



Perilous Profiteering

The companies building nuclear arsenals and their financial backers.

Executive Summary



ICAN
International Campaign to
Abolish Nuclear Weapons

Utrecht, November 2021

There remains a marked lack of official information available in the public domain about the use, production, transfer and stockpiling of nuclear weapons. We strived to achieve the highest level of accuracy in reporting. The information in this report reflects official information available in the public domain. We welcome comments, clarifications, and corrections from governments, companies, financial institutions and others, in the spirit of dialogue, and in the common search for accurate and reliable information on this important subject. If you believe you have found an inaccuracy in our report, or if you can provide additional information, please contact: info@dontbankonthebomb.com

Principal Author: Susi Snyder

Primary Researchers

Susi Snyder (PAX, The Netherlands)

Jeroen Walstra (Profundo, the Netherlands)

Our thanks:

Joseph Rowntree Charitable Trust, Jubitz Family Foundation, CoreLab, Maaïke Beenes, Roelien Donker, Vicki Elson, Beatrice Fihn, Venessa Hanson, Daniel Högsta, Hans M. Kristensen, Cor Oudes, Grethe Østern, Lucero Oyarzún, Gem Romuld, Alicia Sanders-Zakre, Seth Shelden, Frank Slijper, Max Tegmark, Michel Uiterwaal, Timmon Wallis, and Tim Wright.

And all those who work tirelessly to stigmatize, outlaw, and eliminate nuclear weapons.

Notes:

Certain figures in this report may not tally exactly due to rounding. All figures are presented in U.S.D (unless otherwise indicated). Commas (,) are used as thousands separators.

This document, as well as any data and any map included herein, are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

About PAX

PAX means peace. Together with people in conflict areas and concerned citizens worldwide, PAX works to build just and peaceful societies across the globe. PAX brings together people who have the courage to stand for peace. Everyone who believes in peace can contribute. We believe that all these steps, whether small or large, truly matter and will contribute to a just and peaceful world. PAX is an ICAN partner.

About ICAN

ICAN is a global campaign coalition working to mobilize people in all countries to inspire, persuade and pressure their governments to sign and ratify the Treaty on the Prohibition of Nuclear Weapons. ICAN is comprised of more than 600 partner organisations in over 100 countries. More information about ICAN can be found at: www.ICANw.org

About Profundo

Profundo is an economic research consultancy analysing commodity chains, financial institutions and corporate social responsibility issues. It works predominantly for environmental, human rights and development organisations in the Netherlands and abroad. www.profundo.nl

© Don't Bank on the Bomb

Permission is granted for non-commercial reproduction, copying, distribution, and transmission of this publication or parts thereof so long as full credit is given to the coordinating project organization, editor, and relevant authors; the text is not altered, transformed, or built upon; and for any reuse or distribution, these terms are made clear to others.

Cover image: Daniel Lloyd Blunk-Fernández On Unsplash (<https://unsplash.com/photos/vrSKrUEZsDY>)

Nuclear weapons are prohibited by international law, yet 25 companies remain heavily involved in their production, manufacture and development. These companies are supported by 160 banks that lend them money or underwrite bonds, while another 186 institutions seek to profit from holding shares or bonds. Altogether 338 financial institutions made more than \$685 billion available to the nuclear weapon industry since 2019.

In January 2021, the Treaty on the Prohibition of Nuclear Weapons (TPNW) entered into force. The treaty explicitly prohibits the manufacture, production and development of nuclear weapons, as well as assistance with those prohibited acts. Financial institutions are divesting from their nuclear weapon related holdings, the number of total investors continues to drop with every Don't Bank on the Bomb publication.

Nuclear weapons are controlled by governments, but their production is often contracted to private companies. This is the situation in about half of the nuclear armed countries, though in bringing together materials to develop, test, produce, manufacture or stockpile nuclear weapons it is safe to assume there is a great deal of private sector involvement along the supply chain. Companies in China, France, India, Russia, the United Kingdom, and the United States, are listed in this report along with information about the key components they produce for nuclear arsenals.

Nearly every country in the world has undertaken a legally binding agreement to, at a minimum, negotiate the disarmament of nuclear arsenals. Many countries worked together to fulfil this obligation by negotiating the TPNW, yet the nine nuclear armed countries are doing the opposite. They are spending upwards of 100,000 per minute on a new nuclear arms race.

This report looks at those with vested interests to keep a nuclear arms race going. The companies that want to get contracts to build weapons of mass destruction, and the private sector financiers and investors that want to generate a profit without apparent concern for the devastating potential consequences of any use of the products they support. It is only by knowing those who seek to maintain the status quo that we can engage and shift their behaviour.

These profiteers can and do change their behaviours. A combination of the emerging norm against nuclear weapons, the growing strength and membership of the TPNW, and the increasing stigma against weapons designed for mass destruction are leading companies away from harmful contracts and investors to consider alternatives.

Susi Snyder.

Utrecht November 2021

Key findings



\$685 billion invested

\$685,164 million was made available to the 25 nuclear weapons producing companies between January 2019 and July 2021, a \$44 billion increase from the previous year. The increase can be attributed to \$80 billion more underwriting in 2021 compared to 2020. The financial sector helped the nuclear weapon industry sell pieces of its debt. Shareholding values dropped by \$67 billion, and bondholding value by \$2 billion.



52 fewer financial institutions invest

338 institutions have financing or investment relationships with the 25 nuclear weapon producing companies, down from 390 institutions the previous year.



25 Companies producing nuclear weapons

Companies from China, France, India, Italy, the Netherlands, the Russian Federation, the United Kingdom and the United States are significantly involved in the production of nuclear weapons. Many of the companies involved have multi-year production contracts, totalling at least \$200 billion and continuing for decades.

Northrop Grumman is the biggest single nuclear weapons profiteer, with at least \$24 billion in contracts, not including consortium and joint venture revenues. Raytheon Technologies and Lockheed Martin also hold multi-billion-dollar contracts to produce new nuclear weapon systems.

The list of companies profiled in this report and the arsenals to which they contribute are:

1. Aerojet Rocketdyne (United Kingdom, United States);
2. Airbus (France);
3. BAE Systems (France, United Kingdom, United States);
4. Bechtel (United States);
5. Bharat Dynamics (India);
6. Boeing (United Kingdom, United States);
7. China Aerospace Science and Technology (China);
8. Constructions Industrielles de la Méditerranée (France);
9. Fluor (United States);
10. General Dynamics (United Kingdom, United States);
11. Honeywell International (United States);
12. Huntington Ingalls Industries (United States);
13. Jacobs Engineering (United States);
14. L3 Harris Technologies (United States);
15. Larsen & Toubro (India);
16. Leidos (United States);
17. Leonardo (France);
18. Lockheed Martin (United Kingdom, United States);
19. Northrop Grumman (United Kingdom, United States);
20. Raytheon Technologies (United States);
21. Rostec (Russian Federation);
22. Safran (France);
23. Textron (United States);
24. Thales (France), and;
25. Walchandnagar Industries Limited (India).

Nuclear weapons remain the worst weapon ever deployed. They are designed to cause mass murder, mayhem and catastrophe. The primary ideology behind the retention of nuclear weapons in the arsenals of nine countries, or the security strategies of their allies, is one of deterrence. An idea predicated on breaking the laws of war, an ever-present threat to civilisation as we know it.

Nuclear weapons cannot be used without breaking international law. These bombs are designed to destroy cities in a flash. Nuclear weapons development, production and testing has left a contaminating legacy that will remain for hundreds of generations. If a nuclear bomb is dropped in your neighbourhood, there is no help coming. That is why most countries have rejected nuclear weapons. Even though advanced nuclear programmes were developed in several dozen countries, only ten crossed the threshold and possess nuclear weapons now.

The consequences of nuclear weapons cannot be controlled in time nor space, so governments negotiated the Treaty on the Prohibition of Nuclear Weapons (TPNW). The treaty entered into force in January 2021. The treaty explicitly prohibits the manufacture, production and development of nuclear weapons, as well as assistance with those prohibited acts.

Despite global calls for restraint and nuclear disarmament, new nuclear weapons are being developed in all nuclear armed countries. The report includes information about the nuclear weapon programmes of the five countries legally obligated under the nuclear Non Proliferation Treaty to negotiate the disarmament of their arsenals, as well as the nuclear programme of India. New nuclear weapons systems, including the U.S. Ground Based Strategic Deterrent and Long-Range Standoff weapons, the French ASMPA-successor the ASN4G, and the Indian efforts to expand to submarine launched ballistic missiles are also presented in this report. Several of the nuclear armed countries are also investing in developing hypersonic missile technologies, but at this stage of the research and development it is still unclear whether those new missiles will carry a nuclear or conventional payload.

Impact of the Treaty on the Prohibition of Nuclear Weapons

The nuclear industry is changing. The re-nationalization of the UK's Atomic Weapons Establishment- removing Serco from the list of publicly traded companies involved in the production and maintenance of nuclear arsenals is one example. The sale of all government related contracts of another long-term nuclear weapon associated company (AECOM) so that it is no longer involved in any aspect of nuclear weapon development or stockpiling is another. These changes removed these companies from their association with the production of nuclear weapons, as well as several investor blacklists.

More than 100 financial institutions divested from the nuclear weapon industry in the last year. Several of these are from states that joined the TPNW. This includes the Bank of Ireland and AIB (Ireland), and Investec (South Africa). While other institutions made new investments, these are predominantly from countries not yet a member of the TPNW.

Nuclear weapon producing companies

Northrop Grumman is the biggest nuclear weapons profiteer, with at least \$24 billion in outstanding contracts, not including the consortium and joint venture revenues. Raytheon Technologies and Lockheed Martin also hold multi-billion-dollar contracts to produce new nuclear weapon systems. The other 25 companies profiled in this report build the key components or otherwise contribute to nuclear weapon development, testing, production, manufacture, possession, stockpiling or use, now prohibited under international law.

