to have a current arsenal of around 35 assembled nuclear warheads.[2] The DPRK has asserted that its nuclear weapon and missile programmes are a "deterrent" against the United States, due to the lack of formal conclusion to the Korean War between the two countries and what the DPRK describes as the US government's "hostile policy".[3]

The DPRK has at various times participated in negotiations with the United States and other relevant parties. The 1994 Agreed Framework between the United States and the DPRK, and the September 2005 Six Party Talks joint statement from the United States, the DPRK, the Republic of Korea (ROK), China, Russia, and Japan, both made some progress to halt the DPRK's nuclear and missile programme. However, the efforts of the action-for-action approach of the Six Party Talks toward denuclearisation and the development of a peace regime failed under the lack of political will. In the years following the failure of the talks, the DPRK stepped up its nuclear and long-range ballistic missiles tests, to which the US has responded with policies of "strategic patience" and "maximum pressure".

The DPRK's six nuclear tests and intercontinental ballistic missile (ICBM) test-launching led to the UN Security Council's resolutions imposing sanctions on the DPRK. The last three years, from 2017 to 2019, are a microcosm of the 70 year-old story of the Korean peninsula under the state of war: the war of words and escalating tensions, leading to the brink of war;[4] inter-Korean rapprochement; suspension of a military drill; moratoria on nuclear and ICBM tests; a first-ever US-DPRK summit; and then an impasse under ongoing sanctions, military drills, and advancements of the nuclear and missile programmes. Yet, while there have been continuous voices in favour of maximum pressure for DPRK's denuclearisation, the voices calling for an end to the Korean War with a peace agreement and phased diplomatic approach are increasing.

Current status

While the DPRK has rarely disclosed information about its nuclear programme, there is a growing body of data provided externally by experts and intelligence agencies based on official DPRK statements, information provided during negotiations, and satellite imagery. Occasionally, the DPRK has invited foreign scientists and inspectors to visit its nuclear facilities to demonstrate its capabilities. The DPRK has also announced the results of successfully conducted nuclear and missile tests.

The DPRK, which joined the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) in 1985 and concluded a comprehensive safeguards agreement in 1992, has been subject to International Atomic Energy Agency (IAEA) inspections in the past. Due to lack of political engagement; the resumption of US-ROK combined military exercises; and conflicts between the IAEA and the DPRK, the DPRK announced in 1993 its intent to withdraw from the NPT. It then reversed its decision and "suspended the effectuation" of its withdrawal.[5] The US-DPRK 1994 Agreed Framework allowed the IAEA to monitor the freeze of the DPRK's graphite-moderated reactors and related facilities until 2002. The facilities subject to the freeze were the 5MW(e) reactor, the Radiochemical Laboratory (reprocessing), the fuel fabrication plant, and the partially built 50 and 200MW(e) nuclear power plants. Following a change in government in the US in 2001, the US-DPRK 1994 Agreed Framework was abandoned. Another attempt to freeze the DPRK nuclear programme was undertaken in 2007, when the DPRK allowed IAEA inspections to confirm the shutdown of five nuclear facilities in Yongbyon under the September 2005 Six Party Talk joint statement.[6] There have been no further formal talks among the Six Party countries since December 2008.

The conflict between the countries was never formally ended, such as through a peace agreement. While it is not an 'active' conflict today, it remains unresolved and contributes to unique dynamics and tensions. For example, the DPRK has made the IAEA's scope of activities in its country a subject of its negotiations with the United States. The lack of verifiable information and the politicisation of the issue have led to varying and even conflicting assessments of the DPRK's capabilities.

Based on internal and external assessments, the current status of the DPRK's nuclear programme is outlined below.

Nuclear tests

The DPRK has tested a nuclear explosive device six times between 2006 to 2017. Kristensen and Norris assessed that "after the six nuclear tests—including two with moderate yields and one with a high yield—there is no longer any doubt that the DPRK can build powerful nuclear explosive devices designed for different yields."[7]

On 3 September 2017, the DPRK announced that it had tested a hydrogen bomb (or two-stage thermonuclear device), which it said was successful,[8] and said that it is developing an intercontinental ballistic missile for delivery.[9]

According to US and international estimates, each test produced underground blasts that were progressively higher in magnitude and estimated yield.

Table 1: DPRK's nuclear tests

NUCLEAR TEST	1ST	2ND	3RD	4TH	5TH	6TH
Date	Oct 9, 2006 (Mon) 10:36	May 25, 2009 (Mon) 09:54	Feby 12, 2013 (Tue) 11:57	Jan 6, 2016 (Wed) 10:30	Sep 9, 2016 (Fri) 09:30	Sep 3, 2017 (Sun) 12:29
Magnitude (mb) ROK MND	3.6	4.5	4.9	4.8	5.0	5.7
Magnitude (mb) Kristensen and Norris	4.1	4.5	5	4.8	5.1	6.1
Yield (kt) ROK MND	Approx. 0.8	Approx. 3-4	Approx. 6-7	Approx. 6	Approx. 10	Approx. 50
Yield (kt) Kristensen and Norris	0.5	1-3	10	5	10-15	140-250
Yield (kt) Hecker	Close to 1	~ 2 to 7	~ 7 to 14	~ 7 to 14	~ 15 to 25	Over 100, possibly 250

Sources: 2018 Defense White Paper, Ministry of National Defense of the Republic of Korea, January 2019. Hans M. Kristensen and Robert S. Norris, "North Korean nuclear capabilities, 2018," Bulletin of the Atomic Scientists, Volume 74, Issue 1, 2018, pp. 41–51.Siegfried S. Hercker, "DPRK nuclear arsenal: How advanced and do we know?" DMZ Seminar 2019, 20 September 2019.

In April 2018, the DPRK announced that it would "discontinue nuclear and inter-continental ballistic missile tests from April 21, Juche 107 (2018)", and "The northern nuclear test ground of the DPRK will be dismantled to transparently guarantee the discontinuance of the nuclear test."[10] On 24 May 2018, the DPRK destroyed test tunnels and buildings of the Punggye Ri nuclear test site, allowing 30 international journalists from the ROK, the US, China, the UK, and Russia to observe.[11] The US State Department stated that Chairman Kim Jong Un had "invited inspectors to visit the Punggye Ri nuclear test site to confirm that it has been irreversibly dismantled" at a meeting with Secretary Pompeo in Pyongyang on 7 October 2018. Such an inspection has not yet occurred, as the second US-DPRK summit ended without agreement.[12] The DPRK explained that these measures were taken voluntarily as a first step towards confidence-building and the removal of bilateral hostile relations with the United States.

Since the US-DPRK Hanoi Summit of 28 February 2019, there has been little progress made between the two countries. In response to the United States' decision to resume US-ROK combined military drills and maintain sanctions against the DPRK, DPRK leader Kim Jong Un declared on 1 January 2020, "The DPRK has found no grounds to be unilaterally bound any longer by the commitment with no other party to honour, and this has put a damper on its efforts for disarmament and the non-proliferation of nuclear weapons across the world."[13]

Delivery systems

The DPRK has a large and diverse arsenal of land-based ballistic missiles and has tested submarine-launched ballistic missiles. In Kristensen and Norris' assessment, the parts of this arsenal that are confirmed to be operational are close-range ballistic missiles, short-range ballistic missiles, and two of its three medium-range ballistic missiles. One of two intermediate-range ballistic missiles may be close to operational status, and one ICBM may have a limited operational capability, while as many as four are in development. Additionally, only one of DPRK's ballistic missiles is thought to have a probable operational nuclear capability: the Rodong, a medium-range ballistic missile. The operational capability of the DPRK's nuclear warhead delivery technology is unclear.[14]

Kristensen and Norris state, "There is no credible public information to demonstrate that the DPRK has developed nuclear warheads for delivery systems other than ballistic missiles, even though warheads for ballistic missiles are more difficult to develop than gravity bombs because of the extreme environment of their launch and trajectory." They added, "All other nuclear-armed states first developed nuclear bombs for aircraft and then proceeded to field warheads for missiles."[15]

Table 2: DPRK's missiles and their specifications

CLASSIFICATION	RANGE (KM)	WARHEAD WEIGHT (KG)	NOTE
Scud-B/C	300-500	1,000	Deployed
Scud-ER	Approx. 1,000	500	Deployed
Rodong	1,300	700	Deployed
Musudan	3,000 or longer	650	Deployed
Taepodong-2	10,000 or longer	500-1,000	Launched
Pukguksong/Pukguksong-2	Approx. 1,300	650	Test-launched
Hwasong-12	5,000	650	Test-launched
Hwasong-14	10,000or longer	Unknown	Test-launched
Hwasong-15	10,000or longer	1,000	Test-launched

Source: 2018 Defense White Paper, Ministry of National Defense of the Republic of Korea, January 2019.

Progress of the DPRK's missile development (after 1 January 2017)[16]

12 February 2017: Launched Pukguksong-2 in Gusong, North Pyongan Province

6 March 2017: Launched Scud-ER in Dongchang-ri, North Pyongan Province

22 March 2017: Launched Musudan in Wonsan, Kangwon Province (failed)

5 April 2017: Launched Hwasong-12 in Shinpo, South Hamgyong Province (failed)

16 April 2017: Launched Hwasong-12 in Shinpo, South Hamgyong Province (failed)

29 April 2017: Launched Hwasong-12 in Pukchang Airfield, South Pyongan Province (failed)

14 May 2017: Launched Hwasong-12 in Gusong, North Pyongan Province

21 May 2017: Launched Pukguksong-2 in Pukchang, South Pyongan Province

29 May 2017: Launched Scud-series missile in Wonsan, Kangwon Province

4 July 2017: Launched Hwasong-14 in Banghyon, North Pyongan Province

28 July 2017: Launched Hwasong-14 in Mupyong, Chagang Province

26 August 2017: Launched a short-range ballistic missile in Gitdaeryong, Kangwon Province

29 August 2017: Launched Hwasong-12 in Sunan Airfield, Pyongyang

15 September 2017: Launched Hwasong-12 in Sunan Airfield, Pyongyang

29 November 2017: Launched Hwasong-15 in Pyongsong, South Pyongan Province

Siegfried S. Hecker, Robert L. Carlin, and Elliot A. Serbin assessed that "the abrupt end to missile testing at a time of rapid progress on several new missile systems, including ICBMs, Submarine-Launched Ballistic Missiles (SLBM), afnd solid-fueled ballistic missiles, set back the DPRK's missile programme significantly when the DPRK announced they would discontinue nuclear and ICBM testing in April 2018." The authors concluded that "the DPRK cannot deliver a nuclear warhead with any measure of confidence to the U.S. mainland, and that much more flight-testing of the intercontinental-range missiles is required." They also noted that "even once missiles have been adequately flight-tested, as has the U.S. Minuteman III, they still need to be test-launched to ensure effectiveness, readiness, and accuracy." As an example, they note that the United States "conducted four unarmed test launches of the Minuteman III from Vandenberg Air Force Base in California toward Kwajalein Island in the Pacific in 2017 and three in 2018, one of which had to be destroyed over the Pacific for an unspecified in-flight anomaly." [17]

While the DPRK announced a moratorium on ICBM testing, it continued to conduct tests of short-range projectiles. From May to November 2019, the DPRK launched short-range projectiles 12 times, including super-large multiple rockets, a newly developed large-caliber multiple launch guided rocket and ballistic missiles, and a new version of a SLBM, the Pukguksong-3.[18]

Meanwhile, according to the Korean Central News Agency (KCNA), the DPRK's Academy of National Defense Science carried out a "very important test" at its Sohae Satellite Launching Station on 7 December 2019, saying, "the results of the recent important test will have an important effect on changing the strategic position of the DPRK once again in the near future." The Academy of the National Defense Science reported again that it had carried out another crucial test at the Sohae Satellite Launching Ground on 13 December 2019. In a statement on 14 December 2019, the DPRK Korean People's Army Chief of the General Staff Pak Jong-chon said, "The new technologies used in the tests will be fully applied to the development of another strategic weapon." While the DPRK had not released any more details of these tests, experts analysed that the second test was probably a second-stage engine test for rockets which technically could be used for both purpose of an ICBM and a satellite.[19]

Fissile materials

In their most recent assessment published by the Federation of American Scientists, Hans M. Kristensen and Robert S. Norris estimated in April 2020 that "after six nuclear tests, including two of 10-20 kilotons and one of more than 200 kilotons, we estimate that North Korea might have produced sufficient fissile material for roughly 35 warheads, although it is difficult to assess how many warheads may have been assembled or deployed."[20] In their view, the DPRK has made considerable progress in its nuclear weapons and missile programme over recent years through a wide range of ballistic and nuclear tests, even as there remains uncertainty over the DPRK's development of an operationally functioning re-entry vehicle for delivery of a nuclear warhead. The authors conclude, "if it hasn't happened already, it is only a matter of time before Pyongyang's nuclear arsenal can be considered fully functioning."[21]

Siegfried S. Hecker, Co-Director of the Center for International Security and Cooperation at Stanford University, who last visited the Yongbyon nuclear complex in 2010, said that, "our analysis of open-source satellite imagery of the Yongbyon complex led us to estimate they may have added sufficient plutonium and highly enriched uranium for an additional 5 to 7 nuclear weapons on top of our 2017 estimate of approximately 30 weapons" in an interview in February 2019.[22]

According to the Ministry of National Defense (MND) of the Republic of Korea (ROK), the DPRK has expanded and reorganised its Strategic Rocket Command into the Strategic Force and elevated it to a command of its own military branch. The MND estimates that "the DPRK possesses around 50kg of weapons-grade plutonium and a substantial amount of highly enriched uranium (HEU), and its ability to miniaturise nuclear weapons seems to have reached a considerable level."[23]

The US Defense Intelligence Agency reportedly estimated in August 2017 that the DPRK had produced sufficient fissile material for up to 60 nuclear weapons and developed a miniaturised nuclear warhead that could fit inside its missiles.[24] However, the US Congressional Research Service reported that there is no public US intelligence community consensus of the DPRK's fissile material stockpiles.[25]

Economics

There is little data on the cost of the DPRK's nuclear and missile programmes. In December 2012, an official from the ROK Ministry of National Defense told reporters that it estimated the DPRK spent US $1.74 billion on missile development and US $1.1–1.5 billion on nuclear development for a total of US $2.8–3.2 billion.[26] Other unconfirmed media reports put South Korean estimates of the DPRK's nuclear programme at US $1–3 billion, with the higher number combining nuclear and missile development. One such media report compared the cost of the DPRK's entire nuclear and missile programme with that of one nuclear-powered Virginia class attack submarine, which costs US $2.5 billion USD, or the USS Gerald Ford, the United States' newest aircraft carrier with an US $8 billion USD price tag, not counting development costs.[27]

In June 2011, Global Zero estimated the core and full cost of the DPRK nuclear programme to be between 500 and 700 million USD respectively. It said, "The former represents about 6 per cent of the DPRK's military spending (US $8.8 billion in 2009, the last available reliable estimate of total military spending, which represents about 33 per cent of the country's national income spent on the military)."[28] According to Global Zero, "Core costs refer to researching, developing, procuring, testing, operating, maintaining, and upgrading the nuclear arsenal (weapons and their delivery vehicles) and its key nuclear command-control-communications and early warning infrastructure; full costs add unpaid/deferred environmental and health costs, missile defenses assigned to defend against nuclear weapons, nuclear threat reduction and incident management."

The ROK Ministry of National Defense estimated the DPRK's nominal gross national income (GNI) (KRW trillion) to be 36.4 in 2016, and 36.6 in 2017. For context, the ROK's defence budget (KRW trillion) was 38.8 in 2016, 40.3 in 2017, and 43.2 in 2018.[29] The ROK's estimate of the DPRK's GNI looks less than its defence budget.

Critics have denounced the DPRK government for investing in a nuclear and missile programme at the expense of the national economy and public welfare. They contend that the DPRK should instead divert its resources toward feeding its people and providing clean water and medical supplies. But some also maintain that economic sanctions should remain in place until the complete, verifiable, and irreversible dismantlement of the DPRK's nuclear programme.[30] Alternatively, some humanitarian and civil society groups argue that the United States and the DPRK should formally end the Korean War with a peace agreement to help facilitate a shift in the government's investments.[31]

International law and doctrine

According to the UN Office for Disarmament Affairs (UNODA), the DPRK is categorised as a state party to disarmament treaties of 1925 Geneva Protocol (1988), Antarctic Treaty (1987), Biological Weapons Convention (1987), Convention on Environmental Modification Techniques (1894), Outer Space Treaty (2009), and the NPT (1985)—though the DPRK says it withdrew from the NPT in 2003 (see below).[32] The DPRK is not a party to the Comprehensive Nuclear-Test-Ban Treaty (CTBT). It is also not party to the Treaty on the Prohibition of Nuclear Weapons (TPNW), though it voted in favour of of the resolution in October 2016 to convene negotiations in 2017 on a "legally binding instrument to prohibit nuclear weapons, leading towards their total elimination".[33]

The DPRK presents itself as a country that is in principle in favour of global denuclearisation, but legally entitled and practically "forced" to develop nuclear weapons for self-defence due to the ongoing state of war with a nuclear-armed state, the United States. It does not consider itself to be party to any binding agreement generally limiting its nuclear programme. It notably considers that it lawfully withdrew from the NPT in 2003, although according to UNODA, "States parties to the Treaty continue to express divergent views regarding the status of the DPRK under the NPT." [34]

The DPRK acceded to the NPT on 12 December 1985, as the Soviet Union required the DPRK's membership for a planned purchase of four Soviet light water-reactors.[35] The DPRK never received the reactors due to Soviet Union's disintegration, but it built in Yongbyon a 5 MW(e) experimental reactor in 1986 and started the construction of two gas-graphite reactors and a radiochemical laboratory around 1987.[36]

The DPRK signed a Safeguards Agreement with the IAEA on 30 January 1992 after signing the Joint Declaration on the Denuclearisation of the Korean Peninsula with the ROK on 20 January 1992, in the context of goodwill gestures by the United States. These efforts included a declaration by the US Deputy Assistant Secretary of State on 17 January 1991 that the United States "will not pose a nuclear threat on the DPRK," a US announcement of the withdrawal of nuclear weapons from the ROK on 27 September 1991, and a suspension of Team Spirits, the US-ROK combined military exercises on 7 January 1992.

When the safeguards agreement entered into force in April 1992, the IAEA began its inspection of the DPRK's initial report. The IAEA found inconsistencies and requested access to two suspected nuclear waste sites at Yongbyon .[37] However, the DPRK refused access, claiming that they were non-nuclear military sites and raising its sovereignty and national dignity concerns.[38] Given the arguments from both sides were not resolved, the DPRK announced its decision to withdraw from the NPT on 12 March 1993 since the US-ROK combined military excercise Team Spirits resumed.[39] But the DPRK suspended its withdrawal in June 1993 under negotiation with the United States. [40]

The negotiation did not succeed, which resulted in the DPRK's withdrawal from the IAEA on 12 June 1994. In the IAEA's view, the withdrawal did not affect the DPRK obligations under its Safeguards Agreement, but the DPRK took the position that it was no longer obliged to allow inspectors to carry out their work under the Safeguards Agreement.[41]

During an interview with journalist Selig Harrison in June 1994, President Kim Il Sung, in explaining why the DPRK had been pursuing light-water reactors, said, "We need energy and we recognise that type of nuclear facilities we are now developing are not the best." When former President Jimmy Carter visited Pyongyang in June 1994, Premier Kim told him, "If the U.S. had helped the DPRK to acquire a light water reactor, even from a third country, the current problem could have been avoided." He went on to say, "if a commitment is made to furnish us with a light water reactor, then we will immediately freeze all our nuclear activities."[42]

After the first nuclear crisis in June 1994, during which the United States considered a range of military options against the DPRK, the US and the DPRK signed the Agreed Framework in October 1994. Despite numerous obstacles following the signing of the Agreed Framework, the Clinton administration prioritised diplomacy with the DPRK. Initially, the DPRK honoured its commitments, however a lack of political will and support from the US Congress under the Clinton administration impeded progress on the full implementation of the Agreed Framework.

The succeeding Bush administration's policy on the DPRK shifted from engagement to a hardline approach based on US intelligence reports of a covert uranium enrichment programme in the DPRK. Unable to resolve the issue through direct talks, the DPRK announced an end to its suspension of the withdrawal from the NPT.

In the years since, there have been several bilateral agreements between the US and the DPRK, and multilateral agreements through the Six Party Talks. None of the denuclearisation agreements concluded between the United States and the DPRK appear to have been considered legally binding by either side and each collapsed one after another. The DPRK is subject to several UN Security Council (UNSC) resolutions banning it from developing nuclear weapons independently of its NPT status, based on Chapter VII of the UN Charter, though the DPRK dismisses these resolutions as unlawful infringements upon its sovereignty. [43]

The DPRK conducted its first nuclear test on 9 October 2006, stating on 11 October that it "was entirely attributable to the U.S. nuclear threat, sanctions and pressure." The DPRK insisted that it remained committed to implementing the Joint Statement and "unchanged in its will to denuclearise the peninsula through dialogue and negotiations."

The UNSC thereupon adopted Resolution 1718 on 14 October 2006, acting under Chapter VII of the UN Charter, condemning the nuclear test, demanding the return of the DPRK to the NPT and IAEA Safeguards Agreement, and deciding that the DPRK should abandon all nuclear weapons, all other existing weapons of mass destruction, and all ballistic missile programmes in a complete, verifiable and irreversible manner, and imposing sanctions.[44]

The DPRK tested a space launch vehicle on 5 April 2009, and a presidential statement of the UNSC condemned it as a violation of UNSC resolution 1718 by treating it as a ballistic missile launch.[45] The DPRK denounced this interpretation on 14 April 2009 as a violation of the freedom of exploration contained in the Outer Space Treaty, declared that "it would permanently pull out of nuclear disarmament talks and restart its nuclear programme," and expelled UN inspectors from the country.[46] On 25 May 2009, it conducted its second nuclear test, which was met by an expansion of sanctions under UNSC resolution 1874 on 12 June 2009. Since a space-launch vehicle sent on 12 December 2012 led the DPRK getting sanctioned under UNSC resolution 2087, there have been a series of DPRK nuclear, space-launch vehicle, or long-range missile tests that were met with progressively stronger sanctions.

While the so-called smart sanctions based on resolutions 1718 (2006), 1874 (2009), 2087 (2013), 2094 (2013), and 2270 (2016) targeted the military and the elite, the sanctions based on resolutions 2321 (2016), 2371 (2017), 2375 (2017), and 2397 (2017) targeted entire sectors of the DPRK's economy, regardless of whether there was a proven direct link to the nuclear programme. The UNSC has increasingly cut off the DPRK from access to international capital and has limited its access to the international banking system. Beyond the funding problems this has caused for the DPRK in general, these financial sanctions have negatively affected the work of humanitarian entities—including UN agencies—by interfering with the administration of funding, adding red tape, and discouraging banks from handling any transactions involving the DPRK under a phenomenon of "de-risking" or "over-compliance."[47]

The DPRK has at the UN General Assembly attacked these sanctions as "illegal and double-standard" for denying it the freedom to explore outer space, for infringing on its national sovereignty, and for preventing it from exercising its right to self-defence. It points out that other satellite-launching countries and nuclear-armed countries are not being sanctioned. It draws the conclusion that the actual reason for these resolutions is "that the permanent members of the Security Council, all nuclear powers, have common interest in maintaining their monopolistic nuclear status." [48]

Doctrine

The DPRK has maintained that it will not use nuclear weapons nor transfer them or related technology unless there is a nuclear threat or provocation against it. In April 2018, at the Third Plenary Meeting of the Seventh Central Committee of the Workers' Party of Korea, the DPRK adopted a resolution stating that "the DPRK will never use nuclear weapons nor transfer nuclear weapons or nuclear technology under any circumstances unless there are nuclear threat and nuclear provocation against the DPRK."[49] Prior to that, during the 7th Congress of the Workers' Party of Korea in 2016, Chairman Kim Jong Un said, "our Republic will not use a nuclear weapon unless its sovereignty is encroached upon by any aggressive hostile forces with nukes, as it had already declared, and it will faithfully fulfill its obligation for non-proliferation and strive for the global denuclearisation."[50] Some civil society nuclear disarmament organisations categorise the DPRK as a country of that does not have a no first use policy.[51]

The DPRK has asserted that its denuclearisation is contingent upon ending hostile relations with the United States. According to the report of the Fifth Plenary Meeting of the 7th Central Committee of the Workers Party of Korea at the end of 2019, Chairman Kim Jong Un declared, "If the United States persists in its policy hostile towards the DPRK, there will never be the denuclearisation of the Korean peninsula." He also stated that the DPRK "will steadily develop indispensable and prerequisite strategic weapons for national security until the United States rolls back its hostile policy and a lasting and durable peace mechanism is in place."[52]

The DPRK has long preferred an action-for-action approach to advance denuclearisation and the establishment of a peace regime. It opposes the so-called "Libya model," which requires the DPRK to fully denuclearise before receiving concessions from the United States, such as sanctions relief. A phased approach was adopted during the Agreed Framework negotiation, which resulted in a nearly 10-year freeze of the DPRK's nuclear activities. It was also adopted following the Joint Statement of the Six Party Talks on 19 September 2005, which stipulated that "the Six Parties agreed to take coordinated steps to implement the afore-mentioned consensus in a phased manner in line with the principle of commitment for commitment, action for action."[53]

The DPRK has pursued a similar approach in its negotiations with the Trump administration and to advance the goals outlined in the US-DPRK declaration signed at the Singapore Summit in June 2018. The DPRK has demanded the Unites States take appropriate reciprocal action toward its voluntary halt on nuclear and ICBM testing and the destruction of tunnels at its Punggye-ri nuclear test site.

Public discourse

To people in the Korean peninsula and the region, public discourse on the DPRK's nuclear weapons has been focused on how to achieve denuclearisation along with a peace regime on the peninsula. There have been various and diverse public discourses from different perspectives for over 75 years as the armistice regime has been maintained without political settlement to replace it into a peace agreement. This section of the report will focus on recent public discourse.

It was widely welcomed when the ROK and the DPRK agreed on participation from the DPRK in the Winter Olympic in Pyeongchang in 2018. It was also surprising to hear that the US agreed to suspend the annual US-ROK combined military exercise for the successful Winter Olympics. On top of that, the DPRK announced it would discontinue nuclear and ICBM tests, dismantle the nuclear test site, and affirm not to transfer nuclear weapons and nuclear technology under any circumstances. The highlight was the announcement of the first-ever US-DPRK summit.

