

# **CIF Project 2008-2009**

## **“Factors Encouraging and Discouraging Nuclear Non-Proliferation”**

### **Benchmark II**

Advanced Physics  
Orinda Academy

#### *Student Authors*

Ian Busher  
Ben Freitag  
Matt Hirsch  
Zeke Nierenberg  
Jack Wranovics

#### *Editor*

Van-Anh Su

#### *Faculty Facilitator*

Bob Shayler

#### *Faculty Reviewer*

Robyn Linder

# Table of Contents

## Objective I

Nuclear Treaties and the Quest for Global Peace.....3

The Role and History of the International Atomic Energy Agency.....6

## Objective II

Opinions Abroad.....9

## Objective III

Modernization of Nuclear Weapons.....12

Keeping Nuclear Weapons Secure and Reliable.....15

Bibliography.....18

## **Nuclear Treaties and the Quest for Global Peace (Objective I Activity #1,2)**

Ever since the United States showed the world in 1945 that it could harness the power to destroy an entire city, the threat posed by nuclear weapons has been on the minds of national leaders. The realization became greater with the subsequent arms race. It became clear that two global superpowers (the U.S. and the Soviet Union expanding their nuclear stockpiles) posed a threat to human existence. Following this understanding, powerful nations have taken steps to prevent mass human destruction. However, nuclear disarmament has proven a difficult and complicated process. The various attempts to reduce nuclear weapons through multilateral agreements demonstrate the enormous challenges governments and humanity in general face in ending this enormous and pressing danger.

When the Nuclear Non-Proliferation Treaty (NPT) was designed in 1968, five nations (the United States, the Soviet Union, the United Kingdom, China, and France) had access to nuclear weapons. The treaty was designed to prevent any further states from easily acquiring nuclear weapons, prohibiting signatory countries from supplying military nuclear technology to any states that hoped to possess it.<sup>[1]</sup> When the treaty was finalized, the U.S., U.K., and U.S.S.R. immediately signed and eventually the remaining powers agreed to sign.<sup>[2]</sup> In addition, the treaty prohibited states without access to nuclear weapons from attempting to acquire them, and called for the five nuclear powers to negotiate terms for disarmament.<sup>[3]</sup> To this day, only Cuba, Israel, India, and Pakistan have refused to sign the treaty, while North Korea withdrew in 2003.<sup>[4]</sup> In terms of disarmament treaties, the NPT is a truly significant and resonant landmark. More countries have ratified the treaty than have signed any other document establishing the terms for worldwide disarmament.<sup>[5]</sup>

The treaty also includes safeguards implemented by the International Atomic Energy Agency (IAEA).<sup>[6]</sup> The agency inspects the weapons of all signing states parties, and provides them equal access to safe nuclear technology. To prevent the use of nuclear power counterproductively increasing the number of weapons, the IAEA blocks the spread of fissile material to any state or non-state actor. A formal review of the treaty has been put in place every five years since the treaty went into effect in 1970. In 1995, the NPT Review and Extension Conference went a step further and extended the treaty's provisions "indefinitely".<sup>[7]</sup>

In September 1993, Bill Clinton spoke before the UN and declared his support for an end to the production of fissile materials for explosive devices. He also insisted the creation of a convention to form a treaty to realize this goal.<sup>[8]</sup> Less than two months later, the UN General Assembly adopted Resolution 48/57L, calling for a negotiation to totally end fissile production for any nuclear devices.<sup>[9]</sup> In March 1995, the Conference on Disarmament met in Geneva to discuss the provisions of such a treaty.<sup>[10]</sup> The Fissile Material Cut-Off Treaty (FMCT) has not been formed to this day, in large part due to controversy raised over the possibility that powerful nations (especially China) would refuse to accept a policy enforced by an international body. Negotiations on the treaty have been consistently stalled, and the treaty's proposal was damaged even further in 2004. The United States announced that it would not sign the treaty if it included a mechanism to verify nations' abiding to its terms, arguing that there was no conclusive method to determine international compliance. Instead, President George W. Bush postulated, individual states should use their own national security systems to regulate themselves and report to all other signatories. The United Kingdom and Israel abstained from voting on the issue at the First Committee of the General Assembly.<sup>[11]</sup>