There are changes in the number of nuclear weapon associated companies. Some companies, like Serco, had long-term contracts government contracts revoked. Others, like AECOM, have chosen to end their involvement in the nuclear weapon industry. The industry itself is getting smaller, with companies acquiring or merging together. Raytheon and United Technologies is one example, Northrop Grumman's acquisition of Orbital ATK is another. Raytheon is in the process of acquiring Aerojet Rocketdyne, which will further shrink the industry.

The reduction in the number of contractors in the nuclear weapon industry makes it easier for financial institutions and other investors to exclude them from investments. Instead of tracking down hundreds, or even thousands of contributors to catastrophic threats, it's simply a matter of exiting a few relationships.

Renationalization of the Atomic Weapons Establishment- an illustration of risky business

In 2020, the UK decided to nationalize its nuclear weapons facilities and start a new nuclear warhead project at the Atomic Weapons Establishment (AWE).¹ That meant ending what was meant to be a 25-year non-revocable contract with the AWE-ML consortium (Serco, Jacob's Engineering and Lockheed Martin).²

This is an illustration of the risks faced by any company taking contracts for nuclear weapon related work. Each of these companies already knows that there are some risks from government contracting, they state as much in each annual report. However, until recently, the idea that long-term nuclear weapon related contracts might be terminated was not given much credit. Now that the weapons are prohibited under international law, an additional level of risk exists. This is also true for those relying on a supply chain involving States inside the treaty- which could halt those shipments to reduce any risks of assisting in the production, manufacture, or development of nuclear weapons.

China's nuclear weapon development- the new missile silos and the need to address nuclear weapon infrastructure

While there it remains very difficult to get reliable information on the companies involved in the arsenals of China, Russia, North Korea and Pakistan, more is coming to light. Partly a result of increased open-source monitoring of nuclear weapon related activity in China with information on locations that can help track down some company involvement in key facilities. Nevertheless, the gaps in information and lack of transparency about nuclear weapon production, development and stockpiling remains a challenge.

Chinese industries are also reaching further abroad to finance debt. Combined with the request for more transparency by investors from companies connected to the Silk Road initiative, there is scope to include more Chinese companies in future reporting. China Aerospace Science and Technology (CASC), at the group level, is included in this report because of this increase in available information. CASC has many subsidiaries, and affiliated entities which are also facing increasing scrutiny.

Major nuclear weapon system producing companies

Most of the nuclear armed countries have several major systems in place to use their nuclear weapons. The United Kingdom is an exception, as it uses the same basic Trident missile delivery system as the United States, and it only intends to fire these missiles from submarines. Others, have air-launched or ground-launched systems as well. Some ground-launched systems are designed to also be mobile, including some Chinese systems.

The following is a snapshot of the various systems, and the companies involved. Not all systems are included, only those for which a clear connection to specific companies was found. Additional details information is found in the full report.

Agni series (India)

India has three different ranged nuclear capable ballistic missiles in its arsenal, the Agni I (700 km), Agni II (2000 km) and Agni III (3200 km). It is currently developing Agni IV (>3500 km) and Agni V (>5000 km).³ Bharat Dynamics Limited manufactures key components for the Agni weapons. Walchandnagar Industries produces the launch systems for the Agni series.⁴

AGM-86 Air-Launched Cruise Missile (U.S.)

The Air-Launched Cruise Missile (ALCM) is a long-range missile that is part of the U.S. strategic bomber force. The B-52 airplane is able to carry 20 200 kT missiles.⁵ The U.S. plans to keep the existing design in place until deploying its replacement, the Long Range Standoff, around 2030.⁶ Boeing builds these missiles for the U.S.

ASMPA (France)

The ASMPA is a medium-range air-to ground nuclear armed missile that has been operational since 2009.⁷ In 2016, MBDA France commenced work on design and development of the mid-life upgrade of the ASMPA, to extend life through 2035. In the 2021 budget of the French Ministry of Defence, three deliveries of upgraded ASMPAs are planned after 2021, and financing was set aside to ensure the ASMPA is viable beyond 2030.⁸ It is built by MBDA, a joint venture between BAE Systems (37.5%), Airbus (37.5%) and Leonardo (25%).⁹ Thales also builds key components for the missile.¹⁰ A Safran subsidiary is also part of an MBDA joint venture called Roxel, which is involved in design, development, manufacture and sale of solid propulsion systems for the ASMPA.¹¹

ASN4G (France)

MBDA (a joint venture between BAE Systems (37.5%), Airbus (37.5%) and Leonardo (25%)) is also contracted by the French government for airborne component work related to development of the ASMPA-successor ASN4G, to be operational in 2035.¹² The new weapon is scheduled to enter service in 2035 with range exceeding 1,000km, double that of the ASMPA. The French Directorate General for Armaments indicated that the ASN4G will be a hypersonic missile.¹³ Like the ASMPA, the missiles will be developed with the capacity for submarine launch, for which the manufacturers concerned are mainly ArianeGroup, Naval Group, Safran, TechnicAtome and Thales.¹⁴

B61 (U.S.)

The B61 is a nuclear gravity bomb, dropped from airplanes and currently deployed at U.S. and NATO bases.¹⁵ There are an estimated 100 B61 bombs stationed in five European countries (Kleine Brogel AB in Belgium, Büchel AB in Germany, Aviano AB and Ghedi AB in Italy, Volkel AB in the Netherlands, and Incirlik AB in Turkey).¹⁶ The B61-12 will consolidate and replace earlier B61 weapon designs. The first bombs will be produced in 2020.¹⁷ This modernisation is expected to cost around \$8.25 billion, not including the modification of nuclear capable aircraft.¹⁸ Boeing is producing the guided tail-kit assembly.¹⁹ Northrop Grumman produces the fixed wing.²⁰

Most of the U.S. nuclear complex is involved in producing the weapons. Design and engineering take place at Los Alamos and Sandia labs. High explosives and the final assembly of the B61-12 is done at Pantex. The Y-12 complex is where uranium (and other) components are manufactured, and the firing, safing and use control components will be produced at the Kansas City National Security Campus.²¹ Honeywell International operates the Kansas City facility.²²

DF- 26 (China)

The DF-26 is an intercontinental ballistic missile in China's nuclear arsenal. It has a range of approximately 4,000km, and is one of the most widely deployed in China.²³ CASC is the only manufacturer of Chinese ICBMs.²⁴

Dhanush (India)

The Dhanush is a ship-based variant of the Prithvi-II. The nuclear-capable short-range ballistic missile is designed to launch from the back of two specially configured patrol vessels; each ship can carry two missiles. Larsen & Toubro is involved in producing the Dhanush weapons.²⁵

Ground-Based Strategic Deterrent (U.S.)

The Ground-based Strategic Deterrent (GBSD) will be produced by Northrop Grumman for the U.S. as a replacement to the Minuteman III ICBM around 2030.²⁶ The U.S. Air Force will also replace the current warheads with the new W87-1 variant. The U.S. government is also planning to produce new plutonium pits for these warheads at the Los Alamos National Laboratory and Savannah River Site.²⁷ The GBSD programme is estimated to cost \$85 billion over a 30 year period, with 400 missiles going on alert by 2036.²⁸

The Northrop Grumman GBSD team includes Aerojet Rocketdyne, which expanded its Advanced Manufacturing Facility (AMF) in Huntsville, Alabama to produce solid rocket motors for these weapons.²⁹ Aerojet Rocketdyne will develop the large solid rocket motor and the post-boost propulsion system and will also be responsible for testing of post-boost system components.³⁰ Bechtel will provide launch system design, construction, and integration during the next development phase for this new nuclear weapon.³¹ General Dynamics is working on command and control systems.³² Honeywell International will develop guidance and missile electronics.³³ L3 Harris will design the training systems.³⁴ Lockheed Martin is handling missile payload integration.³⁵ Raytheon Technologies unit Collins Aerospace will also build components for command and control systems.³⁶ Textron will develop missile payload integrations.³⁷

Iskander (Russian Federation)

The Iskander is a short range ballistic missile with a range of at least 350km. It is deployed in several locations around Russia.³⁸ Rostec produces this missile.³⁹

Long Range Stand-off (U.S.)

The U.S. Air Force is planning on replacing the current stockpile of Air Launched Cruise Missiles with a new Long-Range Standoff (LRSO) cruise missile. According to the U.S. Congressional Research Services, the U.S. Air Force plans to buy up to 1,100 LRSO missiles at a cost of around \$10.8 billion. The new missiles will be armed with the W80-4 warhead.⁴⁰ Lawrence Livermore National Laboratory is the primary facility responsible for the new warhead design, and the new weapon is expected to be completed by 2031.⁴¹ Boeing is contracted to make sure the LRSO can be dropped by B-52H bombers.⁴² A wholly owned subsidiary of Honeywell operates the Sandia National Laboratory where the warheads will be integrated to the missiles.⁴³ Raytheon was contracted in 2021 for development and manufacture of the LRSO.⁴⁴

M51 (France)

The M51 is a submarine launched ballistic missile. The M51 missile is currently available in two versions the M51.1 and M51.2. Preliminary work on the third version began in 2014, and the French Ministry of Defence 2021 budget states that the M51.3 entered production in 2019.⁴⁵ The M51.3 version is due to enter service around 2025. Under the 2019-2025 defence budget law, the government earmarked €25 billion (\$29 billion) for work on all nuclear weapons systems, including seaborne and airborne weapons.⁴⁶ A fourth version of the missile, M51.4, is expected to enter service around 2035.⁴⁷ The French Ministry of Defence anticipates

spending at least 3.3 billion on the M51 modifications between 2019 – 2022, with ArianeGroup, a joint venture between Airbus and Safran, as the prime contractor.⁴⁸ Naval Group is the main contractor for submarines maintenance, with the M51 integration contracted to CNIM.⁴⁹ The ocean components of the missile are produced by ArianeGroup, Naval Group, Safran, TechnicAtome and Thales.⁵⁰

Minuteman III (U.S.)