According to the Asan Report in July 2018, 71.8 per cent of South Koreans rated the US-DPRK summit as positive. As perceptions on the prospect for the denuclearisation of the DRPK improved, 62.6 per cent of South Koreans were optimistic about DPRK's implementation of the agreement. The Moon Jae-in administration's policy toward the DPRK received overwhelming support (72.3 per cent) following the April–May inter-Korean talks, the April 27 Panmunjom Declaration, and the closing of the North's nuclear test site in May 2018. The percentage of South Koreans who viewed future inter-Korean relations and US-DPRK relations as positive also reached 83.2 per cent and 76.7 per cent, respectively.[54]

In October 2018, there was a joint event to celebrate the anniversary of a 2007 inter-Korean summit in Pyongyang with government officials, politicians, civic, religious, and cultural figures from the ROK and the DPRK. The participants called for faithful implementation of the recent summit agreements by the two leaders in a joint letter they adopted. They also urged efforts to make the Korean Peninsula free of nuclear weapons and nuclear threats, while working together in expanding cross-border exchanges and cooperation.[55]

Meanwhile, at the joint event of non-governmental groups in Mount Kumgang in February 2019, groups from the DRPK didn't agree to include denuclearisation in the joint statement with groups from the ROK. They reportedly said the issue was something to be dealt with by the leaders of the two countries at the meeting of a joint new year's event.[56]

In the United States, the public discourse on DPRK's nuclear weapons is dominated by those who advocate resuming large-scale military exercises and maintaining sanctions as leverage to denuclearise the DPRK. Increasingly however, experts and civil society groups are challenging this conventional view, as outlined below.

At a Senate Foreign Relations subcommittee hearing on the DPRK on 25 February 2020,Republican Senator Cory Gardner, chairman of the East Asia, the Pacific and International Cybersecurity Policy subcommittee of the Senate Foreign Relations Committee, called for a return to "the successful policy of maximum pressure that was adopted early in the Trump administration, but since abandoned in earnest effort of diplomatic engagement with Pyongyang." He added, "We must immediately enforce sanctions against Pyongyang and its enablers."[57] He and Democratic Senator Ed Markey, ranking member of the subcommittee, introduced the Leverage to Enhance Effective Diplomacy (LEED) Act, expanding US sanctions against the DPRK and its enablers, including those engaged in illegal oil transfers to the DPRK.[58]

However, in June 2019 Democrat Congressman Ro Khanna introduced House Resolution 152, which calls for a formal end to the Korean War. [59] At a House Armed Services Committee hearing on 28 January 2020, John C. Rood, Under Secretary of Defense for Policy, testified that the DPRK remains a security challenge, and the United States continues to pursue the DPRK's denuclearisation. In response to a question from Rep. Khanna if the US could first agree to a peace declaration before negotiating the details of DPRK's denuclearisation, he also said a long-term peace agreement with the DPRK is "desirable" and in the "interest" of the United States. He said the 1953 Armistice Agreement was "not intended to survive decade after decade after decade."[60]

US public opinion on the threat posed by DPRK's nuclear weapons is also shifting. According to a poll conducted in January 2020 by the Chicago Council on Foreign Affairs, only 13 per cent of US citizens believe that the DPRK presents the world's "greatest threat" to the United States, a significant drop from 59 per cent in 2017.[61] And according to a 2019 poll conducted by Data for Progress and YouGov, 67 per cent of US citizens across political affiliations support negotiating a peace agreement with the DPRK.[62]

However, since the 2019 Hanoi summit ended without an agreement, there has been no progress made between the US and the DPRK, and this has impacted the inter-Korean dialogues and cooperation. Even though there was a surprising trilateral meeting between leaders of the United States, the DPRK, and the ROK in Panmunjom in June 2019, working-level nuclear talks in Sweden in October failed. The DPRK's representative announced, "The negotiations have not fulfilled our expectation and finally broke off."[63]

While the United States keeps saying it maintains a flexible approach, it has nevertheless refused to ease sanctions or durably suspend the US-ROK combined military exercises,[64] which the DPRK had demanded as confidence-building measures. When China and Russia drafted a resolution that reportedly proposed the UNSC relieve sanctions on DPRK exports of seafood and textiles in December 2019, a US State Department official said that it was not the time for the Security Council to consider lifting sanctions on the DPRK as the country was "threatening to conduct an escalated provocation, refusing to meet to discuss denuclearisation, and continuing to maintain and advance its prohibited weapons of mass destruction and ballistic missile programmes."[65]

After the first-ever inter-Korean summit in June 2000, Professor Hamm Taik-young, a well-known expert at comparative study of the ROK and the DPRK, said that the most challenging task ahead was to institutionalise the peace process, including through a peace agreement, cross-recognition of the two Koreas by the four major powers, regional cooperation, and arms control and disarmament. He stressed, "The security policy of the two Koreas should be oriented toward arms control and disarmament, since an arms race beyond 'reasonable sufficiency' is not desirable." He also argued, "Due to the asymmetric balance between ROK (U.S.) superiority in war-fighting capabilities and the DPRK's deterrents, an arms buildup by the ROK will be matched by an asymmetric buildup by the DPRK."[66]

This has indeed come to pass. While sanctions and military build-up have continued, the development of the DPRK's nuclear and missile program has also advanced. But voices on both sides have called on the relevant parties to go beyond the formulas that have failed to resolve this problem for the past 25 years, including US Special Representative for the DPRK Stephen Biegun noted.[67]

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ICAN activists at a missile park in Woomera, Australia, April 2018 © Dimity Hawkins

France

Hans M. Kristensen

France allocated at least US $4.9 billion (€4.5 billion) to nuclear forces in 2019,[1] an increase of more than 10 per cent compared with €4 billion in 2018.[2] The increase is part of an "exceptional increase"[3] of defense spending in response to what is seen as a deteriorating security environment in Europe and elsewhere.

France has recently completed fielding a new class of ballistic missile submarines and aircraft. A modified ballistic missile with a new warhead is being back-fitted onto the submarines. A new class of ballistic missile submarines and a new air-launched cruise missile are in development.

France is not increasing its nuclear forces, nor does it show any indication that it intends to reduce them in the near term. Instead, France continues to reaffirm the importance of nuclear weapons and the 2017 Defence and National Security Strategic Review concluded that maintaining the nuclear deterrent "over the long term" is essential.[4]

Lack of additional reductions combined with increased spending and modernisation to retain nuclear weapons indefinitely appear to conflict with France's obligations under the nuclear Non-Proliferation Treaty (NPT) article VI "to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament…".[5]

Current status

As of early 2020, France possessed a stockpile of an estimated 290 nuclear warheads. Approximately 200 of these warheads are deployed or operationally available for deployment on short notice. This includes about 160 warheads on two of the three deployable submarines and up to 40 cruise missiles on bomber bases. The third submarine might take longer to ready and the cruise missiles for the *Charles De Gaulle* aircraft carrier are stored on land.

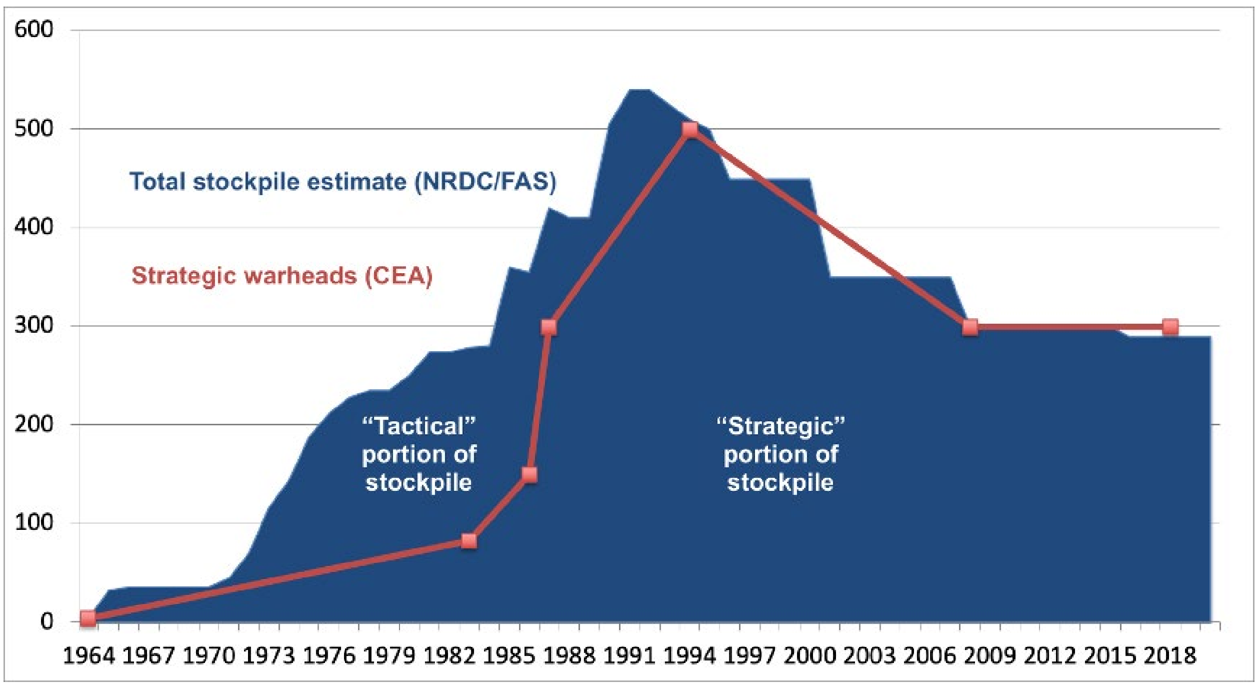
The current forces level is the result of adjustments made to the posture following President Nicolas Sarkozy's announcement March 2008, that the "arsenal" would be reduced to "fewer than 300 warheads" by cutting one of three nuclear bomber squadrons. Sarkozy also declared that France "has no other weapons besides those in the operational stockpile."[6]

A gift from the students at Hiroshima Jogakuin to ICAN, the paper cranes adorned Oslo's Parliament building the morning of 8 December 2017. The cranes are not only a symbol of peace, but one of action © Ari Beser

President François Hollande modified the stockpile size a little in February 2015, when he declared that "France has been exemplary in terms of the volume of its weapons stockpile: 300."[7] But the current President Emmanuel Macron returned to the previous formulation in February 2020, when he declared that France had "reduced the size of its arsenal, which is currently *under* 300 nuclear weapons" (emphasis added).[8]

The current stockpile of approximately 290 warheads, Sarkozy explained, "is half of the maximum number of warheads we had during the Cold War."[9] 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 and capabilities are significantly different. The Nuclear Energy Commission (Le Commissariat à L'énergie Atomique et aux énergies Renouvelables, CEA) recently published strategic warhead numbers (les Forces Nucléaires Stratégiques, FNS) that help illustrate the difference between tactical and strategic warhead inventories in the stockpile between the early-1980s and 1993 when the last tactical warhead was retired.[10]

Figure 1: French nuclear weapons stockpile 1964-20



The roughly 290 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.

Consecutive presidents have been relatively consistent over the past two decades about the role that French nuclear forces play. But the context has recently changed.

According to President Macron, "some states are knowingly opting for opaque and even aggressive nuclear postures, which include a dimension of blackmailing or seeking fait accompli," a thinly vailed reference to Russia. "The deterrence-based power balances have thus become unstable" and although French nuclear forces remain "a last resort," France "may for the first time in a long time have to meet a third challenge, that of directly facing in an uncontrolled escalation, a hostile power, which could have a nuclear weapon or be an ally of a power owning weapons of mass destruction."[11]

Macron reaffirmed that "France will never engage into a nuclear battle or any forms of graduated response." Nonetheless, "a unique and one-time-only nuclear warning could be issued to the aggressor State to clearly demonstrate that the nature of the has changed and to re-stablish deterrence." If that failed, the leader of that state "must realize that our nuclear forces are capable of inflicting absolutely unacceptable damage upon the State's centres of power: its political, economic, and military nerve centres."[12]

Nuclear 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. France considers all its nuclear forces to be strategic, even though the land- and carrier-based aircraft would be considered tactical if they were part of the Russian arsenal. President Macron reaffirmed the intension to retain a nuclear posture based on "two components" (land and sea) for the long term.[13]

Table 1: French nuclear forces, 2020

DELIVERY VEHICLE	NO. OPERATIONAL	YEAR DEPLOYED[A]	RANGE (KILOMETERS)[B]	WARHEADS X YIELD (KILOTONS)	WARHEADS
Land-based aircraft					
Rafale BF3 (ASMPA)	4	2008/2010	2,000	1 TNA x variable to 100[c]	40
Carrier-based aircraft					
Rafale MF3 (ASMPA)	10	2010/2011	2,000	1 TNA x variable to 100[c]	10
Submarine-Launched Ballistic Missiles[d]					
M51.1	16	2010	6,000+	Up to 6 TN75 x 100[e]	80
M51.2	32	2017	9,000+	Up to 6 TNO x 100[f]	160
M51.3	0	(2025)	9,000+	Up to 6 TNO x 100	0
Total	**98**				**290[g]**

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 600+ kilometers.
c) The ASMPA carries a "medium" yield warhead.
d) There are only three sets of missiles available for three of four SSBNs. A fourth boat is in overhaul.
e) The M51.1, which first became operational on the Terrible in late-2010, has "significantly greater range and payload capacity, as well as greater accuracy"[14] than the M45 and can carry up to six TN75 warheads.
f) The M51.2, which became operational on the Triumphant in 2017, has a longer range than the M51.1 and carries the new TNO warhead. Loading varies depending on mission.
g) A small number of these warheads are undergoing surveillance and maintenance at any given time.

Land-based aircraft

The land-based aircraft are organised under the Strategic Air Forces (Forces Aériennes Stratégiques, or FAS), which uses the Rafale BF4 fighter-bombers to deliver the nuclear ASMPA (Air-Sol Moyenne Portée-Améliorée) medium-range cruise missile. There are 40 aircraft available for the Air Force's nuclear mission with up to 40 missiles.

The two-seater Rafale BF3 first entered service in 2009 at Saint Dizier airbase, has an unrefueled combat range of 1,850 kilometres (km). The standard nuclear strike configuration for the Rafale BF3 is with the ASMPA on the centerline pylon and two fuel tanks under the wings.

The Rafale programme has been scaled back significantly to 132 aircraft for the Air Force (and 48 Ms for the Navy). The BF3 model is being upgraded to the BF4 version.

To refuel the nuclear strike aircraft, France operates a fleet of Boeing-produced C-135FR tankers that are being replaced with the Airbus A330 "Phoenix." The modernisation will be completed in 2025. The tankers are organised under the 4/31 "Sologne" squadron at Istres airbase.

The ASMPA is a nuclear enhanced short-range air-to-ground missile with a ramjet engine and a maximum range of more than 600 km. The ASMPA has significantly greater range and penetration capability than its predecessor, the ASMP. The ASMPA carries the new TNA warhead with an estimated yield of up to 100 kilotons. Lowers yield options are also thought to be available. According to MBDA Missile Systems, 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."[15] The French Ministry of Defence states that the TNA (and the TNO) is the only nuclear warhead that has been designed and certified by simulation rather than nuclear test explosions.[16]

The ASMPA programme cost US $146 million (€110 million) in 2011, with another US $68 million (€51 million) budgeted for 2012 as the programme neared completion.[17] The ASMPA first became operational on 1 October 2009 on the Mirage 2000Ns at Istres airbase. Nine months later, on 1 July 2010, it became operational on the Rafale BK3 at Saint Dizier airbase. Production and delivery of the ASMPA and its TNA warhead was completed in 2011. A mid-life upgrade is current underway to enable the ASMPA to be in service until 2035. To eventually replace the ASMPA, France has begun design development of a stealthier, extended-range nuclear missile known as the ASN4G (air-sol nucléaire 4ème génération) that is envisioned to take over from the ASMPA in 2035.

The Strategic Air Force has been significantly reorganised in recent years (see Table 2). Of the three nuclear fighter-bomber squadrons that existed a decade ago, two have been disbanded, one transferred, and an earlier disbanded squadron re-established at a new location. With the retirement of the Mirage-2000N in 2018, the 2/4 "La Fayette" squadron at Istres airbase near Marseille was moved to Saint Dizier airbase east of Paris where it joined the 1/4 "Gascogne" squadron in the 4th Wing at Saint Dizier airbase east of Paris.

Table 2: French strategic air force nuclear organisation, 2020

BASE	UNITS
Avord (BA 702)	"K" weapons storage bunker and personnel
Istres (BA 125)	3/60 "Estérel" refueling squadron with C-135 tankers (being replaced with A330 "Phoenix" tankers) "K" weapons storage bunker and personnel
Luxeuil (BA 116)	No nuclear units but serves as dispersal base
Saint Dizier (BA 113)	4th Wing with two nuclear squadrons: 1/4 "Cascogne" squadron with 20 Rafale BF3/ASMPA 2/4 "La Fayette" squadron with 20 Rafale BF3/ASMPA "K" weapons depot and personnel

Key: ASMPA = Air-Sol Moyenne Portee Amélioré; 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.*

The nuclear custodial units that maintain and protect the ASMPA missiles have also been reorganised. Between 2008 and 2010, special nuclear weapons bunkers were constructed at the Saint Dizier, Istres, and Avon airbases, and the DAMS (Dépôts-Ateliers de Munitions Spéciales) depots that previously housed the nuclear weapons were renamed "K Buildings."[18] Although Istres airbase does not have a nuclear bomber squadron, it remains a nuclear base. The Avord airbase (BA 702) in central France also has a nuclear weapons depot and continues to provide support to the nuclear bomber squadrons.

Carrier-based aircraft

France is the only NATO country that still has a nuclear strike role from surface ships.

The force is known as the Naval Nuclear Aviation Force (Force Aéronavale Nucléaire, or FANu) and consists of one squadron of Rafale MF3 fighter-bombers equipped to deliver ASMPA cruise missiles from the aircraft carrier *Charles de Gaulle* (R91). When not deployed on the carrier, the air wing is based at Landivisau in northern France.

The *Charles de Gaulle* does not carry the nuclear missiles under normal circumstances. They are stored on land, possibly at Istres airbase, and would have to be loaded onboard for the carrier to perform its nuclear strike mission. Management of the ASMPA cruise missile for the Rafale MF3 on the *Charles de Gaulle* carrier is supported by the centre d'expérimentations pratiques et de réception de l'aéronautique navale (the center for practical experiments and integration of naval aviation, CEPA/10S) at Istres airbase (AB 125).

The FANu mission was uniquely affected by the outbreak of the Corona-virus in April 2020 when more than 1,000 of the crew on the Charles de Gaulle were found to be infected, forcing the carrier to return to port with its nuclear strike mission.[19]

Sea-launched ballistic missile submarines

France operates four Triomphant-class nuclear-powered ballistic missile submarines (SSBNs), each equipped with 16 nuclear-armed long-range ballistic missiles (SLBMs). The fleet, which is known as the FOST (La Force Océanique Stratégique), is based at the l'Ile Longue peninsula near Brest. Of the four SSBNs, at least two are always fully operational, one of them at sea of deterrent patrol. A deterrent patrol reportedly lasts about 10 weeks.[20]

Ballistic missiles boosters are thought to be stored at the missile depot near Saint-Jean approximately four kilometres south of the base. The l'Ile Longue island itself also includes a unique arrangement of what appear to be 24 missile silos, although the precise function is unclear, and appears to be expanding with a second missile storage bay. Warheads arrive in unassembled form and are assembled at the base before deployment.[21]

All French SSBNs are equipped to carry the M51 SLBM. Three operational submarines carry the M51.2 equipped with the new TNO (tête nucléaire océanique) warhead. The TNO is based on a design that was tested during France's final nuclear test series at Mururoa in 1995–1996. The fourth SSBN will received the M51.2 in 2020. The M51.2 is thought to have a range of over 9,000 km, depending on how many warheads it is loaded with. The production contract for the M51 was awarded to EADS Astrium SPACE Transportation in 2004 at a price of US $3 billion (€3 billion).[22] A third M51 version known as the M51.3 is in development and scheduled for completion by 2025 and will incorporate a new third stage for extended range and further improvement in accuracy.[23]

Table 3: French SSBN missile and warhead modernisation, 2020

SSBN NAME	2008	2015	2020
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*

Note: The M51.1 has much greater range than the M45 and the M51.2 has greater range than the M51.1. An M51.3 upgraded is planned for the mid-2020s. Each M51 can carry up to six warheads but may carry fewer depending on mission. Only three sets of missiles were produced. A fourth SSBN will be in overhaul at any given time.
**Missile upgrade scheduled for completion in 2020.*

To replace the Triomphant-class SSBNs, development of a next-generation SSBN known as SNLE-3G (Sous-Marin Nucléaire Lanceur d'Engins de 3rd Génération) has begun. Although longer than the Triumphant, the SNLE-3G will carry the same number of missiles (16).

Although not nuclear armed themselves, nuclear-powered attack submarines (SSNs) play an important part in the nuclear mission by providing protection to SSBNs deploying on patrol. Six Rubin-class SSNs will be replaced by the new Barracuda-class between 2020 and 2030.

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). Established in 1958, DAM is responsible for research, design, manufacture, operational maintenance, and dismantlement of nuclear warheads. DAM also builds nuclear reactors for France's nuclear-powered submarines and aircraft carrier. Of CEA's nearly 20,000 employees, more than 4,500 are working for the DAM.

Following the decision to end nuclear testing in 1996, France has reorganised its nuclear weapons centres. Today, DAM operates five major sites (see Table 4).

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. French-British Epure facility added since 2014 to study hydrodynamic behavior of warheads. This includes Airix X-Ray accelerator, previously located at Moronvilliers.
CES/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 Megajoule laser facility designed to study the fusion process of secondaries.
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.

Warhead design and simulation of nuclear warheads take place at the DAM-Ile-de-France (Bruyères-le-Châtel) Centre approximately 30 km south of Paris. The centre houses Tera 100, a supercomputer that went into operation in July 2010. The previous generation supercomputer, Tera 10, is also located at the centre, which employs about half of the people affiliated with the military section (DAM) of the CEA. An even faster supercomputer named Joliot-Curie under construction is designed to reach 22 petaflops.[24]

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 km 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 was moved to Valduc from the Moronvilliers center in 2014, a second radiography facility was added by 2019, and a third is planned for 2022 to form the Epure facility.

The Ripault Centre (Centre d'Etudes de Ripault, or CEA Ripault) is located south of Tours and is responsible for studying and design of new materials used in nuclear weapons and naval reactors. The centre also works on nonproliferation issues.

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 Megajoule laser, France's equivalent of the US National Ignition Facility, and was completed in 2014. CESTA, which was established in 1965, covers an area of 700 acres and employs 1,000 people.

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

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.[25]

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 12 nuclear-powered naval vessels in operation: four Triumphant-class ballistic missile submarines, six Rubis-class attack submarines, one Barracuda-class attack submarine undergoing sea trials, 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. The first Barracuda-class attack submarine undergoing sea trials—the *Suffren*—is one of six boats intended to replace the Rubis-class.[26]

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 approximately 10 years. The reactor core for the next-generation SSBN (SNLE-3G) is in development in a test reactor known as RES (réacteur d'essais) and will have a longer core life.

Economics

Assessing the total cost and breakdown costs of French nuclear forces is difficult. The French Ministry of Defense says France allocated at least US $4.9 billion (€4.5 billion) to nuclear forces in 2019,[27] an increase of more than 10 per cent compared with €4 billion in 2018.[28] But the total apparently does not include all costs.[29] The increase is part of an "exceptional increase"[30] of military spending in response to what is seen as a deteriorating security environment in Europe and elsewhere. In total, the French government says it will spend €25 billion (US $28 billion) on its nuclear forces in the five-year period between 2019 and 2023.[31]

Arms control and doctrine

France is a state party to the nuclear Non-Proliferation Treaty (NPT) having ratified the Treaty in 1992.[32] It maintains it is in full compliance with its commitments under NPT's article VI, but does so "within the framework of a progressive and realistic approach, in order to promote regional and international stability, on the basis of undiminished security for all."[33] In a statement to the 2019 NPT Preparatory Committee, France noted that "We share the ultimate goal of the total elimination of nuclear weapons, when the strategic context allows."[34]

France has stressed for many years the importance of negotiating a Fissile Material Cut-off Treaty (FMCT) within the United Nations' Conference on Disarmament. France participated in an FMCT-relevant Governmental Group of Experts in 2014 and 2015 and in a High-level Experts' Preparatory Group in in 2017 and 2018.

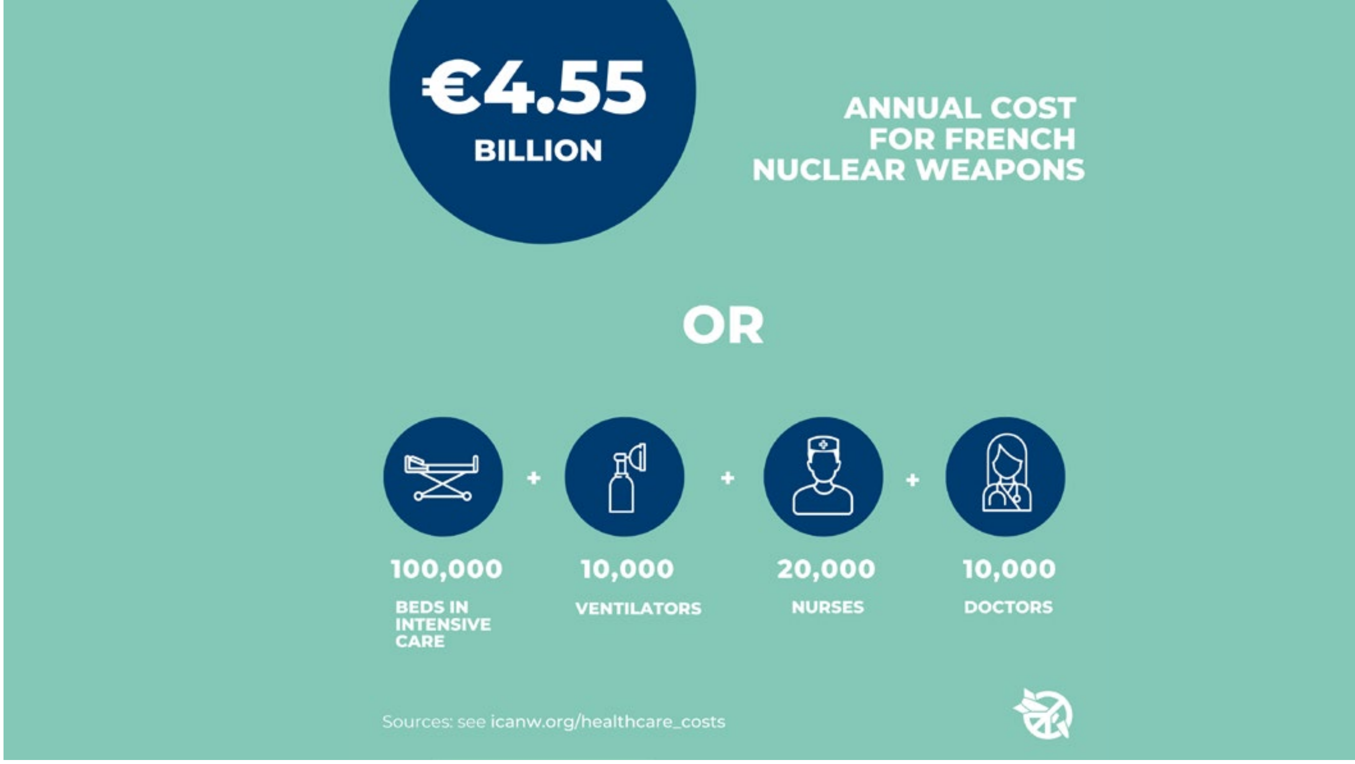
France signed the Comprehensive Test Ban Treaty (CTBT) in 1996 and ratified it jointly with the United Kingdom in 1998.[35] This brought to an end more than three decades of destructive and controversial nuclear weapon testing that involved a total of 210 tests, almost 200 of which took place in the South Pacific.[36]

France did not participate in the negotiations of the Treaty on the Prohibition of Nuclear Weapons (TPNW) and has indicated it does not intend to accede to it. "The entry into force of this Treaty could weaken the NPT as the cornerstone of the international non-proliferation regime by creating an alternative and contrary norm. For this reason, France reiterates that it does not intend to accede to it. Those who have joined must explain how to preserve security and stability, particularly in Europe and Asia, in the absence of nuclear deterrence, in the face of rearmament and the resurgence of threats, without risking high-scale conventional warfare."[37]

France regretted the decision of the United States to withdraw from the Intermediate Range Nuclear Forces (INF) Treaty, concluding that Russia had developed a missile system in violation of the Treaty which effectively left the US with no choice but to withdraw.[38] At the time, it urged Russia to return to full compliance with the Treaty's obligations.