Likewise, the Comprehensive Nuclear Test-Ban Treaty (CTBT), the most far-reaching treaty regarding nuclear arms, has never been approved by all the major nuclear powers. CTBT was opened for nations to sign in New York City in 1996. Five of the eight nuclear powers signed the treaty, and eventually 175 states followed, with 146 total states ratifying it.<sup>[12]</sup> The treaty bans all nuclear explosions in any environment for any purpose.<sup>[13]</sup> While the previous nuclear treaties proposed methods to halt the spread of dangerous nuclear technology and the creation of new missiles, the CTBT aimed to minimize the threat of destruction from existing global nuclear stockpiles. To ensure that countries comply with the treaty, a scientific body has been set up in the fields of seismology, hydroacoustics, infrasound, and radionuclide study.<sup>[14]</sup> The group's measurements will ideally reveal if certain states are disrupting the natural environment in ways achievable through nuclear explosions. The treaty, despite its high level of signatures, has not been ratified yet by the United States, China, Pakistan, India, Israel, or North Korea, and in 1999 the U.S. Senate voted the treaty down. The Senate's vote was likely swayed by a presentation by prominent conservatives Jesse Helms (R-NC) and Trent Lott (R-MS), which declared that a total ban on nuclear testing would not lower the threat of proliferation and saw a zero-yield period of "infinite duration" as a terrifying possibility. In February 2009, President Barack Obama declared that he strongly supports ratifying the CTBT and wants "to launch a diplomatic effort to bring onboard" the remaining states.<sup>[15]</sup>

While the NPT, FMCT, and CTBT are markedly different in their specifics, they all represent serious and essential steps toward building a global consensus to rid the world of nuclear disaster. However, the path to disarmament has raised legitimate concerns and fears from governments and citizens alike. Critics of the United Nations doubt that international organizations can hold any real power over state policies. On another level, the reality of the horrors of global terrorism has shaped our political discourse and radically influenced all policy relating to war and weapons. One can reasonably expect a nation to subscribe to policies where failure to comply results in clear action from a governing body, but stateless organizations (such as a terrorist cell) fueled by ideology have no such concern. Despite the genuine threat of nuclear terrorism, great concerns must also be voiced regarding the proposal to eliminate nuclear threats by self-governing national security organizations. Indeed, self-interested councils could achieve the exact opposite effect, increasing global distrust and ushering in nuclear paranoia on a scale not felt since the end of the Cold War. Although serious problems are encountered on either side of the disarmament debate, the existence of disarmament treaties can only be considered a positive development if world peace is ever to be reasonably achieved.

### **Internal Citation Sources:**

[1] "Nuclear Non-Proliferation Treaty." Atomic Archive. 2008. AJ Software & Multimedia. 9 Mar 2009 <<http://www.atomicarchive.com/Treaties/Treaty6.shtml>>.

[2] ^

[3] Treaty on the Non-Proliferation of Nuclear Weapons, Article VI. 1968.

[4] "Disarmament Treaties." NWIP Fact Sheet. International Student Movement of IPPNW. 15 Mar 2009 <<http://www.ippnw-students.org/NWIP/factsheets/treaties.html>>.

[5] "Nuclear Non-Proliferation Treaty." Atomic Archive. 2008. AJ Software & Multimedia. 9 Mar 2009 <<http://www.atomicarchive.com/Treaties/Treaty6.shtml>>.