There are 400 Minuteman III Intercontinental Ballistic Missiles (ICBMs) currently deployed in the U.S. arsenal, and they are expected to stay active until 2030, these missiles can carry the W78 and W87 warheads.⁵¹ Aerojet Rocketdyne is contracted to provide solid boost technology and strategic propulsion through 2023.⁵² Boeing is contracted for engineering and other services through 2024.⁵³ Honeywell International builds the internal guidance instruments.⁵⁴ Textron builds the multiprobe antenna and Mod5F midsections for the missiles.⁵⁵ Lockheed Martin builds re-entry systems, and the new Airborne Launch Control System Replacement.⁵⁶ Northrop Grumman provides sustainment support.⁵⁷ Raytheon is contracted to build the Minimum Essential Emergency Communication Network for the missile system.⁵⁸ Textron builds the multiprobe antennas and Mod 5F midsections.⁵⁹

Prithvi II (India)

The Prithvi-II is a short range (350 km) ballistic missile used as a nuclear delivery vehicle in the Indian nuclear arsenal.⁶⁰ Bharat Dynamics Limited is the main contractor for this system.⁶¹

Trident II (D5) (U.S. & UK)

The submarine-launched Trident II (D5) ballistic missile is currently aboard U.S. Ohio-class and British Vanguard-class submarines.⁶² In 1963 the UK and U.S. agreed to share procurement for key components for their nuclear missiles.⁶³ The U.S. has more than 530 of the D5 missiles and it plans to spend around \$1 billion per year to keep them available for the current Ohio class submarines and the future Columbia class submarines.⁶⁴ The UK is also engaged in a project for new nuclear warheads for their arsenal.⁶⁵ The UK announcement to parliament came several days *after* the agreement to work closely with the U.S. in developing these weapons was published in major media outlets.⁶⁶

Aerojet Rocketdyne manufactures Post Boost Control System Gas Generator Units for the Trident II D5 program.⁶⁷ BAE Systems is contracted by the U.S. government for technical engineering services on the U.S. and UK Trident II D5 strategic weapon systems.⁶⁸ Boeing is contracted for maintenance, repair and rebuilding of the Trident system.⁶⁹ General Dynamics is responsible for integrating Trident nuclear weapons in the new U.S. Columbia-class program and the United Kingdom Dreadnought-class submarines.⁷⁰ L3 Harris is responsible for flight test instrumentation and support.⁷¹ Lockheed Martin provides engineering and technical support services and related materials.⁷²

Warhead assembly, plutonium and tritium production (U.S.)

Pantex and the Oak Ridge Y-12 facility are where U.S. nuclear weapons are assembled or disassembled.⁷³ Pantex stores thousands of plutonium pits, the heart of thermonuclear weapons, and is responsible for refurbishing existing warheads. The Y-12 site manufactures nuclear weapons components from uranium and lithium, and it is the only source for enriched uranium components for nuclear weapons.⁷⁴ The facilities are managed and operated by Consolidated Nuclear Security, LLC (CNS). CNS comprises member companies Bechtel National, Inc.; Leidos; ATK Launch Systems (a subsidiary of Northrop Grumman); and SOC LLC, with Booz Allen Hamilton, Inc. as a teaming subcontractor.⁷⁵

The Savannah River Site is the only site in the U.S. nuclear weapon complex with capability to extract, recycle, purify and reload tritium which must be periodically replaced in nuclear weapons. Plutonium pit production capabilities are also being developed at the site.⁷⁶ Fluor is the lead partner in Savannah River Nuclear Solutions (SRNS), a joint venture with Honeywell and Newport News Nuclear (part of Huntington Ingalls) that operates the facility.⁷⁷

Honeywell Federal Manufacturing & Technologies manages and operates the National Security Campus (NSC) (formerly Kansas City Plant), the National Nuclear Security Administration (NNSA) facility responsible for producing an estimated 85% of the non-nuclear components for U.S. nuclear weapons.⁷⁸

W78/88 and W80 warheads (U.S.)

The W78/88-1 warhead, used in both U.S. air force and navy nuclear weapons systems, and the W80 warhead (used on the Long Range Stand Off Missile) the responsibility of the Lawrence Livermore National Laboratory.⁷⁹ The lab is operated by Lawrence Livermore National Security, LLC,⁸⁰ which is comprised of Bechtel, the University of California, BWX Technologies and Amentum.⁸¹

Los Alamos is responsible for the nuclear design and engineering of warheads. It also manages the life extension and alteration programs affecting the W76 warhead, the B61-12 bomb, and the W88 warhead.⁸² Los Alamos is managed and operated by Huntington Ingalls Industries.

W88 Alt 370 warheads (U.S.)

Los Alamos National Laboratory and Sandia National Laboratory (operated by Honeywell) are “[t]he design and engineering labs for the W88 Alt 370”.⁸³ The W88 is the nuclear warhead deployed on the Trident II (D5) missiles.⁸⁴ The conventional high explosives and final assembly of the complete warhead takes place at the Y-12 and Pantex Plants (operated by Bechtel National, Inc., Leidos, ATK Launch Systems (a subsidiary of Northrop Grumman) and, SOC LLC⁸⁵) and the gas transfer system and the arming, fuzing, and firing subsystem is produced at the National Security Campus (NSC) (formerly Kansas City Plant) operated by Honeywell International.⁸⁶ The NNSA estimates that the costs for this system will be around \$2.7 billion.⁸⁷



Walchandnagar Industries missile motor casing

Investments

Governments hire companies to build the key components for nuclear weapons and to manage and operate the facilities in which nuclear weapons are produced. To secure those contracts, companies need to raise capital through loans or by issuing bonds. Many of the companies involved in nuclear weapon production are also publicly traded, so both individuals and institutions share profits (and losses).

Companies involved in producing nuclear weapons spend enormous amounts to get contracts, many of which run for multiple years. Nevertheless, even when contracts are in place, every producer also includes notes to their shareholders about the risk of taking on government contracts. Political and regulatory change can cause contracts to be terminated, and companies to report losses on their balance sheets. Reduced appetite for risk, including regulatory and reputational risk, can cause financiers and investors to stay away from companies connected to prohibited weapons.

Nuclear weapon producing companies included in this financial analysis present a significant, but not exhaustive review of the nuclear weapon industry. The 25 companies included are all publicly traded and have multi-year contracts for key components or services that contribute to activities prohibited under the Treaty on the Prohibition of Nuclear Weapons, including development, testing, production, manufacture, possession, stockpiling or use.

Global investments

There are a total of 338 investors with financial relationships to the nuclear weapon producing companies, from 32 countries. Most of these investments comes from countries that either possess nuclear weapons of their own or otherwise endorse the use of nuclear weapons.

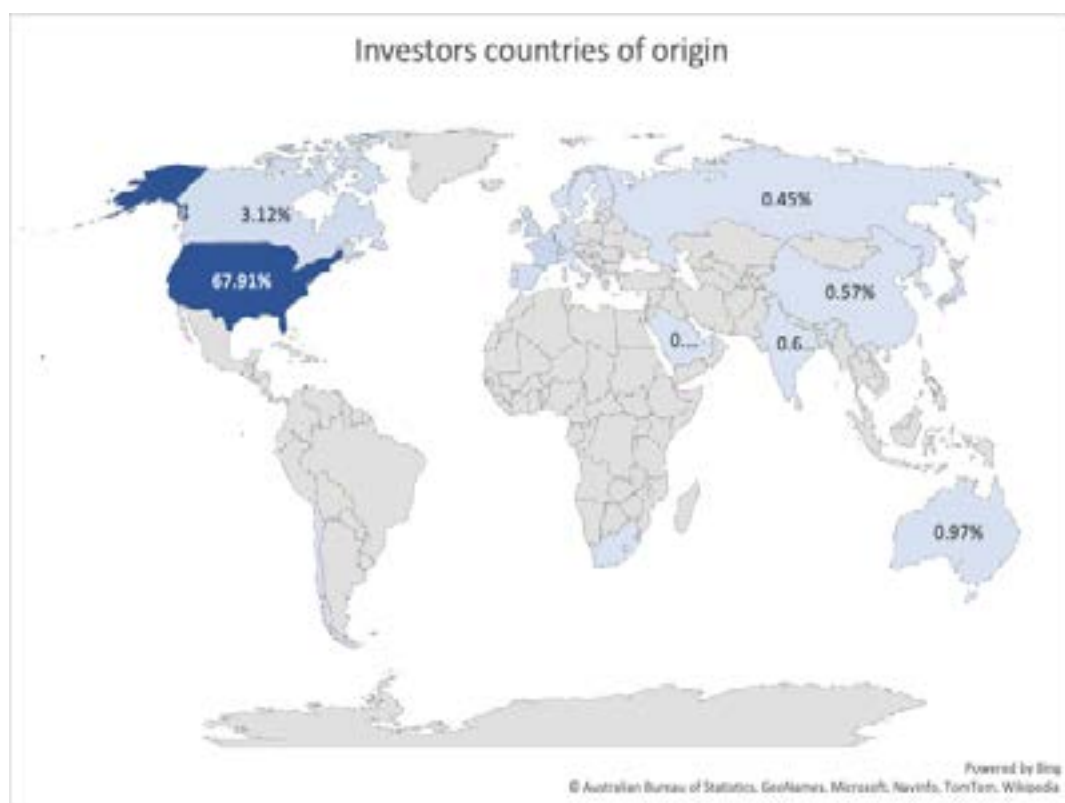


Figure 1 Map of investors globally

The total investments are split, with slightly more in share and bondholding than in loans and underwriting. The top 10 investors are all from the United States and represent \$339 billion, or just under half of all investments.

Top 10 investors compared

Investor	Country	2021	2020	Change
Vanguard	United States	\$50,971	\$61,252	-\$10,281
State Street	United States	\$45,564	\$46,770	-\$1,206
Capital Group	United States	\$41,773	\$62,394	-\$20,621
BlackRock	United States	\$40,711	\$44,792	-\$4,081
Bank of America	United States	\$38,405	\$33,088	\$5,317
Citigroup	United States	\$33,343	\$25,386	\$7,957
JPMorgan Chase	United States	\$30,407	\$17,119	\$13,288
Wells Fargo	United States	\$22,604	\$20,688	\$1,916
Morgan Stanley	United States	\$18,737	\$10,175	\$8,562
Wellington Management	United States	\$16,868	\$13,255	\$3,613
Total		\$339,383	\$334,920	\$4,463

Table 1 Top 10 investors in nuclear weapon producers compared. All figures in USD millions.