France has also engaged in several rounds of multilateral diplomacy with Iran over its nuclear programme. This included the P5+1 talks that led to the 2015 Joint Comprehensive Plan of Action (JCPOA). French President Macron publicly regretted the US' withdrawal from the agreement, and later worked with Germany and the UK to establish the Instrument in Support of Trade Exchanges (INSTEX) to facilitate trade with Iran.[39]

Finally, in February 2020, French President Macron delivered a speech outlining his vision for France's nuclear "deterrence" strategy.[40] In it, he stressed the role of nuclear weapons within European security policy that was widely seen as offering a wider role for France's nuclear weapons in the security of the rest of the continent,[41] including the suggestion that other countries could participate in French nuclear deterrence exercises



ICAN has calculated how the annual cost for French nuclear weapons could pay for health care services.

and war games. Macron's speech dismissed calls for nuclear abolition as an "ethical debate" that lacks "realism in the strategic context" and reiterated France's position on the TPNW. In some respects, this builds on the statements of former leaders as well as more recent actions under Macron that have underlined an interest asserting a more prominent role in providing for European "security" in the face of growing hostility between the United States, China, and Russia.

Public discourse

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 included in the text at the insistence of the French government.[42] 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 NPT to pursue nuclear reductions, its rejection of additional reductions and its ongoing modernisation of its nuclear forces might be seen as being out of sync with those obligations.

Recent polling, however, shows strong opposition to nuclear weapons amongst adults aged 20 to 35, referred to as "millennials". A 2019 poll, commissioned by the International Committee of the Red Cross (ICRC), found that 81 per cent of French millennials think that it is never acceptable to use nuclear weapons in wars or any armed conflict, and 80 per cent agreed that the existence of nuclear weapons is a threat to humanity. Moreover, the same survey showed that 45 per cent of millennials also supported France's accession to the TPNW, while 29 per cent would neither support or oppose France joining, and only 17 per cent opposed it.[43] Finally, a 2018 survey, commissioned by the French Peace Movement and the Catholic newspaper *La Croix*, found that amongst 1001 surveyed French citizens of age 18 and above, 67 per cent affirmed that France should join the TPNW.[44]

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India

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Since 1998, India has been gradually increasing its stockpile of nuclear warheads and diversifying the number of vehicles it could use to deliver these warheads. In addition to aircraft, there are also a range of land-based and naval-launched missiles. The latter can be launched from ships and a nuclear-powered submarine that was deployed a couple of years ago. India's stockpile of fissile materials to make nuclear weapons has also been increasing concomitantly. In addition to nuclear weapons, India's expenditures on conventional military arms and imports of weapons from other countries have continued to expand. India is not a signatory to any multilateral treaty related to nuclear weapons. Over the years, the levels of public discourse have become very militaristic and the current government has been following very aggressive policies in the disputed region of Kashmir.

Current status

India has a fast growing nuclear arsenal and its size has increased significantly in the over two decades since the 1998 nuclear weapon tests. The latest figure is from the Federation of American Scientists (FAS), which, based on publicly available information about India's delivery vehicles and strategy, estimated in 2018 that the country might have 130–140 nuclear warheads.[1] In comparison, FAS estimated 60-80 assembled nuclear warheads in 2010 and 30-35 warheads in 2002.[2] However, numbers of warheads are not the best indicator of changes to India's nuclear arsenal. For that one has to look at the means of delivering these weapons.

Delivery vehicles

The main focus of modernisation and enhancement of the nuclear arsenal has been on developing new and longer-range delivery vehicles. In particular, the deployment of a nuclear powered and armed submarine over the last five years has allowed India to justifiably claim that it now possesses the "triad of aircraft, mobile land-based missiles and sea-based assets" that was called for in the country's 1999 Draft Nuclear Doctrine.[3]

Aircraft

India's first operational nuclear delivery vehicle was the Mirage 2000 aircraft. Although India had purchased these aircraft from France in the 1980s, it was only in the mid-1990s that its use for delivering nuclear weapons was operationalised; a similar effort involving the Jaguar was unsuccessful "because of the low ground clearance between the aircraft and the nuclear weapon container".[4] However, after the 1998 nuclear weapon tests and further refinements in weapon design, the Jaguar might indeed have been capable of use as a nuclear delivery vehicle.

The Mirage 2000H was retired in the summer of 2018, and is undergoing upgrades to extend its service life and enhance its capabilities; the modernised version is called Mirage 2000I.[5] Most of the changes involve upgrades in sensing equipment, such as radars and receivers, navigation and communication systems, and data management systems.[6] While these might not affect the nuclear delivery capability as such, it enhances the ability of the aircraft to carry out such a task without being intercepted.

The Jaguar too is being upgraded, through new systems for avionics, navigation systems, and various information systems. According to India's Ministry of Defence, the "operational capability of the aircraft in terms of weapon carrying capability and mission reliability would improve due to higher available thrust and improved reliability".[7] This suggests that it might have greater range for nuclear delivery.

India also signed a deal with France for purchasing Rafale aircraft.[8] Newspaper reports suggest that it will be used to deliver nuclear weapons and conventional weapons; the first squadron of aircraft are to be based in the eastern part of the country, suggesting that their primary targets will be in China.[9]

Land-based missiles

India's main land-based missiles that are designed for delivering nuclear weapons are the Prithvi and Agni series of missiles. The Prithvi is the shorter range missile that is fueled with a liquid propellant and is originally derived from a Soviet Surface to Air Missile. Of the two land-based variants developed, only the Prithvi II has been inducted into service as a nuclear delivery vehicle. Its range is said to be 250 to 350 kilometres, depending on the payload. It is regularly tested by its "users", the Strategic Forces Command, and the annual reports of India's Ministry of Defence record two tests in 2015, three in 2016, one in 2017, and two in 2018.

The longer range Agni missile comes in multiple versions, with their range going all the way from 700 km to over 5000 km. At least four of these have been delivered to the Strategic Forces Command, and the annual reports of India's Ministry of Defence record them carrying out "user trials" for Agni I (two in 2016, two in 2018), II (one in 2017, one in 2018), III (one in 2017), and IV (one in 2017).

The most recent test of the 2000-km range Agni-II in November 2019 was said to be the first trial carried out at night.[10] The following month, a similar maiden night-trial of Agni-III was reported to have been a failure.[11] The last test of the Agni-IV was conducted on 23 December 2018 and was reportedly the seventh trial carried out by the Strategic Forces Command.[12]

The longest range version of the Agni is Agni-V, a three-stage, solid-fueled, rail-mobile, ballistic missile that is capable of delivering a warhead to 5,000 kilometres or more. Agni-V was successfully tested in December 2018 and is supposed to be inducted into the Indian army in 2020.[13] A special feature of the Agni-V is that it has been tested from a canister rather than a fixed concrete launch pad. The canister design allows for missiles to be launched quickly and for the missile to be transported by trucks on roads, hence making it harder to locate.

Approximately seven years ago India's Defence Research and Development Organisation (DRDO) was reported to be developing a longer range Agni-VI, which was said to be capable of carrying multiple independently targetable re-entry vehicles or MIRVs.[14] This claim was repeated in the government's Press Information Bureau website in December 2016, according to which the Agni-VI was to have "have a strike-range of 8,000–10,000 kilometers".[15] However, this missile has not been tested so far. It is conceivable that the missile has been designed and could be tested at some future date. At the same time, it is possible that Indian leaders might be concerned that testing such a long-range missile would lead to a strong reaction from the United States (US), whose analysts have long warned about the threat from an Indian intercontinental ballistic missile (ICBM).[16]

India is also embarking on developing hypersonic missiles and tested a "hypersonic technology demonstrator vehicle (HSTDV) that will have futuristic applications for next generation missiles and aerial systems" in June 2019.[17] Some reports described the test as a failure, while others reported it as a success and predict that it will be used for furthering India's ballistic missile defence program and developing longer range cruise missiles.[18]

India has also developed a cruise missile, which is described as nuclear capable, with a range of over 1000 km called Nirbhay, which had its first successful test in November 2017 after several failures, and subsequently successfully tested again in April 2019.[19]

Sea-based missiles and submarines

The naval variant of the Prithvi is called the Dhanush, with a range of around 350 or 400 km. Like Prithvi-II, it has been deployed and is regularly tested by its "users", the Strategic Forces Command, and the annual reports of India's Ministry of Defence record two tests in 2015, two in 2016, and two in 2018.

The focus of development in the last few years, however, has been on two submarine-launched ballistic missiles (SLBM), the K-15 and the K-4. The first missile, K-15, which is also termed the B-5 or the Sagarika, is a nuclear-capable SLBM with a range of 750 kilometres and was reportedly tested thrice by users from a submarine that was "positioned nearly 20-meter deep in the sea, about 10-km off the" eastern coast of India in August 2018.[20] Since then, the missile has reportedly been deployed on India's nuclear submarine, the Arihant, that was described as having gone on a "deterrent patrol" in 2018.[21] The Arihant's four launch tubes will reportedly be capable of carrying 12 K-15s.[22]

For many years, Indian naval planners have bemoaned the short range of the K-15 and pressed for longer range missiles that would allow them to target China from the Bay of Bengal or the Arabian Sea. The missile capable of those attacks is the 3000 km range K-4 missile, which was first tested in March 2014.[23] It has subsequently been tested many times, including in January of this year from an underwater platform.[24]

Subsequently, there was a media report that the DRDO is designing a 5,000km-range submarine-launched missile based on the Agni-V missile design; however, the media report goes on to quoting an unnamed senior official as saying "the final decision lies with the government. And no such sanction has been either sought or approved", thus making the status of this missile uncertain.[25]

The K-4 and K-15 missiles are intended for deployment on India's first nuclear-powered ballistic missile submarine, or SSBN, the Arihant. As mentioned earlier, that submarine was reported as having been on "deterrence patrol" suggesting that it has been loaded with nuclear weapons and deployed.[26]

A second SSBN, variously called Arighat and Aridhaman, is reportedly under construction and expected to be commissioned in 2020–2021, and this will be followed by two more SSBNs.[27] India is in the process of constructing nuclear powered attack submarines, with the government reportedly approving six of them.[28] However, the timeline for this construction will stretch well into the next decade and, as of June 2019, the project had only been given seed money to work on a new special alloy for the hull.[29]

The proliferation of nuclear submarines raises the possibility of accidents and concerns about command and control.[30] The Arihant, according to one report, has already been in an accident.[31] The veracity of this report has been questioned, and India's defence ministry refused to answer a question asked in Parliament about the extent of the damage and the cost of repairs.[32]

Fissile materials

India's nuclear weapons are based on plutonium. Although the country produces highly enriched uranium (HEU), the other fissile material commonly used in nuclear weapons, all the HEU produced in the country is believed to be earmarked for the nuclear submarine programme described earlier.

India has historically produced weapons-grade plutonium at two production reactors, CIRUS and Dhruva, both at the Bhabha Atomic Research Centre (BARC), in Mumbai.[33] CIRUS was shut down in 2010 but Dhruva continues to operate. Spent fuel from the reactor is reprocessed to separate out the plutonium contained the Trombay reprocessing plant. BARC is also where most of the nuclear weapons work in the country is carried out; for example, metallurgical activities involving plutonium.[34]

On the basis of the limited amount of publicly available information and reasonable assumptions, and after accounting for material that would have been used in nuclear weapons tests and other purposes, India is estimated to have a net stockpile of weapon-grade plutonium of 0.69±0.14 tons of weapon-grade plutonium as of the end of 2019.[35] In comparison, in the 2012 edition of Assuring Destruction Forever, the estimated stockpile was around 0.43 tons. The 2019 stockpile should suffice for about 140 nuclear weapons.

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 speculation that one of the devices tested in 1998 used reactor-grade plutonium.[36] If this is the case, then India's nuclear arsenal could potentially be much larger. The estimated stockpile of separated plutonium from power reactors is around 7.7±4.1 tons of reactor grade plutonium, of which about 0.4 tons are under IAEA safeguards.[37] Assuming that about eight kilograms of the material is required for a weapon, this stockpile could be used to make 400 to 1400 weapons.

The HEU used to fuel nuclear submarines comes from the Rare Materials Plant in the state of Karnataka. The HEU is said to be enriched to a level between 30 and 45 per cent of uranium-235, which is significantly less than what can be used to make weapons. Assuming an enrichment level of 30 per cent, India might have produced 5.2±1.8 tons of HEU as of the end of 2019 with a uranium-235 content of 1.6±0.5 tons.[38]

Economics

According to the Stockholm International Peace Research Institute (SIPRI) database on military expenditures, India's military spending has traditionally been around 2.5 to 3.0 per cent of its GDP. Other sources record lower percentages but it is not clear what expenditures are included. For example, the International Institute for Strategic Studies database puts the figures closer to 2 per cent.[39] In 2018, it reached 2.4 per cent, the lowest it had been in a decade. The slowdown in economic growth and a widening budget deficit are probably driving the reduction in defence expenditure.

Table 1: Military expenditure (local currency, current prices for calendar years)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Military Expenditure (bn Rs)	1874	2108	2316	2523	2778	3107	3291	3805	4209	4547
Military Expenditure (bn constant 2017 USD)	51.6	51.8	52.3	52.1	51.7	54.2	54.7	60.3	64.6	66.6

Source: SIPRI Military Expenditure Database, https://www.sipri.org/databases/milex.

India, however, is one of the world's largest arms importers. Between 2014 and 2018, it was the world's second largest importer of major arms and accounted for 9.5 per cent of the global total.[40] Traditionally, the majority of its imports came from Russia but in recent years the share of imports from Israel, the US, and France have been increasing.

Practically all of these arms imports are in the realm of conventional military capabilities. These increases in conventional military capabilities do have a bearing on the risk of nuclear war because they are aimed at the two countries that Indian political leaders point to as their nuclear rivals: Pakistan and China. With regard to Pakistan, the primary purpose of enhanced military capabilities are to credibly threaten to fight limited wars before Pakistan might consider using nuclear weapons, or "under the nuclear threshold" as strategists term such plans. In the case of China, the primary purpose is to try and match China's much larger military capabilities.

In addition to arms imports, one of Prime Minister Narendra Modi's stated priorities is to increase exports of weapons. In February 2020, at the largest defence exhibition organised so far in India (which involved over 1,000 companies, including 172 foreign ones) he announced that India was looking to achieve defence exports worth Rs 350 billion (or roughly US $5 billion) in the next five years.[41] This has implications for weapons development. The short range (200 km) missile called Pranash that is under development has been described as attractive because it "is outside the purview of the Missile Technology Control Regime (MTCR), which places export restrictions on missiles with ranges of more than 300km" and can therefore be exported to other countries.[42]

The current government is, as a matter of stated policy, promoting the privatisation of public sector companies involved in the defence sector.[43] Increasingly, manufacture for defence is also contracted to private companies, either singly or as public-private partnerships. Some of the companies that are benefitting from this trend are those that have been closely associated with the Prime Minister. For example, the Reliance Group was involved in a controversial deal involving the imports of Rafale jets from France.[44] Another closely associated company belonging to the Adani group came close to being awarded a Rs. 450 billion contract for building submarines, which eventually went to another private company, Larsen & Toubro, that had been traditionally associated with the construction of the Arihant nuclear submarine.[45]

Both these trends—the privatisation of the defence industry and the focus on exports—are worrying and will likely set the course of ever-increasing build-ups of weapons, including nuclear weapons and allied systems.

International law and doctrine

India has not signed either the nuclear Non-Proliferation Treaty (NPT) or Comprehensive Test Ban Treaty (CTBT). Officially, India is "committed to maintaining…the policy of no-first use of nuclear weapons".[46] But there have been signs that this commitment might not be reliable.[47] In parallel, India's development of nuclear missiles in sealed canisters and the deployment of its first nuclear powered and armed submarine, Arihant, raise the possibility of military officials being in a position to launch nuclear weapons without authorisation from the highest political authorities.[48]

During the 2016 dispute with Pakistan, for example, then–Indian defence minister Manohar Parrikar indicated that India should not "bind" itself to that policy.[49] In 2019 the current defence minister Rajnath Singh reiterated that the no first use policy might change in the future, a statement that was particularly relevant because it was made during a period of heightened tension in Kashmir.[50] This has been the case ever since the Hindu Nationalist Bharatiya Janta Party (BJP) came back to power under the leadership of Prime Minister Narendra Modi after the 2019 general elections. The BJP and its support base have been consistently ideologically motivated to support nuclear weapons even before China tested its first bomb, and their role in carrying out the 1998 nuclear weapons tests was considerable.[51]

The BJP's political outlook has also led to heightened tensions between India and Pakistan. In early 2019, the two countries were embroiled in a major standoff that involved aerial attacks and that prominently featured threats to launch missiles at each other.[52] Ceasefire violations in Kashmir along the Line of Control (LOC) between the two countries have increased tremendously. In 2019, a total of 3,200 incidents of firing across the LOC have been reported, which is a large increase over the 1,629 incidents reported in 2018, and an even larger increase over the 583 reported in 2014.[53]

India did not participate in the negotiations of the Treaty on the Prohibition of Nuclear Weapons, adopted in July 2017. At the time, it stated that it was "not convinced" that the negotiations would deliver an effective nuclear disarmament treaty, including one with effective verification mechanisms, and that it would prefer to see discussions occur within the UN Conference on Disarmament.[54] To that end, India has advocated a negotiating process toward a Convention on the Prohibition of Use of Nuclear Weapons including through statements and resolutions tabled at the UN General Assembly's First Committee on International Security and Disarmament.[55]

Public discourse

The expansion and modernisation of nuclear weapons has been accompanied by claims about India becoming a powerful nuclear state. While Pakistan is a traditional target of the media, there has been an increased focus on being able to attack China, although this is usually phrased as 'defend against' China.[56] With Pakistan, surgical strikes and border skirmishes are being highly publicised, with the government's actions being described as a strong response. In both 2016 and 2019, Indian media went into a frenzy on the 24-hour news channels.[57] "We want revenge, not condemnation. … It is time for blood, the enemy's blood," screamed Arnab Goswami, a notoriously aggressive news anchor.[58] Social media too featured similar rhetoric and pro-war hashtags trended on Twitter. One twitter handle started a poll on people's opinion of using nuclear weapons to "finishing Pakistan" as well.[59] A big budget Bollywood film "Parmanu" valorising the 1998 nuclear test by India was a huge financial success. The rhetoric of war and nuclear weapons was used widely in the 2019 general elections with Prime Minister Modi himself implying that he will not be scared to use nuclear weapons.[60]

There is also a long-standing desire on the part of the elite to have India be recognised as a great power. Many official announcements about the achievement of any new capability will be accompanied by a statement about how India has reached some exclusive set of countries with that particular capability. For example, when India destroyed a satellite with an anti-satellite weapon in March 2019, the Prime Minister tweeted "India is only the 4th country to acquire such a specialised and modern capability" and "India stands tall as a space power!".[61]

On 27 May 1998, about two weeks after conducting nuclear tests, India's Prime Minister Atal Behari Vajpayee declared in the Parliament, "India is now a nuclear weapon state" and went on to state that India's "strengthened capability adds to our sense of responsibility".[62] As illustrations of this sense of responsibility, Vajpayee declared the country's intentions not "to use these weapons for aggression or for mounting threats against any country" and not "to engage in an arms race". Today, over two decades after that statement, it is clear that India has been engaged in an arms buildup that is very reminiscent to the Cold War although smaller in scale. The same period has also seen a number of threats issued. An example is the rhetorical question by the current Indian Prime Minister, who belongs to the same political party as Vajpayee and who asked whether India's nuclear arsenal had been kept for Diwali, the traditional Indian festival where firecrackers are burst. Today, India can legitimately lay claim to belonging to another select, if infamous, club: of countries that are at risk of nuclear war. It is not a club worth belonging to, for the lives of millions and millions of people are at stake.


Gas-mask © Yuri B, Pixabay

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Israel

Sharon Dolev

Israel neither confirms nor denies the existence of its nuclear programme[1] and factual information about it relies mainly on sources outside of Israel. Figures and estimates are based on the assumed power capacity of the Dimona nuclear reactor, the pictures and revelations from Mordechai Vanunu[2] (a former Dimona nuclear technician), and publications regarding the purchases of aircraft, submarines, and missile systems, which can be used as means of delivery.

Since the late 1960s, Israeli governments have maintained a policy of ambiguity and opacity about the nuclear programme in their various conversations with the United States government.[3] The main phrase used then (and since) was that Israel won't be the first to "introduce" nuclear weapons to the Middle East. While the word "introduce" is usually considered to mean an Israeli nuclear test, the actual meaning still remains unclear as will be demonstrated in the section of this chapter on public discourse.

Since the New York Times publication in 1970, which featured revelations about the Israeli nuclear programme as based on US intelligence assumptions, it has been widely assumed that Israel possesses nuclear weapons.[4]

Current status

Nuclear weapons

Estimates about the size of the arsenal are based on the power capacity of the nuclear reactor near Dimona, ranging from 26MWt to 70MWt[5] or even 150MWt,[6] and on assumptions about production that in turn are based on speculation, scientific calculations, and unconfirmed revelations dating back to 1986.[7]

Experts and analysts outside of Israel 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 recently cited figure is 80 warheads.[8]

Delivery systems

Israel has been developing its weapon delivery systems since the 1960s and is believed to have a nuclear triad made up of its Dolphin submarines, modified aircraft, and nuclear-tipped Jericho missiles.

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Israel's missile programme is shrouded by a high level of secrecy and Israel does not release missile inventories. However, assumptions about its Jericho-II missiles are made, among others, based on Israel's space-launch rocket, the Shavit, which is similar to the Jericho-II.

Missiles

Sdot Micha Air Force Base is believed to host nuclear-tipped missiles[9] and it is assumed that Israel has deployed between 50 to 100 ballistic missiles:[10] the Jericho-I (now probably out of commission), Jericho-II (1,500km range), and Jericho-III (4,800km-6,500km range and 1,000-1,300kg payload),[11] all capable of carrying nuclear warheads.[12]

It is also believed[13] that on 6 December 2019, Israel conducted a test launch of what is assumed to be a Jericho-IV missile with a range of "thousands of kilometers and able to carry among others, nuclear warheads."[14] Iran's Foreign Minister, Mohammed Javad Zarif, referred to the test on Twitter, saying that "Israel today tested a nuke-missile, aimed at Iran."[15]

Table 1: Design characteristics of Israel's ballistic missiles

	OTHER NAME	LENGTH (M)	DIAMETER (M0	PAYLOAD (KG)	RANGE (KM)	ACCURACY CEP (M)	PROPELIANT	STATUS
Jericho-1 (1)	YA-1	13.40	0.8	450	500	1,000	Solid	Obsolete
Jericho-2 (2)	YA-3	14.0	1.56	1,000	1,500-3,500	n/k	Solid	Deployed
Jericho-3 (3)	YA-4	15.5	1.56	750	4,800-6,500	n/k	Soild	Development
LORA (4)		5.2	0.62	440-600	200	10	Solid	Deployed
Etra (5)		4.0	n/k	120	150	10	Solid	Developments
Lance (6)	MGM-52	6.41	0.56	100	130	150	Liquid	Decommissioned

Source: Nuclear Treat Initiative, May 2012.

Aircraft

Even though Israel assured the US administration back in the late 1960s that it "agrees not to use any aircraft supplied by the US as a nuclear weapons carrier,"[16] it is believed that some of the Israeli Air Force Fleet has been modified to carry nuclear weapons.

Since the 1980s, Israel's estimated 200 F-16 Falcons, with a range of 2500km, have been the backbone of the Israeli Air Force (IAF), alongside a fleet of F-15 Eagles (Boeing). Both of these planes are used by the US and the North Atlantic Treaty Organisation (NATO) for carrying nuclear weapons. At the end of 2017, the new Lockheed-Martin F-35I came into operation in Israel and has already been used to attack Iranian targets in Syria.[17] Despite a number of reservations by Israeli officials,[18] Israel has committed to a further purchase of the aircraft, bringing the total size of its future fleet to 33 in number. The F-35I, which is supposed to replace the older F-16s, is reportedly used by the US for nuclear weapon missions, although there is no indication that Israel will do the same, nor is there any evidence that Israel has made any promises to the US administration regarding any future use.

Submarines

As of January 2016, Israel's fleet includes five Dolphin-class submarines built in Germany.[19] One more submarine should become operational by the end of 2020[20] and will bring the fleet to a total of six. Estimates[21] are that at least some of the submarines have been modified and used for nuclear missions, and even the Israeli press refers to the fleet as Israel's "second strike".[22]

From numerous estimates and articles trying to guess which of the cruise missiles believed to be on board the Israeli submarines are nuclear capable, there are three main options:[23]

- Popeye Turbo, an Israeli air to surface missile, with a payload of 350kg and an estimated range of 1,500km;[24]
- Harpoon, a US anti-ship cruise missile, with a payload of 224kg and a range of 90–240km;[25] or
- Gabriel Mk4-5, an Israeli short-range anti-ship cruise missile, with a payload of about 240kg and an estimated range of 200–400km.[26]

It would be a calculated guess to assume that the Popeye Turbo missile is the best candidate for Israel's second strike capability, based on the following a) no other country has modified its Harpoon missiles for nuclear usage;[27] b) the range of the Popeye missile and its payload; and c) there is an assumption that the Dolphin's nuclear delivery systems have been developed in Israel.[28]

Table 2

NAME (NUMBER)	CLASS	BUILDER	COMMISSIONED
INS Dolphin	Dolphin	HDW	1999
IMS Leviathan	Dolphin	HDW	2000
INS Tekumah	Dolphin	HDW	2000
INS Tanin	Dolphin II	HDW	2014
INS Rahav	Dolphin II	HDW	2016

Source: Nuclear Threat Initiative, 16 Oct 2019.

Fissile materials

It is estimated[29] that Israel could have produced approximately 840 kg of weapons-grade plutonium.[30] Estimates of highly enriched uranium (HEU) production are even more difficult to make. According to the International Panel on Fissile

Materials (IPFM), Israel is believed to not have any significant domestic HEU production for weapons, yet may have acquired a small HEU stockpile.[31] A recent estimate has assumed Israel possesses approximately 300 kg of HEU.[32]

Infrastructure

There are two main nuclear facilities in Israel.