[6] Treaty on the Non-Proliferation of Nuclear Weapons. Article III. 1968

[7] du Preez, Jean. "Avoiding a Perfect Storm: Recharting the NPT Review." Arms Control Association Oct 2008

- [8] Bunn, Anthony. "Securing the Bomb: Ending Production of Nuclear Missiles: Fissile Material Cut-off Treaty." Nuclear Threat Initiative. 01 AUG 2006. The President and Fellows of Harvard College. 9 Mar 2009
- [9] United Nations General Assembly. 14 Dec 1993. International Student Movement of IPPNW. 15 Mar 2009 <<http://www.un.org/documents/ga/res/48/a48r057.htm>>.
- [10] "A/RES/48/57. Strengthening of the coordination of humanitarian emergency." 14 Dec 1993. United Nations General Assembly. 15 Mar 2009
- [11] Summary of the Comprehensive Nuclear Test-Ban Treaty. 2008. CTBTO Preparatory Commission. 9 Mar 2009 <<http://www.ctbto.org/the-treaty/the-comprehensivenuclear-test-ban-treaty/summary-of-the-treaty/summary-of-the-comprehensivenuclear-test-ban-treaty/>>.
- [12] ^
- [13] ^
- [14] ^
- [15] Dunlop, Sean and Jean du Preez. "The United States and the CTBT: Renewed Hope or Politics as Usual?." Issue Brief. Feb 2009. Nuclear Threat Initiative. 15 Mar 2009<[http://www.nti.org/e\\_research/e3\\_ctbt\\_united\\_states.html](http://www.nti.org/e_research/e3_ctbt_united_states.html)>.

## **The Role and History of the International Atomic Energy Agency (Objective I Activity #3)**

The International Atomic Energy Agency (IAEA)<sup>[1]</sup> is a global organization that aims to promote the peaceful employment of nuclear energy and to prevent its military use. It plays key roles contributing to international peace and security and to the World's Millennium Goals for social, economic, and environmental development. It is the world's center of cooperation in the nuclear field. The IAEA's mission is determined by the interests and needs of Member States, strategic plans, and the vision encrusted in the IAEA Statute. The three main components of the IAEA's mission are safety and security, science and technology, and safeguards and verification. Through its history and current goals of controlling nuclear proliferation and promoting nuclear safety, the IAEA is an organization dedicated to making a safer world for all individuals.

As a proponent of safety and security, the IAEA helps countries to upgrade nuclear safety and security, and to prepare for and respond to emergencies. Work is geared towards establishing international conventions, standards, and expert guidance. The primary goal is to protect people and the environment from harmful radiation exposure. The IAEA also helps countries mobilize peaceful applications of nuclear science and technology. It contributes to sustainable development in fields of energy, environment, health, and agriculture, among others, and to cooperation in key facets of nuclear science and technology. The IAEA is also the world's nuclear inspectorate, with more than four decades of verification experience. Inspectors work to verify that safeguarded nuclear material and activities are not used for military purposes. The Agency is also responsible for the nuclear file<sup>[2]</sup> in Iraq, as ordered by the UN Security Council.

The IAEA was founded in 1957 in an effort to curb the fears and expectations resulting from the discovery of nuclear energy. It aims to show how nuclear technology can be used as a weapon or as a practical and useful tool. The Agency's origin was American President Eisenhower's "Atoms for Peace" address to the General Assembly of the United Nations on December 8, 1953.<sup>[3]</sup> Eisenhower's goals, which demonstrated the need for safety and nuclear warfare prevention, helped to form the IAEA Statute, which 81 countries unanimously approved of in October of 1956. The Statute forms the basis of the three facets of the Agency's work-nuclear verification and security, safety, and technology transfer.

The main tasks of the Statute soon, however, became politically impractical because the political and technical climate had drastically changed by 1958. After the 1962 Cuban Missile Crisis, the United States (US) and the Union of Soviet Socialist Republics (USSR) sought a solution in nuclear arms control. In 1961 the IAEA opened its laboratory in Seibersdorf, Austria, thus enabling a means for cooperative global nuclear research. The same year the Agency signed a three-part agreement with Monaco and the Oceanographic Institute headed by Jacques Cousteau to research the effects of radioactivity in the sea.<sup>[2]</sup> This action eventually resulted in the creation of the IAEA's Marine Environment Laboratory<sup>[4]</sup>.