Downward trend

There is a downtrend in the total number of investors, as well as in loans, share and bondholding. Overall, there are 75 new financial institutions with investment in nuclear weapon producers, while 127 divested in the previous year, bringing the total number of investors down from 390 to 338. Compared to the previous year, shareholder values dropped by \$67 billion and bondholding dropped \$2 billion.

Underwriting of bond issuances however rose significantly, by approximately \$80 billion. There is a shift in how the nuclear industry is raising funds to off-set debt, from significant loans to issuances. The top six issuers were from the U.S., with German, French and Japanese banks rounding out the top ten.

Types of investments compared

	2021	2020	2019
Bondholding	\$7,819.7	\$9,180.4	\$25,552.6
Loans	\$211,398.8	\$180,778.3	\$142,606.5
Shareholding	\$345,919.2	\$413,339.9	\$544,704.6
Underwriting	\$120,045.8	\$42,751.9	\$35,576.7
Grand Total	\$685,183.6	\$646,050.5	\$748,440.4

Table 2 Types of investments compared 2021-2019, all figures in USD millions

As the list of producers changes slightly each year, taking a longer look at the same companies over time can offer a better illustration of the downward trend of investments. A comparative analysis over the last three years of financial relationships with 14 companies shows a 72% drop.

Company	Country	2021	2020	2019
Aerojet Rocketdyne	United States	\$4,848	\$5,148	\$4,792
Airbus	Netherlands	\$58,951	\$31,265	\$44,455
BAE Systems	United Kingdom	\$27,247	\$22,666	\$22,814
Bechtel	United States	\$3,500	\$4,544	\$4,000
Boeing	United States	\$143,690	\$131,482	\$254,444
Fluor	United States	\$10,848	\$10,812	\$17,465
General Dynamics	United States	\$55,616	\$54,207	\$72,630
Honeywell	United States	\$34,923	\$78,024	\$78,397
Huntington Ingalls Industries	United States	\$21,772	\$19,408	\$12,568
Jacobs Engineering	United States	\$4,776	\$7,871	\$15,563
Lockheed Martin	United States	\$63,740	\$75,296	\$77,543
Northrop Grumman	United States	\$35,767	\$41,792	\$53,023
Safran	France	\$31,125	\$22,687	\$24,661
Thales	France	\$8,575	\$6,239	\$21,080
Total		\$505,379	\$511,440	\$703,434

The report does not include investments made by governments, universities, or churches, only financial institutions. This selection of financial institutions is limited by a reporting threshold. Only share and bond holdings larger than 0.5% of the total number of outstanding shares of the nuclear weapon producing companies are listed.

Full investor list

The following list contains the names and countries of origin of the financial institutions connected to the nuclear weapon industry. For details on their financing relationships, see the full report.

Investor Parent	Country	investments (US millions)
A.K. Group	India	\$336
Abu Dhabi Investment Council	UAE	\$50
Academy Securities	U.S.	\$352
Aegon	Netherlands	\$159
Affiliated Managers Group	U.S.	\$1,681
AGF Management	Canada	\$142
Algemeen Burgerlijk Pensioenfonds (ABP)	Netherlands	\$20
Allahabad Bank	India	\$10
Allianz	Germany	\$133
Allstate	U.S.	\$91
Ally Financial	U.S.	\$52
Alpine Associates Management	U.S.	\$65
Alyeska Investment Group	U.S.	\$44
American Century Investments	U.S.	\$669
American Equity	U.S.	\$78
American Financial Group	U.S.	\$18
American National Insurance	U.S.	\$14
Ameriprise Financial	U.S.	\$2,974
Anima	Italy	\$33
ANZ	Australia	\$1,716
Apollo Global Management	U.S.	\$50
Apple Financial Holdings	U.S.	\$100
Apto Partners	U.S.	\$64
AQR Capital Management	U.S.	\$150
Arab Banking Corporation (Bank ABC)	Bahrain	\$118
Aristotle Capital Management	U.S.	\$753
ARP Americas	U.S.	\$58
Arrowstreet Capital	U.S.	\$591
Artisan Partners	U.S.	\$330
Auto-Owners Insurance	U.S.	\$15
Aviva	UK	\$229
AXA	France	\$1,066
Axis Bank	India	\$845

Investor Parent	Country	investments (US millions)
Baird	U.S.	\$217
Banca d'Italia	Italy	\$39
Banca Popolare di Sondrio	Italy	\$71
Banco Bilbao Vizcaya Argentaria (BBVA)	Spain	\$5,969
Banco BPM	Italy	\$357
Banco de Sabadell	Spain	\$33
Bancroft Capital (PA)	U.S.	\$13
Bancroft Group (VI)	UK	\$20
Bancroft Holding (MA)	U.S.	\$11
Bank of America	U.S.	\$38,405
Bank of Baroda	India	\$56
Bank of China	China	\$1,012
Bank of East Asia	China	\$59
Bank of India	India	\$11
Bank of New York Mellon	U.S.	\$2,873
Bank of Philippine Islands	Philippines	\$33
Barclays	UK	\$6,286
BayernLB	Germany	\$552
Beach Point Capital Management	U.S.	\$50
Black Creek Investment Management	Canada	\$98
BlackRock	U.S.	\$40,711
Blaylock Beal Van	U.S.	\$84
BMO Financial Group	Canada	\$680
BNP Paribas	France	\$12,338
Boston Private	U.S.	\$68
BPER Banca	Italy	\$79
Brandywine Global Investment Management	U.S.	\$59
BrightSphere Investment Group	U.S.	\$72
Brown Advisory	U.S.	\$485
Cabrera Capital	U.S.	\$70
Cacti Asset Management	U.S.	\$83
Caisse de dépôt et placement du Québec	Canada	\$1,059
Caixa Geral de Depósitos	Portugal	\$33

Investor Parent	Country	investments (US millions)
California Public Employees' Retirement System (CalPERS)	U.S.	\$429
Canara Bank	India	\$10
Capital Group	U.S.	\$41,773
Capital One Financial	U.S.	\$1,495
Cassa Depositi e Prestiti	Italy	\$221
CastleOak Securities	U.S.	\$58
Cathay Financial	Taiwan	\$23
Cathay General Bancorp	U.S.	\$45
Causeway Capital Holdings	U.S.	\$96
Chang Hwa Commercial Bank	Taiwan	\$20
Charles Schwab	U.S.	\$3,587
Children's Investment Fund Management	UK	\$2,911
China Merchants Group	China	\$746
CI Financial	Canada	\$124
CIBC	Canada	\$389
Cincinnati Financial	U.S.	\$15
Citigroup	U.S.	\$33,343
Citizens Financial Group	U.S.	\$324
CL King & Associates	U.S.	\$69
Clartan Associés	France	\$40
Comerica	U.S.	\$124
Commerzbank	Germany	\$5,037
Commonwealth Bank of Australia	Australia	\$76
Compagnie Financière Tradition	Switzerland	\$23
Confédération Nationale du Crédit Mutuel	France	\$94
Cooke & Bieler	U.S.	\$310
Crédit Agricole	France	\$10,938
Crédit Mutuel CIC Group	France	\$3,083
Credit Suisse	Switzerland	\$2,059
Credito Valtellinese	Italy	\$20
CSC Financial	China	\$157
CTBC Financial Holding	Taiwan	\$33
D.E. Shaw & Co.	U.S.	\$43
Danske Bank	Denmark	\$240
DBS	Singapore	\$1,409
Deka Group	Germany	\$496
Dena Bank	India	\$10
Desjardins Group	Canada	\$3
Deutsche Bank	Germany	\$14,030

Investor Parent	Country	investments (US millions)
Development Bank of Japan	Japan	\$300
Diamond Hill Investment Group	U.S.	\$248
Dimensional Fund Advisors	U.S.	\$811
Dodge & Cox	U.S.	\$3,056
Donghai Securities	China	\$104
Drexel Hamilton	U.S.	\$80
DZ Bank	Germany	\$254
E.SUN Financial	Taiwan	\$33
Eaton Vance	U.S.	\$300
Edelweiss Financial Services	India	\$336
EFG International	Switzerland	\$113
Elara Capital	UK	\$41
Empresas Juan Yarur	Chile	\$20
Empyrean Capital Partners	U.S.	\$137
Equitable Holdings	U.S.	\$787
Eurazeo	France	\$50
European Investment Bank	Luxembourg	\$3,318
Export-Import Bank of the U.S.	U.S.	\$350
Fairfax Financial	Canada	\$41
Falcon Edge Capital	U.S.	\$26
Federal Bank	India	\$10
Fidelity International	Bermuda	\$140
Fidelity Investments	U.S.	\$7,779
Fiera Capital	Canada	\$12
Fifth Third Bancorp	U.S.	\$485
Findlay Park Partners	UK	\$246
First Abu Dhabi Bank	UAE	\$1,461
First Capital Securities	China	\$51
First Financial Holding	Taiwan	\$32
First Horizon	U.S.	\$135
First Trust Advisors	U.S.	\$415
FirstMerit	U.S.	\$33
Focus Financial Partners	U.S.	\$66
Foresters Financial	Canada	\$50
Franklin Resources	U.S.	\$7,371
Fuyo General Lease	Japan	\$190
Gabelli Funds	U.S.	\$395
Gamco Investments	U.S.	\$30
Genev Capital	India	\$141
Geode Capital Holdings	U.S.	\$8,411
Goldman Sachs	U.S.	\$13,064

