Producing Mass Destruction

Private companies and the nuclear weapon industry

ican
INTERNATIONAL CAMPAIGN TO ABOLISH NUCLEAR WEAPONS

NOBEL PEACE PRIZE 2017

PAX

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Utrecht, May 2019

There remains a marked lack of official information available in the public domain about the use, production, transfer and stockpiling of nuclear weapons. PAX has strived to achieve the highest level of accuracy in reporting. The information in this report reflects official information available in the public domain known to PAX. 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: snyder@paxforpeace.nl

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

ISBN

Notes

Certain figures in this report may not tally exactly due to rounding.

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 500 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

Foreword

Nuclear weapons modernisation has been taking place as long as nuclear weapons have existed. Despite legally binding commitments to disarmament, the risk of nuclear use is increasing and a new trend is emerging among the few nuclear armed states- a new nuclear arms race. Behind this dangerous new arms race are companies that are profiting from putting humanity at risk, gambling with our survival.

There are nine countries armed with nuclear weapons, developing new capabilities that make the use of nuclear weapons more likely.

This report shows how the private sector is involved in making nuclear weapons. It is the evidence that backs the call to action including by the private sector to stop building nuclear weapons.

Leo Szilard, one of the scientists who pushed for the development of nuclear weapons said: "Atomic bombs are primarily a means for the ruthless annihilation of cities." It was included in a letter written by many of the architects of the first atomic bombs, calling on President Harry S Truman not to use the bomb on Japan.

With new developments in technology, once again, history is at a turning point on nuclear weapons.

The US and Russia are leading the way for a new nuclear arms race, one that will be even more dangerous and unpredictable thant eh one we narrowly escaped from during the cold war. Whether they are trying to destroy entire coastlines or reduce the decades old taboo against using nuclear weapons, the threat is increasing.

But there is hope.

The Treaty on the Prohibition of Nuclear weapons and a broad resistance coalition of governments, international organisations, civil soceity and the private sector is generating that hope. It is a manifestation of responsible governments and individuals seeking to put an end to the threat to cities, to civilians, to children and their parents perpetuated by nuclear weapons. The treaty offers a radical change to the course of history, one that will not end in mushroom clouds but will bring about flourishing opportunities.

This report illustrates just how far some of the companies involved in the production of nuclear weapons are going. It talks about making nuclear weapons usable until, at least, the 2070s. It highlights contracts for developing new types of weapons, including those with new capabilities that greatly increase the risk they will be used- or confused, either way inciting a nuclear retaliation.

The Treaty on the Prohibition of Nuclear Weapons offers a way out of this new nuclear weapons race. It offers an alternative to the nuclear nightmare that we are otherwise rushing towards. The treaty is something for governments, but all of society can commit to a nuclear weapon free world. Now is the time to declare no business as usual, no business with companies building bombs destined to destroy us, now is the time to take a stand. Otherwise business as usual will likely end in a nuclear war.

Beatrice Fihn is the Executive Director of the International Campaign to Abolish Nuclear Weapons (ICAN), winner of the 2017 Nobel Peace Prize.

Executive Summary

Governments are contracting at least US$ 116 billion (€ 102 billion) to private companies in France, India, Italy, the Netherlands, United Kingdom, and the United States for production, development and stockpiling of nuclear weapons. State owned companies in China connected to nuclear weapon production are starting to raise money through bond issuances, while Israeli, Pakistani, North Korean, and Russian nuclear programmes are still not transparent.

Complicit Companies

This report provides full profiles of 28 companies connected to the production of nuclear weapons. Most of those companies are involved in the US arsenal, as the contracting system in the US is quite transparent. However, there is also information on companies connected to the French, Indian and UK arsenals. The full report also contains brief profiles of 11 other companies, including a Chinese company, whose nuclear weapon related activities are outside the scope of the research but are still relevant while painting the picture of the global nuclear weapons industry.

This is the first time a Chinese company has been included. China National Nuclear Corporation is outside the general scope of this research (it is state owned), as they have recently done a bond issuance, some information is included to draw attention to the growing transparency and interconnectivity of even Chinese State-owned nuclear weapon associated companies.

There are a few companies that stand out in terms of their overall nuclear weapon related activities, with billions in outstanding contracts. For example, Huntington Ingalls Industries which is connected to several facilities in the US nuclear weapons enterprise, is part of more than US$ 28 billion in outstanding contracts. Lockheed Martin is a close runner-up, connected to more than US$ 25 billion in contracts.

This report provides information on outstanding contracts related to the production of key components for nuclear weapons. Airplanes and submarines are outside the scope of the report. However, companies involved in producing airplanes and submarines designed to deliver nuclear weapons are often involved in other parts of nuclear weapon production. For example, Lockheed Martin, which is currently producing the F35 (Joint Strike Fighter), one variant of which will be certified to drop nuclear weapons, is included in this report because of more than US$ 7.9 billion (€ 6.9 billion) in outstanding contracts for nuclear armed missiles for the US and UK.

New Nuclear Arms Race

Despite global calls for restraint and nuclear disarmament, new nuclear weapons are being developed in all nuclear armed countries. The report includes information about a few new types of weapons, including the US 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. In addition, efforts to build hypersonic submarine launched ballistic missile capabilities, like those planned in a US$ 109.5 million (€ 95.9 million) contract with the Charles Stark Draper Laboratory, are discussed in the relevant profiles.

Some of the lower yield weapon options outlined in the 2018 US Nuclear Posture Review are also now under development. For example, the US National Nuclear Security Administration has started building the first low-yield, submarine-launched ballistic missile warhead W76-2, at the Pantex Plant in Texas. The conversion of W76-1 warheads into W76-2 warheads will cost a minimum of US$ 125 million (€ 110.1 million).[1] The private contractors involved in this work are part of Consolidated Nuclear Services LLC (CNS), a Bechtel -led

joint venture including Leidos, ATK Launch Systems (now part of Northrop Grumman), SOC, and Booz Allen Hamilton[2] as a teaming subcontractor.[3]

Many of the outstanding contracts identified in this report were granted around 2015 and are set to expire in 2020. However, some nuclear weapon associated contracts were awarded with much longer time frames in mind. For example, a contract for a key component necessary to launch US Intercontinental Ballistic Missiles (ICBMs) was designed to keep the missiles ready to launch until at least 2075. Some Trident contracts are designed to keep the system fully functional until at least 2042. Generally, though, most contracts are arranged in five to ten-year increments, and are modified regularly to meet cost overruns, delivery delays and add-on projects. Contracts are constantly changing, and a contract that is initially set for one amount may be adjusted by an order of magnitude within a month.

In 2018, there were surprising contracts awarded that prepare the ground for future US fissile materials production. Ostensibly for Tritium extraction, the US$ 505 million (€ 427.5 million) contract awarded in September 2018 to a subsidiary of BWX Technologies was for activities described by the US government to "provide a reliable and economical source of unobligated enriched uranium", free from peaceful use restrictions, until at least 2025. [4]

After years of complaints about the contractors running the lab, Huntington Ingalls Industries took over the management and operations for the Los Alamos National Laboratory in 2018 with a five-year contract estimated at US$ 2.5 billion (€ 2.2 billion) annually. [5] However, the same contractors that have been previously reprimanded for poor performance, including BWX Technologies, remain in place at the Lawrence Livermore National Lab in California.

US nuclear weapons in Europe

An estimated 180 B61 nuclear gravity bombs are currently deployed by the US at airbases 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). Despite a majority of those populations objecting to this stationing, work is under way to replace the B61 bombs with a new version, the B61-12. The Federation of American Scientists reports, however, that there are 2-5 year delays on the B61-12 project as a whole, while new bomb plans (B61-13) are meant to start in 2038.[6]

Three of the contractors named in the report are involved in production activities for the B61-12. Boeing is producing the tail-kit assembly under a US$ 185 million (€ 163 million) contract. Honeywell International operates and manages the Sandia National Laboratory which designed the new hardware for the bomb, and Huntington Ingalls Industries provides nuclear operations and manufacturing. According to the contract terms, the Boeing designed B61-12 tail kits are meant to be ready by May 2019.[7] These are the weapons the United States deploys outside their territory, it is yet unclear when the new bombs will be delivered to their European locations. Another company, Atlantic CommTech got a contract in 2016 to modernize the Weapon Storage and Security System at the hosting bases in Europe, but that work is only meant to conclude by October 2020.[8]

The new contracts, the new types of weapons, the new allocation of resources all show that the new nuclear arms race is happening.

Summary of the major nuclear weapon producers profiled.

Aecom is involved in work at the Lawrence Livermore National Laboratory, it is involved in research, design, development and production of nuclear weapons,[9] including the life extension program of the B61 nuclear bomb[10] and of the W80-1 nuclear warhead for air-launched cruise missiles.[11] Aecom has held this US $45.5 million (€ 40.1 million) per year contract since 2007.

Aerojet Rocketdyne is involved in maintaining the propulsion systems for Minuteman III Intercontinental Ballistic Missiles for the US, under a US $28.9 million (€ 25.5 million) contract initially awarded in 2013. It also produces propulsion systems for the Trident II (D5) missiles for the US and UK. [12] Aerojet Rocketdyne is also a subcontractor on the new Ground Based Strategic Deterrent for the US arsenal. In 2018, Aerojet Rocketdyne secured an additional five-year contract for US $20 million (€ 17.6 million) for solid boost technology that will be applied to the next generation of weapons systems.[13]

Airbus is a Netherlands based company involved in the ongoing maintenance and development of several nuclear armed missiles for the French nuclear arsenal through ArianeGroup, a joint venture with the French company Safran. [14] Airbus is also part of the joint venture MBDA that supplies medium-range air to surface missiles, also for the French arsenal. [15]

BAE Systems has a maximum value US$ 368.7 million (€ 328 million) contract originally from October 2014 that will run until 2021 that is paid by the US and UK governments for key components for Trident II (D5) missiles.[16] BAE also has a US$ 951.4 million (€ 830.8 million) contract from the US Air Force for Minuteman III Intercontinental Ballistic Missile (ICBM) system, which will run until 2022.[17] BAE is also involved in the French arsenal directly, through MBDA Systems, developing the medium-range air-to-surface missile ASMPA and its successor, ASN4G.[18] In July 2017, BAE got a new US$ 45.2 million (€ 39.6 million) modification to an existing contract for development work on the Ground Based Strategic Deterrent (GBSD) intercontinental ballistic missile replacement programme.[19]

Bechtel is a family run company involved in nuclear weapon development at the Lawrence Livermore National Laboratory, the Y-12 Complex, and the Pantex Plant. Bechtel currently has approximately US $ 1,174 million (€ 1,035 million) in outstanding contracts at these facilities. Bechtel is also involved in one of the new nuclear weapons under design in the US, the Ground Based Strategic Deterrent, though their exact contract amount is unclear.[20]

Bharat Dynamics Limited produces key components for the Prithvi-II and Agni- V nuclear capable missiles for the Indian arsenal.[21]

Boeing is building new nuclear weapons for the US. These include a 2017 contract for US$ 349.2 million (€ 297 million) for the Ground Based Strategic Deterrent,[22] to replace the Minuteman III ICBMs. Boeing is also involved in the Long-Range Standoff weapon development and has been awarded several contracts since 2017 for this new nuclear weapon, valued at US $ 344.5 million (€ 304 million).[23]

Boeing holds several contracts related to the the US long-range nuclear Minuteman Intercontinental Ballistic Missiles (ICBM). Boeing currently has contracts valued at over US$ 703.3 million (€ 620 million) for key components for the Minuteman system. One of these contracts includes the development of 'kill switches' to cause the missile to self-destruct after launch.[24]

Boeing received a new US$ 26.7 million (€ 23.0 million) contract from the US and UK for Trident II (D5)

work in October 2018.[25] This is in addition to existing outstanding contracts for work related to the system valued at over US$ 88.9 million (€ 79.0 million).[26]

Boeing is also producing the tail-kit assembly for the new B61 bombs. More than half of all these bombs are currently deployed by the US in five European countries (Belgium, Germany, Italy, the Netherlands and Turkey). The US$ 185 million (€ 163 million) in contracts will mean the new B61-12 bombs are ready for use by May 2019.[27] It is yet unclear when the new bombs will be delivered to their European locations, other companies are currently modifying the storage facilities in the host countries.

BWX Technologies has a new US$ 76 million (€ 70.8 million) contract for Trident II (D5) components for the US and UK navies.[28] BWXT also got a US$ 505 million (€ 427.5 million) contract to prepare for additional US nuclear materials production for nuclear weapons, this will initially be Tritium production, but there are also plans to produce additional nuclear materials in the near term.[29]
BWXT is also involved in the partnership that oversees the Lawrence Livermore National Laboratory, including the life extension program of the B61 nuclear bomb[30] and of the W80-1 nuclear warhead for air-launched cruise missiles.[31] The partnership receives US$ 45.5 million (€ 37.6 million) a year for this work.[32]

Charles Stark Draper Laboratory has a US$ 370.2 (€350.5 million) contract, paid by the US and the UK, for work on the Trident II (D5) system.[33] In 2018, Draper got another US & UK funded to US$ 109.5 million (€ 95.9 million) contract for additional work on the Trident system, including hypersonic guidance and support for hypersonic flight experiments, to be concluded by September 2019.[34]

Constructions Industrielles de la Méditerranée is included for the first time as more information on the specifically designed key components for the French nuclear arsenal has become available. CNIM designs and manufactures the submarine launching systems designed for the nuclear-armed M51 missiles.[35]

Fluor is involved at several US nuclear weapons enterprise facilities. Through a joint venture, Savannah River Nuclear Solutions (SRNS) it has an US$ 8 billion (€ 7.1 billion) contract for efforts related to key components for the W88 Alt 370 program, the nuclear warhead deployed on the Trident II (D5).[36]

General Dynamics has a number of contracts related key components for the UK & US Trident II (D5) systems. An initial US$ 30.6 million (€ 28.2 million) contract awarded in 2015 has been modified repeatedly (including five times between November 2017 and December 2018) bringing the total contract value to over US$ 174.4 million (€ 155.6 million).[37]

Another **General Dynamic**s subsidiary, General Dynamics Electric Boat received a maximum dollar value of US$ 46.5 (€ 43.4 million) contract in September 2017 for integration work for United Kingdom Strategic Weapon Support System kit manufacturing for the Columbia class ballistic missile submarines. [38] In 2018 this contract was modified significantly, first in April for US$ 126.2 million (€ 102.4 million),[39] and again for US$ 480.6 million (€ 414 million) in September 2018.[40]

Honeywell International manages and operates the National Security Campus (NSC) (formerly Kansas City Plant), the facility responsible for producing an estimated 85% of the non-nuclear components for US nuclear weapons[41] under a five year US$ 900 million (€ 817.4 million) contract awarded in July 2015.[42] It is also a co-owner of Savannah River Nuclear Solutions (SRNS) which has a US$ 8 billion (€ 7.1 billion) contract for efforts related to key components for the W88 Alt 370 program, the nuclear warhead deployed on the Trident II (D5).[43] Honeywell is also associated with other US nuclear weapons enterprise facilities, including

an outstanding US$ 5 billion (€ 4.6 billion) contract[44] for the Nevada National Security Site and a US$ 2.6 billion (€ 2.5 billion) contract for the Sandia National Laboratory. Both facilities are responsible for warhead production, testing, and design. Also, Honeywell received new contracts in 2018 valued at US$ 19.0 million (€ 16.2 million) for the PIGA guidance instrument for the Minuteman III.[45]

Huntington Ingalls Industries took over the management and operations for the Los Alamos National Laboratory in 2018 with a five-year contracted with an estimated value of US$ 2.5 billion (€ 2.2 billion) annually. [46] Huntington Ingalls Industries will be providing "personnel, systems, tools and corporate reachback in the areas of pit production, plutonium manufacturing, production scale-up and nuclear operations and manufacturing".[47] Huntington Ingalls Industries is also part of a US$ 5 billion (€ 4.6 billion) contract at the Nevada National Security Site,[48] and the US$ 8 billion (€ 7.1 billion) contract at the US Department of Energy's Savannah River Site and Savannah River National Laboratory in South Carolina.[49]

Jacobs Engineering is part of the UK Atomic Weapons Establishment, which currently has a 25-year £ 25.4 billion (€29.6 billion) contract for maintenance of the UK Trident arsenal.[50] Jacobs was also part of the group that took over management and operations of the Nevada National Security Site in 2017 under a 10-year US$ 5 billion (€ 4.6 billion) contract.[51]

Larsen and Toubro are involved in producing key components for the Indian nuclear arsenal. These include the launcher system for the nuclear-capable Prithvi II missile.[52] It is also involved in the Dhanush, the ship-based variant of the Prithvi-II.[53]

Leidos is a minority partner of Consolidated Nuclear Services LLC (CNS), which took over the management and operation of the Y-12 National Security Complex in Tennessee and the Pantex Plant in Texas under the same US$ 446 million (€ 326.5 million) contract in 2014. [54] These facilities are involved in producing Tritium for US nuclear weapons as well as the M76/MK4A, W76-2, W80-1 and, W88 warhead modifications. [55]

Leonardo is an Italian company (formerly known as Finmeccanica) involved in the French nuclear arsenal through MBDA-Systems. In contracts from 2016, MBDA began design and development of the mid-life upgrade of the ASMPA to keep it in the French arsenal through 2035. In the 2019 French Ministry of Defence Budget, three deliveries of upgraded ASMPAs are planned after 2019. MBDA is also involved in work on the successor system (ASN4G) which is meant to be operational after 2035.[56]

Lockheed Martin has outstanding Trident II (D5) contracts valued at approximately US$ 6,550.1 million (€5,730.4 million). Of these US$ 918.9 million (€ 801.9) were awarded in between March 2018 and January 2019. Lockheed also has at least US$ 495 million (€ 413.6 million) in outstanding contracts related to the Minuteman III ICBM. It is also involved in a US$ 900 million (€ 764.2 million) research and design contract for the new US the Air Force Long-Range Standoff (LRSO) missile.[57]

Lockheed Martin's nuclear weapon associated activities aren't limited to US missile production alone. It is also part of the 25-year £ 25.4 billion (€29.6 billion) contract for the UK Atomic Weapons Establishment.[58]

Moog has developed launch vehicle and strategic missile controls for the Minuteman III and Trident (D5) missiles. [59] Moog is also part of the Boeing team that won a US$ 349.2 million (€ 297.0 million) contract in 2017 for technology maturation and risk reduction activities for the new Ground Based Strategic Deterrent.[60]

Northrop Grumman is currently handing over responsibilities to BAE Systems as the prime contractor for the Minuteman III ICBM system. This process began in 2013, but there have been repeated 'bridge' contracts valued at over US$ 165.0 million (€ 128.3 million)[61], most recently in September 2018. Now the handover process is expected to be complete in April 2019. [62]