In operation since the 1960s, the Shimon Peres Negev Nuclear Research Center (NNRC), located near Dimona, is believed to be the oldest heavy water reactor still working today, although it is believed that, if it is still operational, it is mainly for tritium production.[33]

When built in the Negev desert near the city of Dimona, with the assistance of France, the reactor's capacity was 24 MWt, and now it is believed to be between 40–70 MWt[34] or even 150 MWt.[35]

According to the Israel Atomic Energy Commission (IAEC), the NNRC's main purpose is to "broaden basic knowledge in nuclear sciences and adjacent fields and to provide the foundation for the practical and economic utilization of nuclear energy.[36]" The facility hosts Israel's research and production of radioactive isotopes for medical use, an educational programme, and is responsible for Israel's radioactive waste.[37] However, reports based on statements by Mordechai Vanunu, among others, suggest further activities such as plutonium extraction, plutonium reprocessing, production of tritium and lithium-6, uranium processing, enrichment, and fuel fabrication.[38] The NNRC is not under International Atomic Energy Agency (IAEA) safeguards.

The pool-type light water reactor for the Soreq Nuclear Research Center (SNRC) was donated by the United States and built in the 1950s as part of the Atoms for Peace programme. It became operational in 1960.[39] Originally the reactor's capacity was 1MWt and later on expanded to 5MWt. The SNRC is located approximately 40km south of Tel Aviv near the city of Yavne and is the only facility in Israel under IAEA safeguards.

According to the Soreq website, "Today the SNRC is an established research center founded on scientific and technological excellence in a range of areas including nuclear physics and engineering, nuclear medicine, non-destructive testing techniques, laser and optronic applications, testing components and materials in space environment, radiation safety, and more."[40]

In 2012 there were reports[41] that the IAEC was planning to close the reactor in order to focus on its particle accelerator and even suggestions[42] that Israel has shipped 102 spent uranium rods to the US.

The Israeli Atomic Energy Commission (IAEC) oversees Israel's nuclear activities.[43] Responsibility for the IAEC falls under the prime minister's office and it reports directly to him, as the chair of the IAEC.

Although the IAEC was created in 1952,[44] its roles and methods of monitoring its activities have never been enshrined in law.[45] Instead they were established by a secret administrative order, issued by then-prime minister David Ben Gurion and later via a series of secret government rulings.[46] In addition, the IAEC's facilities are excluded from relevant legislation, such as that concerning the treatment of hazardous materials,[47] non-ionising radiation,[48] and the pharmaceutical applications of radioactive materials.[49] These rulings specifically mention that the law doesn't apply to the IAEC's facilities. The Commission deals with a variety of topics concerning health and safety, including nuclear safety, the licensing of facilities and activities, and the treatment of nuclear waste, and serves as a governmental consultant as well as represents Israel in relevant international organisations.

Economics

When trying to estimate Israel's annual spending on its nuclear capabilities, one has to rely on scarce information. The Stockholm International Peace Research Institute (SIPRI) estimates Israel's total military spending for 2018 at US $15.88 billion.[50] If we combine this information with a 2011 report from Global Zero report[51] which estimated that 11.53 per cent of Israeli military spending is allocated to nuclear weapons, we arrive at an estimate of US $1.839 billion for 2018. However, the IAEC budget is under the budget of the Office of the Prime Minster, and Israel military spending remains ambiguous and difficult to understand, organised across a variety of budget lines and items.

International law and doctrine

Israel is not a state party to any of the major arms control related treaties and therefore, argues that it is not bound by them. Though the policy of ambiguity has shaped Israel's behaviour in the international arena, other factors include the fear or resentment of being "singled out," along with a long history of suspicion that "the world" is against Israel.[52] On the other side is Israel's expectation to be treated differently from other states, based on it having been the safe haven for Jews after the Holocaust—but a safe haven surrounded by enemy states that do not recognise Israel's right to exist. At the same time, Israeli officials, in international fora talk about Israel's "long standing policy to bring itself closer, wherever possible, to international norms on nuclear safety, security and non-proliferation."[53]

While Israel resists calls to disarm and join the nuclear Non-Proliferation Treaty (NPT), it is a member state of the Treaty's "watchdog"—the International Atomic Energy Agency (IAEA)--since 1957[54] and "has played a positive role in some of the activities related to the non-proliferation regime, such as in its positive working relations with the IAEA in the area of nuclear safety, and in the creation and operations of the Comprehensive Test Ban Treaty (CTBT) mechanism."[55]

As part of its "positive role," Israel has signed the Convention on Nuclear Safety and the Vienna Convention on Civil Liability for Nuclear Damage. It has also ratified the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency; the Convention on Early Notification of a Nuclear Accident; the Amendment to the Convention on the Physical Protection of Nuclear Material; and the Convention on the Physical Protection of Nuclear Material.[56]

An example of Israel's desire to be recognised as a contributing and technologically advanced member of the IAEA was demonstrated by a statement delivered by Dr. Shaul Chorev, the then-head of the IAEC (2007–2015) at the 56th General Conference of the IAEA in September 2012. After a long statement regarding Iran and the Arab states' call for a weapons of mass destruction free zone in the Middle East, Chorev reported on Israeli participation in the Nuclear Security Summit in the Republic of Korea, announced Israel's "modest contribution"[57] to the IAEA project of enhancing the Capabilities of the Safeguards Analytical Service, and the launch of a project "for improving Quality Assurance in Nuclear Medicine". Despite "unwelcoming circumstances in the Middle East," Chorev also invited all states in the region to an Israeli-hosted workshop for the Asia Pacific Region, so that Israel could share its experience in the application of radiotherapy for cancer treatment. At the end of his statement, Chorev recalled that the IAEA is invited to Israel to conduct an Integrated Safety Assessment of the IRR-1 at the Soreq Nuclear Research Center, in addition to biannual inspections by the IAEA.

Israel has signed but not ratified the CTBT, which was adopted in 1996, and hosts CTBT Organisation (CTBTO) monitoring stations, including a seismic and radionuclide laboratory.[58] Though supportive of the CTBT, Israel has been reluctant to ratify it.

On 21 June 2016, in a first-time meeting between a head of the CTBTO and an Israeli prime minister, Netanyahu repeated Israel's support for the Treaty, but said that ratification "depends on the regional context and the appropriate timing."

In an interview conducted by an Israeli newspaper in 2019, Lassina Zerbo, head of the CTBTO, told the reporter that "Israel will likely agree to ban nuclear testing within the next three years."[59]

Israel abstained from participating in all humanitarian conferences preceding to the negotiations towards the Treaty on the Prohibition of Nuclear Weapons (TPNW).[60] In 2016, Israel voted against the UN General Assembly resolution that established the formal mandate for states to commence the negotiations in 2017 on "a legally binding instrument to prohibit nuclear weapons, leading towards their total elimination".[61] In 2019, Israel voted against a UN General Assembly resolution that welcomed the adoption of the treaty.[62]

Weapons of mass destruction free zone in the Middle East

Banning nuclear weapons in the Middle East has been linked to broader regional security issues and the eventual banning of all weapons of mass destruction. Israel, seen as the sole nuclear weapon state in the region, first insists on discussing security and regional recognition before engaging in talks on disarmament. Conversely, Arab states want an agreement on disarmament prior to discussions on security. This procedural and sequencing disagreement adds to a long list of other regional security-related challenges that have stifled cooperation and solution-based approaches.

A weapons of mass destruction free zone (WMDFZ) was first proposed by Egypt in 1990 with backing from Iran. In 1995, the NPT Review and Extension Conference resulted in the indefinite extension of the NPT, with a specific resolution co-sponsored by Russia, the United Kingdom, and the United States calling for the establishment of a WMDFZ in the Middle East. This resolution linked the indefinite extension of the NPT to commitments to create such a zone.[63]

At the 2010 NPT Review Conference, states parties agreed to practical steps to progress toward establishing the WMDFZ by convening a conference on the zone by 2012 and appointing Finland's Ambassador Jaakko Laajava as facilitator. In November 2012, however, the conference was called off by the United States "because of present conditions in the Middle East and the fact that states in the region have not reached agreement on acceptable conditions for a conference."[64] Similarly, at the 2015 NPT Review Conference, calls to restart the talks on a WMDFZ conference were derailed by the United States, the United Kingdom, and Canada.

Since Israel is a non-signatory to the NPT, it has no obligation to attend the conference on the zone within the NPT framework. That is one reason that led to the adoption by the UN General Assembly (UNGA) First Committee a resolution in 2018, submitted by the Arab states, requesting the UN Secretary-General to convene a regional conference on the zone by the end of 2019. This time around, the conference would be outside of the NPT process, and therefore, Israel would be more inclined to participate.

The first conference on the zone was convened at the UN Headquarters in New York, presided over by the Jordanian UN Ambassador Sima Bahouz with facilitation by the UN Office of Disarmament Affairs (UNODA) from 18—22 November 2019. To the surprise of naysayers, participation in the conference was robust, with the presence of all twenty-two-member states of the Arab League, Iran, four nuclear-armed states (China, France, Russia, and the United Kingdom), relevant international institutions, and a handful of civil society organisations.[65] The only states missing in the room among those invited were Israel and the United States, who remain attached to their insistence that the region is either not "ready" to discuss the zone or that this initiative is simply anti-Israeli. One key feature of the conference proceedings, though, is that all decisions were made based on consensus. Therefore, Israel's participation in the conference would enable its views to be aired and considered while having nothing to lose by virtue of the consensus-based decision-making process. This watershed conference, therefore, presented an opportunity for all regional states to discuss, in good faith, the path forward toward the zone and, through it, the broader geopolitical challenges facing the region.[66]

Ambiguity

The birth of ambiguity as a policy is rooted in several factors: the special relationship between Israel and the United States, the advancement of the already secretive[67] Israeli nuclear programme, and the negotiation and adoption of the NPT in these years.[68] As Merav Datan explained in this publication in 2015:

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. 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.[69]

Israeli officials have always said that Israel "will not be the first to introduce nuclear weapons to the Middle East" ever since the 1960s and still do so today, such as in a more recent CNN interview with Israeli Prime Minister Netanyahu[70]. Presidents, state secretaries, experts, and diplomats have since the 1960s until the present day tried to guess if "introduction" means a nuclear test, the possession of nuclear weapons, their deployment, or an announcement.[71]

While Israel is considered by the rest of the world to be one of nine states possessing nuclear weapons, ambiguity plays a major role in Israel's international relationships and participation in international nuclear-related fora, and even a bigger role in the internal discourse within the state of Israel.

Public discourse

While ambiguity outside Israel mainly covers the question of possession, the ambiguity inside Israel has a different magnitude. There is some limited discussion in academic circles amongst a small group of academics and think tanks, usually comprised of those who used to be part of the security system, and a steadily growing number of discussions in the media, though the focus is usually on Iran's nuclear programme and not Israel's.

The vast majority of Israelis, including the media, parliament,[72] and civil society organisations, are sure that the main reason for ambiguity is security confidentiality. In a way, keeping the secret even from Israelis has become sacred.[73] The fear for Israel's existence, the fear of Israeli isolation, the shared memory of the Holocaust, alongside questions still being posed about whether Israel has the right to exist or be recognised, make it harder to maintain an open discourse. With Israel's long history of self-censorship[74] and a reliance on foreign sources, the discourse is extremely limited and ill-informed.[75] Furthermore, there is no discussion on the existence of the facilities or structures that develop and maintain Israel's arsenal and, therefore, no public discussion regarding the actions or liability of the IAEC.

In fact, there is a common belief among the Israeli public and most members of the media that it is prohibited to even discuss this matter. This secrecy not only covers the question of Israel's arsenal, but also extends to the security of the reactors, radioactive waste, nuclear energy, and even the question of whether Israel should possess such weapons. There is a general sense of fear that asking questions on this matter will raise doubts regarding loyalties and portray individuals, including members of the media and public officials, as traitors and irresponsible. This kind of taboo[76] also prevents a more responsible discussion on the meaning of nuclear weapon possession; related news from international fora (unless about Iran); the fact that the "world" treats Israel as a possessor of nuclear weapons; and even more importantly, how Israel effectively "deter" while keeping its capabilities secret.

On 29 August 2018, Prime Minister Binyamin Netanyahu stood outside the Dimona reactor[77] during a ceremony to rename the nuclear research facility after former president Shimon Peres, also known as the father of Israel's nuclear programme.[78] He said to the media that any country that threatens to destroy Israel risks meeting a similar fate.[79] This kind of direct threat, along with reports on missile tests[80] and "slips of the tongue" by Israeli officials,[81] are seen outside of Israel as nuclear threats[82] and as "maintaining deterrence," but all this seems to be unseen or less understood by the Israeli media and, as a result, by the Israeli public.

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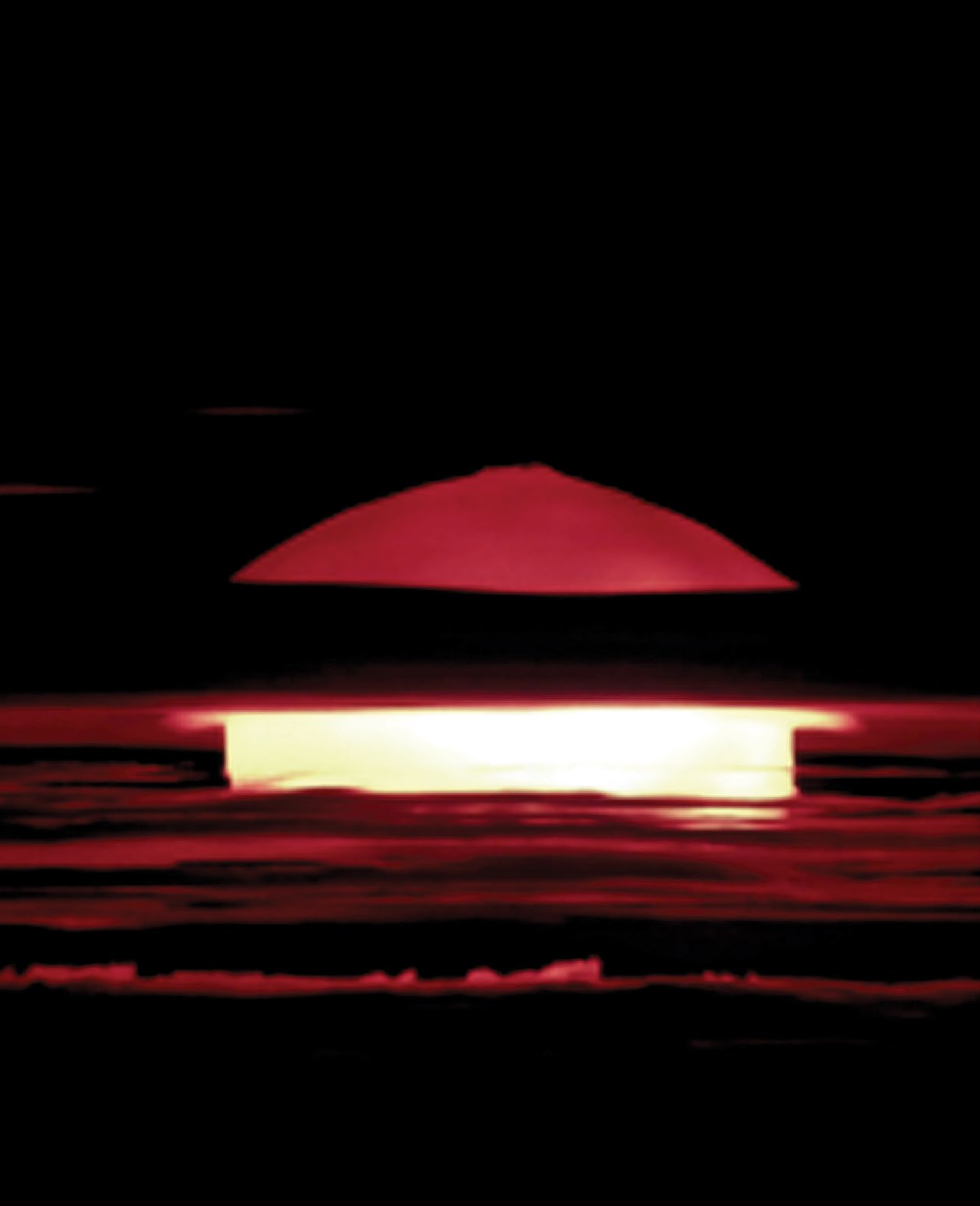

Nuclear explosion © Science in HD, Unsplash

Pakistan

Zia Mian

Pakistan has been developing and rapidly expanding a diverse nuclear arsenal since its first and so far only series of nuclear weapon explosive tests in May 1998. It now has aircraft-delivered nuclear bombs, ballistic missiles of various ranges, and ground-launched, air-launched, and sea-based cruise missiles that can carry nuclear warheads. It has tested a short-range battlefield missile system that is claimed to be nuclear-capable. Pakistan's arsenal likely will continue to grow.

The arsenal initially was based on simple highly enriched uranium (HEU) fission weapons but has moved to greater reliance on lighter and more compact plutonium weapons. This has been made possible by Pakistan's construction of four military plutonium production reactors, the first of which came into operation in 1998. At the diplomatic level, Pakistan has been blocking the start of talks at the United Nations Conference on Disarmament on an international treaty that would ban the production for weapons of HEU and plutonium—the key ingredients in nuclear weapons. There have been concerns in communities near some Pakistani nuclear sites about the environmental and health impacts of nuclear activities, leading in one case to a petition to Pakistan's Supreme Court.

The lack of official information makes estimates of Pakistan's spending on its nuclear weapons programme highly uncertain, but this cost is likely not a large share of its overall military spending. Pakistan's military spending has until recently been subsidised by large amounts of military and economic aid from the United States (US). It is moving now to depending mostly on military and economic assistance from China. Nonetheless, Pakistan still has major problems in meeting the basic social and economic needs of its people.

Over the past two decades, the risk of war and even nuclear war has remained significant. In 2019, Pakistan's Prime Minister Imran Khan warned that "If the world does nothing to stop the Indian assault on Kashmir and its people, there will be consequences for the whole world as two nuclear-armed states get ever closer to a direct military confrontation."[1] He threatened that a conventional conflict would spiral into nuclear war, saying that "If say Pakistan, God forbid, we are fighting a conventional war, we are losing, and if a country is stuck between the choice: either you surrender or you fight 'til death for your freedom, I know Pakistanis will fight to death for their freedom. So when a nuclear-armed country fights to the end, to the death, it has consequences."[2]

Current status

As of the start of 2020 Pakistan was believed to have around 150-160 nuclear weapons, a roughly ten-fold increase from the year 2000. The US government estimated in 2011 that Pakistan's stockpile then may have been in the range of 90 to over 110 weapons.[3] The growth of the arsenal appears to have been steady for most of the past decade (see Table 1). It is projected to increase at a faster rate in coming years, reaching perhaps 250 weapons within five years, making it larger than the arsenal of the United Kingdom and comparable in size to the arsenals of China and France.

Table 1: Estimated number of weapons in Pakistan's nuclear arsenal 2000 to 2025

YEAR	2000	2005	2010	2015	2020	2025*
WEAPONS	14	44	90	120	150-160	220-250

Sources: Adapted from Robert S. Norris and Hans Kristensen, "Global Nuclear Weapons Inventories, 1945–2013," Bulletin of the Atomic Scientists, September/October 2013, Vol. 69 No. 5, pp. 75-81; Hans M. Kristensen, Robert S. Norris, and Julia Diamond, "Pakistani nuclear forces, 2018," Bulletin of the Atomic Scientists, 2018, Vol.74, No. 5, pp. 348-358; Shannon Kile and Hans Kristensen, "Pakistani Nuclear Forces," in SIPRI Yearbook 2019: Armaments, Disarmament and International Security, SIPRI and Oxford University Press, 2019; and Hans M. Kristensen and Matt Korda, "Status of World Nuclear Forces," https://fas.org/issues/nuclear-weapons/status-world-nuclear-forces/, and projected to 2025.

There is little reliable information on the yields of Pakistan's nuclear weapons. The number and yields of the nuclear weapon tests carried out on 28 and 30 May 1998 are disputed, with Pakistan initially claiming six tests with some having explosive yields of tens of kilotons (kts), while independent seismologists found evidence supporting a smaller number of tests and total yields of about 10 kt and 5 kt for the tests on 28 May and 30 May respectively.[4]

Little is known about Pakistan's weapon designs. It is believed to have received in the early 1980s a first-generation Chinese weapon design that used HEU. If two weapon designs were tested in 1998, one may have used HEU and the other plutonium for the hollow shell of fissile material (the "pit") that undergoes the explosive nuclear chain reaction, or possibly a "composite" pit combining both materials.[5] Pakistan may also have developed "boosted" weapons, in which tritium gas is injected into the pit just before it explodes to increase the fraction of the fissile material that undergoes fission, significantly increase the explosive yield of the nuclear weapon, and decrease the required amount of fissile material in each weapon.[6]

Pakistan is not believed to have thermonuclear weapons, although Pakistani nuclear weapon scientists claim they could develop such weapons if tasked and funded to do so.[7] This would most likely require additional nuclear weapon tests. Since the tests in 1998, Pakistan has maintained a declared a moratorium on nuclear testing, following a similar declaration by India.

Delivery systems

Pakistan has various road-mobile ballistic missile systems and ground-launched, air-launched and sea-based cruise missiles to carry its nuclear weapons. These missiles are at various stages in their development and it is unclear which systems will eventually be deployed (Table 2).

Table 2: Pakistan's nuclear weapon delivery systems

DELIVERY SYSTEM	RANGE (KM)	DEPLOYMENT
Aircraft		
Aircraft F-16A/B	1,600	1998
Mirage V	2,100	1998

DELIVERY SYSTEM	RANGE (KM)	DEPLOYMENT
Ballistic missiles		
Abdali (Hatf-2)	180	2015
Ghaznavi (Hatf-3)	400	2004
Shaheen-1 (Hatf-4)	750	2003
Shaheen-1A (Hatf-4)	900	2019
Ghauri (Hatf-5)	1200	2003
Shaheen-2 (Hatf-6)	2000	2014
Shaheen-3 (Hatf-6)	2750	2018
Nasr (Hatf-9)	60	2013
Ababeel (MRV/MIRV)	2200	R&D
Cruise missiles		
Babur (GLCM)	350-750	2014
Babur-2 (GLCM)	700	R&D
Babur-3 (SLCM)	450	R&D
Ra'ad (ALCM)	350	2019

Source: Shannon Kile and Hans Kristensen, "Pakistani Nuclear Forces," in SIPRI Yearbook 2019: Armaments, Disarmament and International Security, Oxford University Press, 2019.

The most recent system to begin development is the 60 km-range Nasr missile. First tested in 2011, Nasr is described as a battlefield system able to carry "nuclear warheads of appropriate yield."[8] Reports suggest that Nasr is presumably intended for use as a short-range battlefield nuclear weapon system against Indian conventional armoured forces during the early stages of a conflict. Analysis of such a scenario suggests Pakistan would need to deploy and use many tens of Nasr missiles to be able to destroy a significant fraction of the 1000 or so Indian tanks that may be involved in such an action.[9] The New York Times reported in 2015 that so far "an unknown number of the tactical weapons were built, but not deployed" by Pakistan.[10]

There is little public information about the storage and deployment status of Pakistan's nuclear weapons. It was believed in the late 2000s that "missiles are not mated with warheads and the physics packages (the fissile cores) are not inserted into the warheads themselves."[11] Reports suggested 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."[12]

In the years since then, however, Pakistan has moved to developing cruise missiles and a potential battlefield nuclear weapon system. These systems may need nuclear warheads that are lighter and more compact than those that could be carried by the ballistic missiles. These new missiles also may not be as amenable as large, long-range ballistic missiles to having their warheads stored in component form ready to be integrated at short notice.

Seven possible locations for Pakistan's nuclear weapons storage have been suggested (Table 3). Some of these sites are associated with airbases that are home to nuclear weapon capable aircraft, which may carry either nuclear bombs or air-launched cruise missiles. Other sites are associated with warhead and missile development and assembly facilities, while some sites seem to be secure underground storage for weapons. No site has yet been identified for possible naval nuclear weapons.

Table 3: Pakistan nuclear weapon storage sites

FACILITY NAME/LOCATION	PROVINCE	FUNCTION
Sargodha Depot	Punjab	Potential storage site for bombs for F-16s at nearby Sargodha Air Base, and warheads for missiles
Gujranwala Garrison	Punjab	Possible weapons storage
Fatejhang National Defense Complex	Punjab	Missile development and potential warhead storage
Wah Ordnance Facility	Punjab	Possible warhead production, disassembly and dismantlement facility
Akro Garrison	Sindh	Possible underground weapons storage
Masroor Weapons Depot	Sindh	Potential storage of bombs for Mirage Vs at Masroor Air Base, and warheads for missiles
Pano Akil Garrison	Sindh	Possible weapon storage
Khuzdar Depot	Balochistan	Potential underground weapons storage
Tarbela Underground Complex	Khyber Pakhtunkhwa	Potential weapons storage

Sources: Hans Kristensen and Robert Norris, "Worldwide Deployments of Nuclear Weapons, 2014," Bulletin of the Atomic Scientists, August 2014; Hans Kristensen, "Pakistan's Evolving Nuclear Weapons Infrastructure," FAS, November 2016;[13] and Hans Kristensen, Robert Norris and Julia Diamond, "Pakistani Nuclear Forces, 2018", Bulletin of the Atomic Scientists, 2018.

Fissile materials

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. Some of these facilities, and the organisations responsible for managing them, also are part of Pakistan's nuclear energy program. 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 may include both military and civilian nuclear facilities but are not made public.

Table 4 presents a list of Pakistan's fissile material production-related sites compiled from open sources as of 2020. 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.

Table 4: Pakistan's fissile material related facilities

LOCATION	FACILITY TYPE	MATERIAL
Dera Ghazi Khan	Uranium mine, ore concentration plant, conversion plant	Uranium
Issa Khel	Uranium mine	Uranium
Qabul Khel	Uranium mine	Uranium
Kahuta	Uranium enrichment (Khan Research Laboratories)	HEU
Gadwal (Wah)	Uranium enrichment (secondary plant)	HEU
Chaklala	Uranium enrichment (pilot plant)	HEU
Sihala	Uranium enrichment (pilot plant)	HEU
Golra	Uranium enrichment (pilot plant)	HEU

LOCATION	FACILITY TYPE	MATERIAL
Khushab–I	Heavy-water plutonium production reactor	Plutonium
Khushab–II	Heavy-water plutonium production reactor	Plutonium
Khushab–III	Heavy-water plutonium production reactor	Plutonium
Khushab–IV	Heavy-water plutonium production reactor	Plutonium
Chashma (Khushab)	Reprocessing facility (being commissioned)	Plutonium
Rawalpindi	Reprocessing facility–I	Plutonium
Rawalpindi	Reprocessing facility–II	Plutonium
Khushab–I-IV	Tritium production	Tritium
Chashma (Kundian)	Reactor fuel-fabrication plant	
Multan	Heavy-water production facility	
Khushab	Heavy-water production facility	

Sources: Adapted and updated from Nuclear Black Markets: Pakistan, A.Q. Khan and the Rise of Proliferation Networks, International Institute of Strategic Studies, London, 2007; Feroz Hassan Khan, Eating Grass: The Making of the Pakistani Bomb, Stanford University Press, 2012; International Panel on Fissile Materials, http://fissilematerials.org and http://fissilematerials.org/blog.