The importance of the IAEA grew more profound as nuclear technology improved and new countries joined the list of countries with nuclear capability in the 1960s. As widespread development in nuclear technology continued, fears deepened that additional countries would sooner or later acquire nuclear weapons. This fear was exacerbated when two new nations joined the list of countries with nuclear technology: France in 1960 and China in 1964. The safeguards illustrated in the IAEA's Statute, designed solely to cover individual nuclear plants or supplies of fuel, were clearly inadequate to deter proliferation. There was a growing interest in international,

legally binding, commitments and detailed protections to prevent the widespread development of nuclear weapons and move closer towards their complete elimination. The approval of the Treaty on the Non-Proliferation of Nuclear Weapons<sup>[2]</sup> (NPT) helped achieve this to some degree by limiting new nations from obtaining nuclear power. This treaty helped keep the number of nuclear weapon states at five (US, Russia, UK, France, and China).

In the following decades, the role of the IAEA changed often as the threat of nuclear attacks fluctuated. The 1970s proved the NPT would be accepted by almost all of the key industrial countries and by the vast majority of developing countries. However, the technology for nuclear power improved immensely as it updated and available in the open market. At this time, the IAEA's functions became distinctly more important. However, the demand for nuclear power lasted less than two decades as several incidents, most notably the Chernobyl incident and the Three Mile Island Accident in Pennsylvania in 1979<sup>[7]</sup>, led to a different worldwide perspective on nuclear weapons. By the early 1980s, the demand for new nuclear power plants had dropped immensely in most Western countries, and it shrank to nearly zero in these countries following the 1986 Chernobyl accident. In 1988 the IAEA and UN Food and Agricultural Organization<sup>[3]</sup> joined forces with other agencies to dispense of New World Screwworm<sup>[6]</sup>, which spreads a deadly livestock disease. The Agency's Seibersdorf Laboratory developed the radiation-based technology to eradicate the worm. Radiation technology worked as a cure for the worm, and a step towards its positive use began.

In 1991, the discovery of Iraq's surreptitious weapon program led to doubts about the reliability of IAEA safeguards, but also led to steps to strengthen them. The Three Mile Island accident and particularly the Chernobyl incident convinced governments to enhance the IAEA's part in developing nuclear safety. The end of the Cold War and subsequent improvement in global security almost dispensed the danger of a global nuclear conflict. Latin America, Africa, South East Asia, and the South Pacific were among the regions to subscribe to a nuclear weapon free status. The threat of proliferation in some new countries that departed from the Soviet Union was avoided, and the threat in Iraq and the Democratic People's Republic of Korea (DPRK) was contained. The IAEA during this era helped curb the threat of nuclear proliferation and also grew in size and resources to meet the increased need for a preventive nuclear program.

During the 1990s, the IAEA continued to grow in size and power as it gained more authoritative power. The NPT was made permanent in 1995, and the UN General Assembly approved and opened for signature a comprehensive test ban treaty<sup>[8]</sup> in 1996. While military nuclear activities may have been outside the IAEA's power, it was now accepted that the Agency might properly deal with some of the problems associated with the nuclear arms race. The IAEA could now verify the peaceful use or storage of nuclear material from dismantled weapons and surplus military stocks of fissile material, determine the risks posed by the nuclear wastes nuclear warships dumped in the Arctic Ocean, and confirm the safety of former nuclear test sites in Central Asia and the Pacific. In recent years, the Agency's work has been directed towards more urgent added measures. Among them are countermeasures against the threat of nuclear terrorism and the focus of a new multi-dimensional Agency action plan. Overall, the IAEA has greatly improved the world's safety by countering the threat of nuclear technology. The Agency has made numerous reforms over the years and continues to work for a safe future that promotes the beneficial implementation of nuclear technology.