Although **Northrop Grumman** is no longer the prime ICBM contractor, it still has additional US ICBM related contracts including those it took over when it acquired Orbital ATK. These additional contracts were mostly awarded in 2015, with a total value of approximately US$ 1,852.9 million (€ 1,642.9 million).[63] Northrop Grumman, via ATK Launch Systems was also awarded another Minuteman related contract for US$ 86.4 million (€ 74.5 million) in September 2018. [64]

Northrop Grumman is also involved in the Trident II (D5) systems for the US and the UK, with outstanding contracts valued at approximately US$ 531.3 million (€ 493.2 million). Many of these Trident II (D5) related production activities are meant to conclude in 2020.[65]

Northrop Grumman is also connected to the nuclear weapons facilities at the Pantex and Y-12 through at US$ 446 million (€ 326.5 million) contract to the Consolidated Nuclear Services (CNS) joint venture. [66]

Raytheon has an outstanding US$ 33.4 million (€ 24.8 million) contract for work related to the Minuteman III ICBMs. [67] Raytheon is also involved in new nuclear weapons development for the US. It is part of the Boeing team working on the Ground Based Strategic Deterrent[68], and in August 2017, Raytheon received a five-year contract for US$ 900 million (€ 764.2 million) for the new Long-Range Standoff weapon. [69]

Safran is a French company and two of their subsidiaries (Snecma and Sagem) are developing key components for the M51 missiles for the French nuclear weapons arsenal.[70] Safran is also part of the joint venture with Dutch company Airbus, responsible for ongoing production and maintenance of the missile system overall. [71] This joint venture is also contracted to carry out the 2019 budgeted tasks of the French Ministry of Defence for three deliveries of upgraded ASMPAs after 2019.[72]

Serco is a UK company involved in management and operations of the UK Atomic Weapons Establishment (AWE) under 25-year contract (1999 to 2024) valued at £ 25.4 billion (€29.6 billion).[73]

Textron has an outstanding US$ 17.2 million (€ 12.5 million) contract to convert up to six Minuteman III MK 12A re-entry vehicles to the Mod 5F configuration.[74]

According to the French Ministry of Defence, **Thales** is one of MBDA's subcontractors supplying medium-range air-to-surface missile ASMPA to the French air force.[75]

United Technologies Corporation acquired Rockwell Collins in November 2018 and renamed it Collins Aerospace Systems.[76] This company has an outstanding US$ 76 million (€ 67 million) contract for the Airborne Launch Control System Replacement for the Minuteman III ICBM missiles.[77]

Walchandnagar Industries Limited produces launching systems for the Indian Agni series of nuclear armed missiles. [78]

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- ASMPA: Airbus Group (the Netherlands); BAE Systems (UK); Leonardo (Italy)
- ASN4G: Airbus Group (the Netherlands); BAE Systems (UK); Leonardo (Italy)
- M51: Airbus Group (the Netherlands); Constructions Industrielles de la Méditerranée (France); Safran (France); Thales (France)

India

- Agni-V: Bharat Dynamics Limited (India); Walchandnagar Industries (India)
- Prithvi II: Bharat Dynamics Limited (India); Larsen & Toubro (India)
- Dhanush: Larsen & Toubro (India)

United Kingdom

- Trident II (D5): Aerojet Rocketdyne (US); BAE Systems (UK); Boeing (US); BWX Technologies (US); Charles Stark Draper Laboratory (US); General Dynamics (US); Honeywell International (US); Jacobs Engineering (US); Lockheed Martin (US); Moog (US); Northrop Grumman (US); Serco (UK)

United States

- B61-12: Boeing (US); Honeywell International (US); Huntington Ingalls Industries (US)
- Minuteman III: Aerojet Rocketdyne (US); BAE Systems (US); Boeing (US); BWX Technologies (US); Honeywell International (US); Lockheed Martin (US); Moog (US); Northrop Grumman (US); Raytheon (US); Textron (US); United Technologies (US)
- Trident II (D5): Aerojet Rocketdyne (US); BAE Systems (UK); Boeing (US); BWX Technologies (US); Charles Stark Draper Laboratory (US); General Dynamics (US); Honeywell International (US); Jacobs Engineering (US); Lockheed Martin (US); Moog (US); Northrop Grumman (US)
- Ground Based Strategic Deterrent (NB: there are two main teams involved in this weapon's development, the Boeing team and the Northrop Grumman team. Many of the companies listed here are involved in both of those teams): Aerojet Rocketdyne (US); BAE Systems (UK); Bechtel (US); Boeing (US); Moog (US); Northrop Grumman (US); Raytheon (US)
- Long Range Standoff (LRSO): Boeing (US); Lockheed Martin (US); Raytheon (US)

Introduction

This is a report about the companies that are most heavily involved in the production of nuclear weapons. It is an in-depth examination of the contracts and types of weapons in which each of the profiled companies is involved.

This report is an extensive examination of the contract relationships between the governments of France, India, the United Kingdom and the United States with the companies profiled. The private sector involvement in the arsenals of China, Israel, North Korea, Pakistan and the Russia Federation is largely hidden. However, for the first time this report does include a little bit of information about a state-owned Chinese company that has recently issued bonds. The report does not include a full profile of the company, because details about their exact activities are unknown. It is included in order to show that some information is available, although much remains opaque.

There are any number of reasons a company might decide to engage in the production of nuclear weapons. For some, the decision fits with a business model based on the production of goods designed to destroy life. For others, it may be a contribution to an interesting challenge of physics. Still others might not give any real thought to their role in the production of nuclear weapons.

Yet many of the same companies listed in this report are working intensively to demonstrate a commitment to Corporate Social Responsibility and Sustainability. According to ISO 26000:2010 Guidance on social responsibility, CSR can be defined as the "responsibility of an organization for the impacts of its decisions and activities on society and the environment, through transparent and ethical behaviour that contributes to sustainable development, including health and the welfare of society; takes into account the expectations of stakeholders; is in compliance with applicable law and consistent with international norms of behaviour; and is integrated throughout the organization and practised in its relationships."[79] The OECD Guidelines for Multinational Enterprises argue that corporations should "contribute to economic, environmental and social progress with a view to achieving sustainable development."[80]

This means companies should not only adhere to legislation and regulations in the countries where they operate, but also are expected to comply with widely supported international conventions, standards, and initiatives that recognise sustainability problems and offer solutions for them - even where these standards are not included in local legislation. It is difficult to reconcile the two realities of the companies profiled in this report – on the one side trying to present themselves as sustainable, socially responsible actors – on the other side producing weapons of mass destruction, designed to kill hundreds of thousands and leave contaminating legacies for generations.

In preparing this report, we reached out to the nuclear weapon producing companies profiled. Not all responded. Others indicated they believe nuclear weapons will be in a handful of arsenals in perpetuity. None of the companies indicated any awareness of the Treaty on the Prohibition of Nuclear Weapons, yet several were familiar with the Treaty on the Non-Proliferation of Nuclear Weapons and said they consider the NPT gives five countries the right to the indefinite possession of nuclear weapons. This assumption is not hard to understand, as those countries seem to act that way. However, it shows the clear disregard by these companies for the principles embedded in international humanitarian law, let alone for the unimaginable human suffering caused by any use of these specific products.

This report puts the spotlight on companies 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.
Susi Snyder, Utrecht, May 2019

Treaty on the Prohibition of Nuclear Weapons

In July 2017, countries at the United Nations adopted the Treaty on the Prohibition of Nuclear Weapons. The first multilateral nuclear weapons related treaty in decades, the TPNW is a comprehensive prohibition of the development, testing, production, manufacture, possession or stockpiling of nuclear weapons. The treaty also outlaws any assistance with the above-mentioned activities.

Although the treaty itself is binding on states, the treaty requires countries that join to implement the treaty by putting in place criminal penalties for treaty violations. This could apply to some of the companies involved in the production of nuclear weapons, if those production activities are, for example, carried out in countries that have joined the treaty.

The Nuclear Weapons Ban Monitor elaborates on the prohibition on assistance in the treaty explaining that a country cannot knowingly[81]help another country, or natural or legal person (note: corporate entities are generally considered legal persons) to develop, test, produce, possess, stockpile, transfer, receive, threaten to use, or use nuclear weapons or other nuclear explosive devices. Also outlawed would be assistance for the deployment by any other state of any nuclear explosive devices anywhere under a state party's jurisdiction or control. The "hosting" of another legal entity's nuclear weapons is also specifically prohibited under paragraph 1(g) of the treaty. The assistance must make a substantive contribution to a prohibited activity: insignificant contributions (for example, a screw or bolt that is used in a nuclear missile) would not violate the prohibition.[82]

The Nuclear Weapons Ban Monitor goes on to explain that a "company that develops or produces key components for a nuclear explosive device would be engaging in prohibited assistance."[83] Parent companies can also be held responsible for the activities conducted by their subsidiaries, in cases where the parent company itself does the development or production, or if the parent company has made the impression that it has made the commitment on behalf of the subsidiary, or if there is interference by the parent company in the management of the subsidiary.[84] In addition, any company that is engaged in a joint venture that develops or produces key components could be engaging in prohibited assistance even if it does not itself contribute materially to the nuclear-weapon development or production.[85]

As more states ratify the Treaty on the Prohibition of Nuclear Weapons and it enters into force, additional discussions are likely to take place about the relationship between the comprehensive prohibition on nuclear weapons and the companies that are involved in their production. Therefore, this is the perfect time for the companies involved in the development, testing and production of nuclear weapons to prepare, and end their nuclear weapons related activities.

Methodology

The initial list of nuclear weapon associated companies investigated was compiled through a wide variety of sources, including financial institution exclusion lists, civil society reports, media reports, trade journals, etc. The list of selected nuclear weapons companies in this report is not exhaustive. Information about the contracts and nuclear weapon involvement was gathered using websites and annual reports of military companies; military and government sources; research reports; trade magazines and general press reports.

Criteria

The companies in this report were selected on the basis of predetermined criteria:

- The company is directly involved in the development, testing, production, maintenance or trade of nuclear weapons related technology, parts, products or services.
- The company's involvement is related to warheads, or to delivery systems such as missiles, that are specifically developed for nuclear tasks. This includes technology that is designed for 'dual use' (military and civilian) but excludes technology that is not designed for but can be used in nuclear warfare. It does not include delivery platforms such as bombers and submarines.
- Information on investments in the company is publicly available.

This report makes a distinction between 'delivery systems' and 'delivery platforms'. Delivery systems (missiles, rockets, missile torpedo launch installations, etc) are considered key components of nuclear arsenals, whereas delivery platforms (submarines, bombers, fighter planes, etc) are excluded. This is in order to maintain methodological consistency. We believe that although any definition has its own debatable grey areas, this definition sets a clear boundary and allows us to focus on the businesses most heavily involved in the centre of the nuclear weapons industry. It is important to note that some of the companies listed are involved in numerous activities related to the production of nuclear weapons. Information on their wider involvement, which could include both delivery systems and platforms, may be included in these cases.

Based on these criteria, a list of companies involved in producing or maintaining nuclear weapons or significant, specific components thereof was composed. Besides a company's involvement in the production of nuclear weapons, the selection further considered the likelihood that the company is predominantly financed by financial institutions, rather than government funding. Most of the included companies are therefore stock-exchange listed.

Subcontractors are companies without a direct government contract, hired by other companies associated with the production of nuclear weapons. As a rule of thumb, subcontractors are not included in the scope of research. However, some may be included if they are involved in the production of components designed specifically for nuclear weapons. Subcontractors involved in personnel or facilities management are not included. All subcontractors are clearly noted.

The resulting list of companies compiled in this report is not exhaustive. It is an attempt to identify the privately-owned companies that are most heavily involved in the nuclear weapon industrial complex. There are numerous other companies involved on a different scale or more indirectly. For example, companies involved in the production of small parts used in the assembly or maintenance of nuclear devices. In that sense, it is important to note that the total nuclear weapons industry may be much larger than what is identified in this report.

Scope

State owned or controlled nuclear industries are also outside the scope of this research, as are most companies not publicly listed. The financing of nuclear programmes in China, Israel, the Democratic People's Republic of Korea (North Korea), Pakistan and the Russian Federation remain largely invisible.

There are a number of university contracts also identified in connection to nuclear weapons development

and production. While universities remain outside the scope of this report, some information about relevant contracts has been added to the www.dontbankonthebomb.com website.

The initial list of nuclear weapon producers investigated was compiled through a wide variety of sources, including financial institution exclusion lists, civil society reports, media reports, etc. We welcome information at any time about possible nuclear weapons producing companies to investigate.

Companies not in scope, but of interest

This report focuses on the production of key components for nuclear weapons, but there are other companies involved in activities that are prohibited by the Treaty on the Prohibition of Nuclear Weapons (including stockpiling the weapons or building facilities to allow any stationing, installation or deployment of nuclear weapons on national territory). While these activities fall outside the scope of this report per se, as they are not directly production efforts, some information may be of interest.

The following profiles are not a comprehensive review of companies of this nature, rather they are an example of the types of companies also involved in maintaining nuclear weapon arsenals.

Atlantic CommTech Corp

Atlantic CommTech Corp was awarded a US$ 36 million (€32 million) contract by the US Air Force in 2016 "to modernize the Weapon Storage and Security System (WS3)" at bases in Europe in which the US deploys nuclear weapons, notably: Aviano AB, Italy; Büchel AB, Germany; Ghedi AB, Italy; Incirlik AB, Turkey; Kleine Brogel AB, Belgium; and Volkel AB, Netherlands. This activity is meant to conclude by October 2020.[86]

Battelle Memorial Institute

Battelle is involved at both the Lawrence Livermore National Laboratory and the Los Alamos National Laboratory.[87] Battelle accepts numerous contracts, but is established as a non-profit organisation They are involved in a number of activities directly related to nuclear weapon modernisation and new warhead production, however as they are not externally or privately financed, they fall out of the scope of this report.

Booz Allen Hamilton Holding Corp

Booz Allen Hamilton is part of the Consolidated Nuclear Security (CNS) Joint Venture, involved in a contract for design and construction of a Uranium Processing Facility (UPF) at the Y-12 National Security Complex and an option for Savannah River Tritium Operations at the Savannah River Site in South Carolina.[88] Most of the activities conducted by Booz Allen Hamilton Holding, in regards to other contracts, appear to be not related to the production of key components for weapons. Therefore, they are not included in this report.

China National Nuclear Corporation

China National Nuclear Corporation (CNNC) claims to be a leading company producing key components for the Chinese nuclear arsenal and that it is "[e]ngaged in research, development, production and operation in the areas of nuclear military programs".[89] In 2017, the China Council for the Promotion of International Trade (CCPIT) promoted CNNC as the *core of China's nuclear deterrence*: "CNNC developed atomic and hydrogen weapons […] CNNC is the main part of China's nuclear science and technology advancement, the core of State nuclear deterrence and the major force of nuclear power development".[90] According to the South China Morning Post, CNNC "operates several uranium enrichment facilities at three plants".[91] As CNNC is a Chinese state-owned company,[92] it is outside the scope of this report.

Geocent

Geocent is part of the Boeing Ground Based Strategic Deterrence team.[93] Geocent involvement in Boeing's GBSD team includes engineering and scientific support, including propulsion, avionics, Guidance Navigation and Control and missile system software.[94] It is currently in a research and development phase, not yet production, and is therefore out of the general scope of this report.

Merrick & Company

Merrick, along with Strategic Management Solutions, provides support for the Triad National Security joint venture at the Los Alamos National Laboratory.[95] Their work is primarily associated with large scale infrastructure, as they are primarily an engineering and architecture firm. They are listed here for information purposes as they are directly associated with the Los Alamos Nuclear Laboratory, responsible for US nuclear weapon modernisation and stockpile retention, however the services they provide appear to be outside the scope

of this report.

Naval Group

Naval Group is involved in the overhaul of the French nuclear armed submarines. This includes equipping the submarines with the M51 missiles. The first nuclear submarine to be equipped with the M51 was *Le Terrible* in 2010, followed by the other new-generation submarines, *Le Vigilant*, delivered in 2013, *Triomphant,* delivered in 2015, and *Le Téméraire*.[96] The overhaul will be carried out by Naval Group (formerly known as DCNS)[97] with the French defence procurement agency (DGA) and the Fleet Support Service (SSF).[98] The delivery of *Le Téméraire* is scheduled for 2019.[99] Delivery platforms such as submarines fall outside the scope of this report.

Peraton

Peraton is involved in the maintenance and development of for the Trident II (D5) for the US arsenal.[100] According to the Orlando Business Journal, the contract for Peraton will support the maintenance work of Lockheed Martin on the Trident II.[101] Peraton is a private company, owned by Veritas Capital.[102] As it is not publicly traded, Peraton (and Veritas Capital) fall outside the scope of this report.

Rolls Royce

Rolls Royce is known to be involved in producing key components for the new Dreadnought submarines that comprise the UK nuclear weapons system. The UK government has reportedly set awarded contracts worth more than £986 million (€ 1.15 billion) for manufacturing and an additional £277 million (€ 323 million) for additional design work. Rolls Royce is involved, along with BAE Systems in the project, due to be delivered in the 2030s.[103] While these submarines are specifically designed for the UK nuclear arsenal, submarines remain outside the scope of this report.

Strategic Management Solutions

Strategic Management Solutions provides support for the Los Alamos National Laboratory management and operations contractor Triad National Security (a consortium).[104] The role played by this company is primarily one of project management. However, its direct involvement in the Dual Axis Hydrodynamic Radiographic Test (DARHT) Facility, notably the efforts to develop an integration approach with LANL's weapons certification and surety program,[105] does warrant a note about their involvement in efforts to maintain the US nuclear weapons stockpile.

Systems Planning and Analysis Inc.

Systems Planning and Analysis Inc. (SPA) provides technical and analytical support services to government actors in the defence and national security sector.[106] It is involved in analysis to support selection of strategic warheads for Trident II (D5) for the US Navy.[107] However, Systems Planning and Analysis Inc. is a private company,[108] putting it outside the scope of this report.

Changes from previous reports

The first report was launched in 2012 and included 20 nuclear weapon producers. That number was expanded to 27 in 2013, 28 in 2014. Due to contract terminations the 2015 report included 26 companies, and in the 2017/8 report, we put an emphasis only on the top 20 companies.

This report is much more comprehensive, providing full profiles of 28 companies and additional information about another 11.

Each of the company profiles continues to present the same information including background about the company, their contact details, and the relationship to the production of key components for nuclear weapons. However, in this report the way of presenting that information has changed slightly, in order to illustrate exactly in which parts of the relevant nuclear arsenals the companies are involved.