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 the start of 2020, Pakistan could have a stockpile of about 3.6 tons of weapon-grade (90 per cent-enriched) HEU.[16]

As of early 2020, Pakistan operates four weapons plutonium production reactors. A semi-official account states these reactors have a capacity of about 50 MW-thermal, with Khushab-IV possibly being larger, with a capacity of 50-100 MW-thermal.[17] The Khushab-I plutonium production reactor, a heavy-water-moderated, light-water-cooled, natural-uranium-fueled reactor has been operating since 1997-1998. The Khushab-II reactor started operation in late 2009 or early 2010. Khushab-III began operating early in 2013.[18] Khushab-IV was operational as of early 2015.[19]

Pakistan has been reprocessing 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.[20] Satellite imagery from January 2015 suggests construction of the large reprocessing plant at Chashma may have been completed, and the facility may be being commissioned or even be operational.[21] The Chashma reprocessing plant was originally intended to handle 100 tons of spent fuel per year. This capacity would be sufficient in principle to treat all the spent fuel from the four Khushab reactors. Pakistan is estimated to have produced a total of almost 350 kg of plutonium as of 2020.[22]

Infrastructure

Pakistan's nuclear weapons research, development, and production infrastructure are managed by the military-run Strategic Plans Division (SPD) and overseen by a National Command Authority (NCA) set up in February 2000. 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, and the director-general of SPD.

The 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. The former head of SPD has suggested that only about 2000 people hold "critical knowledge" of Pakistan's nuclear weapons complex.[23] A 2011 report suggested a total of about 70,000 professional staff in the entire strategic weapons complex.[24] A former SPD official has indicated that as of 2013 the security division alone had 20,000 personnel and the force would grow to a total of 28,000 within a few years.[25]

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 (PAEC) 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.[26] These three bodies are managed by the National Engineering and Scientific Commission.

Pakistan's nuclear weapons currently 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's Naval Strategic Force Command was established in 2012. Pakistan has been testing a sea-launched nuclear capable cruise missile probably to be deployed on submarines.[27] It is unclear if this system has been deployed as of 2020.

Economics

The cost of Pakistan nuclear weapons programme cannot be estimated with any reliability. Secrecy prevents access to details 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 and the environmental consequences of nuclear weapon related activities.

In 2001, retired Major-General Mahmud Ali Durrani (who later served as National Security Advisor to the President of Pakistan) estimated that Pakistan's annual expenditure on "nuclear weapons and allied programs" was about US $300–400 US million 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."[28] Citing an earlier estimate by Rammanohar Reddy for the cost of nuclear weapons development by India, Durrani suggested that Pakistan might need to spend about 0.5 per cent of gross domestic product (GDP) for a period of at least 10 years on such nuclear weapons activities.[29]

General Pervez Musharraf, who seized power in 1999 and ruled until 2008, and held the positions of Chief of Army Staff and President, affirmed in 2004 that there had been a significant increase in nuclear weapon spending after 2000 (when SPD had been established) as part of a15 year plan. General Musharraf claimed in particular that during the previous three to four years the government had spent more on the nuclear weapons programme than in the previous 30 years.[30] This increase in spending would be consistent with the large expansion in fissile material production capabilities and new missile system development that occurred after the year 2000.

An independent estimate in 2011 suggested Pakistan's nuclear spending could be about US $800 million per year and possibly as much as US $2 billion per year if health and environmental costs are included—and this spending was projected to rise significantly because of Pakistan's expanding nuclear programme.[31] Later estimates seem roughly consistent, given the lack of reliable data.[32] For Pakistan to spend on the order of perhaps a few billion dollars per year on its nuclear weapons is feasible. The annual official military spending for 2019–2020 was budgeted at Rs1.15 trillion, an almost 5 per cent increase from the previous year, but this omits Rs327 billion for military pensions and other costs.[33] This suggests an overall military budget of about Rs.1.5 trillion or 3.3 per cent of GDP—this military spending amounts to roughly US $10 billion. This would suggest Pakistan spends the equivalent of 10 per cent or so of its total military budget on its nuclear weapons programme. In 2019, the overall military budget was seen as a burden given the prevailing economic crisis in Pakistan economy with reports that "the military has agreed to slash the military budget for the next fiscal year in line with broader austerity measures being introduced by the government."[34]

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 US $34 billion in military and economic assistance from the United States, of which about US $11 billion was economic aid of various kinds.[35] Pakistan has also received extensive economic aid and military assistance from China for its nuclear weapons, missile, and conventional weapons programmes.[36] China has planned since 2013 over US $60 billion in infrastructure projects in Pakistan as part for the China-Pakistan Economic Corridor and there is growing military collaboration as US assistance has declined.[37]

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.[38] 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.[39]

China's conventional military assistance to Pakistan now exceeds the scale of support previously provided by the United States. Since 2010, US weapons exports to Pakistan have fallen, from US $1 billion a year to US $21 million as of 2017, while in 2017 China sold US $514 million worth of arms to Pakistan.[40] 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 US $20 25 million each, which suggests that the total cost of the 50 JF-17 deal with China is about 1 billion USD or more.[42] Pakistan in 2015 agreed to buy eight new submarines from China.[43] The submarines are expected to be completed between 2023 and 2028 at an estimated cost of up to US $5 billion.[44]

Environment

The nuclear weapons programme has had environmental impacts. These include concerns about health effects from uranium mining and radioactive waste disposal in a former uranium mining site.[45] A 2006 lawsuit filed by villagers from Bagalchur, Pakistan's first uranium mining site, which operated from 1978 to 2000, complained that uranium mining waste and other radioactive wastes was being dumped in the now empty mine tunnels.[46] More than 5000 people live within a kilometre from the site and lack basic healthcare facilities, while the primary school is located next to the nuclear waste site.[47] The villagers cited increases in infant mortality, and disease and premature death in farm animals due to the waste dumping. The case was referred to Pakistan's Supreme Court. The court hearings were closed to the public. There also have been unconfirmed reports about health effects from the May 1998 nuclear tests.[48]

International law and doctrine

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 recognise no international legal obligation to restrain or end its nuclear weapons and missile programme. Pakistan is the subject, along with India, of a unanimous UN Security Council resolution calling for restraint of its nuclear weapon and ballistic missile programmes. Resolution 1172 (June 1998) calls upon India and Pakistan immediately to stop their nuclear weapon development programmes; to refrain from weaponisation 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; 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.[49]

Pakistan did not participate in the negotiations of the 2017 Treaty on the Prohibition of Nuclear Weapons. Pakistan, however, has said that it remains committed to the goal of complete nuclear disarmament in a universal, verifiable and non-discriminatory manner and supports the start of negotiations towards this goal.[50] It has previously called for negotiation of a nuclear weapons convention along with a phased programme for the complete elimination of nuclear weapons within a specified time frame.[51]

Pakistan's long-running search for strategic parity with India informs almost all its nuclear diplomacy, including on a possible international treaty banning the production of fissile materials for nuclear weapons (known as a fissile material cut-off treaty or FMCT).[52] Pakistan has continued to block talks at the United Nations Conference on Disarmament (CD) on such a treaty. In January 2019, Pakistan again objected to discussion on an FMCT, preventing the consensus required by the CD rules of procedure to agree the annual programme of work and so ensuring there were no formal FMCT talks.[53] Pakistan explained that We believe that a treaty which only results in a cut-off in the production of fissile material, as envisaged under the Shannon Mandate and favoured by the other nuclear weapon States holding large stockpiles of such materials, would contribute little to nuclear disarmament. It would jeopardise Pakistan's security unless it addresses the vast asymmetries in existing stocks of fissile material.[54] Progress towards an FMCT may have to wait until Pakistan's SPD believes it has a big enough fissile material stockpile or the international community decides to make achieving an FMCT a much higher priority in its relationships with Pakistan.

Public discourse

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, and many crises that threatened to lead to war. 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. Given this set of arguments, and that the nuclear weapon systems coming into the arsenals are all new, there has been no discussion about other reasons justify weapons development and no concerns about modernisation.

Nuclear weapons have played a major role in Pakistan's domestic political discourse for over 40 years. Prime Minister Zulfikar Ali Bhutto, who launched the nuclear weapons programme in 1972, had earlier 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

"End the arms race." This picture was taken during the Australian "Nobel Peace Ride", where ICAN members journeyed from Melbourne to Canberra by bicycle with the Nobel Peace Prize medal, raising awareness of the UN Treaty on the Prohibition of Nuclear Weapons, September 2018 © Martin Ollman

the nuclear weapons programme, often by linking it to national pride and national identity.

After the nuclear tests of May 1998, Pakistan's military and political leaders saw the bomb as a panacea for solving many long-standing national political, social, and economic problems. One assessment observes that at the time Pakistan's leaders told themselves and their people that the bomb would bring national security, allow Pakistan to liberate Kashmir from India, bind the nation together, make its people proud of their country and its leaders, free the country from reliance on aid and loans, and lay the base for the long-frustrated goal of economic development.[55] None of these hopes have come to pass in the two decades since then. The recurring crisis over Kashmir, driven by India repression of Kashmiri demands for greater autonomy and even independence and by Pakistan's support for Islamist and Kashmiri nationalist militant groups to fight against India have not lessened with the coming of nuclear weapons.[56]

All of Pakistan's major political parties support the nuclear weapons programme. Pakistan's current Prime Minister Imran Khan, who came to power in 2018, supported the 1998 nuclear tests, declaring My party was clear that we had to tell India that we had a deterrent. He claimed the bomb was proof of Pakistan's possibilities, arguing that if Pakistan can have scientists that develop nuclear bombs then we can develop our own country.[57] The prior government, led by the Pakistan Muslim League (PML) and Prime Minister Nawaz Sharif claimed credit for the bomb since it was an earlier Nawaz Sharif led PML government that ordered the 1998 nuclear tests. Pakistan's other major national political party, the Pakistan People's Party (PPP) also claims credit for the nuclear programme because the PPP and the nuclear weapons programme were both founded by Zulfikar Ali Bhutto.

It has been commonplace for prime ministers to inaugurate nuclear facilities and they are often photographed at nuclear missile tests and send public messages of commendation and congratulations after such tests. Pakistan also bring out its nuclear missiles in the military parades in the capital city that mark some national holidays. Opposition to nuclear weapons is limited to small progressive civil society groups struggling against great odds on multiple political and policy issues.

The underlying dynamics of the Pakistan-India relationship may be shifting, however. A longer-term concern now driving Pakistan's nuclear programme is the United States policy of cultivating a much stronger US strategic relationship with India to counter the rise of China as a potential great power competitor.[58] This set of relationships tie the future of Pakistan's nuclear weapons, and those of India, to the contest between the US and China for long-term global hegemony, making nuclear restraint and disarmament increasing unlikely in South Asia.

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Russia

Pavel Podvig

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 maintains and modernises the strategic triad of land-based intercontinental missiles, submarines with sea-launched ballistic missiles, and long-range bombers. The modernisation programme also includes a number of non-traditional delivery systems, such as a hypersonic glider vehicle, a nuclear-powered cruise missile, and an underwater nuclear-powered vehicle. 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-defence missiles.

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.

Current status

According to the most recent New Strategic Arms Reduction Treaty (New START) data exchange, in September 2019 Russia had 513 operationally deployed strategic launchers that carried 1,426 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 2019, Russia was estimated to have about 1,600 deployed warheads in its strategic arsenal. The total number of warheads associated with strategic launchers is estimated to be about 2,700.[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 1,800 non-strategic warheads that could be considered operational.[3] All these warheads are consolidated at centralised 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 that are awaiting dismantlement. This category is estimated to include about 2,000 warheads.[5]

These estimates suggest that Russia has a total arsenal of about 6,500 nuclear warheads. Non-deployed nuclear warheads and the warheads that are awaiting dismantlement are stored at centralised 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 modernisation 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]

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 has historically been the largest component of the Soviet and Russian strategic forces. As of early 2020, it includes about 320 operationally deployed ballistic missiles of five different types that carry up to 1,180 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 each. As of early 2020, the Strategic Rocket Forces were estimated to have 46 R-36M2 missiles that could carry 460 warheads. In addition,

Nuclear-waste © Enrique Lopez Garre, Pixabay

Russia has two types of single-warhead missiles—72 road-mobile Topol (SS-25) missiles and 78 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 RS-24 Yars missile, on road-mobile launchers and in silos. This missile, which is believed to carry up to four warheads, is expected to become the main missile system of the Strategic Rocket Forces. By 2020, the Strategic Rocket Forces deployed 149 missiles of this type—135 road-mobile missiles and 14 missiles in silos.

Russia appears to be determined to preserve the leading role of land-based ICBMs in its strategic triad. In addition to the deployment of new missiles, RS-24 Yars in particular, it has undertaken a programme to extend the service life of older missiles. For example, the modification of the currently deployed SS-18 missile, known as R-36M2 or RS-20V, was produced and deployed in the late 1980s-early 1990s, and will probably stay in service as long as until 2026, provided its service life is extended to 33 years, which seems likely as Russia has substantial experience with extending the service of its liquid-fuel ICBMs.

To replace the SS-18 missile, Russia began development of a new heavy ICBM, Sarmat. The development programme reached the stage of ejection tests from a silo, which were conducted in 2017-2018. The first flight tests of the missile are expected to take place in 2020. According to the current plan, the serial production and deployment of Sarmat will begin in 2021, although given the history of delays in the programme, this seems unlikely.[10] Like the ICBM it is intended to replace, SS-18, Sarmat will carry ten warheads and will be deployed in the same silos.

In 2019, the Strategic Rocket Forces received the first two Avangard missile systems that include a UR-100NUTTH ICBM equipped with a hypersonic glider vehicle.[11] Avangard is one of the “non-traditional” strategic systems that Russia has been working on in recent years. The glider is expected to provide Russia with the capability to penetrate the US missile defence system. It is expected that Russia will deploy 12 systems of this type by 2027.[12]

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. The Rocket Forces would therefore preserve their status as the key component of the strategic triad.

Strategic submarines

As of the beginning of 2020, Russia’s strategic submarine force included six Project 667BDRM (Delta IV) submarines; one submarine of the older Project 667BDR (Delta III) class; and three new Project 955 Borey submarines. A new submarine of the Project 955A Borey-A class, a moderate upgrade of the Project

955, will enter service in the first quarter of 2020. All submarines carry 16 SLBMs each. Delta IV carries R-29RM missiles with four warheads each and Delta III carries R-29R missiles with three warheads. Borey and Borey-A submarines are built to carry new Bulava solid-propellant SLBMs with up to six warheads per missile. Overall, in early 2020, Russia had an estimated 144 deployed SLBMs that were capable of carrying up to 656 nuclear warheads.

The Delta IV/Project 667BDRM submarines and the lead submarine of the Project 955 Borey class are based at the Northern Fleet. They will be joined by the lead Project 995A submarine, Knyaz Vladimir, when it enters service in the first half of 2020. Two submarines of the Project 955 class as well as the old Delta III/Project 667BDR submarine are currently based at the Pacific Fleet base Vilyuchinsk at the Kamchatka Peninsula.

Most of the Delta IV/Project 667BDRM submarines underwent an overhaul in the last decade or so and would probably be able to stay in service for additional ten years, approximately. 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.[13]

As the submarines of the older types—Project 667BDR and Project 667BDRM—reach the end of their service lives, they will be replaced by Borey and Borey-A submarines. In addition to the four submarines that will be in service by the end of 2020, Russia has four more ships under construction and is planning to build at least two more by 2028, for the total of ten. This would allow it to maintain the number of deployed SLBM at the level of 160 missiles, which could carry as many as 960 warheads. The actual number of deployed warheads is likely to be smaller, especially if Russia and the United States preserve their arms control dialogue.

Strategic bombers

Strategic bombers have traditionally played a secondary role in Soviet and then Russian nuclear postures. Although the nuclear role of strategic bombers is unlikely to change in the future, Russia has been investing in a modernisation programme that will expand the range of their conventional missions. In 2015, strategic bombers launched long-range conventional cruise missiles against targets in Syria.[14]

As of 2020, Russia is estimated to have 66 heavy bombers—11 Tu-160 aircraft and 55 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. Most open estimates assume that Russia allocates about 200 nuclear warheads to its bombers.[15]

Most of the bombers that are currently operational were built in the late 1980s and are currently undergoing an overhaul to extend their service life. In addition, in 2015 Russia announced the plan to resume production of Tu-160 aircraft. The current plan is to build about 50 new bombers, which will be known as Tu-160M2. In addition to this, the Russian defence industry is working on a completely new aircraft, PAK DA (Advanced Long-Range Aviation System). The first aircraft of this type is expected be begin flight test in around 2025.[16]

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 is designed to include two tiers—a network of radars that could detect incoming missiles and a constellation of satellites that could provide early detection of missile launches.

In the last decade Russia has initiated an extensive programme to build a network of new early-warning radars. The new radars almost completely replaced old ones that were built during the Soviet time and were located outside of Russia. By 2020, Russia discontinued the use of all but two early-warning radars that are not located in Russia. The last two radars—in Belarus and Kazakhstan—will eventually be replaced as well. The new radar network currently includes eight operational radars, with three more under construction and at least two—at the planning stage.[17]

While the modernisation of the radar network has been a largely successful programme, replacement of old early-warning satellites has encountered significant delay. The last satellite of the old early-warning constellation completed its mission in 2015.[18] The deployment of a new space-based early-warning system, known as EKS, began in November 2015.[19] Two more satellites were added to the constellation in 2017 and 2019. The satellites, known as Tundra, appear to provide continuous coverage of the key potential missile launch regions.

The command and control system that provides communication between the central command authority and individual launchers has been undergoing almost continuous modernisation. The currently deployed system has been described by the Russian military as a "fifth-generation" system. According to the official account, this system provides the Strategic Rocket Forces not only with the capability to control individual launchers, but also with the flexible targeting capability.[20]

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 were withdrawn from the system. The short-range 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".[21] In 2017 Russia began tests of a new modernized interceptor of the A-135 system. Seven tests have been conducted as of July 2019 and it is possible that the new interceptor will be operationally deployed in the near future.

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 2019 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. Russia's stock of highly enriched uranium (HEU) was estimated to include about 646±120 tonnes of HEU. Of this amount, about 640 tonnes are available for weapons and for fueling naval, research, and civilian reactors.[22]

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.[23] 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. About 15 tonnes of plutonium that were produced by these reactors after September 1994 are covered by Russia's pledge not to use it for military purposes. Russia also declared 25 tonnes of plutonium from its pre-1994 stock as excess to national security needs. This material is also not available for military purposes, leaving a potential military stock of 88 tonnes.

The 25 tonnes of excess military plutonium and 9 tonnes of the plutonium produced after 1994 were to be eliminated as part of Russia's obligations under the US-Russian Plutonium Management and Disposition Agreement that was concluded in April 2010.[24] However, in 2016 Russia suspended the implementation of that agreement, citing "unfriendly" US policies and the inability of the United States to fulfil its plutonium disposition obligations. Importantly, while suspending the agreement, Russia pledged not to use the PMDA plutonium for weapons or any other military purpose.[25]

The plutonium disposition programme 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, began initial operations in 2014. In order to begin the plutonium elimination activities, Russia is developing the technology to produce plutonium-containing fuel assemblies for the BN reactors and to build a facility that will manufacture the fuel.

In addition to the weapon-grade plutonium, as of the end of 2018 Russia had 61.3 tonnes of unirradiated separated civilian plutonium.[26] Virtually all this material is stored at a dedicated storage facility at the RT-1 reprocessing plant at the Mayak Combine. This material will be used to manufacture fuel of the BN-800 fast-neutron reactor.

The Soviet Union stopped production of highly enriched uranium (HEU) for weapons in 1988. Before that it had produced about 1470±120 tonnes of 90 per cent HEU equivalent. About 287 tonnes of HEU have been used in various applications, military as well as civilian.[27] 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 about 60 research reactors and critical and subcritical assemblies that use highly enriched uranium.[28]

There were 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 programme blended down military-origin HEU to produce low-enriched uranium that is then used to fuel US nuclear reactors. The programme, which began in 1996, eliminated 500 tonnes of HEU by the end of 2013, when it was successfully completed. 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. By the time the program was terminated in 2015, it eliminated about 17 tonnes of HEU.

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.[29] 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.

Infrastructure

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 (VNIITF) 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 programmes.

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. 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 (Chelyabink-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. The chemical reprocessing plants that were extracting weapon-grade plutonium from spent fuel of production reactors have been either shut down or converted for non-military applications.

The Mayak Plant continues to operate two production reactors, Ruslan and LF-2 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.[30]

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 gas 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, these enrichment plants produce low-enriched uranium for civilian purposes. The plant in Zelenogorsk is also producing some highly enriched uranium for non-military applications.[31]

Russia operates two major warhead assembly and dismantlement facilities the Electrochemical Instrument Combine in Lesnoy (Sverdlovsk-45) and the Instrument Building Plant in Trekhgorny (Zlatoust-36).[32] 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. 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.

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 organisation for solid-propellant ballistic missiles. It has developed Topol (SS-25), Topol-M (SS-27), RS-24 Yars 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. The Makeyev design bureau is the primary contractor for the development of the Sarmat ICBM.

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. It will be producing the Sarmat ICBM as well.

The lead design organisation 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 ballistic missile submarines that is currently in production is Project 995 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, which remains the leading developer of long-range bomber aircraft. It is responsible for the development of the Tu-160M2 and PAK DA bombers. The new aircraft are produced by the Kazan Aviation Plant. The Taganrog Aviation Plant participates in the modernisation of Tu-95MS bombers.

Modernisation

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

Rearmament of the ICBM leg of the strategic triad concentrates on deployment of multiple-warhead RS-24 Yars and Sarmat missiles. Deployment of multiple-warhead missiles allows Russia to keep the number of deployed warheads at a 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.

As of early 2020 there are no plans to extend modernisation of the strategic fleet beyond the planned construction of ten Project 955 and Project 955A submarines. 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 well beyond 2020.

As far as the strategic aviation is concerned, in the next few years Russia will continue an overhaul of its current strategic bomber fleet, construction of Tu-160M2 bombers and the development of the PAK DA aircraft.

Russia s strategic modernisation 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.

In addition to the delivery systems that traditionally constituted a strategic nuclear triad ICBMs, SLBMs, and heavy bombers Russia is working on a number of new systems that were unveiled in the presidential address to the parliament in 2018.[33]

One of these systems, Sarmat, is a new ICBM that will replace the R-36M2/SS-18 missile. Another system, Avangard, while different from traditional delivery systems in some respects, is essentially a UR-100NUTTH/SS-19 missile that carries a new type of payload a hypersonic glide vehicle. As noted earlier, the first two Avangard missiles were deployed in 2019. Sarmat is expected to begin flight tests in 2020.

Less traditional systems mentioned in the 2018 presidential address were Burevestnik nuclear-powered cruise missile and Poseidon underwater vehicle. These are apparently still at the development stage, although both systems appear to have undergone some testing.

Economics

Modernisation of the strategic forces is part of the broader rearmament programme. The 2011 2020 State Armament Program allocated 20 trillion rubles (about US $600 billion at the exchange rate at the time) for various military systems. About 10 per cent of the total funds allocated for rearmament, or 1.9 trillion rubles, was spent on the modernisation of the strategic forces. The current State Armament Program, signed into law in 2017, covers the period from 2018 to 2027. Originally, the military requested a significant increase in funding, up to 35 trillion rubles, but in the end the programme was scaled down to 19 trillion rubles, similar to the funds allocated to the previous programme.[34]

The difficult process to approve the new programme illustrates that financial constraints could affect the scale of strategic modernisation. The Russian economy is heavily dependent on export of natural resources, so a fall in oil and gas prices has already forced the government to reconsider its spending priorities. The economic growth has also slowed down in the last decade or so, reflecting the difficulty to implementing economic reforms. The sanctions imposed on Russia in 2014 after the annexation of Crimea also have an effect on the economic outlook. Some enterprises of the defence industry struggled to find an appropriate substitute to technologies and components that can no longer be imported. However, the rearmament effort appears to have strong support of the political leadership, so significant cuts of the modernisation programme are unlikely.

International law and doctrine

The issues relating to the legitimacy of nuclear weapons under international law are rarely discussed in Russia. Although official documents and statements do not question Russia's right to possess nuclear weapons, they also recognise its responsibilities as a nuclear-armed state party to the nuclear Non-Proliferation Treaty (NPT). The National Security Strategy approved in 2015 recognises the goal of building a world free of nuclear weapons as part of overall progress toward strategic stability with equal security for all.[35] The strategy also gives high priority to nuclear disarmament and to nuclear non-proliferation.

The military doctrine adopted in 2014 emphasises the role of Russia s nuclear forces in maintaining strategic stability in the world.[36] According to the 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. While this policy assumes the right to a first use of nuclear weapons, the doctrine suggests that the range of scenarios in which Russia would consider using nuclear weapons is somewhat limited.

In its 2018 Nuclear Posture Review, the United States asserted that Russia maintains an option of using nuclear weapons to de-escalate a conflict on favourable terms.[37] However, this assertion has been questioned by many experts and there is no evidence that Russia indeed considers using its nuclear weapons in this manner.[38]

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. 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 centralised storage facilities on its national territory.[39] However, Russia has been reluctant to discuss legally binding measures related to its non-strategic nuclear weapons before the United States removes its nuclear weapons from Europe.

Russia has stated[40] that it does not intend to sign the Treaty on the Prohibition of Nuclear Weapons and has further explained that it views the TPNW as failing to promote nuclear disarmament and undermining the NPT.[41]

Public discourse

Public opinion in Russia tends to support the nuclear status of the country according to a poll conducted in 2006, 76 per cent 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 per cent of respondents believe that nuclear weapons play an important, although not a decisive, role.[42]

Two other recent polls discovered a range of opinions about nuclear weapons and nuclear proliferation. In 2017, at the height of tensions around North Korea, over 40 per cent of respondents suggested that states should be allowed to build their own nuclear weapons if they choose to do so. The share of those who believe that the international community should be sanction and isolate such states was comparable, but somewhat smaller.[43] A public opinion poll conducted in 2019 explored attitudes toward the dangers associated with nuclear weapons found that only about half of the respondents, 52 per cent, are to various degrees afraid of a new nuclear war. About 60 per cent of respondents named the United States as the main nuclear threat to Russia, with China a distant second with 13 percent. About 11 per cent of participants do not believe that any state poses a nuclear threat to Russia.[44]

Public discussion of issues relating to nuclear weapons rarely questions the role of these weapons in Russia s national security. The strategic modernisation programme described above is also rarely criticised, despite its potentially 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. It should be noted that the arguments about the modernisation as a way to maintain safety and security of nuclear weapons is almost never used as a justification for the modernisation efforts.

In general, public opinion in Russia tends to view favourably the efforts to support the military industry and introduce modern equipment to the armed forces. Government policy and public attitudes combine to ensure that the strategic modernisation 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

Janet Fenton

Technical co-operation with the United States (US) and the development of its nuclear weapons has been considered an imperative by successive United Kingdom (UK) governments since the beginning of the UK's atomic bomb programme.