## Internal Citation Sources:

- [1]"International Atomic Energy Agency." International Atomic Energy Agency. IAEA.org. 12 Mar 2009 <<http://iaea.org>>.
- [2]"Our Work: Work at the IAEA." International Atomic Energy Agency. IAEA.org. 10 Mar 2009 <<http://www.iaea.org/OurWork/index.html>>.
- [3] "About IAEA:History." International Atomic Energy Agency. IAEA.org. 10 Mar 2009 <http://iaea.org/About/history.html>>.
- [4]IAEA-NAML-Marine Environment Laboratories." International Atomic Energy Agency. IAEA.org. 13 Mar 2009 <<http://www-naweb.iaea.org/naml/>>.
- [5]"FAO:FAO Home." Food and Agriculture Organization of the United Nations. 13 Mar 2009 <<http://www.fao.org/>>.
- [6]"The New World Screwworm." Stop Screwworms. National Agricultural Library. 13 Mar 2009 <<http://www.nal.usda.gov/speccoll/collect/screwworm/Start.htm>>.
- [7]"NRC: Fact Sheet on the Three Mile Island Accident." Fact Sheet on the Three Mile Island Accident. United States Regulatory Commission. 13 Mar 2009 <<http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/3mile-isle.html>>.
- [8]"The Comprehensive Nuclear-Test-Ban Treaty: CTBTO Preparatory Commission." The Comprehensive Nuclear-Test-Ban Treaty. CTBTO Preparatory Commission. 13 Mar 2009 <<http://www.ctbto.org/the-treaty/the-comprehensivenuclear-test-ban-treaty/>>.

**Opinions Abroad:**  
**An analysis of the opinions of African, Asian, South American and  
the Middle Eastern Countries that have voiced dissenting views  
regarding Nuclear Non-proliferation Treaties  
(Objective II Activity #1,3)**

While the decisions made by the central figures in today's nuclear world (namely the United States and the European Union) are of great importance, there are other, less influential countries whose populations or leaders feel that the treaties and laws set forth by the United Nations (UN) concerning nuclear weapons are contrary to their own national interests. Countries in Africa, Asia, the Middle East and South America have elected to pursue their own nuclear policies irrespective of international law, causing growing concern among western leaders who wonder if in the near future their monopoly on nuclear weapons will no longer exist.

**Africa**

In the continent of Africa, only Libya and South Africa have voiced opinions regarding nuclear weapons. South Africa, one of the few African countries with the infrastructure and manpower to produce nuclear bombs, decided in 1989 to begin a process of disarmament as part of a plan to bring the country into full democracy. By late 1994 the International Atomic Energy Agency (IAEA) concluded that South Africa had dismantled all six of the atomic bombs previously housed in its arsenal and all specialized tools and equipment used to produce the bombs, and had safely disposed of all nuclear components.<sup>[1]</sup>

On the northern shore of the African continent, however, the country of Libya has adopted an entirely different stance. As an Islamic dominated country, Libya is publicly fearful of the unofficial but well documented Israeli nuclear arsenal (see Middle East section of this report). Colonel Gaddafi, the present leader of Libya, has openly voiced his desire to acquire nuclear weapons for his country's arsenal, having never recognized Israel as a country, even calling for its destruction. As he said in an interview with Al-Jazirah in 2002, "We demanded the dismantling of the weapons of mass destruction that the Israelis have; we must continue to demand that. Otherwise, the Arabs will have the right to possess that weapon."<sup>[2]</sup> In 1974 an agreement with Argentina (see South American section)<sup>[2]</sup> led to the presence of Argentinean geologists and senior technicians in Libya to advise the government on the location and processing of uranium. An agreement signed with India in 1978 allowed scientists from both countries to develop nuclear energy for supposedly peaceful purposes. In 1981 Libya obtained a ten megawatt nuclear reactor from the Soviet Union<sup>[2]</sup> and a staff of soviet technicians with instructions to teach the Libyan team how to run it. Despite these advancements, the Libyan nuclear program continues to progress at a gruelingly slow pace. This is due in part to the interception of several freighters bound for Libya carrying nuclear material by U.S. Naval forces<sup>[2]</sup>, but also to the fact that the infrastructure of Libya still does not possess the organization and strength required to produce a nuclear weapon. In 2004 the U.S. airlifted several thousand tons of nuclear and nuclear producing material, which Libya had voluntarily given up, and it is believed that the country's program is yet again at a standstill, if not utterly abandoned.<sup>[2]</sup>