No longer listed in this report

In every update of this research, the list of companies looks slightly different. Some companies merge or acquire others, while some change their names. It also happens that contracts expire and are not renewed.

CH2M Hill

CH2M Hill was acquired by Jacobs Engineering, all activities are now included in the Jacobs Engineering profile.

Engility
Previous contracts linking to Minuteman III producer are no longer renewed. Operations activities will be bought by SAIC. One tenuous contract might remain, for the US Defense Threat Reduction Agency's Nuclear Enterprise Support Directorate, but this appears to be more of an advisory than a production contract.[109]

Orbital ATK
As it was acquired by Northrop Grumman, all activities are now included in the Northrop Grumman profile.

Rockwell Collins
Rockwell Collins was included in the 2013 and 2014 reports, but then contracts concluded. However, new contracts have emerged. Also, Rockwell Collins was acquired by United Technologies Corporation, and the subsidiary was renamed Collins Aerospace Systems.

New in this report
In this version, we have decided to provide a much more significant examination of the companies connected to the production of nuclear weapons and their key components- and are publishing this separately from the financial data (which will follow later in the year). The decision to do this is to provide a better overview of the private sector involvement in nuclear weapon activities.

Therefore, there are companies included in this report that were not previously profiled. In addition, the briefer profiles provide a fuller picture of the links between the private sector and the production of key components for nuclear arsenals.

The new companies with full profiles include:

Bharat Dynamics Limited
This company is included in this report due to new information found linking the company to the Indian arsenal. In 2013, Bharat Electronics (another branch) was included, but was later removed due to lack of corroborating evidence of involvement with the nuclear weapon programme.

Constructions Industrielles de la Méditerranée (CNIM)
This company is responsible for the missile compartments on French submarines designed to launch M51 nuclear missiles. It is also developing key components to allow non-explosive nuclear testing for the French arsenal. Additional information about the contract awards from the French government has been made available, which is why they are now included in this report.

Leidos
This company has been monitored for some time due to their role as a minority partner of Consolidated Nuclear Services LLC, involved in the management and operations of the Y-12 National Security Complex in Tennessee and the Pantex Plant in Texas. Additional information has become available about nuclear weapon production activities at these facilities, and that brings Leidos onto the producers list.

In the last edition of this report, partial profiles were only available on the website for several companies, including Bharat Dynamics Limited; Charles Stark Draper Laboratory; Engility Holdings; Leonardo; Moog; Raytheon; Textron, and Walchandnagar Industries. Apart from Engility Holdings, full profiles of these companies are now included in this report.

A note about joint ventures and subsidiaries
There are numerous joint ventures and consortiums operating across the global nuclear weapons industry. Each of these are named in the various producer profiles, but this section provides a listing showing their composite parts. We've done the same for known subsidiaries, to their parent companies.

ArianeGroup
The ArianeGroup joint venture is comprised of Airbus and Safran, who are responsible for the ongoing production and maintenance of the M45 and M51 missiles for the French nuclear arsenal.[110] The French 2019 Ministry of Defence budget states the third version of the ballistic missile, M51.3, produced by ArianeGroup, is scheduled to enter production in 2019.[111]

Consolidated Nuclear Security (CNS)

CNS is a Bechtel-led joint venture including Leidos, ATK Launch Systems (now part of Northrop Grumman), SOC, and Booz Allen Hamilton[112] as a teaming subcontractor.[113] CNS is responsible for the management and operation of the Y-12 National Security Complex and the Pantex Plant.

Lawrence Livermore National Security partnership

This partnership is involved in management and operations of the Lawrence Livermore National Laboratory. The partnership includes AECOM, Battelle[114] and Texas A&M University.[115] There are a number of nuclear weapon related activities taking place at the Lawrence Livermore National Laboratory, including the life extension program of the B61 nuclear bomb[116] and of the W80-1 nuclear warhead for air-launched cruise missiles.[117]

Los Alamos National Security (LANS)

This consortium involved BWX Technologies, the University of California, Bechtel and Aecom. Until February 2019, this private limited liability company was responsible for management and operations of the Los Alamos National Laboratory. [118]

MBDA

MBDA is a joint venture operated by Airbus, BAE Systems and Leonardo. It has operations in Spain, Italy, France, Germany, UK and US.[119] MBDA is engaged in ongoing work related to the ASMPA nuclear missiles for the French arsenal.[120]

Mission Support and Test Services LLC (MSTS)

MSTS is a limited liability company consisting of Honeywell International Inc., Jacobs Engineering Group Inc., and Huntington Ingalls subsidiary Stoller Newport News Nuclear, Inc.[121] On 1 December 2017 MSTS took over the management and operations of the National Nuclear Security Site from the previous contractor National Securities Technologies, LLC. [122] Sandia National Laboratory and Los Alamos National Laboratory are the design and engineering labs for the W88 Alt 370 warheads. [123]

National Technology and Engineering Solutions

This is a wholly owned subsidiary of Honeywell International. It currently has a ten-year contract for management and operations of the Sandia National Laboratory. [124] Sandia National Laboratory and Los Alamos National Laboratory are the design and engineering labs for the W88 Alt 370 warheads.[125]

Roxel

Roxel is a joint venture between MBDA (another joint venture) and the Safran subsidiary Safran Ceramics. It is involved in the French nuclear arsenal. [126]

Savannah River Nuclear Solutions (SRNS)

Fluor is the lead partner in Savannah River Nuclear Solutions, together with Honeywell and Newport News Nuclear (part of Huntington Ingalls Industries).[127] They are involved with activities at the Savannah River facilities, which includes tritium extraction, plutonium pit production and activities related to W88 Alt 370 warhead production. [128]

Triad National Security LLC

Triad National Security, LLC is a limited liability company, which consists of Battelle Memorial Institute, the Regents of the University of California and the Regents of Texas A&M University.[129] Triad began taking over the management of the Los Alamos National Laboratory towards the end of 2018.[130] Sandia National Laboratory and Los Alamos National Laboratory are the design and engineering labs for the W88 Alt 370 warheads. [131]

Profiles of Nuclear Weapon Producers

This section provides basic information about each of the identified nuclear weapon producers, including their work on nuclear weapons.

İncluded in each section:

Company profile
Main stock exchange ID
Contact information
Nuclear Weapons

As much as possible, the information on nuclear weapon related activity is sorted by weapon or production facility type.

1. Aecom (United States)

Company profile

Aecom, based in the US, provides professional technical and management support services to a broad range of markets, including transportation, facilities, environmental, energy, water and government. Aecom also provides construction services, including building construction and energy, infrastructure and industrial construction.[132]

In the financial year ending 30 September 2018, Aecom reported revenues of more than US$ 20 billion (€ 17.7 billion), resulting in an operating income of US$ 424.9 million (€ 377.8 million) and a net profit of US$ 136.5 million (€ 121.3 million).[133]

Stock exchange listing

NYSE: ACM

Contact

Aecom Global Headquarters
1999 Avenue of the Stars
Suite 2600
Los Angeles, CA 90067
United States

Website: https://www.aecom.com/
Facebook: https://www.facebook.com/AecomTechnologyCorporation/
Instagram: https://www.instagram.com/aecom/
LinkedIn: https://www.linkedin.com/company/aecom/
Pinterest: https://www.pinterest.com/aecomtechnology/
Twitter: https://twitter.com/AECOM
YouTube: https://www.youtube.com/user/AECOMTechnologyCorp

Nuclear weapons

Aecom is primarily involved in stockpile maintenance and modernisation of the US nuclear arsenal at the Lawrence Livermore National Laboratory.

Lawrence Livermore National Laboratory

Through its acquisition of URS in October 2014, Aecom became involved in the Lawrence Livermore (LLNL) and Los Alamos National Laboratories (LANL). As of 31 January 2019, Aecom is no longer involved at the Los Alamos National Laboratory.[134] The Lawrence Livermore National Security partnership also includes Battelle[135] and Texas A&M University.[136]

The contract for LLNL was awarded in 2007 and currently runs through September 2023.[137] The maximum possible fee to be collected under the contract is US$ 45.5 million (€ 37.6 million) a year.[138] The National Nuclear Security Administration was criticised for renewing lucrative deals at LLNL despite poor performance of the contractors.[139]

Research, design, development and production of nuclear weapons,[140] including the life extension program of the B61 nuclear bomb[141] and of the W80-1 nuclear warhead for air-launched cruise missiles takes place at the Lawrence Livermore National Laboratory.[142]

2. Aerojet Rocketdyne (United States)

Company profile

Aerojet Rocketdyne, formerly GenCorp, based in the US, is engaged in aerospace and military (through subsidiary Aerojet) and real estate (Easton).[143]

In the financial year ending 31 December 2018, Aerojet Rocketdyne generated revenues of US$ 1.895 billion (€ 1.7 billion), resulting in a net income of US$ 137.3 million (€ 122.0 million).[144]

Stock exchange listing

NYSE: AJRD

Contact

Aerojet Rocketdyne Holdings Inc.
222 N. Sepulveda Blvd, Suite 500,El Segundo, CA 90245
1-310-252-8100

Website: http://www.aerojetrocketdyne.com/
Facebook: https://www.facebook.com/AerojetRdyne
Twitter: http://www.twitter.com/AerojetRdyne
YouTube: http://www.youtube.com/user/AerojetRocketdyne

Nuclear weapons

Aerojet Rocketdyne's aerospace and military segment is involved in design, development and production of both land and sea-based nuclear ballistic missile systems for the US and UK arsenals.[145] In 2018, Aerojet Rocketdyne secured an additional five-year contract for $20 million for solid boost technology that will be applied to the next generation of weapons systems.[146]

Minuteman Intercontinental Ballistic Missiles (ICBMs)

Aerojet Rocketdyne currently maintains the solid and liquid propulsion systems for the Minuteman III and Trident II (D5) nuclear missile systems.[147] There are 400 Minuteman III currently deployed and they are expected to stay active until at least 2030.[148]

Trident II (D5) missiles

The submarine-launched Trident II (D5) missile is currently aboard US Ohio-class and British Vanguard-class submarines.[149] The US is planning to keep the Trident II missiles deployed until 2042.[150]

Aerojet produces solid and liquid propulsion systems for the Trident II (D5) nuclear missile systems.[151] Aerojet Rocketdyne also delivers the Trident D5 post-boost gas generators.[152]

Ground-based Strategic Deterrent (GBSD)

Aerojet Rocketdyne is part of both the Boeing and the Northrop Grumman GBSD teams. The GBSD program aims to develop a replacement for the current Minuteman III Intercontinental Ballistic Missile (ICBM) system around 2030.

Aerojet Rocketdyne stated that "The recent award to Boeing for the TMRR phase of the GBSD acquisition program will last approximately three years and will culminate in a weapon system preliminary design. During that period, Aerojet Rocketdyne will evaluate multiple boost and post-boost propulsion system options and provide early designs that meet specific prime contractor ICBM configurations".[153] Aerojet Rocketdyne issued the same press release on its role in the Northrop Grumman GBSD team.[154]

The US Air Force "plans to replace the Minuteman III missiles with a new Ground-based Strategic Deterrent around 2030".[155]

3. Airbus Group (The Netherlands)

Company profile

Airbus Group, based in the Netherlands, engages in the manufacture and sale of commercial aircraft, civil and military helicopters, commercial space launch vehicles, missiles, military aircraft, satellites, military systems and military electronics.[156]

In the year ending 31 December 2018, Airbus Group generated revenues of € 64 billion, resulting in a net income of € 3.05 billion.[157]

Stock exchange listing

EURONEXT: AIR
XETRA: AIR
MADRID: AIR
FRANKFURT: AIR

Contact

Airbus Group SE
PO Box 32008
2303 DA Leiden
The Netherlands

Website: https://www.airbus.com/
Facebook: https://www.facebook.com/airbus/
LinkedIn: https://www.linkedin.com/showcase/airbus-defence-and-space
Twitter: https://twitter.com/AirbusDefence

Nuclear weapons

Airbus, through its German-headquartered division Airbus Defence and Space, is involved in ongoing maintenance and development of several nuclear armed missiles for the French nuclear arsenal through ArianeGroup, a joint venture with the French company Safran.[158]

M51

Airbus is currently responsible for the ongoing maintenance of the M51 missiles, as part of ArianeGroup.[159]

Airbus is the main contractor for the M51 missile, which is assembled at its nearby Guenvénez plant and delivered to the Ile Longue base, where the atomic warheads are fitted by the French government's Alternative Energies and Atomic Energy Commission (Commissariat à l'énergie atomique et aux énergies alternatives, CEA). [160]

Each of the Triomphant-class submarines carry 16 M51 missiles, which can carry up to six independent warheads.[161] ArianeGroup states that its role in the M51 production "covers upstream research, design, development and production of the missiles, the land-based operating infrastructure and the command and control system on board the submarines. ArianeGroup is also responsible for the system support in service as well as end-of-life disposal".[162]

Next generations- M51.2, M51.3 & M51.4

A second version of the missile, the M51.2, with new nuclear warheads, was commissioned in July 2010, and entered into service in 2016.[163] It is equipped with a new sea-launched nuclear warhead (TNO) developed by the French Alternative Energies and Atomic Energy Commission.[164] In 2014, Airbus announced that it was also awarded a contract for the development of the third version of the ballistic missile, M51.3, to be completed around 2025.[165] The development and production of the M51.3 is managed by ArianeGroup.

The French Ministry of Defence 2019 budget states that the M51.3 is scheduled to enter production in 2019.[166] The M51.3 version is due to enter service around 2025. Under the newly adopted 2019-2025 defence budget law, the government earmarked €25 billion (US$ 29 billion) for work on the nuclear deterrent, including seaborne and airborne weapons.[167] A fourth version of the missile, M51.4, is expected to enter service around 2035.[168]

ASMPA

MBDA-Systems, a joint venture between BAE Systems (37.5%), Airbus (37.5%) and Leonardo (25%), supplies the medium-range air-to-surface missile ASMPA to the French air force. The ASMPA has been operational since 2009 and carries a nuclear warhead developed by the French Alternative Energies and Atomic Energy Commission (Commissariat à l'énergie atomique et aux énergies alternatives, CEA).[169] 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 2019 budget of the French Ministry of Defence, three deliveries of upgraded ASMPAs are planned after 2019.[170]

ASN4G

MBDA is also contracted by the French government for work related to development of the ASMPA-successor ASN4G, to be operational in 2035.[171]

Treaty on the Prohibition of Nuclear Weapons

The Nuclear Weapons Ban Monitor measures progress related to the TPNW including the extent to which the policies and practices of all states comply[172] with the core obligations in the treaty. The Nuclear Weapons Ban Monitor used Airbus as a case study in examining questions of non-compliance with the treaty.

"A third case of non-compliance relates to assistance for the development of nuclear weapons by private companies. Some companies involved in such activities have headquarters or production facilities in non-nuclear-armed states.[173] The Dutch company Airbus Group – through its German-headquartered division Airbus Defence and Space – is currently involved in the development and production of the French Navy's M51 nuclear-tipped SLBM (but not the warhead). The development and production by Airbus of missiles designed to deliver nuclear warheads constitutes assistance for the development and production of nuclear weapons. Since Airbus considers that the actions of its subsidiaries form part of the work of Airbus as a group entity,[174] should either Germany or the Netherlands sign and ratify or accede to the TPNW, it would not be in compliance with Article 1(1)(e) if Airbus and its subsidiaries were to engage in any further assistance of the development and production of nuclear weapons. As provided by Article 5 of the TPNW, states parties are obliged to adopt measures to implement their obligations under the Treaty and to suppress violations by persons, or on territory, under their jurisdiction or control. Allowing private companies to produce nuclear weapons would clearly constitute a violation of Article 5 of the Treaty as well as Article 1(1)(e)."[175]

4. BAE Systems (United Kingdom)

Company profile

BAE Systems, based in the UK, operates as a military, security and aerospace company worldwide. The company's main segments are electronic systems, intelligence & security, maritime, military air & services and support solutions.[176]

In the financial year ending 31 December 2017, BAE Systems reported revenues of £ 18.3 billion (€ 20.3 billion), resulting in an operating income of £ 1.5 billion (€ 1.7 billion) and a net income of £ 884 million (€ 979 billion).[177]

Stock exchange listing

LON: BA

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Twitter: https://twitter.com/baesystemsplc
YouTube: https://www.youtube.com/BAESystemsplc

Nuclear weapons

BAE Systems is involved in three nuclear weapon arsenals- those of France, the United Kingdom and the United States.

Trident II (D5)

BAE holds several Trident II (D5) related contracts, these include an award in October 2014 by the Strategic Systems Programs (SSP) of the US Navy, in cooperation with the UK Navy, with a total value of US$ 75.0 million (€ 54.1 million). Under the contract, BAE Systems provides supply support and information technology services for the Trident II (D5) Strategic Weapon System (SWS) Program and the SSGN Attack Weapon System (AWS) Program.[178] In 2016, BAE Systems received a one year contract modification, with the possibility to extend the contract to 2021, in order to: "[…] provide systems engineering and integration services in support of Trident II (D5) strategic weapons system, the SSGN attack weapon system, and nuclear weapon surety." The contract for the US and UK Trident II can have a maximum contract value of US$ 368.7 million (€ 328 million).[179] The contract was extended several times in 2017 and 2018, with the latest modification in November 2018 and an expected completion date of September 30, 2019.[180]

Minuteman III (ICBM)

In August 2013, BAE Systems took over from Northrop Grumman as the prime contractor for Minuteman III Intercontinental Ballistic Missile (ICBM) system engineering/technical assistance support, training and development. The contract awarded by the US Air Force is worth more than US$ 535 million (€ 403.3 million) and originally ran through 2021.[181] In March 2018 the contract was extended to January 2022.[182] The transfer of tasks by BAE from Northrop Grumman was completed in June 2014. Among the 29 key tasks, two critical activities were identified as weapon system effectiveness and force development evaluation, which involves analysing the Air Force's Minuteman III test launches.[183] Since 2013, BAE Systems was provided with various

contract modifications, bringing the contract value with all options exercised to US$ 951.4 million (€ 830.8 million).[184] Additionally, in July 2016, BAE Systems was awarded an US$ 51 million (€ 45.9 million) updated contract to "[…] provide systems engineering, technical assistance support, training and development in performing integration, sustaining engineering and program management support functions for the Minuteman III weapon system."[185] The contract was updated in July 2017 for US$ 72.6 million (€ 63.6 million).[186]

ASMPA

MBDA-Systems, a joint venture between BAE Systems (37.5%), Airbus (37.5%) and Leonardo (25%), supplies the medium-range air-to-surface missile ASMPA to the French air force. The ASMPA has been operational since 2009 and carries a nuclear warhead developed by the French Alternative Energies and Atomic Energy Commission (Commissariat à l'énergie atomique et aux énergies alternatives, CEA).[187] 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 2019 budget of the French Ministry of Defence, three deliveries of upgraded ASMPAs are planned after 2019.[188]

ASN4G

MBDA is also contracted by the French government for work related to development of the ASMPA-successor ASN4G, to be operational in 2035.[189]

Ground Based Strategic Deterrent

In July 2017, BAE Systems was also awarded a US$ 45.2 million (€ 39.6 million) modification to an existing contract for development work on the Ground Based Strategic Deterrent (GBSD) intercontinental ballistic missile replacement programme.[190] The US Air Force "plans to replace the [Minuteman III] missiles with a new Ground-based Strategic Deterrent (GBSD) around 2030".[191]

5. Bechtel (United States)

Company profile

Bechtel Group, a private company based in the US, operates as an engineering, construction and project management company. Its business units are infrastructure, nuclear, security and environmental, oil, gas and chemicals and mining and metals markets.[192]

In the financial year 2017, Bechtel Group reported revenues of US$ 25.9 billion (€ 21.6 billion). Profits are not reported by the company.[193]

Stock exchange listing

Bechtel is not publicly traded.