Investor Parent	Country	investments (US millions)
Government Pension Fund Global	Norway	\$2,670
GQG Partners	U.S.	\$406
Grantham Mayo Van Otterloo & Co	U.S.	\$66
Great Pacific Securities	U.S.	\$62
Groupe BPCE	France	\$7,046
Guardian Life Insurance Company of America	U.S.	\$44
Guggenheim Capital	U.S.	\$358
Gulf International Bank	Bahrain	\$39
Guzman & Co	U.S.	\$66
Hancock Whitney	U.S.	\$83
Hankou Bank	China	\$104
HDFC Bank	India	\$482
Hengistbury Investment Partners	UK	\$159
Hoover Financial Advisors	U.S.	\$57
Hotchkis & Wiley Capital Management	U.S.	\$197
HSBC	UK	\$6,200
Hua Nan Financial	Taiwan	\$46
Hubei Bank	China	\$104
Hudson Bay Capital Management	U.S.	\$35
Iberia Bank	U.S.	\$20
ICICI Bank	India	\$518
IDBI Bank	India	\$41
IFS Group	U.S.	\$19
Impala Asset Management	U.S.	\$36
Industrial and Commercial Bank of China	China	\$1,474
ING Group	Netherlands	\$730
Intesa Sanpaolo	Italy	\$1,523
Invesco	U.S.	\$3,633
ISALT	France	\$285
Janus Henderson	UK	\$2,086
JM Financial	India	\$268
JPMorgan Chase	U.S.	\$30,407
Jupiter Fund Management	UK	\$181
KeyCorp	U.S.	\$144
KfW	Germany	\$254
Kohlberg Kravis Roberts & Co	U.S.	\$36
Lagan Holding Company	U.S.	\$113

Investor Parent	Country	investments (US millions)
Landesbank Baden-Württemberg (LBBW)	Germany	\$76
Landesbank Hessen-Thüringen	Germany	\$76
Lazard	Bermuda	\$48
Legal & General	UK	\$1,020
LKP Group	India	\$57
Lloyds Banking Group	UK	\$3,493
Loews Corporation	U.S.	\$15
Lone Star Funds	U.S.	\$163
Loop Capital	U.S.	\$261
Lord, Abbett & Co	U.S.	\$253
LSV Asset Management	U.S.	\$669
M&G	UK	\$219
M&T Bank	U.S.	\$37
Macquarie Group	Australia	\$1,792
Madison Asset Management	U.S.	\$84
Magnetar Capital	U.S.	\$143
Majedie Asset Management	UK	\$234
Manulife Financial	Canada	\$151
Marathon Asset Management (UK)	UK	\$94
MassMutual Financial	U.S.	\$123
MBS	U.S.	\$58
Mediobanca Banca di Credito Finanziario	Italy	\$51
Mega Financial	Taiwan	\$60
MetLife	U.S.	\$225
MFR	U.S.	\$64
Millennium Management	U.S.	\$38
Mirae Asset Financial Group	South Korea	\$46
Mischler Financial Group	U.S.	\$68
Mitsubishi UFJ Financial	Japan	\$12,622
Mizuho Financial	Japan	\$13,307
Modern Woodmen of America	U.S.	\$30
Morgan Stanley	U.S.	\$18,737
National Life Group	U.S.	\$20
National Western Life Group	U.S.	\$30
Nationwide Mutual Insurance	U.S.	\$71
NatWest	UK	\$3,016
Neuberger Berman	U.S.	\$338
New York Life Insurance	U.S.	\$136

Investor Parent	Country	investments (US millions)
Newport Group	U.S.	\$15,133
NewSouth Capital Management	U.S.	\$64
Nierenberg Investment Management	U.S.	\$20
Ninety One	South Africa	\$200
Nordea	Finland	\$81
Norges Bank	Norway	\$2,256
Northern Trust	U.S.	\$6,577
Northill Capital	UK	\$790
Northwestern Mutual	U.S.	\$304
Novikombank	Russia	\$37
Nuance Investments	U.S.	\$29
Oddo BHF	France	\$290
OneAmerica Asset Management	U.S.	\$50
Opus Corporate Finance LLP	UK	\$37
Orix Corporation	Japan	\$1,261
P. Schoenfeld Asset Management	U.S.	\$56
Pacific Century Group	Hong Kong	\$719
Pacific Investments	UK	\$60
Passionate Investment Management	India	\$46
Pendal Group	Australia	\$311
PenderFund Capital Management	Canada	\$13
Penserra Capital Management	U.S.	\$93
People's United Financial	U.S.	\$74
Perpetual	Australia	\$764
Pictet	Switzerland	\$61
PNC Financial Services	U.S.	\$1,982
Power Financial Corporation	Canada	\$570
Primecap Management	U.S.	\$2,340
Principal Financial Group	U.S.	\$141
Prudential Financial (US)	UK	\$20
Prudential Financial (US)	U.S.	\$803
Prudential Plc	UK	\$38
Punjab & Sind Bank	India	\$10
Pzena Investment Management	U.S.	\$509
Quaero Capital	Switzerland	\$1
R. Seelaus & Co	U.S.	\$76
Raven's Wing Asset Management	U.S.	\$5,454

Investor Parent	Country	investments (US millions)
Raymond James Financial	U.S.	\$28
Regions Financial	U.S.	\$872
Reinhart Partners	U.S.	\$38
Renaissance Technologies	U.S.	\$18
Riyad Bank	Saudi Arabia	\$1,578
Royal Bank of Canada	Canada	\$9,095
Royal London Group	UK	\$99
Ruane, Cunniff & Goldfarb	U.S.	\$503
Samlyn Capital	U.S.	\$50
Santander	Spain	\$6,328
SAR Holdings	U.S.	\$54
Schroders	UK	\$125
Schweizerische Nationalbank	Switzerland	\$64
Scotiabank	Canada	\$2,306
Securian	U.S.	\$14
Select Equity Partners	U.S.	\$651
Shank Williams Cisneros & Co	U.S.	\$163
Shenwan Hongyuan Group	China	\$104
Silchester International Investors	UK	\$642
Skandinaviska Enskilda Banken	Sweden	\$344
SMBC Group	Japan	\$10,529
Sociedad Estatal de Participaciones Industriales	Spain	\$3,861
Société Générale	France	\$9,169
Southern Farm Bureau Life Insurance	U.S.	\$4
Sovcombank	Russia	\$37
Spring Creek Capital	U.S.	\$44
Standard Chartered	UK	\$2,333
Standard Life Aberdeen	UK	\$297
State Bank of India	India	\$946
State Farm	U.S.	\$284
State Street	U.S.	\$45,564
Steel Partners Holdings	U.S.	\$185
Stern Brothers & Co	U.S.	\$64
Stifel Financial	U.S.	\$4
Sumitomo Mitsui Trust	Japan	\$193
Sun Life Financial	Canada	\$4,242
T. Rowe Price	U.S.	\$6,710

Investor Parent	Country	investments (US millions)
Tamilnad Mercantile Bank	India	\$10
TCW Group	U.S.	\$3
Teacher Retirement System of Texas	U.S.	\$103
Telsey Advisory Group	U.S.	\$91
The Hartford	U.S.	\$21
Thrivent Financial	U.S.	\$9
TIAA	U.S.	\$3,029
Toronto-Dominion Bank	Canada	\$2,381
Towle & Co	U.S.	\$48
Travelers	U.S.	\$25
Tredje AP-Fonden (AP-3)	Sweden	\$14
Tribal Capital Markets	U.S.	\$56
Trinity Street Asset Management	UK	\$90
Truist Financial	U.S.	\$1,398
Trust Group	India	\$450
Two Sigma Investments	U.S.	\$110
UBS	Switzerland	\$2,562
UniCredit	Italy	\$5,713
Union Bank of India	India	\$10
Union Bankshares	U.S.	\$7
United Services Automobile Association	U.S.	\$20
Unum Group	U.S.	\$50

Investor Parent	Country	investments (US millions)
US Bancorp	U.S.	\$5,407
Van Eck Global	U.S.	\$13
Vanguard	U.S.	\$50,971
Victory Capital	U.S.	\$669
Vijaya Bank	India	\$10
Voya Financial	U.S.	\$20
VTB Group	Russia	\$3,000
Water Island Capital	U.S.	\$29
Wellington Management	U.S.	\$16,868
Wells Fargo	U.S.	\$22,604
Westchester	U.S.	\$55
Westchester Capital Management	U.S.	\$32
Westpac	Australia	\$1,995
White Mountains Insurance	Bermuda	\$260
Williams Capital Group	U.S.	\$85
Woodforest Financial	U.S.	\$67
WoodmenLife	U.S.	\$20
World Bank	U.S.	\$125
Yes Bank	India	\$137
Zions Bancorporation	U.S.	\$46
Grand Total		\$685,164

Conclusion

The entry into force of the Treaty on the Prohibition of Nuclear Weapons is an historic shift in the way the world deals with nuclear weapons. They are now comprehensively outlawed, as is any assistance with producing, manufacturing or developing them. Financial institutions that continue investing in companies building nuclear weapons face regulatory risks as more countries join the treaty. They also face an increased reputational risk as clients learn of their support for weapons of mass destruction and terminate their relationships.

This report puts the spotlight on companies and their financial backers that are making weapons designed to cause massive civilian casualties and violate the rules of war. These companies, and the contracts they accept, are part of the nuclear weapons problem. Avoiding business with these companies is a way for others to become part of the solution.