**Asia**

The Continent of Asia houses five countries that have expressed opinions of nuclear disarmament in either word or action. China, Pakistan, India and North Korea are all countries which have refuted ideas of nuclear disarmament and developed their own nuclear weapons. The last country, Japan, the only country to feel the effects of nuclear war in the form of the attacks against the cities of Hiroshima and Nagasaki, has developed and pursued a strict abstinence from all forms of nuclear research. Although Japanese individuals and statesmen have begun to voice the issue more openly, the official attitude of the country is that no nuclear program will take place under the current government, and the situation is unlikely to change.<sup>[3]</sup>

The situation could not be more different just across the Sea of Japan, where North Korean leader Kim Jong-Il has avidly pursued his country's goal of nuclear armament. In 2006 North Korea tested its first nuclear bomb underground.<sup>[4]</sup> The results were disappointing. Approximately one kiloton of energy was released, far below modern nuclear capabilities.<sup>[4]</sup> Nevertheless, the explosion demonstrates clearly that North Korea is intent on developing nuclear weapons and is very close to doing so. Earlier in 2002, North Korea expelled UN Nuclear weapons inspectors and reactivated a nuclear reactor. The reasons why North Korea has invested so much time and energy into its nuclear program is still unclear, though it may be that the country's leaders hope to see their country on par with the west in terms of military and technological power. For that purpose, nuclear weapons might simply be the most convenient measuring stick.<sup>[4]</sup>

India and Pakistan, however, have a far different take on nuclear weapons and their use in comparison with North Korea. Since their creation as separate countries in 1947 with the collapse of British rule,<sup>[5]</sup> Pakistan and India have been almost constantly at odds. Long standing religious, political, and cultural differences have led the two to be in a state of almost constant unrest. Against this backdrop of consistent hostility, both countries regard nuclear weapons as a necessary deterrent to prevent the other from launching its own nuclear strike.<sup>[5]</sup> Their attitudes toward nuclear weapons and their refusal to obey international disarmament standards have led both to possess nuclear weapons as a deterrent to the other. In 1998, India tested its first nuclear warhead underground and later that year Pakistan followed suit.<sup>[5]</sup> In response, several countries, including the U.S., have imposed economic sanctions against both countries<sup>[5]</sup>, but tensions are still high along the India-Pakistan border.

### **Middle East**

The Middle-Eastern countries primarily concerned with nuclear weapons and defying the UN nonproliferation treaties are Israel and Iran. Israel has never confirmed its possession of nuclear weapons. However its perilous political and military situation coupled with documents recently declassified by the CIA reveal that as early as 1975, the U.S. government knew of Israel's ability to house and produce nuclear weapons.<sup>[6]</sup> In addition, several Israeli agreements for procuring nuclear producing materials and facilities from France have also come to light,<sup>[6]</sup> further exposing the country's nuclear capabilities. The reason for this development is Israel's need for weaponry and defense against the bulk of the Arabic countries bordering it, which have consistently threatened its destruction. Libya and Iran have taken the step of attempting to acquire nuclear weapons for this purpose. The Chairman of the Israel Atomic Energy Commission (IAEC), Ernst David Bergmann, advocated the acquisition of nuclear weapons as early as 1952, claiming that they were needed to make sure "that we shall never again be led as lambs to the slaughter,"<sup>[6]</sup> a reference to the Holocaust.