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Twitter: https://twitter.com/bechtel
YouTube: https://www.youtube.com/user/BechtelCorporation

Nuclear weapons

Bechtel's business unit, US Government Services, assists the US Department of Energy (DoE) in the areas of nuclear weapons development, scientific research and environmental clean-up.[194] Bechtel is also involved in providing nuclear propulsion components for the US Navy, though that falls outside the scope of this report.[195]

Lawrence Livermore National Laboratory

The Lawrence Livermore National Security partnership includes Battelle[196] and Texas A&M University.[197] LLNL plays an important role in the research, design, development and production of nuclear weapons,[198] including the life extension program of the B61 nuclear bomb[199] and of the W80-1 nuclear warhead for air-launched cruise missiles.[200] The contract for LLNL was awarded in 2007 and currently runs through September 2023.[201] The maximum possible fee to be collected under the contract is US$ 45.5 million (€ 37.6 million) a year.[202] The US National Nuclear Security Administration has been criticised for renewing lucrative deals at LLNL despite poor performance of the contractors.[203]

Y-12 Complex – Uranium Processing & Savannah River Tritium Operations

Bechtel is a member of Consolidated Nuclear Services (CNS), which took over the management and operation of the Y-12 National Security Complex in Tennessee and the Pantex Plant in Texas under the same contract in 2014. CNS is a Bechtel -led joint venture including Leidos, ATK Launch Systems (now part of Northrop Grumman), SOC, and Booz Allen Hamilton[204] as a teaming subcontractor.[205]

The US$ 446 million (€ 326.5 million) contract has a base-term of five years, with options for an additional five years. In June 2019 the first of three options might be entered.[206] The contract includes design and construction of a Uranium Processing Facility (UPF) at the Y-12 National Security Complex and an option for Savannah River Tritium Operations at the Savannah River Site in South Carolina.[207] The construction of the UPF facility started in 2018. CNS states "UPF will be built by 2025 for no more than US$ 6.5 billion through a series of seven subprojects".[208] CNS is responsible for the construction. Bechtel states UPF "will be a multi-building, state of the art complex for enriched uranium operations related to nuclear security. It will not only ensure

the long-term viability, safety, and security of the enriched uranium capability in the US but also support the nation's nuclear weapons stockpile, the downblending of uranium to prevent the spread of nuclear weapons and provide uranium for fuel for US Navy submarines and aircraft carriers."[209]

Pantex Plant

Bechtel is a member of Consolidated Nuclear Services (CNS), which took over the management and operation of the Y-12 National Security Complex in Tennessee and the Pantex Plant in Texas under the same contract in 2014. CNS is a Bechtel -led joint venture including Leidos, ATK Launch Systems (now part of Northrop Grumman), SOC, and Booz Allen Hamilton[210] as a teaming subcontractor.[211]

Pantex has been described as the primary US facility for "the final assembly, dismantlement and maintenance of nuclear weapons".[212]

W76-1/ Mk4A warheads

At the Pantex Plant in Texas the life extension programme for the W76 warheads deployed on Trident II (D5) ballistic missiles is expected to continue through 2019.[213] The programme is on track to complete production in 2019.[214]

W76-2 warheads

In January 2019, the US National Nuclear Security Administration (NNSA) said to researchers of the Nuclear Security & Deterrence Monitor that "it has started building the first low-yield, submarine-launched ballistic missile warhead", the W76-2, at the Pantex Plant. Nuclear Security & Deterrence Monitor reports that "the NNSA has said it will convert 'a small number' of W76-1 warheads into W76-2 warheads" as outlined by the Trump administration in the 2018 Nuclear Posture Review. The conversion to the W76-2 will cost a minimum of USD 125 million (€ 110.1 million).[215]

W80-1 Alt 369 warheads

In October 2017 CNS completed the first W80-1 Alt 369 update. The W80-1 is the nuclear warhead on the US air-launched cruise missiles. "The W80-1 Alt 369, scheduled to run through December 2020, will remain operational until the transition to the life-extended W80-4".[216]

W88 Alt 370 warheads

Los Alamos National Laboratory and Sandia National Laboratory are "[t]he design and engineering labs for the W88 Alt 370, while multiple nuclear security enterprise facilities are responsible for other aspects of the W88 Alt 370". The Pantex Plant is responsible for producing the conventional high explosives and final assembly of the complete W88 Alt 370 for delivery to the US Navy. The W88 is the nuclear warhead deployed on the Trident II (D5). The US National Nuclear Security Administration "is on schedule to provide the W88 Alt 370 first production unit in December 2019 and will complete all production by 2024".[217]

Ground-based Strategic Deterrent (GBSD)

Bechtel is part of both the Boeing and the Northrop Grumman GBSD teams, likely for their expertise in launch facilities.[218] The GBSD program aims to develop a replacement for the current Minuteman III Intercontinental Ballistic Missile (ICBM) system around 2030.[219] The US Air Force "plans to replace the [Minuteman III] missiles with a new Ground-based Strategic Deterrent around 2030".[220]

Arnold Engineering Development Complex (AEDC)

The AEDC conducts rocket motor tests, including for nuclear missiles like the Minuteman III,[221] and to "support modernization and life extension for the LGM-30 Minuteman III (MMIII) and development of the next generation Ground Based Strategic Deterrent (GBSD) ICBM" [222] as well as to support other Air Force Nuclear Weapons Center programmes. [223] Since 2015, the US Air Force has contracted with a Bechtel-led team National Aerospace Solutions (NAS) 224 for test operations and sustainment at the AEDC. [225] These activities are not expressly within the scope of this report.

6. Bharat Dynamics Limited (İndia)

Company Profile

Bharat Dynamics Limited (BDL) is an Indian company, founded in 1970, that produces and sells guided missiles and defense equipment.[226] BDL describes itself as a government company under the Ministry of Defense.[227] However, in March 2018 BDL was partially listed on the BSE (India) and NSE (India) stock exchange.[228] BDL works for the Defence Research and Development Organization (DRDO) to produce missiles for the Indian armed forces.[229]

In the financial year ending 31 March 2018, BDL generated revenues of Rp 1212.7 billion (€ 572.3 million), resulting in an operating income of Rp 67 billion (€ 83.3 million) and a net income of Rp 52 billion (€ 65.9 million).[230]

Stock exchange listing

BSE: 541143
NSE: BDL

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Nuclear Weapons

Bharat Dynamics Limited produces nuclear capable missiles for the Indian arsenal.

Prithvi II

BDL produces the Prithvi II. According to the Bulletin of Atomic Scientists, the Prithvi-II missile was the first missile in the Indian Integrated Guided Missile Development Program. "The Prithvi-II can deliver a nuclear or conventional warhead to a range of 250 kilometres (155 miles). Given the relatively small size of the Prithvi missile (nine meters long and one meter in diameter), the launcher is difficult to spot in satellite images and therefore little is known about its deployment locations. [T]he Strategic Forces Command conducted three user trials of the Prithvi-II in 2016 – potentially one for each missile group – and further trials in June 2017 and February 2018, the latter during night time".[231]

The Prithvi-II was tested in February 2018. The Prithvi-II ICBM is nuclear capable and can also carry high-explosive and cluster munitions warheads.[232] Regarding the test, the DRDO stated that the tested missile had been randomly selected from the production lot of BDL, which manufactures the missile in Hyderabad.[233]Missile Threat reports that "*if carrying a 1000 kg payload, the missile could probably be fitted to any of the warheads developed for the Prithvi-I, but it would have a reduced range*".[234]

Agni-V

BDL also produces the Agni missiles, including the nuclear-capable Agni-V ICBM.[235] The missiles have been developed by the Aeronautical Development Establishment (ADE), Bengaluru, and have been produced by Bharat Dynamics Limited (BDL), in Secunderabad. The rate of production of Agni missiles is reported to be twelve to eighteen missiles per year. The Agni-V missile was successfully tested in January, June and December 2018 and will be brought into India's arsenal in the next year to two years. The Agni-V missile has a range of over 5,000 km.[236]

The earlier Agni missiles are also reportedly capable of carrying a nuclear and a cluster munitions warhead.[237]

7. Boeing (United States)

Company profile

Boeing, based in the US, is the world's largest aerospace company and a leading manufacturer of jetliners and military, space and security systems. Its products and services include commercial and military aircraft, satellites, bombs and missiles, electronic and military systems, launch systems, advanced information and communication systems, and performance-based logistics and training.[238]

In the financial year ending 31 December 2018, Boeing reported revenues of US$ 101.1 billion (€ 89.8 billion), resulting in an operating income of US$ 11.98 billion (€ 10.64 billion) and a net income of US$ 10.46 billion (€ 9.29 billion).[239]

Stock exchange listing

NYSE: BA

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Twitter: http://www.twitter.com/Boeing
YouTube: http://www.youtube.com/user/Boeing

Nuclear weapons

Boeing is involved in the production of Minuteman III and Trident II (D5) missiles as well as B61-12 gravity bombs. Boeing also has contracts related to developing the Ground Based Strategic Deterrent and the Long-Range Standoff missiles for the US.

Minuteman III (ICBM)

Since 1958, Boeing has been responsible for the development and production of the US long-range nuclear Minuteman Intercontinental Ballistic Missiles (ICBM). All Minuteman I and II have been retired,[240] however, 400 Minuteman III are currently deployed, and they are expected to stay active until at least 2030.[241] Boeing oversees guidance, flight controls, secure codes and ground subsystems, as well as designing, testing, modernizing and repairing ICBM systems and components.[242]

In early 2015, the US Air Force awarded US$ 51.2 million (€ 45.3 million) to Boeing to provide sustaining engineering support and programme management support services for ICBM guidance systems. Work is expected to be completed by February 2023.[243] The contract has been modified several times, including a US$ 15.6 million (€ 14.2 million) one-year award in January 2016, a US$ 8.1 million (€ 7.2 million) two-year award in June 2016, a US$ 13.3 million (€ 12.5 million) two-year award in November 2016, a US$ 15.6 million (€ 14.5 million) one-year award in January 2017 and a US$ 40.5 million (€35.3 million) in December 2017.[244]

As part of the Minuteman III life extension program, in June 2015, the Air Force Nuclear Weapon Center awarded Boeing a US$ 466.5 million (€ 423.3 million) contract for Minuteman III guidance repair. Work is expected to be completed by June 2021.[245] In October 2015, Boeing obtained a US$ 110.1 million (€ 96.8

Note: The development of "self-destruct" capabilities in an intercontinental ballistic missile is a dangerous one. It increases the risk of accidental use, by building a culture of complacency wherein missileers might believe they can 'call the bomb back'. There are already significant problems amongst the personnel responsible for firing these missiles, including significant drug use, sleeping on the job[250] and more.[251]

million) award for replacement of the Minuteman III telemetry, test and termination systems running until August 2019.[246] The contract was again modified for US$ 70.5 million (€ 62.5 million) in November 2018, work is now expected to be completed by January 2021.[247]

In July 2018, the Air Force Nuclear Weapon Center awarded Boeing a US$ 15.5 million (€ 13.3 million) contract to develop, qualify and deliver a Flight Termination Receiver (FTR) 2.0. According to Defense Industry Daily, "the FTR external link is an essential piece that allows for the missiles destruction after it has already been launched. The Flight Termination System can take a number of commands via Radio Frequency that range from safing and arming devices to terminating the missiles flight". Work is expected to be completed by July 2021.[248]

As part of the same program, Boeing was awarded a US$ 17.4 million (€ 14.8 million) contract in August 2017 for "[s]ustaining engineering and program management support for the intercontinental ballistic missile guidance subsystem. The contract modification is for engineering and manufacturing development and production of a Pendulous Integrating Gyroscopic Accelerometer". Work is expected to be completed by October 2020.[249]

In September 2017, Boeing was awarded a US$ 23.3 million (€ 20.0 million) service contract for operations and maintenance, testing and technical data delivery in support of the Minuteman III weapon system. Work is expected to be completed by September 2023.[252]

Trident II (D5)

In December 2014, Boeing was awarded a US$ 39.5 million (€ 32.0 million) contract with options of up to US$ 80.2 million (€ 64.9 million) to provide the US and UK Trident II (D5) maintenance, repair, and rebuilding as well as technical services in support of the navigation subsystem. Work was expected to be completed in September 2017.[253] However, the contract was followed up in October 2016 with an US$ 32.8 million (€ 29.2 million) award. Now, work is expected to be completed in September 2019, but if all options are exercised, the contract will be extended until September 2020 with a maximum value of US$ 88.9 million (€ 79.0 million).[254]

In October 2018, Boeing was awarded a US$ 26.7 million (€ 23.0 million) contract to provide the US and United Kingdom Trident II (D5) with maintenance, rebuilding and technical services. Work is expected to be completed by September 2020.[255]

B61-12

In October 2015, Boeing was awarded US$ 11.8 million (€ 10.4 million) for engineering and manufacturing development of the B61-12 tail-kit assembly for the replacement of the parachute system to be finalized by July 2017.[256] In April 2017 the tail-kit was successfully tested.[257] Boeing's initial three-year contract for the design, development and qualification phase of the B61 (Mod 12) life-extension running until 2015 had a value of US$ 178 million (€ 137.6 million).[258] The contract was modified in June 2016 for US$ 7.6 million (€ 6.8 million), with an expected completion date in May 2019.[259] The B61 is a nuclear gravity bomb.[260] There are an estimated 150 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).[261]

Ground-based Strategic Deterrent (GBSD)

The US Air Force "plans to replace the [Minuteman III] missiles with a new Ground-based Strategic Deterrent (GBSD) around 2030".[262] In August 2017, Boeing and Northrop Grumman each won contracts to complete the next phase ("technology maturation and risk reduction") in the process to deliver a total system replacement

of Minuteman III." Boeing was awarded a US$ 349.2 million (€ 297.0 million) contract. Work is expected to be completed in August 2020.[263]

Long range Standoff (LRSO)

Since 2013, Boeing along with Lockheed Martin, Northrop Grumman and Raytheon, have been under contract to conduct studies in support of the Air Force Long-Range Standoff (LRSO) missile plans.[264] The LRSO will carry the new W80-4 (a revision of the W80-1 thermonuclear warhead).[265] It is scheduled for deployment in 2027. [266]

In August 2017, Boeing received an initial US$ 59.5 (€ 50.6) contract to begin work on the LRSO. Work is planned to be completed at the end of 2019.[267] In December 2017 Boeing was awarded two additional contracts worth US$ 17 million (€14.3 million) and US$ 18 million (€ 15.2 million) for the integration of the LRSO on B-52 bombers.[268] In April 2018, the Air Force Materiel Command (AFMC) awarded Boeing a contract valued up to US$ 250 million (€ 203 million) for "integration development and testing of the weapon system on the USAF's fleet of 76 B-52H bombers between 1 January 2019 and 31 December 2023 (with provision for an additional year if needed)".[269]

MINOT AIR FORCE BASE, N.D. (Nov. 18, 2014) Chief Master Sgt. Dan Willand, 705th Munitions Squadron (MUNS) air launch cruise missile flight chief, displays the internal components of a cruise missile to Adm. Cecil D. Haney, U.S. Strategic Command (USSTRATCOM) commander, in the weapons storage area at Minot Air Force Base, N.D., Nov. 17, 2014. As part of his ongoing series of visits with nuclear deterrent forces personnel, Haney viewed 705th MUNS Airmen conducting maintenance and training in both high and low maintenance. The 5th Bomb Wing and 91st Missile Wing at Minot support USSTRATCOM's nuclear deterrence mission set by operating and maintaining both B-52 Stratofortress bombers and Minuteman III intercontinental ballistic missiles.