The UK government initiated the MAUD Committee in 1940[1] with the remit of giving the highest priority to obtain nuclear weapons in the shortest possible time. In 1945, Conservative Prime Minister Churchill approved of the US attacks on Hiroshima and Nagasaki, after which Atlee's Labour government stated, "The answer to an atomic bomb on London is an atomic bomb on another great city."[2] By 1948 the Labour government told the House of Commons that UK weapons were in development.[3] Two years later, the Conservatives were back, led by Churchill authorising the tests which commenced at Monte Bello off the coast of Australia in 1952.[4] By 1957, US President Eisenhower was enabling US-UK exchange of nuclear weapon information. In response, plans were also being put into place for the formation of the Campaign for Nuclear Disarmament (CND) and the first Aldermaston march.[5]

A decade later, as the negotiations leading to the nuclear Non-Proliferation Treaty (NPT) were starting, the UK tested its first US supplied Polaris missiles off the coast of Florida and the carrying fleet was commissioned.[6] Then-UK Prime Minister Harold Macmillan had already agreed to allow the US to establish a ballistic missile submarine base in Scotland in return for access to US missiles. This was despite concerns about the proposed site's proximity to Scotland's largest city, Glasgow. Former UK Prime Minister Thatcher and then-US President Reagan's continued commitment to the new Trident system in the early 1980s is well documented[7] as is the protest movement that led to the serious reductions in the number of nuclear weapons held by the US and Russia. These reductions were undertaken by Reagan and Gorbachev[8] albeit not to the extent of fulfilling their NPT disarmament obligations to end the arms race and eliminate their arsenals.

Meanwhile, the history of UK nuclear-armed policy and its nuclear alliance with the US does not offer any evidence of any real intention by the UK government to disarm or to fulfil its obligations under Article VI of the NPT. Scotland's deep-water fjord coast and cloud cover, as well as the comparative remoteness of its west coast, provided a strategic location for occupation by the Ministry of Defence (MoD) and establishment of its nuclear submarine base at Faslane and adjacent weapons store at Coulport.[9] In 1998, The Scotland Act allowed devolution and a degree of autonomy to the Scottish Parliament, but the Act has separate articles, naming *International Relations and Co-operation, Defence of the Realm, and Implementing Obligations under the Human Rights Convention* as firmly reserved to the UK government at Westminster. The opposition to nuclear weapons in Scotland expressed by its government is not considered to be an issue of democracy by the UK government.[10]

John Ainslie of the Scottish Campaign for Nuclear Disarmament meticulously researched MoD and government publications. He persistently questioned parliament and statutory agencies as well as observed and analysed military activities in the UK, which informed scientifically robust and reliable earlier editions of this publication. Many of us are indebted to him for that and are still utilising work that he undertook and questions that he raised while exploring the developments since his death. In collating this account of developments since then, the author has relied on John's work and that of many others who have built on, expanded, or added to his reports and questions. They include but are not limited to David Cullin, Peter Burt, Jane Tallents, David Mackenzie, Lynn Jamieson, and Stuart Parkinson.

Current status

The United Kingdom (UK) has 120 operationally available nuclear warheads. This is part of a larger stockpile of between 180 and 225 warheads. The Ministry of Defence (MoD) has indicated that it will reduce the overall stockpile to 180 warheads by the mid-2020s. There are four Vanguard class submarines, three of which are normally armed. Each armed submarine carries eight US-built Trident D5 missiles and a total of 40 nuclear warheads.[11] Observations of warhead convoy movements undertaken by the citizen activist group Nukewatch UK suggest that warheads have gradually been removed from service at a rate of around three warheads per year to meet this stockpile reduction target with around 60 warheads which are not operationally available.[12]

The UK Trident warhead contains a mixture of UK and US elements. The high explosive in the warhead is British. Three key components, which are part of the US W76 warhead, are supplied from the United States. The final design could be described as a W76 variant, i.e. around 100 kilotons.[13] The Atomic Weapons Establishment (AWE) warheads are manufactured and serviced at two sites in Berkshire: at Aldermaston, which includes research into warhead design and the manufacture of plutonium components, and at Burghfield where the warheads are assembled and disassembled. They are routinely transported on public roads between the HM Clyde Naval Base at Faslane, 25 miles from Glasgow, Scotland's largest city, and AWE in Berkshire for maintenance or replacement. Nuclear warheads in these convoys consist of nuclear materials surrounded by high explosives, a combination that is prohibited by regulations governing civil transportation of radioactive materials.[14]

The base includes a submarine facility, Faslane, and a nuclear weapons depot, Coulport. 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.

The MoD has restructured its internal arrangements for management of the Defence Nuclear Enterprise. An internal body called the Defence Nuclear Organisation (DNO) oversees the Enterprise and acts as a customer to another internal body, the Submarine Delivery Agency (SDA), which is in charge of building and supporting the submarine fleet. The DNO also acts as customer in the contract managing the Atomic Weapons Establishment. The SDA manages 52 procurement and support projects within the Enterprise. The Navy, as operator of the submarine fleet, also acts as a customer of the SDA.[15]

Twenty decommissioned Royal Navy nuclear powered submarines are floating in nuclear licensed dockyards at Rosyth (Scotland) or Devonport (England). The Submarine Dismantling Project was established in 2000 following a study by the MoD, which concluded that the radioactive waste should be stored on land. In 2011 the MoD conducted a consultation on how this waste should be removed from the submarines, where this process should be conducted, and the type of sites where waste should be stored. Following the public consultation, it was decided that initial dismantling will take place at both dockyards and that the Reactor Pressure Vessel (RPV) from each submarine will be removed and stored whole at Capenhurst Nuclear Services (CNS) in the interim.[16] The MoD has not yet approved the technical processes and is paying an estimated £1.5 million a year for storage at the Cheshire site. Initial dismantling on HMS Swiftsure began in December 2016 at Rosyth. On 1 April 2019 the National Audit Office (NAO) published a report which detailed many delays to the project and associated cost increases, stating that the [DNO] is responsible for all disposal-related projects, including those previously within the Royal Navy's remit. It continues to recognise as a high risk the failure to manage its nuclear liabilities coherently.[17]

Modernisation

Submarines

The UK continues to drive forward its Defence Nuclear Enterprise (DNE) programme to replace its Vanguard class submarines with new Dreadnought class vessels.[18] It is also proposed that from 2020, all of the UK's submarine fleet will be based at the upgraded Faslane naval base, located in Scotland.[19]

The UK began the process of replacing the Vanguard class submarines following the publication of a White Paper in 2006[20] and parliamentary votes which took place in 2007 and 2016. Contracts for the second phase of the Dreadnought submarine build programme were signed by the MoD in May 2018. The majority of the UK's nuclear-powered submarines have been constructed at Barrow-in-Furness at the BAE Systems Marine site, with deep maintenance taking place at Devonport Royal Dockyard in Plymouth by Babcock Marine Systems. The Dreadnought submarines will also be built by BAE at Barrow-in-Furness.

The Scottish Environment Protection Agency (SEPA) works within a framework drawn up by the Scottish Government subject to approval by the Minister for Environment, Climate Change and Land Reform.[21]
The MoD has applied to licence the Nuclear Support Hub (NSH) which it is building at Faslane and which is intended to centralise the existing radioactive waste handling facilities and radiochemistry laboratories there. The key legislation governing radioactive substances and SEPA's responsibilities, the Environmental Authorisations (Scotland) Regulations 2018 (EASR), makes the MoD exempt from many its provisions as in this case. The Hub is situated in a new location within the Faslane site, with a new effluent discharge point into the middle of the Gare Loch.[22] With the increased number of nuclear submarines, radioactive discharges into the Gare Loch are expected to increase and could cause radioactive contamination of the entire Gare Loch, including its flora and fauna, and result in increased radiation doses to people living in the vicinity of the Loch.

Submarine reactors

At Rolls Royce's privately owned Raynesway factory in Derby the MoD is overseeing its Core Production Capability programme to produce reactor cores for Astute

Class attack submarines, and building new facilities that will produce cores for Dreadnought submarines. The new PWR3 Dreadnought reactor is based on a US design and runs on highly enriched uranium fuel.[23] The Astute class submarines carry conventional weapons but will use the same reactor cores as Dreadnought and there are complex dependencies and mechanisms that mean they are deeply integrated in the UK's nuclear weapons programme.

Missiles

D5 missiles were developed and produced at Kings Bay, Georgia in the United States. The UK has rights to a total of 58 missiles from a common pool shared with the US. 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.[24] All of these modernisation measures apply to the system deployed on British submarines. The missile compartments on Dreadnought submarines will accommodate D5 missiles and will be identical to the missile compartments on the US Colombia-class submarines. The UK has paid towards the cost of the Common Missile Compartment and towards the US-run Life Extension Programme, primarily being carried out by US firm Lockheed Martin, to extend the life of the D5 so that it can remain in service until the 2040s. Since the intention is that Dreadnought will be in service until the late 2060s and 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 stated that "investment in a replacement ballistic missile would eventually be needed."[25] The Life Extension version may already have been introduced on some submarines, though there is no information in the public domain to confirm this, and the US may be working on a further life extension rather than a new missile.

Warheads

Work under the Nuclear Warhead Capability Sustainment Programme (NWCSP) is funded through a contract between the MoD and AWE Management which has a predicted end date of 3 April 2025. The NWCSP is an ongoing rolling programme with no defined end date, that aims to ensure that the UK retains the infrastructure, skills, and capability to develop and manufacture nuclear warheads. This includes increasing the likelihood that each of the separately targeted warheads carried by a D 5 missile will explode close enough to its target to completely destroy it. This means that the reduction in the number of warheads referenced in the previous section on the UK's current status is not intended to reduce the number of sites targeted in the UK's nuclear attack plan, merely that the sites can be completely destroyed while using a smaller number of warheads.[26]

Collaboration

UK parliamentarians and experts learned through a Pentagon announcement in early February 2020 that billions of UK pounds will be spent on a new generation of warheads based on US technology. The Pentagon announcement stated that the W93 or Mk 7 warhead "will support a parallel replacement warhead programme in the UK." This expenditure had not been reported to them in the House of Commons or by the MoD.[27]

From December 2006, when correspondence between former US President George W. Bush and then UK Prime Minister Tony Blair referenced the latter in stressing the need to "maintain and modernise the UK's capability in the longer term," close work between AWE Aldermaston and US research laboratories has been evident, despite the major gaps in the UK's transparency. In 2007, the senior official responsible for defence procurement had reported that the plan was "to replace the entire Vanguard submarine system, including the warhead and missile".[28] The linking of US nuclear weapons laboratories and AWE is a crucial element of the US-UK nuclear special relationship.

Dating from 2013, the Teutates warhead science programme is a UK collaboration with France, covering three areas of support for their independent nuclear weapons capabilities: safety and security, stockpiles, and counter-nuclear terrorism. Funds have been invested in regenerating the infrastructure at AWE sites.[29] This is part of a joint construction with a new hydrodynamics facility at Epure in France and a technology department and interim firing point at AWE Aldermaston, which is purposed with enabling performance checks without nuclear explosive tests. In 2019, the MoD Investment Approval Committee (IAC) approved rising costs as in line with the programme within the context of the NWCSP,s though delivery of the programme is challenging and technically demanding. The instrument that dictates this collaboration is a binding treaty that commits the UK to ten years' notice of intent to withdraw, well beyond the timescale of the present NWCSP.[30] The IAC will continue to assess the possible impact of Brexit on the costs.[31]

Infrastructure

The problems in the UK's nuclear weapons programme are considerable. Burgeoning costs, delays of several years, and the impact of these factors on each other has escalated to the point where it is unlikely that the new submarines will be available by the end of the already over-extended lifetime of the outgoing vessels. Building projects that began ten years before the 2016 Parliamentary vote are still incomplete or have been delayed, leaving retired submarines occupying docks instead of being dismantled. Leaks, accidents, and neglect add to the dangers that the public and those working on the project face, aside from the squandering of resources vital for addressing a climate change situation, thus increasing the likelihood of a nuclear incident at the same time as reducing the capacity to survive it.[32]

Deployment of a fully armed submarine at sea on patrol at all times will be impossible to maintain if there is a lack of submarine availability before the current system is replaced. The current submarines are already at the end of their projected functional lifetimes. An overall equipment plan that underestimated the costings, radioactive leaks, limited dock space, shortage of staff, poor contractor performance, and fluctuating currency each put the nuclear weapons programme at risk.

The expenditure is failing to keep pace with the demands of the programme, delays exacerbate the escalating costs, and secrecy surrounds the projections of completion dates. Efforts to reign in escalating costs, included moving the Dreadnought delivery back from 2024 to 20, may reduce expenditure during that budget period but does not reduce the overall cost of the Dreadnought programme. In fact, delays of this sort increase the costs in the longer term.[33]

Amongst the early lead-in items purchased before the 2016 vote, Common Missile Compartments (CMCs) were produced for the Dreadnought programme and US Columbia-class submarines. When it became apparent that these were affected by faulty welds, the schedule for the project was in question and as well as safety being severely compromised and there were, again, major cost implications.[34]

Since 1980 every decommissioned Royal Navy nuclear-powered submarine has been floating in a nuclear licensed dockyard at either Rosyth in Scotland or Devonport in England. Pressure on dock operations are likely to lead to further delays in dismantling the twenty submarines, nine of which still carry fuel.[35] Their presence in turn adds pressure on any major upgrade to address dock capacity. Extending the lifetime of the Vanguard class will put pressure on the limited dock space at Devonport, where the life extension work would be carried out. Defuelling Vanguard-class submarines when they come out of service will create bottlenecks arising when deep maintenance is being done on the Dreadnought submarines in the 2040s. Babcock may be unable or unwilling to manage the building projects at Devonport needed to mitigate the bottleneck issues.

Since the initial plans for the upgrade, maintaining and developing a workforce in conjunction with the civil nuclear industry has been seen as critical.[36] Government and the nuclear industry both continue to have concerns in this regard, added to which the Navy is struggling to recruit submariners.[37] In August 2018, 15 per cent of MoD civilian positions for Nuclear Suitably Qualified and Experienced Personnel (NSQEP) were unfilled and the MoD was unwilling to disclose the number of unfilled military NSQEP posts, on the grounds that doing so would be “detrimental to the armed forces”.[38]

The MoD is expected to play a part in maintaining the expectations of contractors and ensuring the competence of their workforce. Components that are commissioned may require service for the duration of another aspect of the programme, while the contractors need the workforce to be fully and profitably occupied at all times. Meantime they have to maintain their own workforce against diminishing enthusiasm for life on board a submarine without access to social media.[39] The lived experience of the COVID-19 pandemic is unlikely to create an appetite for this work. In 2018, Rolls Royce restructured internally with thousands of job losses, while conducting a public campaign for government support to develop SMR technology. Another significant contractor, Babcock, announced the intended closure of its shipyard in North Devon against a background of public criticism and falling share prices.

With ongoing problems for Babcock[40] and Rolls Royce[41], the government and the MoD may be on the horns of a dilemma in which maintaining the capacity of these firms is one priority, and maintaining the lowest prices is the other. Babcock’s current diversification into manufacturing ventilators for COVID-19 may impact on this balance in the future, and the UK government may consider the company’s ongoing arms manufacturing as ‘essential work’ that is allowed to continue during the lock down.[42]

Even without the impact of coronavirus on next year’s market, purchases from the US means that currency value differences will affect the cost of components and services purchased, and the MoD works with the Treasury to ensure that a proportion of fluctuations are hedged. This may no longer be possible at all, and in any case the arrangement applies for three years, which is unsustainable for maintenance of the decades-long dollar purchases for Dreadnought. Fluctuations for exchange costs beyond this proportion need to be paid for from MoD contingency funds, which are already over-stretched. Brexit scenarios remain likely to cause long term currency depreciation and drive up the overall project costs. This is not addressed in the most recent Government briefings available, and neither is the potential impact of COVID 19 on the economy.[43]

The replacement uranium facility known as Pegasus was suspended because of safety concerns. Previously, similar concerns have been the cause of regulatory action when corrosion was discovered in the steel columns supporting the building, involving expenditure of £150 million.[44]

Devonport has been under enhanced regulatory attention since 2013 and there is a Nuclear Safety Improvement Plan in place to try and improve safety standards at the site. These included problems with the fire alarm detection and emergency lighting systems. Crane lifting operations were carried out that "fell short of the required standard" and two further crane incidents occurred at Devonport in September 2018, resulting in another halt to crane work on site and an investigation by the ONR.[45]

If the HMS Vanguard is retired as soon as deep maintenance on all the Vanguard submarines has been completed in 2030, several years before the first Dreadnought comes into service, it will be 37 years old, a service life almost 50 per cent longer than that for which it was designed. Admiral Lord West, previously Chief of Naval Staff, called the plan "bloody dangerous" and "very high risk," saying that it was contrary to the advice he had been given when he was in post.[46] There exists a significant question mark over the capacity of the UK to continuously keep one nuclear weapon submarine deployed at sea during the transition to the Dreadnought submarines. In the 1980s, the Thatcher government kept Polaris on continuous deployment against the advice of safety regulators about known problems with the reactor pipework.[47] As the programme proceeds, pressure from regulators, parliamentarians, or the public could force action to be taken at a time that is not of the MoD's choosing. The MoD may be forced to prioritise sustaining its contractors over keeping costs low if it wishes to retain a nuclear weapon programme.

Economics

The upgrading of the UK's nuclear weapons programme is now entering a critical phase. Although the building of the Dreadnought submarines is underway, there appear to be mounting problems and escalating costs that cast doubt on any possibility that the project will be delivered on time or within the projected costs. The lack of public awareness of this state of affairs is matched by lack of capacity or willingness by the MoD or the UK government to be subjected to scrutiny.

Procurement and maintenance within the nuclear weapon programme are paid by the MoD equipment budget, which updates costs annually including projections for the following nine years. In the past, an annual update for the MoD's large value projects was published by the National Audit Office (NAO), and since 2015 it has been published by the government's Infrastructure and Projects Authority, which offers less detailed information.[48]
The obfuscation of the difficulties is facilitated by the highly technical nature of much of the documentation. Changed procedures for budgeting and accounting further obscure what is happening from the public, thus reducing opposition to the government's plans.[49]

In addition to the lack of easily comprehensible information on cost, matters of safety and environmental considerations arising from the NWCSP are also subject to secrecy and lack of transparency. During 2017, the MoD refused to publish the annual report of the Defence Nuclear Safety Regulator and redacted all information about nuclear safety from the annual report of the Defence Safety Agency.[50]

The Nuclear Information Service in the UK uses a wide range of elements as well as extrapolating from the MoD's own figures and historical spending to estimate costs over time. This method estimates the total cost of the UK's nuclear weapons programme between 2019 and 2070 to be £172 billion. This is a low estimate based on 2019 prices, yet is far higher (four times) that the most commonly cited Government figures. The UK government does not release total cost figures, but the estimate for the Dreadnought programme figure is £31 billion, plus the additional £10 billion contingency for building four new Dreadnought submarines.[51]

MoD expenditure on the nuclear weapon programme is not released into the public domain, although the National Audit Office has disclosed the current MoD estimate for the DNE (which includes the cost of the UK's nuclear attack submarines, which is £50.9 billion. In 2016, the Campaign for Nuclear Disarmament (CND) produced an estimate including cost of missiles, warhead infrastructure, security, and decommissioning. Based on an MoD estimate that the programme would cost 6 percent of MoD spending over the lifetime and that an MoD budget of 2 per cent of GDP, CND's estimate for the programme is £205 billion.[52]

There are a number of areas where costs are at best bewildering, if not politically misleading. Environmental considerations and risks become externalities that are neither considered nor identified, with no analysis of remediation requirements or responses to climate change impacts, accidents, or the protection of civilian populations.

The Astute submarine programme shares infrastructure and workforce with the nuclear armed submarines, while its activities are not related to nuclear weapons. Reconnaissance aircraft, mine warfare vessels, and destroyers are utilised by the nuclear weapons programme, but they have other primary duties, meaning their costs are not accounted for within the programme.

The MoD 2018 Update to Parliament reports on its part in the Nuclear Skills Strategy Group. This group supports the civil nuclear sector and a primary aim for the group is developing a workforce that can support the NWCSP. The absence of a buoyant civil nuclear sector makes government financial support a likely requirement. This is a historical relationship. In 2005, the MoD funded a RAND Corporation report highlighting the links between developing and servicing the nuclear submarines and a robust civil nuclear industry.[53]

The different lifespans of various elements in the nuclear weapon programme make it difficult to estimate life-cycle costs overall. For example, the development of the new warhead does not match the production cycle of the submarine. Time-slippage in the programme, delaying procurement work as a means of managing in-year funding gaps, and not including the costs of other future work, such as dock upgrade at Devonport, add to the complications. Other costs are unquantifiable liabilities listed in the MoD accounts,[54] in particular indemnities to Rolls Royce, Babcock, and BAE Systems, amongst others. These are complicated to negotiate and can lead to costs increasing along with risks.

In the absence of transparency and given the urgency of addressing the real risks presented by both the climate emergency and the planetary risks presented by nuclear weapons, inclusive cost accounting could soon become a necessity for the UK government. The inscrutable and escalating cost of the UK's nuclear ambitions are set against a background of crippling austerity, with social security payments at their lowest level since the establishment of the welfare state in the UK. In a report published by the Institute for Public Policy Research (IPPR) just before the December 2019 election, it was noted that food bank use is escalating with the steepest rise the Trussell Trust charity has witnessed since its network of food banks was established.[55] The most common driver of food bank use relates to the characteristics and functioning of the British welfare system. The IPPR report goes on to state that in the UK,

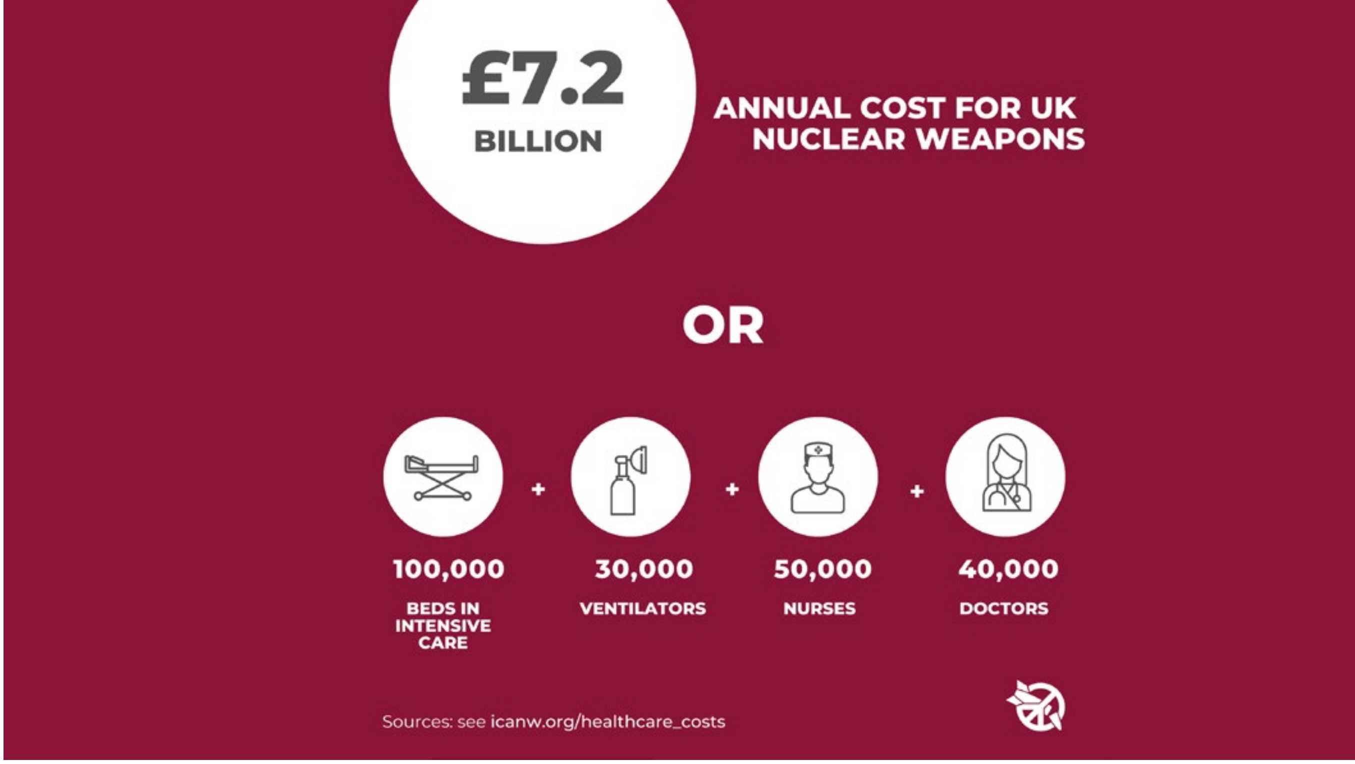
"The economy is not working for millions of people and needs fundamental reform. Average earnings have stagnated for more than a decade; young people are set to be poorer than their parents; the nations and regions of the UK are diverging further. Many of the causes of the UK's poor economic performance go back 30 years or more, particularly its weaknesses in productivity, investment and trade."[56]

From March 2020, in responding to the COVID-19 pandemic, action and investment from the government to secure the economy and the UK workforce clarifies that economy enhancing choices can be made and that reconsideration of spending priorities is perfectly possible where there is a will. Given the volte face that has taken place on public spending to protect those unable to work because of the lock down, questions are being raised in the UK mainstream media about the real nature of what constitutes security.[57]

International law and doctrine

The UK Government Foreign and Commonwealth Office (FCO) and the Ministry of Defence offers a fact sheet on International Legal Obligations with regard to its nuclear weapons.[58] This states that the UK's possession of nuclear weapons is entirely lawful because the UK is designated a nuclear weapons state by the terms of the nuclear Non-Proliferation Treaty (NPT). The briefing describes the modernisation programme as simply "maintaining no more than the very minimum nuclear capability judged necessary for security". Twenty-two years after signing the NPT, the UK considers that it is fully compliant with its obligation to "pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date". The UK claims to have increased its transparency about its nuclear holdings in recent years, and since 1995 has ceased the production of fissile material for nuclear weapons. However, the UK has accumulated almost 139 metric tons of separated plutonium at its plant at Sellafield.[59] Because it has never used any of the material it recouped from reprocessing except for nuclear weapons, the result is that it already has enough plutonium to produce approximately 20 thousand Hiroshima size bombs. The costs attached to the storage of this material are astronomical.

The government's briefing on its legal position references the International Court of Justice (ICJ) Advisory Opinion[60] as rejecting the argument that nuclear weapons use would necessarily be unlawful in all circumstances, but does not examine the more detailed premise of the opinion that "The unique characteristics of nuclear weapons, the use of such weapons seemed scarcely reconcilable with respect for the requirements of the law applicable in armed conflict," or that the possible circumstances in which lawfulness may be argued would be "an extreme circumstance of self-defence, in which the very survival of a State would be at stake.



ICAN has calculated how the annual cost for UK nuclear weapons could pay for health care services.