Iran, meanwhile, has actively pursued gaining nuclear energy for ostensibly peaceful purposes. However, Iran's traditional distrust of the West, and its openly anti-Israeli policy have led some to believe that its nuclear program is also meant to develop the capability of producing nuclear weapons. Iran has already gained several thousand pounds of low enriched uranium and is capable of turning it into the high enriched quality required for a nuclear weapon.<sup>[7]</sup> Should this occur, and Iran gain a nuclear weapon for use against Israel, the possibilities are: that Israel will attack and destroy Iran's nuclear facilities, thus provoking yet another full scale war in that region; that Iran will use that nuclear weapon against Israel and accomplish its long time goal of destroying the country; or that Iran will deliver the weapon into the hands of Muslim extremists, who will use it towards their own ends.<sup>[7]</sup>

### South America

The Countries of Latin America that have begun nuclear programs at varying levels of success are Mexico, Argentina and Brazil. Argentina (arguably the most involved in nuclear power) began its program in 1964 with the construction of a nuclear power plant for peaceful purposes, and it reached operational levels in 1974.<sup>[8]</sup> Another reactor went into operation in 1984.<sup>[8]</sup> A nuclear weapons program was briefly enacted during the military rule of the country in 1980, but it was abandoned in 1983 with the reestablishment of democracy.<sup>[8]</sup> Mexico has constructed a nuclear facility capable of producing electricity but is currently considering shutting it down to reduce costs.<sup>[8]</sup> Brazil also constructed a nuclear power plant in 1984 but seems to have achieved the limit of its ambitions. Another plant begun some time later will most likely be abandoned before completion.<sup>[8]</sup>

### Internal Citation Sources:

- [1] "Putting Down the Sword." South Africa's nuclear weapons program. 7/9/2001. Nuclear Weapons Archive. 8 Mar 2009 <<http://nuclearweaponarchive.org/Safrica/SADisarming.html>>.
- [2] Pike, John. "Libyan Nuclear Weapons." Global Security.org. 21/11/2008. Globalsecurity.org. 8 Mar 2009 <<http://www.globalsecurity.org/wmd/world/libya/nuclear.htm>>.
- [3] Bakanic, Elizabeth. "The End of Japan's nuclear Taboo." Bulletin of the Atomic Scientists. 9/6/2008. Bulletin of the Atomic Scientists. 8 Mar 2009 <<http://www.thebulletin.org/web-edition/features/the-end-of-japans-nucleartaboo>>.
- [4] Aftergood, Steven. "Nuclear Weapons Program." Federation of American Scientists. 16/11/2006. Federation of American Scientists. 8 Mar 2009 <<http://www.fas.org/nuke/guide/dprk/nuke/index.html>>.
- [5] "India-Pakistan: Troubled relations." BBC News. 2001. British Broadcasting Corporation. 8 Mar 2009 <[http://news.bbc.co.uk/hi/english/static/in\\_depth/south\\_asia/2002/india\\_pakistan/timeline/2001.stm](http://news.bbc.co.uk/hi/english/static/in_depth/south_asia/2002/india_pakistan/timeline/2001.stm)>.
- [6] Keinon, Herb. "Yadlin: Iran has crossed nuclear 'technological threshold'." The Jerusalem Post (2009)
- [7] Aftergood, Steven. "Nuclear Weapons - Israel." Federation of American Scientists. 8/1/2007. Federation of American Scientists. 8 Mar 2009 <<http://www.fas.org/nuke/guide/israel/nuke/index.html>>. Israel <<http://www.fas.org/nuke/guide/israel/nuke/index.html>>
- [8] Fernandez-Vazquez, Eugenio. "Latin America rethinks Nuclear Energy." Americas Program. 12/09/2005. Americas Program. 8 Mar 2009 <<http://americas.ironline.org/am/558>>.