U.S. Air Force photo by Senior Airman Stephanie Morris

8. BWX Technologies (United States)

Company profile

BWX Technologies ("BWXT"), formerly known as Babcock & Wilcox Company, supplies nuclear components and fuel to the US government, technical and management services to national nuclear security sites, and supplies components and services for the commercial nuclear power industry.[270]

In the financial year ending 31 December 2018, BWXT reported revenues of US$ 1.8 billion (€ 1.59 billion), resulting in a net income of US$ 227.0 million (€ 201.7 million).[271]

Stock exchange listing

NYSE: BWXT

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Twitter: https://twitter.com/BWXTech
YouTube: https://www.youtube.com/channel/UCSgCJ1E5p9alNfmbF_bGFWg

Nuclear weapons

BWXT is involved in uranium processing and other site-specific services for the US nuclear arsenal.[272] BWX Technologies is also involved in environmental site restoration, providing naval nuclear reactor fuel and services for the US Navy, though that falls outside the scope of this report.[273]

Trident II (D5)

In 2017, BWXT was awarded a US$ 76 million (€ 70.8 million) contract to manufacture additional Common Missile Compartment (CMC) tube assemblies for the US Navy's Columbia Class and the UK Navy's Dreadnought Class nuclear submarines. The tubes are specifically designed to enable the launch of Trident II (D5) missiles from these submarines. According to BWXT this is the third such contract they've received, and they expect to conclude work in 2021.[274] Previously, the tubes would be purchased only when the submarines were nearly complete, but this contract agreement is designed to minimize overall production time by having the tubes on hand to slot into the subs at the appropriate moments.[275]

Tritium production

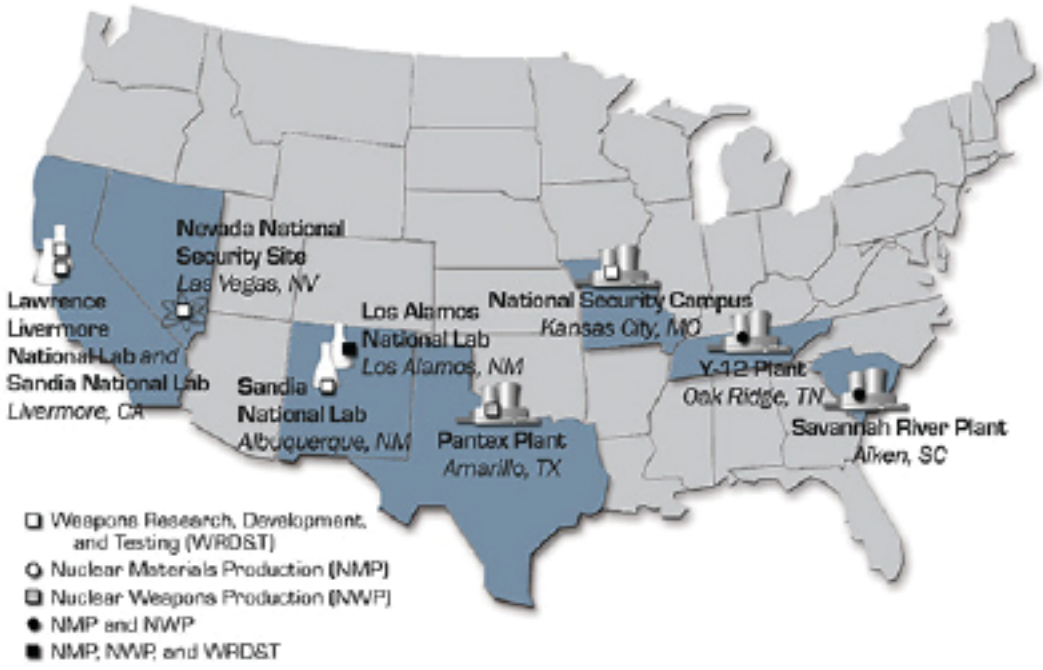
In September 2018 the US National Nuclear Security Administration awarded a US$ 505 million (€ 427.5 million) contract for the period 2019-2025 to a subsidiary of BWX Technologies called Nuclear Fuel Services, Inc. for down-blending 20.2 metric tons of highly enriched uranium (HEU) to produce low enriched uranium (LEU).[276] According to the US National Nuclear Security Administration this process enables the "production of tritium, a key component of the US nuclear weapons stockpile" and is part of the National Nuclear Security Administration's effort to "provide a reliable and economical source of unobligated enriched uranium", free from peaceful use restrictions, until at least 2025. Work will be carried out at the Tennessee Valley Authority.[277] Once the materials are downblended, tritium extraction takes place at the Savannah River Site.[278]

Lawrence Livermore National Laboratory

LLNL plays an important role in the research, design, development and production of nuclear weapons,[279]

including the life extension program of the B61 nuclear bomb[280] and of the W80-1 nuclear warhead for air-launched cruise missiles.[281]

The Lawrence Livermore National Security partnership includes BWX Technologies, Battelle[282] and Texas A&M University.[283] The current contract for LLNL was awarded in 2007 and runs through September 2023.[284] The maximum possible fee to be collected under the contract is US$ 45.5 million (€ 37.6 million) a year.[285] The US National Nuclear Security Administration was criticised for renewing lucrative deals at LLNL despite poor performance of the contractors.[286]



In partnership with the DoD, the DOE/NNSA provides the research, development, production, and dismantlement capabilities necessary to support the U.S. nuclear weapons stockpile. The DOE/NNSA manages the physical infrastructure comprising the DOE/NNSA nuclear security enterprise (NSE) that sustains these capabilities. The NSE spans eight sites with headquarters elements in Washington, DC, including:

- *Manufacturing sites: National Security Campus, Kansas City, Missouri; Pantex Plant, Amarillo, Texas; Savannah River Site, Aiken, South Carolina; and Y-12 National Security Complex, Oak Ridge, Tennessee.*
- *National laboratories: Lawrence Livermore National Laboratory, Livermore, California; Los Alamos National Laboratory, Los Alamos, New Mexico; and Sandia National Laboratories located in Albuquerque, New Mexico and Livermore, California.*
- *Test site: Nevada National Security Site, Nye County, Nevada.*

9. Charles Stark Draper Laboratory (United States)

Company profile

Charles Stark Draper Laboratory ("Draper") is a US-based non-profit research and development organization. It engages in design, development and deployment of advanced technological solutions, providing engineering services to government, industry, and academia.[287] It was founded as a teaching laboratory in the 1930s and since the 1950s, it has been involved in the intercontinental ballistic missiles (ICBM) development of the United States.[288]

In the financial year ending June 2017, Draper generated revenues of US$ 571.5 million (€ 500.9 million).[289]

Although Draper is a non-profit research and development organisation, they are included here for their significant involvement in research and design for US and UK Trident II (D5) missiles. They will not be included in the overall financial research of the report.

Stock exchange listing

Charles Stark Draper Laboratory ("Draper") is a US-based non-profit research and development organization.

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Twitter: https://twitter.com/draperlab

Nuclear weapons

Draper is directly involved in the Trident II (D5) systems for the UK and US arsenals.

Trident II (D5)

Draper has been designing and developing inertial guidance systems for strategic missile applications since the 1950s. It designed, among others, the guidance system for the US Air Force Peacekeeper ICBM.[290] Furthermore, it designed, upgraded and maintains the Trident boost guidance system. As the prime contractor for Trident Life Extension (LE) boost guidance, Draper has completed the design phase and begun manufacturing of the MK6 MOD 1 Guidance System, which will function as the boost guidance system for the Trident D(5)LE missile through 2040.[291]

In March 2016, Draper was awarded a maximum US$ 163.6 million (€ 147.3 million) contract by the US and UK Navy for Trident (D5) MK 6 guidance system production. The contract includes failure verification, test, repair and recertification of inertial measurement units, electronic assemblies, and electronic modules. The contract has undergone multiple modifications (February 2017, January and February 2018) and is expected to run until September 2021 if all options are exercised. The maximum value of the contract, paid for by the US and UK navies, is now US$ 370.2 (€350.5 million).[292] Draper reported in April 2018 that there have been two missiles tests of the Trident II D5 Life Extension missiles equipped with a guidance system developed by Draper. These tests were part of the Demonstration and Shakedown Operation (DASO) 28 in the Pacific Test Range off the coast of Southern California.[293]

In October 2018, Draper was awarded a contract to help the US and UK navy integrate the updated Trident

II weapon systems in their submarines. The initial contract award was for US$ 13.4 million (€ 11.6 million), but it was modified to US$ 109.5 million (€ 95.9 million) one month after being awarded. The contract is for Draper to ensure guidance requirements for the Trident II D5 missiles will be met on the US Columbia-class program and the United Kingdom Dreadnought-class program, and to provide specialized technical knowledge and support for the hypersonic guidance, navigation and control application; provide technical and engineering services to support the Guidance, Navigation and Control system that will support the Navy's hypersonic flight experiments. Work is expected to be completed in September 2019.[294]

In February 2019, Draper was awarded a contract to produce Trident II D5 Strategic Weapon System MK6 Guidance Equivalent Units. The contract contains options, which if exercised, would bring the total value to over US$ 391 million. Work is expected to be completed by July 2022, unless the option is exercised in which case work will continue through the end of July 2023.[295]

10. Constructions Industrielles de la Méditerranée (CNIM) (France)

Company Profile

(CNIM) is a French equipment manufacturer and industrial contractor. It supplies products and services to major public and private sector organizations, local authorities and national governments in the Environment, Energy, Defense, and high technology markets.[296]

CNIM's principal shareholder is Soluni, a family-owned company that holds 56.56% of the shares in CNIM.[297] In the financial year ending 31 December 2017, CNIM reported revenues of € 634.9 million, resulting in an operating income of € 22.1 million and a net income of € 20.0 million.[298]

Stock exchange listing

Euronext Paris: ISIN FR0000053399

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YouTube: https://www.youtube.com/GroupeCNIM

Nuclear Weapons

CNIM states that it is "a leading player in France's nuclear deterrent programs since 1961." CNIM is the sole supplier of missile launch systems for nuclear submarines. CNIM has also been involved in large-scale experiments of the Laser Mégajoule.[299]

M51

CNIM's operating segment, Industrial Systems Sector, designs and manufactures the submarine launching systems designed for the nuclear-armed M51 missiles.[300]

Since 2018 CNIM has been involved in the integration of the missile launch systems on board the French nuclear-armed submarine *Le Téméraire* and the preparation for next round of maintenance of the nuclear-armed submarine *Le Terrible*.[301] Naval Group (formerly known as DCNS)[302] is the main contractor on the maintenance on the submarines, with the M51 integration subcontracted to CNIM.[303]

French testing

In 1996 France ended full scale explosive nuclear testing and instead "launched the Laser Mégajoule project (LMJ) to extend the life of its nuclear deterrent by simulating explosions of nuclear weapons".[304] The nuclear test simulations are managed by CEA/DAM (Military Applications Directorate of France's Atomic and Alternative Energy Authority).[305] CNIM states that it has been involved since 1999 with the manufacture of high-precision mechanical and optical devices for the LMJ.[306] The Laser Mégajoule is designed to "validate theoretical models of nuclear weapon detonations, and therefore plays an important role in France's nuclear simulation program."[307]

11. Fluor (United States)

Company profile

Fluor, based in the US, provides complex engineering, procurement, construction, and maintenance projects for commercial and government clients.[308]

In the year ending 31 December 2018, Fluor generated revenues of US$ 19.2 billion (€ 17.0 billion), resulting in a net income of US$ 225 million (€ 199.7 million).[309]

Stock exchange listing

NYSE: FLR

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Nuclear weapons

Fluor is involved in a number of US nuclear weapon facilities including as a subcontractor at the Los Alamos National Laboratory, to "provide personnel, systems, tools and corporate reachback support for the critical area of capital construction".[310] While they are involved in LANL efforts, we have been unable to find a direct link between their work and the work at Los Alamos producing the new type W88 warheads deployed on the Trident II (D5) missiles.[311]

Savannah River Site and Savannah River National Laboratory

Fluor is the lead partner in Savannah River Nuclear Solutions (SRNS), a joint venture with Honeywell and Newport News Nuclear (part of Huntington Ingalls).[312] Since 2008, SRNS remains responsible for the management and operation of the Department of Energy's Savannah River Site and Savannah River National Laboratory in South Carolina. The Department of Energy has prolonged the initial contract several times, most recently until July 2019.[313] The most recent extension brings the total value of the SRNS contracts to approximately US$ 8 billion (€ 7.1 billion).[314]

Tritium extraction

Savannah River Nuclear Solutions is responsible for site management and operation, including management of the nuclear arsenal. Savannah River Site is the only place in the US where tritium production now occurs.[315]

Plutonium pit production

Plutonium pits are the grapefruit-sized triggers for some nuclear weapon designs. In order to meet the projected new nuclear weapon demands in the 2018 US Nuclear Posture Review, the US is planning to produce 50 pits per year at the Savannah River Site, and 30 pits per year at Los Alamos.[316]

W88 Alt 370 warhead

Savannah River Site is also responsible for testing, evaluating, and replenishing the gas transfer system of the W88 Alt 370 program. The W88 is the nuclear warhead deployed on the Trident II (D5). The first of the new warheads (the W88 Alt 370) will be produced in December 2019, and the US National Nuclear Security Administration seeks to complete all production by 2024.[317]


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UNITED STATES
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12. General Dynamics (United States)

Company profile

General Dynamics, based in the US, provides business aviation; combat vehicles, weapons systems and munitions; IT and C4ISR solutions; and shipbuilding and ship repair.[318]

In the financial year ending 31 December 2018, General Dynamics reported revenues of US$ 36.2 billion (€ 32.1 billion), and full-year earnings from continuing operations of $3.4 billion (€ 3.0 billion).[319]

Stock exchange listing

NYSE: GD

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Twitter: https://twitter.com/GDMS
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Nuclear weapons

General Dynamics is involved in the production and maintenance of the Trident II (D5) for the US and UK. General Dynamics is also responsible for integrating the Trident SLBM in the new US Columbia-class program and the United Kingdom Dreadnought-class submarines.

Trident II (D5) – US and UK arsenal

General Dynamics has for many years been involved in stretching the lifecycle of the Trident II (D5) nuclear missiles of the US Navy.[320] The submarine-launched Trident II (D5) missile is currently aboard US Ohio-class and British Vanguard-class submarines.[321] The US plans to keep the Trident II missiles deployed until 2042.[322]

Fire control systems and common missile compartment

In December 2015, General Dynamics business unit General Dynamics Advanced Information Systems (GDAIS) was awarded a US$ 30.6 million (€ 28.2 million) contract for work that includes sustainment of the fire control systems aboard the US and UK ballistic missile submarines, integrated nuclear weapon security systems and missile flight test systems, and missile fire control for the Ohio replacement and UK Successor Dreadnought-class Common Missile Compartment Program.[323] The original contracted work was expected be completed by December 2020[324] however, there have been numerous contract modifications. These modifications include in February 2016, obligating US Navy funds in the amount of US$ 2 million (€ 1.77 million); and United Kingdom funds in the amount of US$ 15 million (€ 13.3 million), US$ 5.1 million (€ 4.5 million).[325]

The contract was again modified in April 2017, at which time GDAIS was awarded a modification to the existing contract, of US$ 32.9 million (€ 30.2 million). The contract was extended to 2021.[326] In July 2017, the contract was modified again to the value of US$ 8.8 million (€ 7.5 million). The contract was updated 5 more times between November 2017 and December 2018 for a total of US$ 80 million (€ 70.1 million). Work is now expected to be completed in September 2023. [327]

Strategic Systems Programs Shipboard Integration

In April 2017, General Dynamics Electric Boat was awarded a US$ 13.1 million (€ 12.2 million) contract to

produce US and UK ship alterations for the Strategic Systems Programs Shipboard Integration and support installations. Furthermore, General Dynamics will provide "technical engineering support for Trident II Submarine Launched Ballistic Missile programs, Ohio-class SSGN requirements, attack weapon system trainer requirements, and advanced weapons system development requirements." The contract also includes strategic weapon systems technical engineering support for ship systems and subsystems supporting SSBN weapon systems as well as technical services for Trident engineering, refuelling, and overhaul maintenance period and demonstration and shakedown operation. The contract contains options, which if exercised, can bring the contract value to a maximum dollar value of US$ 46.5 (€ 43.4 million).[328] In September 2018 the contract was modified for US$ 7.7 million (€ 6.5 million) "to provide various labor and material items in support of Strategic Weapons Systems Ashore, SSGN Repair, United Kingdom Dreadnought Trainer upgrades and training for Strategic Systems Programs". The work is expected to be completed by April 2021.[329]

Integrated Product and Process Development

In September 2017, General Dynamics Electric Boat was awarded a US$5 billion (€ 4.2 billion) contract "for the Integrated Product and Process Development design completion for the Columbia-class ballistic missile submarines (SSBNs). The contract also includes component and technology development, missile tube module and reactor compartment bulkhead prototyping and manufacturing efforts, and United Kingdom Strategic Weapon Support System kit manufacturing for the Columbia class ballistic missile submarines". Work is expected to be completed by December 2031.[330] The contract was modified for US$ 126.2 million (€ 102.4 million) in April 2018.[331] The contract was modified again for US$ 480.6 million (€ 414 million) in September 2018.[332]

13. Honeywell International (United States)

Company profile

Honeywell International, based in the US, operates as a diversified technology and manufacturing company. The company's business units are aerospace, building technologies, safety and productivity solutions and performance materials and technologies.[333]

In the financial year ending 31 December 2017, Honeywell International generated revenues of US$ 40.5 billion (€33.8 billion), resulting in an operating income of US$ 6.9 billion (€ 5.8 billion) and a net income of US$ 1.7 billion (€ 1.4 billion).[334]

Stock exchange listing

NYSE: HON

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However, they plan to relocate to Charlotte, North Carolina in September 2019.[335]

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YouTube: http://www.youtube.com/user/honeywell

Nuclear weapons

Honeywell is involved in US nuclear weapon facilities as well as producing key components for the US Minuteman III ICBM and the Trident II (D5) system, currently in use by the US and UK.