The current briefing concedes that the ICJ opinion is significant enough to be referenced in defence of its nuclear weapons policy. However, in the early 1990's the UK government was so strongly opposed to the question of the legality of nuclear weapons even being put to the ICJ by the World Health Organisation (WHO) that it produced a lengthy report to the ICJ[61] with the first chapter devoted to disputing the question being asked at all. The report claimed that the essential aim of the sponsors of the project was a political, and not a legal matter. It was further argued that, in any case, any opinion could not be implemented by WHO, and if the Court were to rule in favour of an absolute prohibition, the effects could be highly damaging, and jeopardise the NPT.

This historical resistance to the work of the ICJ in forming an opinion resonates with the actions taken by the and views expressed by the UK before and during the negotiations for the 2017 Treaty on the Prohibition of Nuclear Weapons (TPNW). In a letter to the United Nations Association-UK (UNA UK)[62] during the 2019 NPT Preparatory Committee the FCO described the TPNW as a risk to the non-proliferation regime and thus in conflict with the NPT. The letter was part of an exchange that took place following a House of Lords International Relations Enquiry[63] which called on the government to address grave concerns about the deteriorating state of nuclear diplomacy. Submissions from civil society were invited to answer questions relating to the NPT, including the potential impact of the TPNW. The report summary cites the lack of progress in the disarmament pillar of the NPT as leading to considerable dissatisfaction, which helped to facilitate the decision to negotiate the TPNW; while its conclusions urge more openness from the UK, as a "responsible" nuclear-armed state, on the possible humanitarian impact of nuclear weapons.

Despite a separate legal system in Scotland and opposition to UK nuclear weapons policy, it has not so far been possible to engage either government to seriously consider their legal obligations under international humanitarian law or to test the legality of the nuclear weapons under UK jurisdiction and based in Scotland.

At the Edinburgh conference, "Trident and International Law, Scotland's Obligations"[64] in 2009, His Excellency Judge Mohammed Bedjaoui, former President of the International Court of Justice stated,

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.

Public discourse

The present UK government has repeatedly expressed its intention to maintain a nuclear weapons programme for the foreseeable future and it continues with its renewal programme. The main opposition party, Labour, initiated the replacement programme and has also expressed a commitment to maintaining nuclear weapons. In Scotland, the Scottish National Party (the government party) opposes all nuclear weapons,[65] as does the Scottish Green Party[66] and both have committed to a nuclear free Scotland that is independent of the UK government and supportive of the TPNW. Scottish Labour is opposed to the replacement programme, with a proviso that an appropriate diversification programme is put in place. It seems that one, or a combination of several possibilities are needed to deliver change to UK nuclear weapon policy:

- Real and quantifiable progress in aspects of international disarmament that would affect the UK's status in global structures, for example the entry into force of the Treaty on the Prohibition of Nuclear Weapons or a nuclear-armed state disarming;

- Election of a UK government that is committed to nuclear disarmament and addressing the climate emergency;

- A major nuclear accident and/or climate disaster affecting the UK directly;

- A constitutional crisis delivering an independent Scotland that could demand immediate disarming of warheads and removal of weapons and submarines from its territory; or

- Economic shocks that seriously disrupt the capacity to continue the nuclear weapon programmes.

These are perhaps the early days of the last of the above changes, as governments struggle to maintain the economy and fulfil their healthcare obligations during the pandemic that has stalled the 2020 NPT Review Conference.[67]

Professor Michael Clarke, Former Director General of the Royal United Services Institute, argued that Britain "scrapping" Trident would be the most significant nuclear decision the world has ever seen.[68] Professor William Walker pointed 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.[69]

In the period leading up to the 2014 referendum on Scottish independence, the late John Ainslie undertook a rigorous programme of work which enabled him to provide Scottish CND with invaluable resources to show that a Scottish government that could control policies on defence and international relations could not only insist that the UK remove its nuclear weapons from Scotland, but also initiate the elimination of the Trident nuclear weapon system in the UK. When the world came together at the UN in 2017 to adopt the Treaty on the Prohibition of Nuclear Weapons, many Scots were heartbroken that an independent Scotland was not in a position to sign it.

The deep seated disregard for the UK government throughout Scotland (there has, for example, been a permanent peace camp on the grass verge opposite the entrance to the submarine base in continuous occupation since 1982[70]) along with the uncertainty over UK economics, constitutional problems created by Brexit, and the huge economic pressure on the government in responding to the COVID-19 pandemic, creates a necessity and a culture where the UK government is more open than at any time since the dawn of the nuclear age to think the "unthinkable" and consider an alternative to such a patriarchal and imperialistic position of power.

Additional reading

John Ainslie's painstaking work is still as relevant as it is accurate and the three detailed reports: *Trident Shambles; Nowhere To Go, No Place for Trident;* and *Disarming Trident* are all available from the Scottish Campaign for Nuclear Disarmament at http://www.banthebomb.org/index.php/publications/reports.

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United States

Greg Mello and Trish Williams-Mello

While every nuclear-armed state is certainly unique, the magnitude and diverse modalities of geopolitical power unapologetically wielded by the United States in its perceived self-interest makes the US an exceptionally important barrier to successful disarmament diplomacy.

By the same token it is impossible to understand why the US deploys—and is modernising—so *many*, and so many *kinds*, of nuclear weapons, without understanding the specific nuclear dangers that arise from the unique US ambition to project overwhelming military force in support of its economic and geopolitical interests globally, especially in Eurasia.

The overall geopolitical threat from the US is not just theoretical or latent but is constantly exercised in ways great and small, through means overt and covert, in large wars, small wars, special forces missions,[1] regime change operations, drone attacks and much more, all supported by an "exceptionalist" ideology that is the *lingua franca* of all senior US officials.

The stated primary *raison d'etre* for most US nuclear forces, and therefore also for the scale and urgency of modernisation efforts overall, is Russian nuclear arms. Together, the US and Russia possess 93 per cent of the world's nuclear weapons. Both the US and Russia maintain active stockpiles an order of magnitude more numerous than those of any other nuclear-armed state.[2] Both countries are modernising their forces.

Yet the security situations of the two countries are very different. The US has eleven times the military budget of the Russian Federation; US military spending exceeds the *combined* total military spending of *all the other countries in the world*, save three.[3] Despite repeated US promises otherwise, the North Atlantic Treaty Organisation (NATO) has expanded eastward to Russia's borders, adding 14 countries since 1999.[4] NATO's military outlays are 16 times Russia's—in fact, NATO military spending is more than the rest of the world combined.[5] The US maintains a global garrison of nearly 800 US military bases in more than 70 countries, a great many in Eurasia near Russia.[6] The US uses its unequaled economic power as a weapon, with dozens of states currently under some form of US sanctions, including Russia.[7] The US has spent more than US $200 billion since 1985 in pursuit of an effective ballistic "missile defence" (BMD) system, not counting battlefield systems.[8] In June 2002, the US unilaterally withdrew from the Anti-Ballistic Missile (ABM) Treaty; US BMD systems are by now located in Romania and Poland as well as at sea.

From the Russian perspective, attempts to enforce unipolar global security have led to "an almost uncontained hyper use of force—military force—in international relations, force that is plunging the world into an abyss of permanent conflicts," where "one state… first and foremost the United States, has overstepped its national borders in every way."[9] The Russian government has made it clear that it will not relinquish a large, advanced nuclear arsenal, capable of overcoming all foreseeable US ballistic missile defences, as long as existential threats to its existence and sovereignty persist.[10]

For its part the US will spare no expense to maintain and modernise a large nuclear arsenal as long as Russia does. Thus the present nuclear arms race between these two states will persist without addressing wider security threats and conventional weapon systems and alliances and without the US abandoning its claims to exceptionalism and unipolar power.

As long as an enormous disparity exists in conventional military force based near or quickly deployable to Russia's borders, together with an equally enormous disparity in non-military modes of power, nuclear disarmament will be off the table for nearly all the world's nuclear weapons.

Current status

The US nuclear weapons programme is relatively transparent. Three overviews are particularly useful.[11] Figure 1, taken verbatim from the Federation of American Scientists, provides a succinct overview.

There have been a number of changes in the US nuclear modernisation programme since the April 2019 edition of *Assuring Destruction Forever*. These are not so much changes in *scope* but in *speed*:

First, accelerated, massive hiring is occurring across the nuclear weapons enterprise:

> We have… in excess of 41,000 people working on the NNSA mission today…. Since March of 2019 we've added more than 4,700 employees in that group of federal employees and labs, plants, and sites. We're going to need to add another 20,000 people by 2025.[12]

Second, parallel investments in warhead core ("pit") factories have begun, to front-load production in the 2020s to support new-warhead (W87-1) production.[13]

Third, accelerated and early-to-need development of a new submarine warhead (W93) is beginning, budgeted at US $53 million for FY2021 with first production in 2034 (see Table 1), a two-year advancement at both ends of the development period.[14]

Fourth, an unusually early—years-ahead—sole-source contract has been awarded for the Long Range Stand Off (LRSO) cruise missile.[15]

Fifth, unprecedented near-term spending increases for FY21 have been requested to enable these accelerations as discussed below, despite the US $8 billion already available in unspent prior appropriations.[16]

At this point the success of these attempted accelerations remains uncertain. There have been significant delays in the B61-12 and W88 Alt 370 warhead upgrades,[17] which may affect the W87-1 warhead programme.[18] Delays are likely in several other programmes including warhead core ("pit") production,[19] special explosives production,[20] and infrastructure projects.[21] Congressional auditors are warning that there are too many accelerated nuclear modernisation programmes proceeding in parallel, with attendant increases in the risk of delays, cost overruns, and failures.[22]

Meanwhile, some existing nuclear weapons face mounting maintenance and sustainability issues, from lack of unique spare parts to bulging walls, water intrusion, and corrosion in missile silos.[23]

Two programmes were completed since the April 2018 edition of this report. The W76-1 submarine warhead upgrade was completed in late 2018, extending this warhead's life by a planned 30 years while dramatically increasing its accuracy.[24] Some W76 warheads were easily and cheaply converted to low-yield W76-2s in early 2019. These low-yield warheads began deployment in December 2019.[25]

The context in which US nuclear modernisation is conducted has also changed over the last two years, primarily in ways that challenge nuclear modernisation.

First, the Pentagon's share of the military budget request for FY2021 is 1.1 per cent lower than FY2020 spending (US $705 billion vs. US $713 billion). The four subsequent years are expected to have flat Department of Defense (DoD) spending in constant dollar terms.[26] This intensifies the latent conflict between conventional and nuclear weapons in the overall military budget.

The as-yet-unknown extent of the cascading crises that have befallen the United States, US allies, and the world due to COVID-19 threatens to rock the weapons world. In just a few weeks, the expected federal deficit has increased by roughly a factor of four to the neighborhood of US $4 trillion; tens of millions of US citizens are out of work, many permanently, with unemployment levels exceeding those of the Great Depression; additional resources for economic renewal are expected to be required, also to be financed by debt; five hundred million people globally could be pushed into poverty;[27] famines of "biblical" proportions[28] may occur. Supply chains and specialised labour needs for nuclear modernisation may be at risk.

In this environment, current US military expenditures, and therefore nuclear modernisation plans, do not appear politically sustainable. We do not believe they are socially or managerially sustainable in some key situations either.[29]

As this goes to press, US authorities are almost doubling their predictions of COVID-19 deaths even as restrictions are relaxed. No one can say where this will lead, from either public health, economic, or political perspectives. All in all, we see rising risk to complex modernisation programmes across the board, for many reasons that go far beyond the scope of this chapter.

Table 1: US nuclear forces, 2020

TYPE/DESIGNATION	NO.	YEAR DEPLOYED	WARHEADS X YIELD (KILOTONS)	WARHEADS (TOTAL AVAILABLE)[A]
ICBMs				
LGM-30G Minuteman III				
Mk12A	200	1979	1-3 W78 x 335 (MIRV)	600[b]
Mk21/SERV	200	2006[c]	1 W87 x 300	200[d]
Total	**400**[e]			**800**[f]

TYPE/DESIGNATION	NO.	YEAR DEPLOYED	WARHEADS X YIELD (KILOTONS)	WARHEADS (TOTAL AVAILABLE)[A]
SLBMs				
UGM-133A Trident II D5/LE	**240[g]**			
Mk4A		2008[h]	1-8 W76-1 x 90 (MIRV)	1,486[i]
Mk4A		2019	1-2 W76-2 x low (MIRV)[j]	50[k]
Mk5		1990	1-8 W88 x 455 (MIRV)	384
Total	**240**			**1,920[l]**
Bombers				
B-52H Stratofortress	87/44[m]	1961	ALCM/W80-1 x 5-150	528
B-2A Spirit	20/16	1994	B61-7 x 10-360/-11 x 400 B83-1 x low-1,200	322
Total	**107/60[n]**			**850[o]**
Total strategic forces				**3,570**
Nonstrategic forces				
F-15E, F-16 DCA	n/a	1979	1-5 B61-3/-4 bombs x 0.3–170p	230
Total				**230[q]**
Total stockpile				**3,800**
Deployed				1,750[r]
Reserve (hedge and spares)				2,050
Retired, awaiting dismantlement				**2,000**
Total Inventory				**5,800**

ALCM: air-launched cruise missile; DCA: dual-capable aircraft; ICBM: intercontinental ballistic missile; LGM: silo-launched ground-attack missile; MIRV: multiple independently targetable reentry vehicle; SERV: security-enhanced reentry vehicle; SLBM: submarine-launched ballistic missile.

a) Lists total warheads available. Only a portion of these are deployed with launchers. See individual endnotes for details.

b) Roughly 200 of these are deployed on 200 Minuteman IIIs equipped with the Mk-12A reentry vehicle. The rest are in central storage.

c) The W87 was initially deployed on the MX/Peacekeeper in 1986 but first transferred to the Minuteman in 2006.

d Of 567 W87s produced, 540 remain. The 200 Mk21-equipped ICBMs can each carry one W87. The remaining 340 W87s are in storage. Excess W87 pits are planned for use in the W78 Replacement Program previously designated IW-1 but now called W87-1.

e) Another 50 ICBMs are in storage for potential deployment in 50 empty silos.

f) Of these ICBM warheads, 400 are deployed on operational missiles and the rest are in long-term storage.

g) Only counts 240 SLBMs for 12 deployable ballistic missile submarines. Two other ballistic missile submarines are in refueling overhaul, for a total of 280 launchers. There are a total of 448 SLBMs in the inventory, of which about half are for spares and flight tests. The life-extended DFLE is replacing the original missile.

h) The W76-1 is a life-extended version of the W76-0 that was first deployed in 1978.

i) All W76-0 warheads are thought to have been replaced on ballistic missile submarines by W76-1 warheads, but several hundred are still in storage, and more have been retired and are awaiting dismantlement. After the W76-1 life-extension program production is completed in FY2019, the remaining W76-0 warheads will be scrapped.

j) The W76-2 is a single-stage low-yield modification of the W76-1 with an estimated yield of 5–7 kilotons.

k) Assumes two SLBMs, each with two W76-2s, available for each deployable SSBN.

l) Of these SLBM warheads, approximately 890 are deployed on missiles loaded in ballistic missile submarine launchers.

m) Of the 87 B-52s, 76 are in the active inventory. Of those, 46 are nuclear-capable, of which less than 40 are normally deployed.

n) The first figure is the total aircraft inventory, including those used for training, testing, and back-up; the second is the portion of the primary-mission aircraft inventory estimated to be tasked with nuclear missions. The United States has a total of 66 nuclear-capable bombers (46 B-52s and 20 B-2s).

o) Of these bomber weapons, only about 300 are deployed at bomber bases. These include an estimated 200 ALCMs at Minot Air Force Base and approximately 100 bombs at Whiteman Air Force Base. The remaining 550 weapons are in long-term storage. B-52s are no longer tasked with delivering gravity bombs. p The F-15E can carry up to 5 B61s. Some tactical B61s in Europe are available for NATO DCAs (F-16, PA-200). Maximum yield of B61-3 is 170 kt; maximum B61-4 yield is 50 kt.

q) Up to 150 B61-3 and −4 bombs are deployed in Europe, of which about 80 are earmarked for use by NATO aircraft. The remaining 80 bombs are in central storage in the United States.

r) Deployed warheads include approximately 1,300 on ballistic missiles (400 on ICBMs and 900 on SLBMs), 300 weapons at heavy bomber bases, and up to 150 nonstrategic bombs deployed in Europe.

Nuclear weapons test © WikiImages, Pixabay

Economics

In January 2020, the Congressional Research Service (CRS) summarised recent official estimates of current and future US nuclear weapons costs. CRS found "a broad base of agreement," noting, however, that:

> It was difficult, if not impossible, to determine how much the United States spent each year on nuclear weapons, as the funding was divided between the Department of Defense and the Department of Energy, and, in many cases, was combined with funding for other, nonnuclear activities. In other words, the United States does not maintain a single, unified budget for nuclear weapons and other nuclear activities.[30]

"Broad … agreement" does not imply accuracy. Ambiguities, omissions, programme changes, rapid cost escalations, and secrecy make nuclear weapons costs difficult to estimate now and in the immediate future—and impossible to predict beyond that.

Already, observed rising costs and schedule delays are signaling mounting "execution risks" in an increasingly contingent, unpredictable future. Over the next ten years US nuclear weapon modernisation programmes will require ever-increasing funding, the recruitment and retention of tens of thousands of skilled workers, capable management, and an enduring political consensus, among other factors, all far from guaranteed. This is discussed further below.

For FY2019, the most recent year for which an independent estimate is available, the Congressional Budget Office (CBO) assessed annual then-current spending on US nuclear weapons at $33.6 billion—US $21.8 billion in DoD and US $11.8 billion in Department of Energy (DOE).[31] This figure does not include the development of naval reactors for nuclear weapons platforms (US $1.8 billion, in DOE) or warhead-associated DOE environmental expenses of US $6 billion in that year. If included, these would raise the total to US $41.4 billion.[32] By way of comparison, this is larger than the *total* military spending in all but nine other countries.[33]

Costs are increasing rapidly. That same CBO ten-year estimate showed US $42 billion in unanticipated cost growth over the front decade in comparison to its 2017 ten-year estimate—5.3 per cent/year above inflation. Most of the unanticipated growth came from "new modernisation programmes" added since 2017 and "more concrete plans for nuclear command-and-control systems."[34]

The Trump Administration is now requesting US $44.5 billion for nuclear weapons in FY2021,[35] not including US $1.7 billion for naval reactors and US $5.0 billion for environmental cleanup, or US $51.2 billion in all. The request includes US $15.6 billion for warheads—a 25 per cent increase over FY2020 and a 40 per cent increase over FY2019—as well as US $28.9 billion for nuclear weapons in DoD, a 32 per cent increase over two years. Some US $14.8 billion in DoD research and development costs are requested.[36] In 2017, CBO had estimated FY2021 nuclear weapon costs would be about US $40 billion, so the FY2021 request represents about US $5 billion (11 per cent) in unanticipated cost growth in FY2021 since then.[37]

This US $51.2 billion, the Administration's estimate of nuclear weapon costs in FY2021 including environmental management, is now greater than the *total* military budgets of all but four other countries.[38]

Given this observed steep cost growth, and the long-standing nuclear management challenges in both DoD and DOE discussed briefly below, all nuclear weapon cost estimates must be taken with a large grain of salt.

Now, given the cascading, multifaceted COVID-19 crisis, with its very large fiscal and national security implications,[39] uncertainty has exploded. All stockpile plans and costs must be considered highly mutable, subject to hitherto unthinkable magisterial forces—biological, ecological, economic—that operate quickly, without submission to prior political consensus.

Even prior to the present national emergency, stockpile plans and associated costs carried a large number of hidden business-as-usual assumptions. Change has been unimaginable. Centrally in the present context, deployment of a thousand or more nuclear weapons has been assumed not just by government but also by several leading non-governmental organisations (NGOs)—in effect, nuclear Non-Proliferation Treaty (NPT) article VI noncompliance.

Despite their absurdity, we nonetheless include the official government projections here as well as NGO alternatives based on them.

In 2017, CBO estimated the 30-year (2017–2046) cost of US nuclear weapons (modernisation, operation and sustainment, command and control, and the warhead complex) at $1.24 trillion (US $1.32 trillion in 2020 dollars). Of this, 28 per cent (US $352 billion) was in DOE (for warheads) and 72 per cent (US $890 billion) was in DoD (for everything else). Of the total, US $400 billion was for modernisation; the balance was for operations and sustainment of existing forces.[40]

This figure did not include DOE's legacy environmental liabilities. In 2018, DOE estimated its warhead-related liabilities at US $541 billion (US $573 billion in today's dollars).[41] Despite cleanup investments, these estimated environmental liabilities have grown in each of the last seven years at an average rate of US $31 billion/year.[42] Given this pattern we can roughly estimate, in the absence of any official figure and accounting for estimated savings in the programme to dispose of surplus plutonium, that DOE's environmental liabilities lie in range of US $600 billion today.

So, including environmental costs, CBO's 2017 estimate of 30-year US nuclear weapon costs would expand to US $1.92 trillion in 2020 dollars.

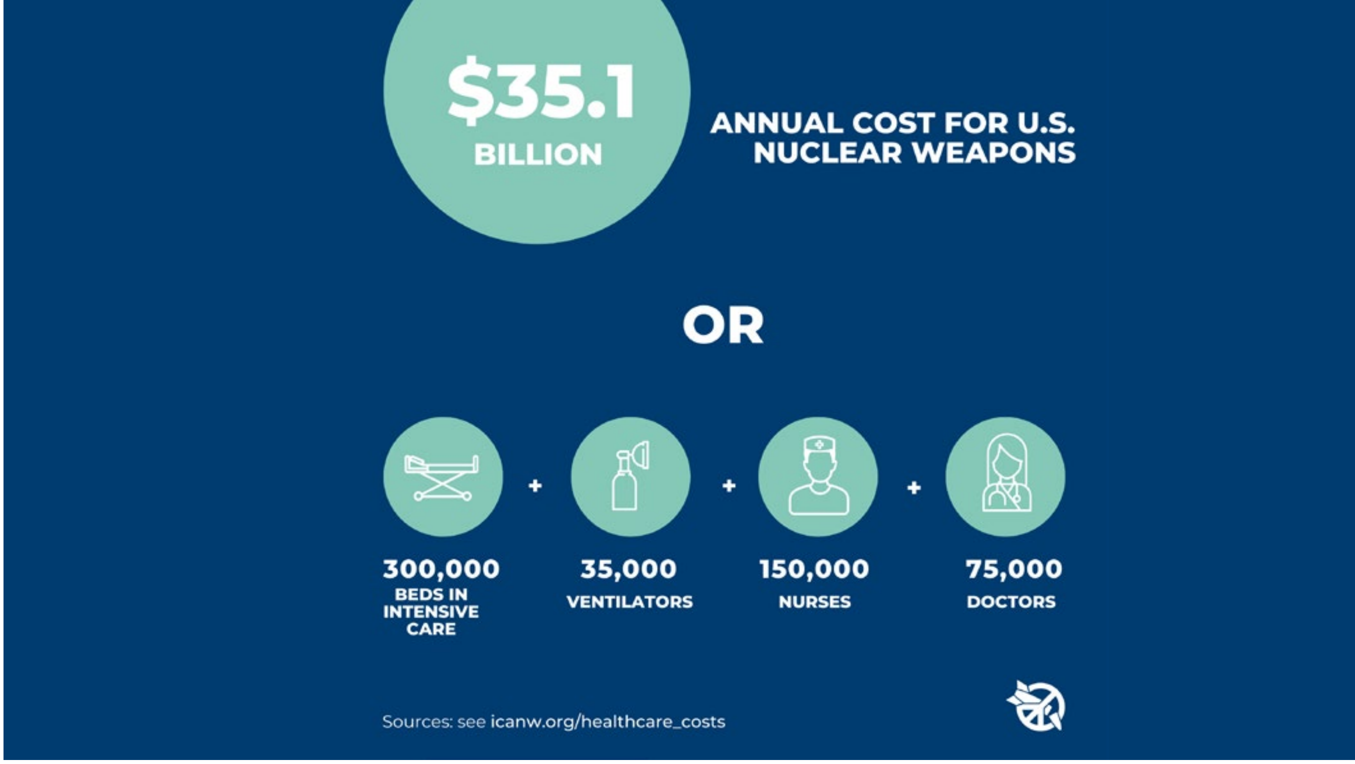
Considering the cost growth seen by CBO over the 2017–2019 period, and the 30 per cent requested real annual cost growth just over the past two years as reflected in this year's budget request, we can safely estimate that the present-value cost of sustaining, deploying, and modernising US nuclear weapons over the next 30 years will be greater than US $2 trillion, well above the "broad … agreement" observed by CRS.

Before proceeding, we can observe that this 30-year sum comes to more than US $15,460 per US household, in present value. On an annual basis, the average cost of US nuclear weapons over the next 30 years is at least US $67 billion/year, including current legacy environmental costs, or at least US $44 billion/year—US $5 million per hour, 24/7—without those costs. These figures do not include interest on the federal debt used to finance these programmes.

In 2017, CBO was concerned about whether these large commitments could be sustained:

> Pursuing nuclear modernization will be challenging in the current environment…. Even if the [2011 Budget Control Act] funding caps were lifted, nuclear modernization would compete with other defense priorities in those years, including proposals to increase the number of warships in the Navy's fleet, modernize DoD's fleet of aircraft, and expand the size of the Army. Beyond 2021, budgetary pressures may continue: appropriations for both defense and nondefense programs may be constrained in the longer term because of rising spending on the aging population (for Social Security and Medicare benefits), health care, and interest on the national debt.[43]

In its 2017 report CBO examined the savings available from nine policy and stockpile variations from the then-current programme of record. Rightly or wrongly, CBO estimated that even significant stockpile changes would produce only modest savings over the coming 30 years. Eliminating bombers would save only 6 per cent of total costs; eliminating intercontinental ballistic missiles (ICBMs) only 10 per cent; eliminating bombers while cutting deployment to 1,000 warheads would save only 9 per cent; eliminating ICBMs while cutting deployment to 1,000 warheads would save only 11 per cent of total costs.[44]



ICAN has calculated how the annual cost for US nuclear weapons could pay for health care services.

Combining CBO's 2017 estimated savings from four of its options (immediately eliminating all US ICBMs, long range bombers, gravity bombs, and nuclear cruise missiles, while continuing to deploy and modernise a stockpile of 1,000 deployed warheads on ten ballistic missile submarines (SSBNs) and their replacements) would save approximately 26 per cent of the 30-year costs for the current arsenal and comprehensive modernisation plan.[45] Keeping only eight SSBNs would shave off another US $19 billion (1.4 per cent).

All CBO's estimates assume that the costs for DOE's "laboratories and supporting activities" remain unchanged at US $261 billion (2017 dollars) over 30 years (US $8.7 billion/year), under all options.[46] For comparison, DOE's expenses for comparable activities during the Cold War averaged US $4.79 billion/year (2017 dollars), for a far larger and much less well-understood arsenal. DOE is requesting US $16 billion for FY2021, including administrative expenses.[47] See Figure 1.