Endnotes

- ¹ Ministry of Defence and Defence Nuclear Organisation (2020) Atomic Weapons Establishment (AWE) Written Ministerial Statement, GOV.UK. Available at: <https://www.gov.uk/government/news/atomic-weapons-establishment-awe-written-ministerial-statement> (Accessed: 18 October 2021);
- Defence Secretary announces programme to replace the UK's nuclear warhead (2020) GOV.UK. Available at: <https://www.gov.uk/government/news/defence-secretary-announces-programme-to-replace-the-uks-nuclear-warhead> (Accessed: 18 October 2021).
- ² Our history – AWE (no date). Available at: <https://www.awe.co.uk/about-us/our-history/> (Accessed: 18 October 2021);
- MOD drives efficiencies in improved contract for nuclear sites (2016) GOV.UK. Available at: <https://www.gov.uk/government/news/mod-drives-efficiencies-in-improved-contract-for-nuclear-sites> (Accessed: 18 October 2021);
- Serco (2016) AWE review concluded successfully and updated contract agreed, Serco. Available at: <https://www.serco.com/media-and-news/2016/awe-review-concluded-successfully-and-updated-contract-agreed> (Accessed: 18 October 2021).
- ³ Hans M. Kristensen and Matt Korda (2020) 'World Nuclear Forces', in SIPRI Yearbook 2021: Armaments, Disarmament and International Security. Oxford University Press. Available at: https://sipri.org/sites/default/files/2021-06/yb21_10_wnf_210613.pdf (Accessed: 19 October 2021).
- ⁴ Walchandnagar Industries- Defence (no date) Walchandnagar Industries. Available at: <https://walchand.com/business-area/defence-misile/> (Accessed: 19 October 2021).
- ⁵ AGM-86 Air-Launched Cruise Missile (ALCM) (2021) Missile Threat. Available at: <https://missilethreat.csis.org/missile/alcml/> (Accessed: 19 October 2021).
- ⁶ Amy F Woolf (2021) 'U.S. Strategic Nuclear Forces: Background, Developments, and Issues', Congressional Research Service, p. 66. Available at: <https://crsreports.congress.gov/product/pdf/RL/RL33640> (Accessed: 15 August 2021).
- ⁷ Le missile ASMPA (2016) Direction Générale de Armement. Available at: <https://www.defense.gouv.fr/dga/equipement/dissuasion/le-missile-asmpa> (Accessed: 18 October 2021).
- ⁸ Justification au premier euro (2021) Ministère de Finances et des Comptes Publics. Available at: https://www.budget.gouv.fr/files/uploads/extract/2021/PLF/BG/PGM/146/FR_2021_PLF_BG_PGM_146_JPE.html (Accessed: 18 October 2021).
- ⁹ Le missile ASMPA (2016) Direction Générale de Armement. Available at: <https://www.defense.gouv.fr/dga/equipement/dissuasion/le-missile-asmpa> (Accessed: 18 October 2021);
- About Us | MBDA Systems (no date) MBDA. Available at: <https://www.mbda-systems.com/about-us/> (Accessed: 18 October 2021).
- ¹⁰ 'PLF 2019: Extrait du Bleu Budgétaire de la Mission: Défense – Programme 146: Équipement Des Forces' (2018). Ministère de Finances et des Comptes Publics. Available at: https://www.performance-publique.budget.gouv.fr/sites/performance_publique/files/farandole/ressources/2019/pap/pdf/DBGPGMPGM146.pdf (Accessed: 15 June 2021);
- Ministère de Finances et des Comptes Publics (2020) JUSTIFICATION AU PREMIER EURO; ÉLÉMENTS TRANSVERSAUX AU PROGRAMME, Ministère de Finances et des Comptes Publics. Available at: https://www.performance-publique.budget.gouv.fr/sites/performance_publique/files/farandole/ressources/2020/pap/html/DBGPGMJPEPGM146.htm (Accessed: 19 October 2021).
- ¹¹ 'Roxel market segments: military propulsion systems, civil sector...' (no date) Roxel. Available at: <https://www.roxelgroup.com/en/market-segments/> (Accessed: 19 October 2021).
- ¹² 'Roxel market segments: military propulsion systems, civil sector...' (no date) Roxel. Available at: <https://www.roxelgroup.com/en/market-segments/> (Accessed: 19 October 2021).
- ¹³ Steve Trimble (2019) Scramjet Will Power France's Next Nuclear Missile | Aviation Week Network, Aviation Week. Available at: <https://aviationweek.com/defense-space/scramjet-will-power-frances-next-nuclear-missile> (Accessed: 18 October 2021).
- ¹⁴ Justification au premier euro (2021) Ministère de Finances et des Comptes Publics. Available at: https://www.budget.gouv.fr/files/uploads/extract/2021/PLF/BG/PGM/146/FR_2021_PLF_BG_PGM_146_JPE.html (Accessed: 18 October 2021).
- ¹⁵ 'B61-12 Life Extension Program' (no date). National Nuclear Security Administration. Available at: <https://www.energy.gov/sites/prod/files/2018/12/f58/B61-12%20LEP%20factsheet.pdf> (Accessed: 15 March 2020).
- ¹⁶ Hans M. Kristensen and Matt Korda (2021) 'United States nuclear weapons, 2021', Bulletin of the Atomic Scientists, 77(1), pp. 43–63. doi: 10.1080/00963402.2020.1859865.
- ¹⁷ 'B61-12 Life Extension Program' (no date). National Nuclear Security Administration. Available at: <https://www.energy.gov/sites/prod/files/2018/12/f58/B61-12%20LEP%20factsheet.pdf> (Accessed: 15 March 2020).
- ¹⁸ Aaron Mehta (2019) How a \$5 part used to modernize nuclear warheads could cost \$850 million to fix, Defense News. Available at: <https://www.defensenews.com/smr/nuclear-arsenal/2019/09/25/nuclear-warhead-programs-need-850m-fix-heres-how-the-government-plans-to-cover-it/> (Accessed: 18 October 2021).
- ¹⁹ 'B61-12 Life Extension Program' (no date). National Nuclear Security Administration. Available at: <https://www.energy.gov/sites/prod/files/2018/12/f58/B61-12%20LEP%20factsheet.pdf> (Accessed: 15 March 2020).
- ²⁰ Delivery Order FA861614D6060-FA861618F0041 - GovTribe (2021) GovTribe. Available at: <https://govtribe.com/award/federal-contract-award/delivery-order-fa861614d6060-fa861618f0041> (Accessed: 19 October 2021).
- ²¹ 'B61-12 Life Extension Program' (no date). National Nuclear Security Administration. Available at: <https://www.energy.gov/sites/prod/files/2018/12/f58/B61-12%20LEP%20factsheet.pdf> (Accessed: 15 March 2020).
- ²² Definitive Contract DENA0002839 - GovTribe (2021) GovTribe. Available at: <https://govtribe.com/award/federal-contract-award/definitive-contract-dena0002839> (Accessed: 18 October 2021).
- ²³ Ma Xiu and Peter W. Singer (2021) What Do We Know About China's Newest Missiles?, Defense One. Available at: <https://www.defenseone.com/ideas/2021/03/what-do-we-know-about-chinas-newest-missiles/172782/> (Accessed: 19 October 2021).
- ²⁴ Strategic Nuclear Missiles (no date) China Aerospace Science and Technology Corporation. Available at: <http://english.spacechina.com/n16421/n17215/n17272/c2388530/content.html> (Accessed: 18 October 2021).
- ²⁵ Hans M. Kristensen and Matt Korda (2018) 'Indian nuclear forces, 2018', Bulletin of the Atomic Scientists [Preprint]. doi:10.1080/00963402.2018.1533162;
- Dhanush (2021) Missile Threat. Available at: <https://missilethreat.csis.org/missile/dhanush/> (Accessed: 19 October 2021);
- New Construction - Defence Shipbuilding | Shipbuilding | L&T India (no date) Larsen & Toubro. Available at: <https://www.intshipbuilding.com/products-services/new-construction-defence-shipbuilding/> (Accessed: 19 October 2021).
- ²⁶ Aaron Mehta (2019) Northrop teams with Lockheed on ICBM replacement. Here's who else is involved., Defense News. Available at: <https://www.defensenews.com/digital-show-dailies/afa-air-space/2019/09/16/northrop-teams-with-lockheed-on-icbm-replacement-heres-who-else-is-involved/> (Accessed: 18 October 2021).
- ²⁷ Amy F Woolf (2021) 'U.S. Strategic Nuclear Forces: Background, Developments, and Issues', Congressional Research Service, p. 66. Available at: <https://crsreports.congress.gov/product/pdf/RL/RL33640> (Accessed: 15 August 2021).
- ²⁸ Amy F Woolf (2021) 'U.S. Strategic Nuclear Forces: Background, Developments, and Issues', Congressional Research Service, p. 66. Available at: <https://crsreports.congress.gov/product/pdf/RL/RL33640> (Accessed: 15 August 2021).