National Security Campus (NSC) (formerly Kansas City Plant)

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 US nuclear weapons.[336] Honeywell had previously held a five year contract[337] for managing the facility and in July 2015, a US$ 900 million (€ 817.4 million) follow-on contract for an initial period of five years and five one-year options was awarded.[338]

W88 Alt 370 warhead

Kansas City National Security Campus produces the gas transfer system and the arming, fuzing, and firing subsystem of the W88 Alt 370 program. The W88 is the nuclear warhead deployed on the Trident II (D5). The first of the new warheads (the W88 Alt 370) will be produced in December 2019, and the US National Nuclear Security Administration seeks to complete all production by 2024.[339]

Savannah River Site and Savannah River National Laboratory

Honeywell is co-owner of Savannah River Nuclear Solutions (SRNS), together with lead partner Fluor and Newport News Nuclear (part of Huntington Ingalls). SRNS is responsible for the management and operation of the Department of Energy's Savannah River Site and Savannah River National Laboratory in South Carolina. Since 2008 there were several contracts for the site,[340] most recently in January 2018 extending the contract until July 2019.[341] The latest extension brings the total value of the SRNS contract to approximately US$ 8 billion (€ 7.1 billion).[342]

Tritium extraction

Savannah River Nuclear Solutions is responsible for site management and operation, including management of the nuclear arsenal. Savannah River Site is the only place in the US where tritium production now occurs.[343]

Plutonium pit production

Plutonium pits are the grapefruit-sized triggers for some nuclear weapon designs. In order to meet the projected new nuclear weapon demands in the 2018 US Nuclear Posture Review, the US is planning to produce 50 pits per year at the Savannah River Site, and 30 pits per year at Los Alamos.[344]

W88 Alt 370 warhead

Savannah River Site is also responsible for testing, evaluating, and replenishing the gas transfer system of the W88 Alt 370 program. The W88 is the nuclear warhead deployed on the Trident II (D5). The first of the new warheads (the W88 Alt 370) will be produced in December 2019, and the US National Nuclear Security Administration seeks to complete all production by 2024. [345]

Minuteman III

In November 2013 Honeywell International was awarded a US$ 10 million (€ 7.4 million) contract for the Pendulous Integrating Gyroscopic Accelerometer (PIGA), a component on the Intercontinental Ballistic Missile. Honeywell will produce 96 PIGA floats that will be reinserted within the PIGA float assembly repair line. The PIGA float is an extremely complex, critical precision sub-assembly that is the heart of the PIGA instrument. Work was expected to be completed by November 2015,[346] but the contract was extended in October 2015 for US$ 9.8 million (€ 8.9 million) and in October 2016 for US$ 10.0 million (€ 9.1 million). A similar new contract was awarded in May 2018 for US$ 7.5 million (€ 6.1 million) and updated in November 2018 for US$ 11.5 (€ 10.1 million). Work is expected to be completed by December 2019.[347] Honeywell is the original equipment manufacturer of the PIGA guidance instrument for the Minuteman III.[348]

Nevada Nuclear Security Site

In May 2017 Mission Support and Test Services LLC (MSTS) was awarded with the management and operating contract for the Nevada National Security Site (NNSS). MSTS is a limited liability company consisting of Honeywell International Inc., Jacobs Engineering Group Inc., and Stoller Newport News Nuclear, Inc. (part of Huntington Ingalls Industries)".[349] The US$ 5 billion (€ 4.6 billion) contract runs over 10 years if all options are exercised. The NNSS contributes to nuclear weapons stockpiling through the Stockpile Stewardship Program.[350] On 1 December 2017 MSTS took over the management from former NNSS contractor National Securities Technologies, LLC.[351]

Sandia National Laboratory

In December 2016, National Technology and Engineering Solutions of Sandia (NTESS), a wholly owned subsidiary of Honeywell, was awarded a 10-year contract for the management and operation of Sandia National Laboratories (SNL), by The Department of Energy's National Nuclear Security Administration (DOE/NNSA). The total possible value of the contract, if all options are exercised is US$ 2.6 billion (€ 2.5 billion). SNL is responsible for non-nuclear engineering development of all US nuclear weapons and for systems integration of the nuclear weapons with their delivery vehicles. SNL's responsibilities include design, qualification, certification, and assessment of the nonnuclear subsystems and system qualification of nuclear weapons. Northrop Grumman and Universities Research Association[352] will support NTESS in the performance of this contract.[353]

B61-12

In November 2017, the National Nuclear Security Administration (NNSA) and the US Air Force completed two flight tests for the B61-12 gravity bomb which included hardware designed by Sandia National Laboratories and Los Alamos National Laboratory and manufactured by the Nuclear Security Enterprise plants.[354]

The B61 is a nuclear gravity bomb.[355] There are an estimated 150 B61 bombs stationed in five European countries (Kleine Brogel AB in Belgium, Buechel AB in Germany, Aviano AB and Ghedi AB in Italy, Volkel AB in the Netherlands, and Incirlik AB in Turkey).[356]

W88 Alt 370

Sandia National Laboratory and Los Alamos National Laboratory are "[t]he design and engineering labs for the W88 Alt 370, while multiple nuclear security enterprise facilities are responsible for other aspects of the W88 Alt 370". Sandia National Laboratories also produces the neutron generators. The W88 is the nuclear warhead deployed on the Trident II (D5). The first of the new warheads (the W88 Alt 370) will be produced in December 2019, and the US National Nuclear Security Administration seeks to complete all production by 2024. [357]

14. Huntington Ingalls Industries (United States)

Company profile

Huntington Ingalls Industries ("HII"), based in the US, designs, constructs and maintains nuclear and non-nuclear ships for the US Navy and Coast Guard and offers after-market services for military ships around the world.[358] In 2014, HII acquired the S.M. Stoller Corporation (Stoller) as a wholly owned subsidiary.[359]

In the financial year ending 31 December 2018, HII generated revenues of US$ 8.2 billion (€ 7.3 billion), resulting in an operating income of US$ 951.0 million (€ 843.3 million) and a net income of US$ 836.0 million (€ 741.3 million).[360]

Stock exchange listing

NYSE: HII

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Nuclear weapons

Huntington Ingalls Industries is involved in several facilities involved in the production, development and stockpiling of US nuclear weapons.

Los Alamos National Laboratory

In June 2018 the Department of Energy's National Nuclear Security Administration (DOE/NNSA) announced that it awarded Triad National Security, LLC (TNS) the management and operating contract for the Los Alamos National Laboratory (LANL). Triad National Security, LLC is a limited liability company, which consists of Battelle Memorial Institute,[361] the Regents of the University of California, and the Regents of Texas A&M University. The five-year base contract includes five one-year options, for a total of 10 years if all options are exercised. The estimated value of the contract is US$ 2.5 billion (€ 2.2 billion) annually. The initial contract ends in October 2023.[362]

B61-12

The National Nuclear Security Administration (NNSA) describes the Los Alamos National Laboratory as "a design laboratory responsible for the safety and reliability of the nuclear explosives package in nuclear weapons. This lab possesses unique capabilities in neutron scattering, enhanced surveillance, radiography, and plutonium science and engineering". LANL plays an important role in the research, design, development and production of nuclear weapons,[363] including the life extension program of the B61 nuclear bomb.[364]

The B61 is a nuclear gravity bomb.[365] There are an estimated 150 B61 bombs stationed in five European countries (Kleine Brogel AB in Belgium, Buechel AB in Germany, Aviano AB and Ghedi AB in Italy, Volkel AB in the Netherlands, and Incirlik AB in Turkey).[366]

W88

Los Alamos National Laboratory and Sandia National Laboratory are "[t]he design and engineering labs for the W88 Alt 370, while multiple nuclear security enterprise facilities are responsible for other aspects of the W88 Alt 370". Los Alamos National Laboratory also produces detonator assemblies. The W88 is the nuclear warhead

deployed on the Trident II (D5). The first of the new warheads (the W88 Alt 370) will be produced in December 2019, and the US National Nuclear Security Administration seeks to complete all production by 2024. [367]

Plutonium pit production
Plutonium pits are the grapefruit-sized triggers for some nuclear weapon designs. In order to meet the projected new nuclear weapon demands in the 2018 US Nuclear Posture Review, the US is planning to produce 50 pits per year at the Savannah River Site, and 30 pits per year at Los Alamos.[368]

Huntington Ingalls Industries is subcontracted by Triad National Security to "provide Triad with personnel, systems, tools and corporate reachback in the areas of pit production, plutonium manufacturing, production scale-up and nuclear operations and manufacturing".[369]

Savannah River Site and Savannah River National Laboratory

Huntington Ingalls Industries subsidiary Newport News Nuclear is co-owner of Savannah River Nuclear Solutions (SRNS), with lead partner Fluor and partner Honeywell. HII has a 34% ownership interest in SRNS.[370] Since 2008, SRNS remains responsible for the management and operation of the Department of Energy's Savannah River Site and Savannah River National Laboratory in South Carolina. The Department of Energy has prolonged the initial contract several times, most recently until July 2019.[371] The most recent extension brings the total value of the SRNS contracts to approximately US$ 8 billion (€ 7.1 billion).[372]

Tritium extraction
Savannah River Nuclear Solutions is responsible for site management and operation, including management of the nuclear arsenal. Savannah River Site is the only place in the US where tritium production now occurs.[373]

Plutonium pit production
Plutonium pits are the grapefruit-sized triggers for some nuclear weapon designs. In order to meet the projected new nuclear weapon demands in the 2018 US Nuclear Posture Review, the US is planning to produce 50 pits per year at the Savannah River Site, and 30 pits per year at Los Alamos.[374]

W88 Alt 370 warhead
Savannah River Site is also responsible for testing, evaluating, and replenishing the gas transfer system of the W88 Alt 370 program. The W88 is the nuclear warhead deployed on the Trident II (D5). The first of the new warheads (the W88 Alt 370) will be produced in December 2019, and the US National Nuclear Security Administration seeks to complete all production by 2024. [375]

Nevada Nuclear Security Site

In May 2017 Mission Support and Test Services LLC (MSTS) was awarded "with the management and operating contract for the Nevada National Security Site (NNSS) near Las Vegas. MSTS is a limited liability company consisting of Honeywell International Inc., Jacobs Engineering Group Inc., and Stoller Newport News Nuclear, Inc. (part of Huntington Ingalls Industries)". Through Stoller Newport News Nuclear, HII has a 23% ownership interest in MSTS.[376] The US$ 5 billion (€ 4.6 billion) contract runs over 10 years if all options are exercised. The NNSS contributes to nuclear weapons stockpiling through the Stockpile Stewardship Program.[377] On 1 December 2017 MSTS took over the management from former NNSS contractor National Securities Technologies, LLC.[378]

15. Jacobs Engineering (United States)

Company profile

Jacobs Engineering Group, based in the US, provides professional, technical and construction services. Among its primary markets are aerospace and technology, energy, automotive and industrial, buildings, mining, nuclear, oil and gas, petrochemicals and chemicals, pharmaceuticals and biotechnology, power and utilities, pulp and paper and consumer products, refining, telecommunications, transportation and water and wastewater.[379]

In the financial year ending 29 September 2018, Jacobs Engineering generated revenues of US$ 15.0 billion (€ 12.9 billion), resulting in an operating income of US$ 648.0 million (€ 557.9 million) and a net income of US$ 163.4 million (€ 140.8 million).[380]

In December 2017 Jacobs Engineering completed the acquisition of its competitor CH2M Hill.[381]

Stock exchange listing

NYSE: JEC

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Nuclear weapons

Jacobs is involved in the life cycle of the UK Trident II (D5) nuclear weapons programme.

Atomic Weapons Establishment (AWE)

Lockheed Martin, Jacobs Engineering and Serco own AWE ML, the company that manages the UK Atomic Weapons Establishment (AWE). Following a previously equal distribution with partners Lockheed Martin and Jacobs Engineering, it was agreed during a restructuring in March 2016 that Lockheed Martin would increase its share to 51%, with Serco and Jacobs Engineering then holding 24.5% each.[382]

Trident II (D5)

The AWE is responsible for the maintenance of the warheads for the UK Trident nuclear arsenal. Trident is a submarine-launched, intercontinental ballistic missile system carried by the fleet of Vanguard-class submarines. AWE-ML is responsible for managing and operating the AWE sites at Aldermaston, Burghfield, and Blacknest, and is a partner in the consortium operating the nuclear arms depot in Coulport, Scotland.[383]

AWE's involvement with Trident missiles covers the entire life cycle, from initial concept to assessment, design, component manufacture and assembly, in-service support and decommissioning and disposal.[384] AWE-ML has a 25 year-long non-revocable contract to run the AWE that expires in March 2025. [385] In the 15 years from 2000 to 2015, the contract had a value of an estimated £ 9 billion (€ 10.5 billion). The contract came under discussion in 2015 due to poor performance of the operator.[386] In March 2016, a modified contract that will run until 2025, between the Ministry of Defence and AWE-ML was agreed, described as including performance incentives as well as penalties for not meeting targets, and including the new consortium structure.[387] The contract value in the 25 years from 1999 to 2024 is £ 25.4 billion (US$ 33.6 billion or €29.6 billion).[388]

In December 2018 the UK Ministry of Defence stated that work at AWE facilities is ongoing to transition the warhead to the Mark 4A.[389] The programme reportedly commenced without formally notifying the UK parliament.[390]

Nevada Nuclear Security Site

In May 2017 Mission Support and Test Services LLC (MSTS) was awarded with the management and operating contract for the Nevada National Security Site (NNSS). MSTS is a limited liability company consisting of Honeywell International Inc., Jacobs Engineering Group Inc., and Stoller Newport News Nuclear, Inc. (part of Huntington Ingalls Industries)".[391] The US$ 5 billion (€ 4.6 billion) contract runs over 10 years if all options are exercised. The NNSS contributes to nuclear weapons stockpiling through the Stockpile Stewardship Program.[392] On 1 December 2017 MSTS took over the management from former NNSS contractor National Securities Technologies, LLC.[393]

16. Larsen & Toubro (India)

Company profile

Larsen & Toubro Limited (L&T), based in India, is a technology, engineering, construction and manufacturing company. Its operating divisions include hydrocarbon, infrastructure, power, process industries, and defence.[394] Larsen & Toubro is also the parent company to around 120 subsidiaries, including joint ventures with European arms producing companies MBDA (L&T MBDA Missile Systems Limited) and Thales (L&T Thales Technology Services Private Limited).[395]

In the financial year ending 31 March 2018, Larsen & Toubro generated revenues of Rp 1212.7 billion (€ 15.1 billion), resulting in an operating income of Rp 115.1 billion (€ 1.4 billion) and a net income of Rp 84.4 billion (€ 1.05 billion).[396]

Stock exchange listing

NSE: LTEQ
BSE: 500510

Contact

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Nuclear weapons

L&T advertises their involvement in the development of launching systems and key components for the Indian nuclear arsenal, but we were unable to confirm the duration of current contracts.

Prithvi II

In collaboration with India's state-owned Defence Research and Development Organisation, Larsen & Toubro was responsible for developing the launcher system for the nuclear-capable Prithvi II missile.[397] The Bulletin of Atomic Scientists describes the Prithvi-II missile as "'the first missile to be developed under India's Integrated Guided Missile Development Program... The Prithvi-II can deliver a nuclear or conventional warhead to a range of 250 kilometres (155 miles)."[398]

Dhanush

The Dhanush is a ship-based variant of the Prithvi-II. The nuclear-capable missile is "a 400-kilometre (249-mile) single-stage, liquid-fuel, short-range ballistic missile designed to launch from the back of two specially configured Sukanya-class patrol vessels (Subhadra and Suvarna); each ship can carry two missiles".[399]

L&T states it has designed and produced the launching system for the Dhanush: "The Dhanush Stabilised Launch and Fire Control System has been designed, developed and realised by L&T, jointly with DRDO. The system comprises an electro-hydraulic stabilised weapon platform for launch of Dhanush Missile from the deck of Naval Platforms, and an Object Handling System for the transfer of missiles from storage hangar to the stabilised weapon.".[400]

17. Leidos (United States)

Company Profile

Leidos, formerly known as Science Applications International Corporation and based in the United States, is active in aviation, energy, surface transport, defence, health, and intelligence markets.[401] Leidos activities for US and NATO forces include "enterprise and mission IT, large-scale intelligence systems, command and control, geospatial and data analytics, cybersecurity, logistics, training, and intelligence analysis and operations support".[402]

In the financial year ending 28 December 2018, Leidos generated revenues of US$ 10.19 billion (€ 9.03 billion), resulting in an operating income of US$ 749 million (€ 663.9 million) and a net income of US$ 582 million (€ 515.8 million).[403]

Stock Exchange Listing

NYSE: LDOS

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Nuclear Weapons

Leidos in involved in US nuclear weapon production facilities.

Y-12 National Security Complex

Leidos is a minority partner of Consolidated Nuclear Services LLC (CNS), which took over the management and operation of the Y-12 National Security Complex in Tennessee and the Pantex Plant in Texas under the same contract in 2014. CNS is a Bechtel -led joint venture including Leidos, ATK Launch Systems (now part of Northrop Grumman), SOC, and Booz Allen Hamilton[404] as a teaming subcontractor.[405]

The US$ 446 million (€ 326.5 million) contract for CNS has a base-term of five years, with options for an additional five years. In June 2019 the first of three options might be entered. The contract includes design and construction of a Uranium Processing Facility (UPF) at the Y-12 National Security Complex and an option for Savannah River Tritium Operations at the Savannah River Site in South Carolina. The construction of the UPF facility started in 2018. CNS states "UPF will be built by 2025 for no more than US$ 6.5 billion through a series of seven subprojects". CNS is responsible for the construction of the UPF, described by Bechtel as "a multi-building, state of the art complex for enriched uranium operations related to nuclear security. It will not only ensure the long-term viability, safety, and security of the enriched uranium capability in the US but also support the nation's nuclear weapons stockpile". [406] The UPF will consist of processing capabilities for enriched uranium casting, oxide production and salvage and accountability operations, directly contributing to the US nuclear arsenal fissile materials capabilities.[407]

Pantex Plant

Leidos is a minority partner of Consolidated Nuclear Services LLC (CNS), which took over the management and operation of the Y-12 National Security Complex in Tennessee and the Pantex Plant in Texas under the same contract in 2014. CNS is a Bechtel -led joint venture including Leidos, ATK Launch Systems (now part of Northrop Grumman), SOC, and Booz Allen Hamilton[408] as a teaming subcontractor.[409]

Pantex has been described as the primary US facility for "the final assembly, dismantlement and maintenance of nuclear weapons".[410]

W76-1/Mk4A warheads

At the Pantex Plant in Texas the life extension programme for the W76 warheads deployed on Trident II (D5) ballistic missiles is expected to continue through 2019.[411] The programme is on track to complete production in 2019.[412]

W76-2 warheads

In January 2019, the National Nuclear Security Administration (NNSA) said to researchers of the Nuclear Security & Deterrence Monitor that "it has started building the first low-yield, submarine-launched ballistic missile warhead", the W76-2, at the Pantex Plant. Nuclear Security & Deterrence Monitor reports that "the NNSA has said it will convert 'a small number' of W76-1 warheads into W76-2 warheads" as outlined by the Trump administration in the 2018 Nuclear Posture Review. The conversion to the W76-2 will cost a minimum of US$ 125 million (€ 110.1 million).[413]

W80-1 Alt 369 warheads

In October 2017 CNS completed the first W80-1 Alt 369 update. The W80-1 is the nuclear warhead on the US air-launched cruise missiles. "The W80-1 Alt 369, scheduled to run through December 2020, will remain operational until the transition to the life-extended W80-4".[414]

W88 Alt 370 warheads

Los Alamos National Laboratory and Sandia National Laboratory are "[t]he design and engineering labs for the W88 Alt 370, while multiple nuclear security enterprise facilities are responsible for other aspects of the W88 Alt 370". The Pantex Plant is responsible for producing the conventional high explosives and final assembly of the complete W88 Alt 370 for delivery to the US Navy. The W88 is the nuclear warhead deployed on the Trident II (D5). "National Nuclear Security Administration (NNSA) is on schedule to provide the W88 Alt 370 first production unit in December 2019 and will complete all production by 2024".[415]

18. Leonardo (Italy)

Company profile

Leonardo, based in Italy, develops products and services in the fields of aerospace, military and security.[416] The company changed its name from Finmeccanica to Leonardo in April 2016.[417]

In the financial year ending 31 December 2017, Leonardo generated revenues of € 11.5 billion, resulting in an operating income of € 397 million and a net profit of € 274 million.[418]

Stock exchange listing

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Twitter: http://twitter.com/Leonardo_live
YouTube: https://www.youtube.com/c/LeonardoCompany

Nuclear weapons

Leonardo is involved in the production of nuclear missiles for the French arsenal.