Dropping back to Cold War spending levels in DOE, while still allowing tens of billions of dollars in new and renewed infrastructure, again using CBO's estimates, would bring the 30-year cost of a 1,000 warhead monad on ten submarines down to roughly two-thirds of current estimates, to roughly $882 billion in today's dollars or US $29 billion/year. This would save roughly US $435 billion (US $15 billion/year) over the coming 30 years.

The scenario of a 1,000 warhead monad (with dramatic DOE management reform added) is roughly the lower limit of 30-year costs that can be constructed from policy options in CBO's 2017 analysis. It reflects neither a "minimum deterrence" policy nor the trajectory toward full disarmament required by Article VI of the NPT.

If CBO is right, fielding even dramatically smaller nuclear forces than the US possesses today—smaller but still far larger than any country except Russia—would remain a costly endeavor. At US $29 billion/year, the vastly reduced nuclear scenario above would still cost more than the *total* military expenditures of all but 12 countries.[48]

In 2019 the Arms Control Association (ACA) generated three nuclear cost-saving and force reduction scenarios based on CBO's analysis and other sources, with projected 30-year savings ranging from US $29 billion to US $282 billion.[49] The smallest savings envisioned came from elimination of four post-2016 additions to nuclear modernisation.[50] The largest savings resulted from a 1,000 deployed-warhead dyad based on elimination of all ICBMs plus the Long Range Stand Off (LRSO) missile and its warhead, the withdrawal of all B61s from Europe, reduction of the SSBN force to eight boats, and the elimination of post-2016 additions to nuclear modernisation.[51] And like the scenario above, none of the ACA scenarios envisioned a trajectory toward NPT compliance.

A different smorgasbord of possible nuclear policies and cost savings, but also built around CBO's 2017 analysis, was assembled by the Cato Institute.[52]

Current modernisation costs and schedules for US nuclear weapons are assembled in Table 1.

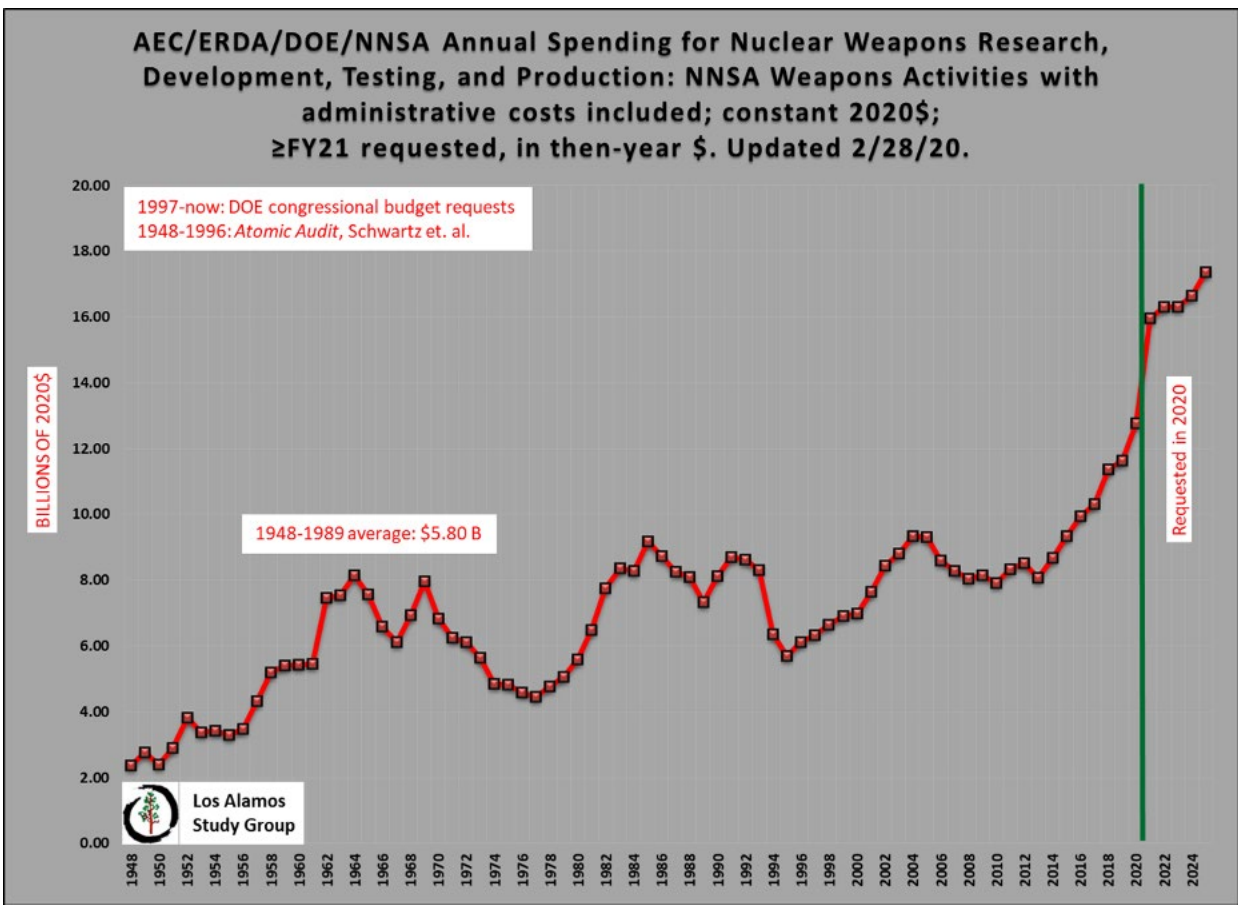
Table 2: US nuclear weapons

BOMBS (B) OR WARHEADS (W)	FISCAL YEAR (FY) 2020 COST ($M)	FY 2021 REQUESTED ($M)	TOTAL	FIRST PRODUCTION UNIT OR FIRST DEPLOYMENT, ESTIMATED COMPLETION YEAR (ECY)
B61-12 life-extension program (LEP)	792.6 (2, 111)	815.7 (2, 111)	9.9 (3, 8-37 & 11, 4)	2022; ECY 2026 (2, 120)
B61-12 Tail Kit Assembly	100.0 (7, 4-2)	50.0 (7, 4-2)	2.0 (6, 2)	2020 (6, 2)
B61-13 LEP	none	none	22.5 (3, 8-41)	2038
B83-1	51.5 (2, 111)	30.8 (2 p 111)	n/a	as of 2018, to be retained indefinitely (3, 1-5)
W76-1 LEP (for SLBMs)	n/a	n/a	4.2 (3, 8-36)	completed in 2019 (1, 8)
W76-2 Modification (Mod) (for SLBMs)	10.0 (2, 111)	n/a	.076 (3, 8-36)	Feb 2019 (3, 2-38); deployed Dec 2019
W80-4 LEP (for LRSO cruise missile)	898.5 (2, 111)	1.0 (2, 111)	12.0 (11, 4)	2026; ECY 2031 (2, 120)
W87-1 Mod for ICBM, former W78 replacement or W1 (3, 1-6)	112.0 (2, 111)	541.0 (2, 111)	14.8 (11, 4)	2030 (2, 121); ECY 2038 (11, 8)
Mk21A aeroshell for W87-1	65.7 (14, 22)	112.8 (14, 22)		2030
W88 Alteration (Alt) 370	304.2 (2, 111)	256.9 (2, 111)	2.75 (11, 4)	2021; ECY 2025 (2, 120-122)
W93/Mk7 SLBM Next Navy Warhead, former IW2 (3, 2-45)	0	53.0 (2, 111)	17.6 (3, 8-41)	2034 (3, 8-6); ECY 2041 (11, 8)
Future strategic missile warhead LEP, former IW3	0	0	18.6 (3, 8-41)	2037 (3, 8-6)
Bombers & Dual-Capable Aircraft (DCA)				
B-2A Spirit Defensive Management System	3,057 (5, 143)	337 (7, 8-3)	1.91 (16, 763	June 2022 (5, 143)
B-21 Raider (Long-Range Strike Bomber, LRS-B)	3,000 (7, 4-2)	2,800 (7, 4-2)	102.8 (13, 53)	2025 (6, 2)
B-52H (replacing engines, upgrading radar, avionics, and NC3 systems)	2,116 (5, 167)	unknown	unknown	November 2025 (5, 167)
F-15 Eagle DCA (upgrade passive active warning & survivability systems - EPAWSS)	47.3 (16, 2)	170.7 (16, 2)	4.0 (17)	2019 (16)
F-16 DCA Mid-Life Upgrade	18.8 (10, 39)	57.6 (13, 43)	unknown	n/a
F-35A DCA (expected to replace F-15E)	70.0 (7, 4-8)	110 (7, 4-8)	unknown	Nuclear certification expected 2024 (7, 4-8), deployment 2025 (8, 40)
Missiles				
Ground-Based Strategic Deterrent (GBSD) (to replace MMIII ICBM)	557.5 (4, 5-19)	1,525 (4, 5-19)	85-150 over 30 years (19, 2)	2029; ECY 2036 (6, 2)
LRSO cruise missile - replaces AGM-86B ALCM	712.5 (4, 5-21)	474.4 (4, 5-21)	10.8 (6, 2)	2026 (14, 41)

BOMBS (B) OR WARHEADS (W)	FISCAL YEAR (FY) 2020 COST ($M)	FY 2021 REQUESTED ($M)	TOTAL	FIRST PRODUCTION UNIT OR FIRST DEPLOYMENT, ESTIMATED COMPLETION YEAR (ECY)
Trident II D-5 Submarine-Launched Ballistic Missile (SLBM) Life-Extension (D5LE)	1,189 (4, 5-15)	1,191 (4, 5-15)	19.0 (13, 53)	February 2017 (7, 4-8); ECY 2040 (15, 3)
Sea-Launched Cruise Missile, Nuclear (SLCM-N) (19, 12)	5.6 (1, 10)	none	unknown	Analysis of Alternatives
Ballistic Missile Submarine				
Columbia class ballistic missile submarine (SSBN)	2,480 (7, 4-2 & 2, 694)	4,470 (7, 4-2 & 2, 694)	139.0 for 12 subs (6, 2)	2031 (6, 2); ECY 2043, if purchase one/
Nuclear Command, Control and Communications (NC3)				
NC3	3,500 (7, 4-8)	7,000 (18, 1)	195.0 over 30 years (13, 17)	ECY 2037 (14, 20)

Sources for Table 2 can be found at the end of the chapter.

Figure 1 summarises current and planned near-term cost growth in warhead spending in historical context.



Source: Los Alamos Study Group.

As of this writing, there are no current long-term estimates for the National Nuclear Security Administration (NNSA)'s warhead work. This year's proposed huge increase in warhead spending, coupled with the arrival of COVID-19 on top of other converging crises, have made all long-term estimates obsolete.

International law and doctrine

More than four decades after the United States signed and ratified the NPT, it retains a nuclear arsenal large enough to end civilisation, if not human life, in a few minutes. Stockpile reductions, which began in 1968, are not disarmament, and in any case no further reductions are currently planned or being negotiated. At the conclusion of the 2000 NPT Review Conference, the US agreed that a no-backtracking "principle of irreversibility" applies to nuclear disarmament. Yet endless modernisation of the research laboratories and factories necessary to design and produce nuclear weapons is inherently incompatible with any "principle of irreversibility" in regard to disarmament. Doing so with the express intention of being able to re-arm, and to permanently hold open the potential to reconstitute large nuclear arsenals throughout the course of disarmament, also is inconsistent with an "unequivocal undertaking" to eliminate nuclear arsenals.

Since 2018, the US government has been promoting an initiative it calls Creating the Conditions for Nuclear Disarmament (CEND).[53] This approach, which focuses on the measures other countries need to take in order for the US to feel "secure" enough to engage in nuclear disarmament, undermines past NPT commitments and other nuclear weapon governance agreements. It demands that the international community should focus on "the underlying security concerns" that led to the creation of nuclear weapons. Of course, implementation of the NPT, including article VI, has never been predicated on first establishing conditions or an environment deemed appropriate by the nuclear-armed states. The leap backwards from decades of agreed commitments is an affront to all of the efforts made over the years in the NPT, and to the United States' own allies that support the step-by-step approach. While some countries have engaged with the CEND initiative as a credible process, most have expressed concern that this is another ploy by the US government to detract from its own responsibilities and defer action on disarmament.[54]

The US has not signed or ratified the Treaty on the Prohibition of Nuclear Weapons. It has repeatedly said that will "never" support the Treaty and that it does not consider itself bound by it through customary international law.[55] The US has actively lobbied its allies and other countries to not support the negotiation of the Treaty or to ratify it after its adoption in 2017.[56]

The US has signed but not ratified the Comprehensive Nuclear Test Ban Treaty (CTBT); ratification was rejected by the US Senate in 1999 even after a bargain was made to modernise its nuclear weapons infrastructure in exchange for ratification.[57] There has been no technical need, or any publicly expressed desire, for nuclear testing in or from the US warhead complex for 20 years. The negative consequences of nuclear testing for US security are very well-established throughout the foreign policy establishment. Comments from the current US administration have given rise to concerns that the US may resume testing, though officials have said the US intends to abide by its explosive nuclear testing moratorium (it has continued to engage in ever-more-sophisticated subcritical testing since the CTBT's adoption in 1996).[58]

The US announced its withdrawal from the Anti-Ballistic Missile Treaty in 2001; continuing US development and deployment of ballistic missile "defence" systems is a serious impediment to further disarmament progress as well, to say the least. Russia understood that withdrawal as a bid for strategic supremacy, as many in the US had long warned, and undertook development of multiple kinds of non-ballistic nuclear delivery systems.[59]

On 2 August 2019, the US completed its withdrawal from the Intermediate-Range Nuclear Forces (INF) Treaty. It blamed its withdrawal on Russia, which it accused of violating the INF Treaty by testing and deploying a banned missile system. Russia denied the accusations and said that it would "mirror the development" of any missiles the US makes.[60]

The New Strategic Reduction Arms Reduction Treaty (New START) is the only remaining treaty that places limits on US and Russian nuclear weapon deployments. It is set to expire in February 2021. The US government has said it is interested in pursuing "tripartite" nuclear arms control with Russia and China rather than a bilateral agreement,[61] which China does not see as reasonable given its much smaller arsenal size.

On 8 May 2018, the US government announced its withdrawal from the Joint Comprehensive Plan of Action (JCPOA) with Iran and other states, despite the fact that the International Atomic Energy Agency (IAEA) consistently found Iran to be in compliance with the agreement. The US then reapplied sanctions against Iran; as the JCPOA was endorsed unanimously by the UN Security Council on 20 July 2015 in resolution 2231, the unilateral sanctions are in violation of this resolution. The US withdrawal and sanctions led Iran, after a "year of patience," to slowly begin reducing its compliance with the JCPOA in 2019.

The 2018 Nuclear Posture Review (NPR) continues but also makes more explicit, and in newly-bellicose language, a number of long-standing US nuclear weapons policies. In contrast with the 2010 NPR, the most recent version highlights the possibility for the first use of nuclear weapons, in detail, and calls for new nuclear weapons.[62] The first such weapon, the low-yield Trident ballistic missile warhead, has entered deployment.

Public discourse

"Talk is cheap," they say. Does public discourse regarding nuclear weapons matter in the US? And in an age of propaganda, social media, and fragmentation of the public sphere, does "public discourse" even exist, in any meaningful sense?

Setting aside the second question, a large body of research has shown that citizen opinion—and public discourse based on those opinions—have little or nothing to do with national policy outcomes.[63] The NGO community, which still attempts to mold overall public discourse and "build awareness" of the need for nuclear disarmament, has not sufficiently processed this reality.

To a considerable extent, the US is simply not a functioning democracy at the national level. In 2017 the *Economist* downgraded the US to a "flawed democracy," finding that the US had been "teetering on the brink" of that downgrade for years and is now struggling to sustain representative democracy.[64]

This is especially true in regard to military and defence issues, ring-fenced as they are with secrecy and subject to a rigid chain of command. Even congressional dissent—ostensibly the main channel through which public discourse could influence policy—is minimal on defence issues, as any comparison of funding requests versus congressional authorisations and appropriations would show.

Congressional dissent on some nuclear weapons issues has nonetheless been important at times, though mostly on the margins of policy.

Success in modifying proposed executive branch policies requires bipartisan support. Unfortunately, dissent from executive proposals has in recent years acquired a strongly partisan and divisive character, which has undermined effectiveness. Much of this dissent is relatively insubstantial, as both major parties have adopted belligerent rhetoric toward Russia and China, which implies strong political support for "defence" and nuclear weapons programmes in particular.

At present there is no significant public or congressional opposition to any major US nuclear weapons modernisation program.

Acceptable narratives in US public discourse on nuclear issues largely flow directly and indirectly from government sources—"newsmakers"—which news outlets favour. Narratives from other sources, if present at all, come primarily from certain academics, think tanks, and government- or party-aligned NGOs and are typically reactive, and secondary or pro forma.

In other words, most "public" discourse about nuclear weapons comes directly or indirectly from government. Government is in turn largely captive of the "unwarranted influence" of the "military-industrial complex."[65]

The "born-secret,"[66] formidably technical issues relating to nuclear weapons are among the least accessible of all defence issues to informed public discourse. Nuclear modernisation is managed in a uniquely corrupt manner in government.[67] In the absence of effective congressional oversight or arms control interest, the political power of the warhead laboratories, the core of the modernisation lobby, has grown in discernable steps since 1994.[68]

There are no signs that public enfranchisement on nuclear weapons issues will increase any time soon. On the other hand, local concerns—which in cases of nuclear deployment and modernisation activities become national concerns—remain potentially potent. Within narrow limits, so does informed analysis within and among the specialist community and government decisionmakers. This discussion is inaccessible to a disempowered and distracted public.

Recent polls reveal that Americans overall don't know or care much[69] about nuclear weapons, and harbor contradictory ideas about them.[70] They do clearly support further mutual stockpile reductions with Russia,[71] and if asked do express a wish to rid the world of nuclear weapons.[72] Recent polling once again affirms support for arms control objectives.[73]

While popular attitudes about nuclear weapons change with events and media narratives, and factual knowledge is at best vague, these polls and others suggest *there is no popular barrier to significant—even deep—mutual nuclear disarmament*. Thus the low salience of nuclear issues cuts both ways.

What is absent is leadership capable of confronting and transcending the nuclear weapons lobby. In the past, antinuclear activism in the United States has concretely impacted nuclear weapon policies. Today, efforts in the United States have not placed sufficient pressure on the actual decisionmakers regarding specific material policies and programs.

Effectively challenging the nuclear-industrial complex is different today than in past decades: highly-negative trends in campaign finance; steep declines in the quality, quantity, and independence of journalism; the extreme fragmentation of public information sources coupled with a rising inability to discern facts from ever more sophisticated propaganda; deepening economic inequality and expanding precarity; rapidly rising student debt; perceptions of disenfranchisement leading to political withdrawal and cynicism; the enormous rise of various forms of identity politics, which fragment polities; a shocking foreshortening of historical memory; and the rise of other existential crises with immediate impact—a process which will intensify from this point forward—are among the factors that have made US citizens much more malleable and quiescent as regards nuclear weapons issues.

The COVID-19 pandemic has ushered in an era of widespread precarity unprecedented in the US since the Depression of the 1930s, and still growing. We are observing that even among strongly antinuclear constituencies, the quantum of attention formerly available for activism is now directed to more basic human needs such as safety and security. Even more fundamental needs, such as for food and shelter, may be increasingly challenged in the months and years ahead as additional economic and environmental dimensions of our converging crises manifest.

There is no reason to think the material, social, and political conditions for single-issue antinuclear activism will return. On the other hand, the time is riper than ever for activism based on the fundamental redirection of security priorities, in which nuclear weapons issues are an important aspect. To be fruitful in the long run, activism must achieve short-term victories that halt nuclear modernisation projects. Real traction will produce real victories.

Politically meaningful discourse about nuclear modernisation is inseparable from discourse about nuclear weapons more generally, for the simple reason that as long as nuclear weapons are retained, modernisation will occur. Modernisation can be slowed and its scope narrowed, but nuclear modernisation has an inconvenient internal logic that defies gradual reforms. Stasis and like-for-like replacement are impossible—continual modernisation is required or the else the industry will collapse.

Nuclear weapon modernisation is strongly shaped and constrained by a complex interplay of internal institutional imperatives within the privatised US nuclear weapons enterprise involving (in no particular order) technological opportunism, considerations of workforce stability and recruitment, infrastructure modernisation (sometimes with construction timelines exceeding one decade), transmission of key skills and ideologies, stability of specialised supply chains, "pork-barrel" politics, worker safety and environmental priorities, economies of scale, and efficiencies in manufacturing and maintenance. These constraints are largely impervious to democratic, or even congressional or executive branch, control.

Why? Any nuclear weapon that is retained must sooner or later be modernised or replaced. The people and the labs and factories necessary to undertake this massively complex task will need to be in place, trained, equipped, resourced, and in practice when the time comes to do so. The necessary technology must be developed and tested. In some cases, it will not be the technology of 30 years prior (for which no supplier base exists), which is not taught in schools. The only way this readiness can be maintained is for these facilities and staff, both of which must themselves be continually renewed, to design and produce modernised warheads more or less continuously.

What *can* be changed, above minimum stability thresholds, is the scale of the sustainment and modernisation endeavor, which depends on the diversity and size of the stockpile to be maintained. Great savings and downscaling in modernisation can be achieved, but only if the stockpile is cut deeply.

Detailed questions regarding modernisation are largely inaccessible to the public and even to most members of Congress. The President will delegate such decisions to his appointed experts, all drawn from within the field and subject to its loyalties.

For these and many other reasons, popular discourse about nuclear weapons and modernisation doesn't, and won't, influence US nuclear weapons policy, *within the current broad parameters of current US national security discourse.*

These broad parameters are however changing due to the cascading impacts of the COVID-19 pandemic, although precisely how, how much, and when is impossible to ascertain at present.

Late last month the CBO estimated the current-year federal fiscal deficit at US $3.7 trillion, 18 per cent of estimated GDP—over three times last year's deficit.[74] For structural and psychological reasons, as well as from premature lifting of social distancing requirements and a likely second pandemic wave, official and popular estimates of economic recovery may be optimistic.

Even *before* the pandemic, US military and national defence accounts were likely to be unsustainable, as CBO gently warned in 2017.[75]

The situation is much worse now. The pandemic involves at least four out of the eight top strategic risks to the US, as identified in the 2015 National Security Strategy. None of these four has a military character or requires a military response.[76]

As noted above, the CBO found that even fairly large adjustments in modernisation policy and the nuclear arsenal did not generate large budget savings in the context of military spending overall, in which spending for nuclear weapons comprises only about 7 per cent.

Whereas cuts to the *overall* military budget, including but not limited to nuclear weapons, *would* generate large savings—and liberate resources on the scale needed to address the truly existential national security crisis of climate collapse, while also creating millions of accessible, near-term jobs and careers. At present, the total US military budget approaches—or, if interest payments are included, exceeds—one trillion dollars per year.[77] The US lacks any viable plan for replacing the tens of millions of jobs that the coronavirus will destroy. Redirecting national security priorities could provide that plan.

In this context, expert discourses that involve paring the US nuclear arsenal to save US $1–9 billion annually—the range of savings in the Arms Control Association report cited above—will likely not find much traction. That much savings isn't significant when hundreds of billions, even trillions, in new debt-based spending are being authorised, quite likely in vain, to quickly end the current "recession".

"Make no small plans" is sound advice in this context.[78] Efforts at gradual reform have conspicuously failed; their political effect has been to protect the status quo.

It should be noted that in the US, nuclear weapons function politically to help deter military budget cuts. The presence of a nuclear adversary that is capable of annihilating the entire United States allows the aggressive nature of US foreign policy and global military adventurism to pass largely unnoticed. Without existential nuclear fears, it would be difficult to maintain current levels of austerity in social programmes while US "defence" expenditures far exceed those of all potential adversaries put together.

The *New York Times* recently quoted Dominique Moïsi, a political scientist and senior adviser at the Paris-based Institut Montaigne, "[In its response to the pandemic] America has not done badly, it has done exceptionally badly.... America prepared for the wrong kind of war.... It prepared for a new 9/11, but instead a virus came. It raises the question: Has America become the wrong kind of power with the wrong kind of priorities?"[79]

This question will grow in importance.

The Gallup organisation conducts a monthly open-ended poll that asks US citizens, "What do you think is the most important problem facing the country today?" In April 2020, "national security," "lack of military defence," "situation with China," and "situation with Russia," were each chosen by less than 0.5 per cent of respondents. No military- or defence-related concern topped the 0.5 per cent popularity mark. "War/conflict between Middle East nations" and "situation with North Korea" had zero responses. It was coronavirus (45 per cent), "government/poor leadership" (20 per cent), the economy (13 per cent), and healthcare (6 per cent) which topped the most recent list.

Even in the few months prior to the pandemic and despite constant government and heavy media propaganda, "situation with Russia" never cracked 0.5 per cent. All national security issues taken together fell in the 1–3 per cent range while environmental issues fell in the 3–5 per cent range and healthcare in the 5–10 per cent range. The "Overton Window" is wide open.[80]

In announcing the assassination of Dr. Martin Luther King, Robert Kennedy quoted Aeschylus, "And even in our sleep, pain which cannot forget falls drop by drop upon the heart, until in our own despair, against our will, comes wisdom through the awful grace of God."[81]

Wisdom is something more than "discourse". Truth matters, and the truth of our overall predicament, interpreted variously, is beginning to seep in for many people. We are at the end of an age. What was "normal" is vanishing irrevocably in the rear-view mirror.

The truth is that neither the US nor world civilisation can long survive the madness of the US investing so much of its political attention, scarce real capital, and skilled labour in armaments, including nuclear armaments—which are primary lynchpins in our ever more complex predicament. The central historical and ecological reality of our time is that we—all of us—are in the first stages of a complex catastrophe which will re-sort our priorities and stress our institutions to—and beyond—the breaking point.[82] The public discourse we most need to focus on is our own.

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70 Kelsey Piper, "Americans are terrifyingly supportive of nuking civilians in North Korea," Vox, 26 June 2019, https://www.vox.com/future-perfect/2019/6/26/18750566/nuclear-war-polling-americans-support-civilian-deaths.

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71 Jeffrey M. Jones, "In U.S., 56% Favor U.S.-Russian Nuclear Arms Reductions," Gallup, 11 March 2013, https://news.gallup.com/poll/161198/favor-russian-nuclear-arms-reductions.aspx: "Americans, by 56% to 38%, support a reduction in U.S. and Russian nuclear arsenals. Democrats are most inclined to support it -- saying they would vote for such a law if they could -- while Republicans are about evenly divided in their views."

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Peace flag, 2018 © Martin Ollman

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Reaching Critical Will works for disarmament and arms control of many different weapon systems, the reduction of global military spending and militarism, and the investigation of gendered aspects of the impact of weapons and of disarmament processes. It produces research studies, reports, statements, fact sheets, and other publications on key issues relevant to disarmament, arms control, and militarism.

This updated study explores the ongoing and planned nuclear weapon modernisation programmes in China, the Democratic People's Republic of Korea, France, India, Israel, Pakistan, Russia, the United Kingdom, and the United States.

Non-governmental researchers and analysts provide information on each country's modernisation programmes, plans, and budgets while its introduction reflects on the costs of nuclear weapons spending in the context of the COVID-19 pandemic.

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