- ²⁹ Noel Oman (2019) 'News in brief', Arkansas Democrat Gazette, 26 April. Available at: <https://www.arkansasonline.com/news/2019/apr/26/news-in-brief-20190426/> (Accessed: 19 October 2021);
- Aerojet Rocketdyne Expands Solid Rocket Motor Center of Excellence at Arkansas Facility | Aerojet Rocketdyne (2018) Aerojet Rocketdyne. Available at: <https://www.rocket.com/article/aerojet-rocketdyne-expands-solid-rocket-motor-center-excellence-arkansas-facility> (Accessed: 19 October 2021).
- ³⁰ Aerojet Rocketdyne Selected to Power Nation's Next Generation Strategic Deterrent | Aerojet Rocketdyne Holdings, Inc. (2020) Aerojet Rocketdyne Holdings, Inc. Available at: <https://ir.aerojetrocketdyne.com/news-releases/news-release-details/aerojet-rocketdyne-selected-power-nations-next-generation> (Accessed: 19 October 2021);
- Aerojet Rocketdyne Holdings, Inc. Annual Report on Form 10-K For the Year Ended December 31, 2020 (2020) Aerojet Rocketdyne Holdings, Inc. Available at: <https://ir.aerojetrocketdyne.com/node/25406/html> (Accessed: 18 October 2021).
- ³¹ Fred deSousa (2020) Bechtel Joins Northrop Grumman's Ground Based Strategic Deterrent Team, Bechtel Corporate. Available at: <https://www.bechtel.com/newsroom/releases/2020/02/bechtel-joins-northrop-grumman-gbsd-team/> (Accessed: 19 October 2021).
- ³² Aaron Mehta (2019) Northrop teams with Lockheed on ICBM replacement. Here's who else is involved., Defense News. Available at: <https://www.defensenews.com/digital-show-dailies/afa-air-space/2019/09/16/northrop-teams-with-lockheed-on-icbm-replacement-heres-who-else-is-involved/> (Accessed: 18 October 2021).
- ³³ Aaron Mehta (2019) Northrop teams with Lockheed on ICBM replacement. Here's who else is involved., Defense News. Available at: <https://www.defensenews.com/digital-show-dailies/afa-air-space/2019/09/16/northrop-teams-with-lockheed-on-icbm-replacement-heres-who-else-is-involved/> (Accessed: 18 October 2021).
- ³⁴ Northrop Grumman (2020) 'Our Ground Based Strategic Deterrent (GBSD) nationwide team will involve over 10,000 people across the United States directly working on this vital national security program.', p. 1. Available at: <https://www.northropgrumman.com/wp-content/uploads/Approved-NG20-1485-200812-GBSD-Nationwide-Team-Map.pdf>.
- ³⁵ Aaron Mehta (2019) Northrop teams with Lockheed on ICBM replacement. Here's who else is involved., Defense News. Available at: <https://www.defensenews.com/digital-show-dailies/afa-air-space/2019/09/16/northrop-teams-with-lockheed-on-icbm-replacement-heres-who-else-is-involved/> (Accessed: 18 October 2021).
- ³⁶ Jessica Napoli (2020) Collins Aerospace to deliver launch platform for ICBM modernization program, Collins Aerospace. Available at: <https://www.collinsaerospace.com/newsroom/News/2020/11/Collins-deliver-launch-platform-ICBM-modernization-program> (Accessed: 19 October 2021).
- ³⁷ Aaron Mehta (2019) Northrop teams with Lockheed on ICBM replacement. Here's who else is involved., Defense News. Available at: <https://www.defensenews.com/digital-show-dailies/afa-air-space/2019/09/16/northrop-teams-with-lockheed-on-icbm-replacement-heres-who-else-is-involved/> (Accessed: 18 October 2021).
- ³⁸ Hans M. Kristensen and Matt Korda (2021) 'Russian nuclear weapons, 2021', Bulletin of the Atomic Scientists, 77(2), pp. 90–108. doi:10.1080/00963402.2021.1885869.
- ³⁹ S V Chemezov and N V Borisova (2019) Science. Overcoming Technologic Barriers. Rostec, p. 123. Available at: <https://rostec.ru/upload/iblock/baf/baf448d95ffa861fad46e0df57032df.pdf> (Accessed: 1 October 2021).
- ⁴⁰ Amy F Woolf (2021) 'U.S. Strategic Nuclear Forces: Background, Developments, and Issues', Congressional Research Service, p. 66. Available at: <https://crsreports.congress.gov/product/pdf/RL/RL33640> (Accessed: 15 August 2021);
- 'W80-4 Life Extension Program' (2019). National Nuclear Security Administration. Available at: <https://www.energy.gov/sites/prod/files/2019/04/f61/2019-04-16-FACTSHEET-W80-4.pdf> (Accessed: 15 September 2021).
- ⁴¹ 'W80-4 Life Extension Program' (2019). National Nuclear Security Administration. Available at: <https://www.energy.gov/sites/prod/files/2019/04/f61/2019-04-16-FACTSHEET-W80-4.pdf> (Accessed: 15 September 2021).
- September 2021).
- ⁴² Contracts for March 13, 2019 (2019) U.S. Department of Defense. Available at: <https://www.defense.gov/News/Contracts/Contract/Article/1784315/> (Accessed: 18 October 2021);
- Indefinite Delivery Contract FA210319D3000 - GovTribe (2021) GovTribe. Available at: <https://govtribe.com/award/federal-idv-award/indefinite-delivery-contract-fa210319d3000> (Accessed: 19 October 2021);
- CONTRACT to BOEING COMPANY, THE | USASpending (2018) US-Aspending. Available at: https://usaspending.gov/award/CONT_AWD_FA812818C0003_9700_-NONE_-NONE- (Accessed: 19 October 2021).
- ⁴³ NNSA Awards Sandia National Laboratories Management & Operating Contract to National Technology and Engineering Solutions of Sandia (NTES) (2016) Energy.gov. Available at: <https://www.energy.gov/nnsa/articles/nnsa-awards-sandia-national-laboratories-management-operating> (Accessed: 18 October 2021).
- ⁴⁴ Contracts for July 1, 2021 (2021) U.S. Department of Defense. Available at: <https://www.defense.gov/News/Contracts/Contract/Article/2680485/> (Accessed: 19 October 2021).
- ⁴⁵ Justification au premier euro (2021) Ministère de Finances et des Comptes Publics. Available at: https://www.budget.gouv.fr/files/uploads/extract/2021/PLF/BG/PGM/146/FR_2021_PLF_BG_PGM_146_JPE.html (Accessed: 18 October 2021);
- 'PLF 2019: Extrait du Bleu Budgétaire de la Mission: Défense – Programme 146: Équipement Des Forces' (2018). Ministère de Finances et des Comptes Publics. Available at: https://www.performance-publique.budget.gouv.fr/sites/performance_publique/files/farandole/ressources/2019/pap/pdf/DBGPGMPGM146.pdf (Accessed: 15 June 2021).
- ⁴⁶ Pierre Tran (2018) France makes progress on refitting submarine for M51 missiles, Defense News. Available at: <https://www.defensenews.com/naval/2018/07/23/france-makes-progress-on-refitting-submarine-for-m51-missiles/> (Accessed: 18 October 2021).
- ⁴⁷ Ariane Group - Summer Defence Conference (2019) The Summer Defence Conference. Available at: https://www.universite-defense.org/en/publications/the_2017_position_papers/ariane-group.htm (Accessed: 19 October 2021).
- ⁴⁸ 'PLF 2019: Extrait du Bleu Budgétaire de la Mission: Défense – Programme 146: Équipement Des Forces' (2018). Ministère de Finances et des Comptes Publics. Available at: https://www.performance-publique.budget.gouv.fr/sites/performance_publique/files/farandole/ressources/2019/pap/pdf/DBGPGMPGM146.pdf (Accessed: 15 June 2021);
- Ministère de Finances et des Comptes Publics (2020) JUSTIFICATION AU PREMIER EURO; ÉLÉMENTS TRANSVERSAUX AU PROGRAMME, Ministère de Finances et des Comptes Publics. Available at: https://www.performance-publique.budget.gouv.fr/sites/performance_publique/files/farandole/ressources/2020/pap/html/DBGPGMJPEPGM146.htm (Accessed: 19 October 2021).
- ⁴⁹ 'PLF 2018: Extrait du Bleu Budgétaire de la Mission: Défense – Programme 146: Équipement Des Forces' (2017). Ministère de Finances et des Comptes Publics. Available at: https://www.performance-publique.budget.gouv.fr/sites/performance_publique/files/farandole/ressources/2018/pap/pdf/DBGPGMPGM146.pdf (Accessed: 15 September 2021).
- ⁵⁰ 'PLF 2019: Extrait du Bleu Budgétaire de la Mission: Défense – Programme 146: Équipement Des Forces' (2018). Ministère de Finances et des Comptes Publics. Available at: https://www.performance-publique.budget.gouv.fr/sites/performance_publique/files/farandole/ressources/2019/pap/pdf/DBGPGMPGM146.pdf (Accessed: 15 June 2021);
- Ministère de Finances et des Comptes Publics (2020) JUSTIFICATION AU PREMIER EURO; ÉLÉMENTS TRANSVERSAUX AU PROGRAMME, Ministère de Finances et des Comptes Publics. Available at: https://www.performance-publique.budget.gouv.fr/sites/performance_publique/files/farandole/ressources/2020/pap/html/DBGPGMJPEPGM146.htm (Accessed: 19 October 2021).
- ⁵¹ Amy F Woolf (2021) 'U.S. Strategic Nuclear Forces: Background, Developments, and Issues', Congressional Research Service, p. 66. Available at: <https://crsreports.congress.gov/product/pdf/RL/RL33640> (Accessed: 15 August 2021).
- ⁵² Contracts for January 16, 2018 (2018) U.S. Department of Defense. Available at: <https://www.defense.gov/News/Contracts/Contract/Article/1784315/>