ASMPA

MBDA-Systems, a joint venture between BAE Systems (37.5%), Airbus (37.5%) and Leonardo (25%), supplies the medium-range air-to-surface missile ASMPA to the French air force. The ASMPA has been operational since 2009 and carries a nuclear warhead developed by the French Alternative Energies and Atomic Energy Commission (Commissariat à l'énergie atomique et aux énergies alternatives, CEA).[419] 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 2019 budget of the French Ministry of Defence, three deliveries of upgraded ASMPAs are planned after 2019. [420]

ASN4G

MBDA is also contracted by the French government for work related to development of the ASMPA-successor ASN4G, to be operational in 2035.[421]

19. Lockheed Martin (United States)

Company profile

Lockheed Martin, based in the US, focuses on aeronautics, space systems, electronic systems and information systems. Its most important divisions are aerospace and defence, information technology and new technologies.[422]

In the financial year ending 31 December 2018, it generated revenues of US$ 53.8 billion (€ 47.7 billion), resulting in net earnings of US$ 5.0 billion (€ 4.4 billion).[423]

Stock exchange listing

NYSE: LMT

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Twitter: http://twitter.com/lockheedmartin
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Nuclear weapons

Lockheed Martin is the world's largest weapons producer.[424] It produces and maintains nuclear weapons for both the US and the UK.[425]

Trident II (D5)

Lockheed Martin is responsible for the construction of the Trident II (D5) nuclear missiles for the US Ohio-class submarines and the British Vanguard-class submarines.[426] The US is planning to keep Trident II missiles deployed until 2042.[427] Throughout the last several years Lockheed Martin was awarded multiple contracts and modifications to Trident-contracts by the United States and the United Kingdom.[428]

A July 2014 contract award of US$ 19.9 million (€ 14.6 million) for long-lead material and the labour, planning and scheduling necessary to support Trident II D-5 missile production was originally expected to be completed in September 2019.[429] However, a US$ 146.3 million (€ 113.6 million) modification included new procurement of Trident II (D5) missile production, D5 Life Extension development and production, and D5 Deployed Systems Support and extended work through November 2019. If all options in the contract are exercised, the overall contract value would reach a total of US$ 828.4 million (€ 643.0 million) to be paid by US and UK budgets.[430]

A contract for engineering efforts in support of integrating the Trident II missile and re-entry strategic weapon system subsystems into the next-generation ballistic submarine designs of the US and UK in the amount of US$ 35.9 million (€ 28.9 million) was awarded to Lockheed Martin in November 2014. The contract contains two option years, which, if exercised, will bring the contract value to a maximum US$ 99.2 million (€ 80.0 million).[431] Under a modification in April 2016, Lockheed Martin Space Systems received another US$ 12.0 million (€ 10.6 million) for this work with completion expected in March 2020.[432] Another modification to the contract was made in April 2017, for US$ 11 million (€ 10.1), to further provide engineering and operations efforts.[433] The contract is currently expected to continue until December 2020.[434]

In April 2015, Lockheed Martin obtained UK contract funds of a maximum US$ 31.1 million (€ 28.9 million) to provide engineering and technical support services and deliverable materials for the UK Trident II Missile System with completion foreseen in March 2019.[435]

A contract from September 2015 provides US$ 392.0 million (€ 346.0 million) to Lockheed Martin for Trident II (D5) missile production, life extension development and production, and deployed systems support. The maximum dollar value including base items and all options exercised is US$ 1.5 billion (€ 1.3 billion). Work is expected to be completed by November 2020.[436]

A contract from April 2016 with a value of US$ 21 million (€ 18.9 million) provides the UK with engineering and technical support services and deliverable materials for the Trident II Missile System. Work is expected to be completed by March 2019.[437]

In February 2017, Lockheed Martin was awarded a US$ 540 million (€ 508.3 million) contract modification to a previously awarded contract for Trident II (D5) missile production and deployed system support.[438] In 2017, four other modifications to the contract were awarded for a total of US$ 125.5 million (€ 105.7 million).[439] It is unclear by which what date the contracted activities are meant to be completed.

In September 2017, Lockheed Martin was awarded a US$ 418.7 million (€ 355.8 million) contract for new US and UK procurement of Trident II (D5) missile production, D5 life extension production, and D5 deployed systems support. Work was expected to be completed by September 2022. The maximum value of the modification, including the base items and all option items if exercised, is US$ 1.1 billion (€ 1 billion).[440] However, the contract was modified 9 times between November 2017 and December 2019, resulting in a total addition of US$ 1.1 billion (€ 1 billion). Work is now expected to be completed by September 2023.[441]

In September 2017, Lockheed Martin was awarded a US$ 55.7 million (€ 47.3 million) contract to provide US and UK Trident II (D5) strategic weapon system navigation subsystem technical engineering support services, including shipboard systems integration. The maximum value of the contract, including the base items and all option items if exercised, is US$ 108.6 million (€ 92.3 million). If all options are exercised, work will continue through August 2020.[442]

In December 2017, Lockheed Martin was awarded a US$ 154.4 million (€ 130.7 million) contract to provide US and UK Trident II (D5) Strategic Weapon System Shipboard Integration for the navigation subsystem. Work is expected to be completed by December 2020.[443]

In March 2018, Lockheed Martin was awarded a US$ 27.1 million (€ 21.9 million) contract to provide the UK with engineering and technical support services and deliverable materials for the Trident II Missile System, including operational support hardware. Work is expected to be completed by March 2022.[444]

In September 2018, Lockheed Martin was awarded a US$ 103.9 million (€ 88.8 million) contract for the US and UK navy for new procurement of Trident II (D5) missile production, D5 Life Extension production, and D5 Deployed Systems Support. Work is expected to be completed by September 2023. The contract was modified in November 2018 for US$ 49 million (€ 43.3 million), in December 2018 for US$ 12.8 million (€ 11.3 million).[445] The contract was further modified in January 2019 for a US$ 559 million (€ 490 million) (of which the UK will pay US$ 137 million (€ 120 million)), work is expected to be completed in September 2023.[446]

In December 2018, Lockheed Martin was awarded a US$ 167.1 million (€ 146.6 million) contract to provide US and U.K. Trident II (D5) Strategic Weapon System Columbia and Dreadnought efforts for the navigation subsystem. It is unknown what 'to provide efforts' amounts to. Work is expected to be completed by September 2021.[447]

Minuteman III

As a member of the ICBM Prime Integration Team, Lockheed Martin is involved in the production and maintenance of the Minuteman III nuclear ICBM. The company has been the principal designer, manufacturer and sustainer of Minuteman III re-entry systems since the 1960s.[448] Lockheed Martin is responsible for the weapons, control and re-entry systems in this project.[449] According to the latest US Air Force plans, these nuclear missiles will continue to be part of the US nuclear weapons programme until at least 2030.[450]

In June 2014, Lockheed Martin was awarded the contract for sustainment of the re-entry subsystem for the Minuteman III. An initial one-year contract from the US Air Force had a value of US$ 109.0 million (€ 80.5 million). In November 2017, to the contract was updated with an additional US$ 386.0 million (€ 333.1 million). The contract includes repair, modification and testing of hardware and software components in the re-entry system-re-entry vehicle subsystem and related support equipment. Work is expected to be completed by June 2022.[451]

In October 2017, Rockwell Collins (now part of United Technologies Corporation) and Lockheed Martin got separate contracts to design and develop a fully functional prototype for the Airborne Launch Control System Replacement (ALCS-R) program. The Lockheed Martin contract was valued at US$ 80.8 million (€ 71.2 million). The contract states that "ALCS-R will deliver an affordable total system replacement of the legacy ALCS to support the Minuteman III intercontinental ballistic missile weapon system through estimated 2036 and provide a solution to meet the survivable launch platform – airborne fire control requirements for the ground based strategic deterrent weapon system through 2075... Work is expected to be completed by Oct. 2, 2020".[452] In December 2018 Lockheed Martin was awarded a US$ $16 million (€14.1 million) add-on to the ALCS-R contract to implement Security Classification Guide changes.[453]

According to Defense News "during ALCS-R, the Air Force intends to replace all of the airborne mission equipment on the E-6Bs [nuclear command and control aircraft] as well as ground-based radios in 450 launch-control centers."[454]

Atomic Weapons Establishment

Lockheed Martin is part of the joint venture AWE-ML, the company that manages the United Kingdom's Atomic Weapons Establishment (AWE).[455] Following a previously equal distribution with partners Lockheed Martin and Jacobs Engineering, it was agreed during a restructuring in March 2016 that Lockheed Martin would increase its share to 51%, with Serco and Jacobs Engineering then holding 24.5% each.[456]

Trident II (D5)

The AWE is responsible for the maintenance of the warheads for the UK Trident nuclear arsenal. Trident is a submarine-launched, intercontinental ballistic missile system carried by the fleet of Vanguard-class submarines. AWE-ML is responsible for managing and operating the AWE sites at Aldermaston, Burghfield, and Blacknest, and is a partner in the consortium operating the nuclear arms depot in Coulport, Scotland.[457]

AWE's involvement with Trident missiles covers the entire life cycle, from initial concept to assessment, design, component manufacture and assembly, in-service support and decommissioning and disposal.[458] AWE-ML has a 25 year-long non-revocable contract to run the AWE that expires in March 2025. [459] In the 15 years from 2000 to 2015, the contract had a value of an estimated £ 9 billion (€ 10.5 billion). The contract came under discussion in 2015 due to poor performance of the operator.[460] In March 2016, a modified contract that will run until 2025, between the Ministry of Defence and AWE-ML was agreed, described as including performance incentives as well as penalties for not meeting targets, and including the new consortium structure.[461] The contract value in the 25 years from 1999 to 2024 is £ 25.4 billion (US$ 33.6 billion or €29.6 billion).[462]

In December 2018 the UK Ministry of Defence stated that work at a number of AWE facilities is ongoing to transition the warhead to the Mark 4A.[463] The programme reportedly commenced without formally notifying the UK parliament.[464]

Long Range Standoff (LRSO)

Since 2013, Lockheed Martin along with Boeing, Northrop Grumman and Raytheon, have been under contract to conduct studies in support of the Air Force Long-Range Standoff (LRSO) missile plans.[465] The

LRSO will carry the new W80-4 (a revision of the W80-1 thermonuclear warhead).[466] It is scheduled for deployment in 2027. [467]

In August 2017, Lockheed Martin and Raytheon were awarded two separate five-year contracts for US$ 900 million (€ 764.2 million) for the Long-Range Standoff weapon's technology maturation and risk reduction acquisition phase. The contract supports replacement of the AGM-86B air-launched cruise missile. Work is expected to be completed in 2022.[468]

20. Moog (United States)

Company profile

Moog, based in the US, manufactures precision motion control components and systems for applications in aircraft, automotive, defence and space, energy, entertainment, marine and medical industries and oil and gas.[469]

In the financial year ending 29 September 2018, Moog reported revenues of US$ 2.7 billion (€ 2.3 billion), resulting in an operating income of US$ 1838 million (€ 158.2 million) and a net profit of US$ 96.5 million (€ 83.0 million).[470]

Stock exchange listing

NYSE: MOGA
NYSE: MOGB

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Nuclear weapons

Moog is involved in both the Minuteman III and Trident II (D5) missile programmes of the US.

Minuteman III

According to its Annual Reports, Moog has developed launch vehicle and strategic missile controls for the Minuteman III and Trident II (D5) missiles.[471]

Trident II (D5)

Moog acts as a subcontractor for Lockheed Martin, providing Trident (D5) first, second, and third state Servo Actuator Assemblies.[472] These are devices used to provide speed control and position accuracy in the stages of missile launch. Moog has also developed launch vehicle and strategic missile controls for the Minuteman III and Trident (D5) missiles. [473]

Ground Based Strategic Deterrent (GBSD)

According to company information, Moog won two two-year technology development studies in 2015 for the Ground Based Strategic Deterrent (GBSD). Moog is exploring new concepts for replacing the Minuteman III ICBM after 2030, including a Thrust Vector Control (TVC) study and a Post-Boost Propulsion System study.[474] In 2016 Moog stated that it "demonstrated its advanced Electromechanical Thrust Vector Control (EM TVC) system on the US Air Force and Orbital ATK ground level static fire test of the Medium-Class Stage III (MCS-III) solid rocket motor. This test demonstrated the advanced Moog EM TVC technology being studied for the forthcoming Air Force GBSD system".[475]

Moog is part of the Boeing team that received a 2017-2020 contract for technology maturation and risk reduction activities for the GBSD.[476]

21. Northrop Grumman (United States)

Company profile

Northrop Grumman, based in the US, provides products, services and solutions in the military aerospace, electronics, information systems and shipbuilding sectors.[477]

In the financial year ending 31 December 2017, Northrop Grumman generated revenues of US$ 30.1 billion (€ 26.7 billion), resulting in an operating income of US$ 3.8 billion (€ 3.4 billion) and net earnings of US$ 3.2 billion (€ 2.8 billion).[478]

In June 2018 Northrop Grumman acquired Orbital ATK and renamed it Northrop Grumman Innovation Systems.[479] Orbital ATK and its subsidiary ATK Launch Systems held nuclear weapons contracts for the US arsenal prior to the acquisition. By acquiring Orbital ATK, Northrop Grumman took over the GBSD, Minuteman III and Trident contracts of Orbital ATK and its subsidiary ATK Launch Systems.

Stock exchange listing

NYSE: NOC

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Nuclear weapons

Northrop Grumman is involved in the US Minuteman III, the US & UK Trident II (D5) as well as with several nuclear weapons production facilities.

Minuteman III (ICBM)

After acquiring the US company TRW in 2002, Northrop Grumman inherited the leadership of the ICBM Prime Integration Team. This ongoing project was initiated in 1997 and has a total value of US$ 6.5 billion (€ 5.0 billion). Northrop Grumman, Boeing and Lockheed Martin, remain involved in the production and maintenance of the Minuteman III. There are 400 Minuteman III currently deployed and they are expected to stay active until at least 2030.[480] The Air Force "plans to replace the missiles with a new Ground-based Strategic Deterrent around 2030".[481]

Northrop Grumman lost its role as prime contractor of the Minuteman III to BAE Systems in August 2013.[482] However, there have been no less than seven modifications to the initial bridge contract (worth US$ 165.0 million (€ 128.3 million)[483]) given during the transition period. It was extended (for US$ 9.9 million (€ 7.4 million)) in September 2013[484], and US$ 13.7 million (€ 10.0 million) in March 2014, and then in September 2014, these contracts were extended to 2018.[485] The same contract was again modified in August 2014, with a one-year modification valued at US$ 12.6 million (€ 9.4 million).[486] Another one-year modification awarded in the same month had a value of US$ 89.9 million (€ 66.9 million).[487] In August 2017, Northrop Grumman was awarded a US$ 16.8 million (€ 14.2 million) modification to the contract, with work expected to be completed in September 2018.[488] In September 2018 the contract had been extended to April 2019.[489]

In January 2015, Northrop Grumman was the sole award recipient for a US$ 963.5 million (€ 817.8 million) contract for ICBM ground subsystems support. The five-year contract entails services for ground subsystems to include sustainment, assessment, system modification and technical support of ICBMs.[490]

In May 2015, it received a US$ 99.1 million (€ 88.0 million) contract to provide independent testing and evaluation of developer's software and hardware for impacts on Minuteman III nuclear safety. Work is expected to be completed by September 2020.[491]

By acquiring Orbital ATK, Northrop Grumman took over the contracts of Orbital ATK and its subsidiary ATK Launch Systems. Orbital ATK was responsible for refurbishing all three solid propellant stages of the Minuteman III Intercontinental Ballistic Missile (ICBM) under the plan to keep the missiles operational until at least 2030.[492]

In November 2015, ATK Launch Systems was awarded a US$ 790.3 million (€ 737.1 million) contract for engineering support and programme management of the Minuteman III propulsion subsystem. Work was expected to be complete by November 2016.[493] The contract was extended several times, with the last update setting the completion date in September 2021.[494]

In September 2018, ATK Launch Systems was awarded a US$ 86.4 million (€ 74.5 million) contract for procurement of motor and component test, evaluation, engineering support, and disposal for all stages of Minuteman and Peacekeeper systems.[495]

Trident II (D5) - US & UK Arsenals

Northrop Grumman provided the original launcher system of the Trident II (D5) in the 1980s.[496] Northrop Grumman manufactures solid-propulsion boost motor systems for all three stages of the Trident II missile, also known as the Trident D5, under a contract from prime contractor Lockheed Martin Space Systems Co.[497]

In November 2015, Northrop Grumman Systems - Marine Systems (NGSC-MS) obtained a US$ 31.6 million (€ 29.5 million) contract under the Strategic Systems Program, providing among others a hardware refresh of the US and UK Trident II (D5) launcher subsystem components. The maximum value, including the base period and four option years, is US$ 223.6 million (€ 208.5 million). Completion was expected by September 2020, if all options are exercised.[498] However, the contract was updated in June 2018, for US$ 14 million (€ 12.1 million), with an expected completion date of June 2022.[499]

Also, in November 2015, Northrop Grumman Systems - Marine Systems (NGSC-MS) was awarded a US$ 15.6 million (€ 14.5 million) contract for technical engineering services, design and development engineering for integrating the D5 missile life extension into the future Ohio replacement submarine. The maximum contract value is US$198.0 million (€ 186.0 million) and work will continue through September 2020 if all options are exercised.[500] An additional contract award (US$ 25.6 million (€ 23.2 million)) was made in March 2016.[501] Additional modifications have been made as well, notably in October 2016 (US$ 18.7 million (€ 17.1); January 2017 (US$ 22.7 million (€ 21.1 million)); June 2017 (US$ 7.0 million (€ 6.3 million)); October 2017 (US$ 10.8 million (€ 9.3 million)), and; October 2018 (US$ 10.9 million (€ 9.6 million). The estimated completion date is now September 2020.[502]

In early 2015, Orbital ATK announced orders placed by Lockheed Martin for additional Trident II fleet ballistic missile rocket motors.[503] Lockheed Martin Space Systems was awarded a US$ 146.3 million (€ 111 million) contract for new procurement of Trident II (D5) missile production, D5 Life Extension development and production, and D5 Deployed Systems Support in August 2014. The value of Orbital ATK's subcontract is not known. Work is expected to be completed by November 2019.[504]

Air Launched Cruise Missile (ALCM)

In September 2017 Northrop Grumman Systems Corp. was awarded a US$ 21.4 million contract for repair of the Air Launched Cruise Missile (ALCM) inertial navigation element and the reconstitution of ALCM test stations. Work is expected to be completed by September 2020. [505] The ALCM in the US arsenal can be armed with a W80-1 nuclear warhead.[506]

Y-12 Complex – Uranium Processing & Savannah River Tritium Operations

Northrop Grumman Innovation Systems is a member of Consolidated Nuclear Services (CNS), which took over the management and operation of the Y-12 National Security Complex in Tennessee and the Pantex Plant in Texas under the same contract in 2014. CNS is a Bechtel -led joint venture including Leidos, ATK Launch Systems, SOC, and Booz Allen Hamilton[507] as a teaming subcontractor.[508]

The US$ 446 million (€ 326.5 million) contract for CNS has a base-term of five years, with options for an additional five years. In June 2019 the first of three options might be entered. The contract includes design and construction of a Uranium Processing Facility (UPF) at the Y-12 National Security Complex and an option for Savannah River Tritium Operations at the Savannah River Site in South Carolina. The construction of the UPF facility started in 2018. CNS states "UPF will be built by 2025 for no more than US$ 6.5 billion through a series of seven subprojects". CNS is responsible for the construction of the UPF, described by Bechtel as "a multi-building, state of the art complex for enriched uranium operations related to nuclear security. It will not only ensure the long-term viability, safety, and security of the enriched uranium capability in the US but also support the nation's nuclear weapons stockpile". [509] The UPF will consist of processing capabilities for enriched uranium casting, oxide production and salvage and accountability operations, directly contributing to the US nuclear arsenal fissile materials capabilities.[510]

Pantex Plant

Northrop Grumman Innovation Systems is a member of Consolidated Nuclear Services (CNS), which took over the management and operation of the Y-12 National Security Complex in Tennessee and the Pantex Plant in Texas under the same contract in 2014. CNS is a Bechtel -led joint venture including Leidos, ATK Launch Systems (now part of Northrop Grumman), SOC, and Booz Allen Hamilton[511] as a teaming subcontractor.[512]

Pantex has been described as the primary US facility for "the final assembly, dismantlement and maintenance of nuclear weapons".[513]

W76-1/ Mk4A warheads

At the Pantex Plant in Texas the life extension programme for the W76 warheads deployed on Trident II (D5) ballistic missiles is expected to continue through 2019.[514] The programme is on track to complete production in 2019.[515]

W76-2 warheads

In January 2019, the National Nuclear Security Administration (NNSA) said to researchers of the Nuclear Security & Deterrence Monitor that "it has started building the first low-yield, submarine-launched ballistic missile warhead", the W76-2, at the Pantex Plant. Nuclear Security & Deterrence Monitor reports that "the NNSA has said it will convert 'a small number' of W76-1 warheads into W76-2 warheads" as outlined by the Trump administration in the 2018 Nuclear Posture Review. The conversion to the W76-2 will cost a minimum of USD 125 million (€ 110.1 million).[516]

W80-1 Alt 369 warheads

In October 2017 CNS completed the first W80-1 Alt 369 update. The W80-1 is the nuclear warhead on the US air-launched cruise missiles. "The W80-1 Alt 369, scheduled to run through December 2020, will remain operational until the transition to the life-extended W80-4".[517]

W88 Alt 370 warheads

Los Alamos National Laboratory and Sandia National Laboratory are "[t]he design and engineering labs for the W88 Alt 370, while multiple nuclear security enterprise facilities are responsible for other aspects of the W88 Alt 370". The Pantex Plant is responsible for producing the conventional high explosives and final assembly of the complete W88 Alt 370 for delivery to the US Navy. The W88 is the nuclear warhead deployed on the

Trident II (D5). The US National Nuclear Security Administration "is on schedule to provide the W88 Alt 370 first production unit in December 2019 and will complete all production by 2024".[518]

Ground-based Strategic Deterrent (GBSD)

The US Air Force "plans to replace the [Minuteman III] missiles with a new Ground-based Strategic Deterrent (GBSD) around 2030".[519] In August 2017, Boeing and Northrop Grumman each won contracts to complete the next phase ("technology maturation and risk reduction") in the process to deliver a total system replacement of Minuteman III." Northrop Grumman was awarded a US$ 328.6 million (€ 279.5 million) contract. Work is expected to be completed in August 2020. [520]

By acquiring Orbital ATK, Northrop Grumman took over the Minuteman III contracts of Orbital ATK and its subsidiary ATK Launch Systems. Orbital ATK was awarded an US Air Force contract in May 2016 for the Ground-Based Strategic Deterrent program (GBSD)" to explore enhanced propulsion capability through improvements and/or alternatives to current post-boost propulsion systems." Once development is completed for the new GBSD system, it will begin replacing the Minuteman III starting in the late 2020s.[521]

22. Raytheon (United States)

Company profile

Raytheon, based in the US, provides mainly military electronics, mission systems integration and other capabilities in the areas of sensing and command, control, communications and intelligence systems as well as a broad range of mission support services.[522]

In the financial year ending 31 December 2018, Raytheon generated revenues of US$ 27.1 billion (€ 24.0 billion), resulting in an operating income of US$ 2.9 billion (€ 2.6 billion).[523]

Stock exchange listing

NYSE: RTN

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Twitter: http://www.twitter.com/raytheon
YouTube: http://www.youtube.com/raytheoncompany

Nuclear weapons

Raytheon is involved in missile production and development for the US nuclear arsenal.

Minuteman III (ICBM)

In September 2013, Raytheon was awarded a US$ 33.4 million (€ 24.8 million) contract for logistic support, installation, and sustainment of Minuteman MEECN (Minimum Essential Emergency Communication Network) programme and the Minuteman MEECN programme upgrade. Work was expected to be completed by September 2016, but the contract was first extended until September 2018[524] and later until February 2021. The total anticipated contract value is over US$ 55.5 million.[525]

Ground-based Strategic Deterrent (GBSD)

Raytheon is part of the Boeing GBSD team. [526] The GBSD program aims to develop a replacement for the current Minuteman III Intercontinental Ballistic Missile (ICBM) system around 2030.[527] The US Air Force "plans to replace the missiles with a new Ground-based Strategic Deterrent around 2030".[528]

Long range Standoff (LRSO)

Since 2013, Raytheon along with Boeing, Lockheed Martin, and Northrop Grumman have been under contract to conduct studies in support of the Air Force Long-Range Standoff (LRSO) missile plans.[529] The LRSO will carry the new W80-4 (a revision of the W80-1 thermonuclear warhead).[530] It is scheduled for deployment in 2027. [531]

In August 2017, Lockheed Martin and Raytheon were awarded two separate five-year contracts for US$ 900 million (€ 764.2 million) for the Long-Range Standoff weapon's technology maturation and risk reduction acquisition phase. The contract supports replacement of the AGM-86B air-launched cruise missile. Work is expected to be completed in 2022.[532]

23. Safran (France)

Company profile

Safran, based in France, is a high-tech group with three key business areas: the aircraft propulsion and equipment, space and defence markets.[533] The French government holds a 13.2% stake in the company.[534]

In the financial year ending 31 December 2018, Safran reported revenues of € 21.0 billion, resulting in an operating income of € 3.0 billion and a net profit of € 2.0 billion.[535]

Stock exchange listing

Share name: SAFRAN
ISIN code: FR0000073272
Abbreviation: SAF

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Fax: +(33) 1 40 60 81 02

Website: https://www.safran-group.com/
Facebook: http://www.facebook.com/GroupeSafran
Instagram: http://instagram.com/safran_group/
LinkedIn: https://www.linkedin.com/company/safran
Twitter: http://twitter.com/SAFRAN
YouTube: https://www.youtube.com/user/GroupeSafran

Nuclear weapons

Safran is involved in the missile production for the French nuclear arsenal.

M51

Safran's subsidiary Snecma is the prime contractor for the propulsion system of the M51 missile project, producing all inert components in the rocket motors. Safran Electronics & Defense, formerly known as Sagem, another subsidiary of Safran, developed the navigation systems for the M51.[536] SNPE Matériaux Energétiques (SME), a subsidiary of SNPE that was merged into Safran's subsidiary Herakles together with Snecma Propulsion Solide (SPS) in 2011, made the rocket propellant that powers the nuclear ballistic missile.[537] Airbus is responsible for the ongoing production and maintenance of the M45 and M51 missiles, in a joint venture with Safran, named ArianeGroup.[538]

The French Ministry of Defence 2019 budget states the third version of the ballistic missile, M51.3, produced by ArianeGroup, is scheduled to enter production in 2019.[539]

ASMPA

Safran's subsidiary Safran Ceramics is involved in the design, development, manufacture and sale of solid propulsion systems and related equipment for all types of rockets and tactical and cruise missiles for air, sea and ground forces through a joint venture with MBDA called Roxel.[540]

Roxel is also involved in the ASMPA mid-life upgrade as a subcontractor to MBDA.[541] MBDA-Systems, a joint venture between BAE Systems (37.5%), Airbus (37.5%) and Leonardo (25%), supplies the medium-range air-to-surface missile ASMPA to the French air force. The ASMPA has been operational since 2009 and carries a nuclear warhead developed by the French Alternative Energies and Atomic Energy Commission (Commissariat

à l'énergie atomique et aux énergies alternatives, CEA).[542] 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 2019 budget of the French Ministry of Defence, three deliveries of upgraded ASMPAs are planned after 2019.[543]

24. Serco (United Kingdom)

Company profile

Serco Group, based in the UK, operates as a service company to governments and commercial customers worldwide. Its main business areas in public service are justice and immigration, health, transport, citizen services and defence.[544]

In the financial year ending 31 December 2018, Serco generated revenues of £ 2.8 billion (€ 3.3 billion), resulting in an operating profit of £ 80.5 million (€ 94.2 million).[545]

Stock exchange listing

LON: SRP

Contact

Serco Group plc
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T: +44 (0)1256 745900
F: +44 (0)1256 744111
E: generalenquiries@serco.com

Website: https://www.serco.com/
LinkedIn: https://www.linkedin.com/company/serco
Twitter: https://twitter.com/SercoGroup
YouTube: https://www.youtube.com/user/sercovideo

Nuclear weapons

Serco is involved in the UK Trident II (D5) nuclear weapons system.

Atomic Weapons Establishment (AWE)

Lockheed Martin, Jacobs Engineering and Serco own AWE ML, the company that manages the UK Atomic Weapons Establishment (AWE). Following a previously equal distribution with partners Lockheed Martin and Jacobs Engineering, it was agreed during a restructuring in March 2016 that Lockheed Martin would increase its share to 51%, with Serco and Jacobs Engineering then holding 24.5% each.[546]

Trident II (D5)

The AWE is responsible for the maintenance of the warheads for the UK Trident nuclear arsenal. Trident is a submarine-launched, intercontinental ballistic missile system carried by the fleet of Vanguard-class submarines. AWE-ML is responsible for managing and operating the AWE sites at Aldermaston, Burghfield, and Blacknest, and is a partner in the consortium operating the nuclear arms depot in Coulport, Scotland.[547]

AWE's involvement with Trident missiles covers the entire life cycle, from initial concept to assessment, design, component manufacture and assembly, in-service support and decommissioning and disposal.[548] AWE-ML has a 25 year-long non-revocable contract to run the AWE that expires in March 2025.[549] In the 15 years from 2000 to 2015, the contract had a value of an estimated £ 9 billion (€ 10.5 billion). The contract came under discussion in 2015 due to poor performance of the operator.[550] In March 2016, a modified contract that will run until 2025, between the Ministry of Defence and AWE-ML was agreed, described as including performance

incentives as well as penalties for not meeting targets, and including the new consortium structure.[551] The contract value in the 25 years from 1999 to 2024 is £ 25.4 billion (US$ 33.6 billion or €29.6 billion).[552]

In December 2018 the UK Ministry of Defence stated that work at a number of AWE facilities is ongoing to transition the warhead to the Mark 4A.[553] The programme reportedly commenced without formally notifying the UK parliament.[554]

25. Textron (United States)

Company profile

Textron is a US-based multi-industry company engaged in aircraft, military, industrial and finance businesses. Military-related business sections include Textron Systems and Bell Helicopter.[555]

In the financial year ending 31 December 2018, Textron generated revenues of US$ 14.0 billion (€ 12.4 billion), resulting in an operating income of US$ 845 million (€ 750 million) and a net income of US$ 1.2 billion (€ 1.06 billion).[556]

Stock exchange listing

NYSE: TXT

Contact

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Facebook: https://www.facebook.com/Textron.Inc?fref=ts
Instagram: https://instagram.com/textron/
LinkedIn: https://www.linkedin.com/company/textron
Twitter: https://twitter.com/Textron
YouTube: http://www.youtube.com/textroninc

Nuclear weapons

Textron produces US ICBM re-entry vehicles.

Minuteman III

Textron designs and builds the US Air Force's operational inter-continental ballistic missile (ICBM) re-entry vehicles. Textron no longer publishes information on its current ICBM work on its website.[557] In March 2014, Textron Defense System was awarded a US$ 17.2 million (€ 12.5 million) contract to convert up to six Minuteman III MK 12A re-entry vehicles to the Mod 5F configuration. The contract was provided for a five-year ordering period by the US Air Force Nuclear Weapons Center in Utah. It is to provide the government with up to 21 Mod 5F midsections for the ICBM. Work is expected to be completed by March 2025.[558]

26. Thales (France)

Company Profile

Thales is a French-based company engaged in aerospace, defence, ground transportation, security and space.[559]

The French state (25.7%) and aircraft manufacturer Dassault Aviation (24.7%) are the main shareholders of Thales.[560]

Thales has a 35% shareholding in the Naval Group: "Naval Group is a French-law Public Limited Company; as at 31 December 2017 62.25% of its capital was held by the French State, 35% by Thales, 1.80% by current and former members of staff and 0.95% by the company itself".[561]

In the financial year ending 31 December 2018, Thales generated revenues of € 15.9 billion, resulting in an operating income of€ 1.65 billion and a net income of € 1.17 billion.[562]

Stock Exchange Listing

EPA: HO
ISIN Code: FR0000121329

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Website: www.thalesgroup.com
Facebook: www.facebook.com/thalesgroup/
Instagram: www.instagram.com/thalesgroup/?hl=en
LinkedIn: www.linkedin.com/company/thales
Twitter: twitter.com/thalesgroup
YouTube: www.youtube.com/user/thethalesgroup

Nuclear Weapons

Thales is involved in the French nuclear-armed medium-range air-to-surface missile ASMPA. Thales, via Naval Group, is also involved in the integration of the M51 nuclear missiles in the French nuclear-armed submarines.[563] In addition, Thales is responsible for the communications network with the nuclear-armed submarines.

ASMPA

According to the French Ministry of Defence, Thales is one of MBDA's subcontractors in the ASMPA mid-life upgrade. MBDA-Systems, a joint venture between BAE Systems (37.5%), Airbus (37.5%) and Leonardo (25%), supplies the medium-range air-to-surface missile ASMPA to the French air force. The ASMPA has been operational since 2009 and carries a nuclear warhead developed by the French Alternative Energies and Atomic Energy Commission (Commissariat à l'énergie atomique et aux énergies alternatives, CEA).[564] 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 2019 budget of the French Ministry of Defence, three deliveries of upgraded ASMPAs are planned after 2019.[565]

27. United Technologies Corporation (United States)

Company profile

United Technologies Corporation (UTC), based in the United States, acquired Rockwell Collins in November 2018. Rockwell Collins was subsequently renamed Collins Aerospace Systems.[566] UTC is involved in the commercial aerospace, defence and building industries.[567]

During the financial year ending 31 December 2018, UTC reported revenues of US$ 66.5 billion (€ 59.0 billion), resulting in a net profit of US$ 5.3 billion (€ 4.7 billion).[568]

Stock exchange listing

NYSE: UTX

Contact

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Instagram: https://www.instagram.com/unitedtechnologiescorp/?hl=en
LinkedIn: https://www.linkedin.com/company/united-technologies
Twitter: https://twitter.com/UTC
YouTube: https://www.youtube.com/user/UTCNews

Nuclear Weapons

United Technologies Corporation (through Collins Aerospace Systems) is involved in producing key components for the US Minuteman III system, including survivable launch technologies.

Minuteman III

In October 2017, Rockwell Collins and Lockheed Martin got separate contracts to design and developed a fully functional prototype for the Airborne Launch Control System Replacement (ALCS-R) program. The Rockwell Collins contract was valued at US$ 76 million (€ 67 million).[569]

The contract states that "ALCS-R will deliver an affordable total system replacement of the legacy ALCS to support the Minuteman III intercontinental ballistic missile weapon system through estimated 2036 and provide a solution to meet the survivable launch platform – airborne fire control requirements for the ground based strategic deterrent weapon system through 2075. Work is expected to be completed by Oct. 2, 2020".[570] In October 2018 Rockwell Collins was awarded an add-on to the ALCS-R contract to implement Security Classification Guide changes.[571]

According to Defense News "during ALCS-R, the Air Force intends to replace all of the airborne mission equipment on the E-6Bs [nuclear command and control aircraft] as well as ground-based radios in 450 launch-control centers, which haven't been updated since the 1960s, said an Air Force official with knowledge of the program."[572]

Furthermore, in the past years Rockwell Collins was granted several contracts to update the E-6B nuclear command and control aircraft, with the latest contract being granted in December 2018. Work is expected to be completed in September 2020.[573]

28. Walchandnagar Industries (India)

Company profile

Walchandnagar Industries Limited ("WIL"), based in India, is a heavy engineering and project execution company with activities in the areas of aerospace and defence, mining and metals, power plants, and other hi-tech and engineering sectors.[574]

In the financial year ending 31 March 2018, WIL generated revenues of Rp 4.0 billion (€ 49.9 million), resulting in a net profit of Rp 764 million (€ 9.5 million).[575]

Stock exchange listing

Bombay Stock Exchange Ltd. (BSE): 507410
National Stock Exchange Ltd. (NSE): WALCHANNAG

Contact

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+91 (022) 23612195/96
Website: https://www.walchand.com/

Nuclear weapons

Walchandnagar Industries Limited produces launching systems for the Indian Agni series of nuclear armed missiles.

Agni series

Walchandnagar Industries Limited ("WIL") supplies critical equipment for India's nuclear weapons programme, including the launching systems for Agni missiles.[576] For the intercontinental ballistic Agni-V missile, WIL Aerospace department manufactured the main thrust motor casing segment. The Agni-V missile, which can carry a nuclear warhead of over one tonne, was first test fired in January 2015.[577] In December 2018, India conducted the seventh successful trial of the Agni V,[578] however the Agni V is not yet included in the Indian arsenal.[579] It is expected to be inducted into service in 2019.[580]
The Indian government stated in December 2016 it started work on the development of the Agni-VI.[581] Other than this announcement there is no official data.

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Cover image

An unarmed Trident II D5 missile is launched from the Ohio-class ballistic-missile submarine USS Maryland (SSBN 738) during a missile test off the coast of Fla., Aug. 31, 2016. The test launch was part of the U.S. Navy Strategic Systems Programs (SSP) demonstration and shakedown operation (DASO) to validate the readiness and effectiveness of the USS Marylandâ€™s Blue Crew and weapon system. Strategic weapons tests, along with exercises and operations, demonstrate the readiness of the nation's nuclear triad, assuring America's allies and deterring potential adversaries. One of nine DoD unified combatant commands, USSTRATCOM has global strategic missions assigned through the Unified Command Plan, which include strategic deterrence; space operations; cyberspace operations; joint electronic warfare; global strike; missile defense; intelligence, surveillance and reconnaissance; combating weapons of mass destruction; and analysis and targeting. (U.S. Navy photo by John Kowalski)

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