- cle/1416414// (Accessed: 19 October 2021).
- ⁵³ Definitive Contract FA821415C0001 - GovTribe (2021) GovTribe. Available at: <https://govtribe.com/award/federal-contract-award/definitive-contract-fa821415c0001> (Accessed: 18 October 2021);
- CONTRACT to BOEING COMPANY (no date) USAspending. Available at: https://usaspending.gov/award/CONT_AWD_FA821415C0001_9700_-NONE_-NONE- (Accessed: 18 October 2021).
- ⁵⁴ Definitive Contract FA821418C0001 - GovTribe (2021) GovTribe. Available at: <https://govtribe.com/award/federal-contract-award/definitive-contract-fa821418c0001> (Accessed: 18 October 2021).
- ⁵⁵ Definitive Contract FA820414C0011 - GovTribe (2021) GovTribe. Available at: <https://govtribe.com/award/federal-contract-award/definitive-contract-fa820414c0011> (Accessed: 19 October 2021);
- Contracts for February 25, 2019 (2019) U.S. Department of Defense. Available at: <https://www.defense.gov/News/Contracts/Contract/Article/1766751//> (Accessed: 19 October 2021);
- Indefinite Delivery Contract FA820414D0001 - GovTribe (2020) GovTribe. Available at: <https://govtribe.com/award/federal-idv-award/indefinite-delivery-contract-fa820414d0001> (Accessed: 19 October 2021).
- ⁵⁶ Indefinite Delivery Contract FA820414D0001 - GovTribe (2020) GovTribe. Available at: <https://govtribe.com/award/federal-idv-award/indefinite-delivery-contract-fa820414d0001> (Accessed: 19 October 2021);
- Contracts for October 3, 2017 (2017) U.S. Department of Defense. Available at: <https://www.defense.gov/News/Contracts/Contract/Article/1333296//> (Accessed: 18 October 2021);
- Definitive Contract FA820418C0009 - GovTribe (no date). Available at: <https://govtribe.com/award/federal-contract-award/definitive-contract-fa820418c0009> (Accessed: 18 October 2021).
- ⁵⁷ Definitive Contract F4261098C0001 - GovTribe (2021) GovTribe. Available at: <https://govtribe.com/award/federal-contract-award/definitive-contract-f4261098c0001> (Accessed: 19 October 2021).
- ⁵⁸ Definitive Contract FA820413C0009 - GovTribe (2021) GovTribe. Available at: <https://govtribe.com/award/federal-contract-award/definitive-contract-fa820413c0009> (Accessed: 19 October 2021).
- ⁵⁹ Definitive Contract FA820414C0011 - GovTribe (2021) GovTribe. Available at: <https://govtribe.com/award/federal-contract-award/definitive-contract-fa820414c0011> (Accessed: 19 October 2021);
- Contracts for February 25, 2019 (2019) U.S. Department of Defense. Available at: <https://www.defense.gov/News/Contracts/Contract/Article/1766751//> (Accessed: 19 October 2021);
- Indefinite Delivery Contract FA820414D0001 - GovTribe (2020) GovTribe. Available at: <https://govtribe.com/award/federal-idv-award/indefinite-delivery-contract-fa820414d0001> (Accessed: 19 October 2021).
- ⁶⁰ Prithvi-II (2021) Missile Threat. Available at: <https://missilethreat.csis.org/missile/prithvi-ii/> (Accessed: 19 October 2021).
- ⁶¹ Parliamentary Standing Committee On Defence Visits BDL (2021) Bharat Dynamics Limited. Available at: <https://bdl-india.in/node/3776> (Accessed: 18 October 2021).
- ⁶² Trident II D5 Fleet Ballistic Missile (2021) Lockheed Martin. Available at: <https://www.lockheedmartin.com/en-us/products/trident-ii-d5-fleet-ballistic-missile.html> (Accessed: 18 October 2021).
- ⁶³ Great Britain and Foreign and Commonwealth Office (2015) Amendment to the Agreement between the government of the United Kingdom of Great Britain and Northern Ireland and the government of the United States of America for cooperation on the uses of atomic energy for mutual defense purposes: Washington, 22 July 2014. London: HM Government. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/396347/TS_2.2015_Cm_8996_Web.pdf.
- ⁶⁴ Woolf, A.F. (no date) 'Defense Primer: Strategic Nuclear Forces', Congressional Research Service, p. 3. Available at: December 3, 2020.
- ⁶⁵ Defence Secretary announces programme to replace the UK's nuclear warhead (2020) GOV.UK. Available at: <https://www.gov.uk/government/news/defence-secretary-announces-programme-to-replace-the-uks-nuclear-warhead> (Accessed: 19 October 2021).
- ⁶⁶ Jamie Doward (2020) 'Pentagon reveals deal with Britain to replace Trident', The Observer, 22 February. Available at: <https://www.theguardian.com/uk-news/2020/feb/22/pentagon-gaffe-reveals-uk-deal-replace-trident-nuclear-weapon> (Accessed: 19 October 2021).
- ⁶⁷ Strategic Systems | Aerojet Rocketdyne (no date) Aerojet Rocketdyne. Available at: <https://www.rocket.com/defense/strategic-systems> (Accessed: 19 October 2021);
- ICBM Post Boost Vehicles | Aerojet Rocketdyne (no date) Aerojet Rocketdyne. Available at: <https://www.rocket.com/defense/gbsd/icbm-post-boost-vehicles> (Accessed: 19 October 2021).
- ⁶⁸ Definitive Contract N0003017C0007 - GovTribe (2021) GovTribe. Available at: <https://govtribe.com/award/federal-contract-award/definitive-contract-n0003017c0007> (Accessed: 18 October 2021);
- Contracts for November 20, 2019 (2019) U.S. Department of Defense. Available at: <https://www.defense.gov/News/Contracts/Contract/Article/2022193//> (Accessed: 18 October 2021);
- Contracts for September 25, 2019 (2019) U.S. Department of Defense. Available at: <https://www.defense.gov/News/Contracts/Contract/Article/1971381//> (Accessed: 18 October 2021).
- ⁶⁹ Definitive Contract N0003021C6002 - GovTribe (2021) GovTribe. Available at: <https://govtribe.com/award/federal-contract-award/definitive-contract-n0003021c6002> (Accessed: 18 October 2021);
- Definitive Contract N0003019C0002 - GovTribe (2021) GovTribe. Available at: <https://govtribe.com/award/federal-contract-award/definitive-contract-n0003019c0002> (Accessed: 18 October 2021);
- Contracts for February 26, 2021 (2021) U.S. Department of Defense. Available at: <https://www.defense.gov/News/Contracts/Contract/Article/2518088//> (Accessed: 18 October 2021).
- ⁷⁰ Contracts for August 22, 2019 (2019) U.S. Department of Defense. Available at: <https://www.defense.gov/News/Contracts/Contract/Article/1941859//> (Accessed: 18 October 2021).
- ⁷¹ Definitive Contract N0003018C0001 - GovTribe (2021) GovTribe. Available at: <https://govtribe.com/award/federal-contract-award/definitive-contract-n0003018c0001> (Accessed: 18 October 2021).
- ⁷² Definitive Contract N0003016C0010 (2021) GovTribe. Available at: <https://govtribe.com/award/federal-contract-award/definitive-contract-n0003016c0010> (Accessed: 19 October 2021);
- Definitive Contract N0003017C0100 - GovTribe (2021) GovTribe. Available at: <https://govtribe.com/award/federal-contract-award/definitive-contract-n0003017c0100> (Accessed: 19 October 2021);
- Contracts for December 20, 2018 (2018) U.S. Department of Defense. Available at: <https://www.defense.gov/News/Contracts/Contract/Article/1719367//> (Accessed: 18 October 2021);
- Definitive Contract N0003019C0045 - GovTribe (2021) GovTribe. Available at: <https://govtribe.com/award/federal-contract-award/definitive-contract-n0003019c0045> (Accessed: 18 October 2021);
- Contracts for January 31, 2020 (2020) U.S. Department of Defense. Available at: <https://www.defense.gov/News/Contracts/Contract/Article/2071889//> (Accessed: 18 October 2021);
- Definitive Contract N0003020C0101 (2021) GovTribe. Available at: <https://govtribe.com/award/federal-contract-award/definitive-contract-n0003020c0101> (Accessed: 19 October 2021);
- Definitive Contract N0003019C0100 (2020) GovTribe. Available at: <https://govtribe.com/award/federal-contract-award/definitive-contract-n0003019c0100> (Accessed: 19 October 2021);
- CONTRACT to LOCKHEED MARTIN CORPORATION (no date) USAspending. Available at: https://usaspending.gov/award/CONT_AWD_N0003020C0100_9700_-NONE_-NONE- (Accessed: 19 October 2021).
- ⁷³ Amy F Woolf and James D Werner (2021) 'The U.S. Nuclear Weapons Complex: Overview of Department of Energy Sites', Congressional Research Service, p. 39. Available at: <https://crsreports.congress.gov/product/pdf/R/R45306> (Accessed: 15 September 2021).
- ⁷⁴ Amy F Woolf and James D Werner (2021) 'The U.S. Nuclear Weapons Complex: Overview of Department of Energy Sites', Congressional Research Service, p. 39. Available at: <https://crsreports.congress.gov/product/pdf/R/R45306> (Accessed: 15 September 2021).
- ⁷⁵ About | Consolidated Nuclear Security, LLC (no date). Available at: <https://cns-llc.us/about> (Accessed: 18 October 2021).
- ⁷⁶ Amy F Woolf and James D Werner (2021) 'The U.S. Nuclear Weapons

Complex: Overview of Department of Energy Sites', Congressional Research Service, p. 39. Available at: <https://crsreports.congress.gov/product/pdf/R/R45306> (Accessed: 15 September 2021).

- ⁷⁷ SRNS - Our Parent Companies (no date). Available at: <https://www.savannahrivernuclearsolutions.com/about/parent.htm> (Accessed: 18 October 2021).
- ⁷⁸ Kansas City National Security Campus contract (2017) Energy.gov. Available at: <https://www.energy.gov/nnsa/kansas-city-national-security-campus-contract> (Accessed: 18 October 2021).
- ⁷⁹ Arnie Heller (2015) Stockpile Stewardship at 20 Years, Lawrence Livermore National Laboratory. Available at: <https://str.llnl.gov/july-2015/verdon> (Accessed: 18 October 2021).
- ⁸⁰ Lawrence Livermore National Laboratory contract (2019) Energy.gov. Available at: <https://www.energy.gov/nnsa/lawrence-livermore-national-laboratory-contract> (Accessed: 19 October 2021).
- ⁸¹ Team (no date) Lawrence Livermore National Laboratory. Available at: <https://www.llnslc.com/#team> (Accessed: 18 October 2021).
- ⁸² 'Fiscal Year 2018 Stockpile Stewardship and Management Plan Report to Congress' (2017). U.S. Department of Energy. Available at: https://www.energy.gov/sites/prod/files/2017/11/f46/fy18ssmp_final_november_2017%5B1%5D_0.pdf (Accessed: 15 March 2020).
- ⁸³ Aaron Mehta (2019) How a \$5 part used to modernize nuclear warheads could cost \$850 million to fix, Defense News. Available at: <https://www.defensenews.com/smr/nuclear-arsenal/2019/09/25/nuclear-warhead-programs-need-850m-fix-heres-how-the-government-plans-to-cover-it/> (Accessed: 18 October 2021).
- ⁸⁴ 'W88 Alteration 370' (no date). National Nuclear Security Administration. Available at: <https://www.energy.gov/sites/default/files/2020/06/f76/W88-Alt%20370-20200622.pdf>.
- ⁸⁵ About | Consolidated Nuclear Security, LLC (no date). Available at: <https://cns-llc.us/about> (Accessed: 18 October 2021).
- ⁸⁶ Definitive Contract DENA0002839 - GovTribe (2021) GovTribe. Available at: <https://govtribe.com/award/federal-contract-award/definitive-contract-dena0002839> (Accessed: 18 October 2021).
- ⁸⁷ Aaron Mehta (2019) How a \$5 part used to modernize nuclear warheads could cost \$850 million to fix, Defense News. Available at: <https://www.defensenews.com/smr/nuclear-arsenal/2019/09/25/nuclear-warhead-programs-need-850m-fix-heres-how-the-government-plans-to-cover-it/> (Accessed: 18 October 2021).



2021

**DON'T BANK
ON THE BOMB**