## **Modernization of Nuclear Weapons (Objective III Activity #1,2)**

In the last 65 years, the pace of technological advancement has grown exponentially. The technical work considered ground breaking and astonishing in the 1940s is relatively simple in comparison to the types of new technologies developing today. Although innovation permeates throughout the field of technology, it is particularly important and prevalent in nations' nuclear arsenals. Many countries want to modernize their nuclear programs for many different reasons. The first five nuclear powers, the United States, Russia, the UK, France, and China, have modernization programs focused on trying to keep their weapons up to date and safe. However, modernization efforts face problems when international agreements the nations have entered into to prevent them from testing weapons. In modern times, all five of the first nuclear states face problems keeping up a reliable nuclear deterrent because their respective arsenals are based on warheads that are past their expiration date.

After the first nuclear weapon was built (1942-1946), the United States immediately started trying to expand and develop its program, while other countries began theirs. In the 1950s, nuclear development meant having more potent and a greater quantity of weapons. One of the main pressures that kept the Cold War "cold" was that the leaders of the Soviet Union and the United States knew each side had a large amount of powerful nuclear weapons. Each side had to keep developing more in order to keep up with the other. The nuclear weapons programs in early nuclear states were all designed to be deterrents. The arms race, and the testing required to keep it up caused serious problems for everyone involved, as discussed further in "The Effects of Nuclear Weapons Testing," Benchmark I. Consequently, a series of treaties was created between each of the nuclear states to stop the proliferation of nuclear weapons. Different treaties had different objectives and parties involved. These treaties are discussed further in the section titled "Nuclear Treaties and the Quest for Global Peace". Most nations who signed them are prohibited from testing nuclear weapons. Most nuclear nations want to see a reduction in the amount of global nuclear weapons.

Now, the Cold War is over. The efforts that led to the development of the first thermonuclear weapons during the cold war had drastically different motivations behind them than the modernization efforts today. The pressure to build more and stronger weapons has lifted. Today, nuclear efforts are about modernization, keeping weapons safer and more reliable. Even though Russia (5,192 weapons)<sup>[1]</sup> and the United States (4,075 weapons)<sup>[2]</sup> have dramatically reduced the sizes of their respective nuclear arsenals (Cold War size was in the 20,000s), the two together own most of the world's nuclear weapons. As a result of the arms race, both countries are left with large amounts of nuclear weapons that are becoming out of date.

Because of test ban treaties, other safety factors, and the reduced political pressure after the end of the Cold War, the development and testing of new nuclear warheads stopped in the early 1990s. Consequently, some of the weapons in use today are employing warheads that are two decades old, and past their programmed life.<sup>[3]</sup> Even though the warheads are never replaced, other parts of the weapons are. Important design modifications in the delivery and storage process of the weapons are part of keeping the nuclear weapons process safe. Advanced computer simulations<sup>[4]</sup> can be used to simulate tests in lieu of actual nuclear weapons testing.

The following table shows the current status of states engaged in safety based modernization efforts. These are the original five nuclear states. Israel is excluded because

details of its nuclear program are unknown. India, Pakistan, and North Korea are excluded because their programs do not operate in the treaties established by the rest of the world. Iran is excluded because it does not yet have nuclear weapons, even if it may be pursuing them. One significant problem with the “# of weapons” column in the table is that the exact numbers of weapons are sometimes unknown. In other cases the information is taken from different time periods and may not be ideally comparable.

# of weapons approximate	Nation	Modernization
5000	Russia	Russia is currently engaged in nuclear modernization programs as part of a wider military modernization program that costs over one trillion U.S. dollars.
4000	United States	The United States has a “Nuclear Stewardship” program designed to keep its current weapons safe and operational.
>200	France	While reducing amount of weapons, it is still funding modernization of its sea based nuclear arsenal.
160-400	China	Modernizing nuclear weapons in order to maintain a limited nuclear deterrent. By 2010, it expects to finish its modernization efforts on its long range, sea based, and plane based weapons.
>200	United Kingdom	In December 2006, the Prime Minister announced that the UK is engaged in modernization efforts centered on maintaining a deterrent.

#### Conclusions:

Each of the original nuclear states is engaged in reduction of weapons and modernization of the weapons it has. While the world has far less nuclear weapons than it once did, all of the five original nuclear powers are still trying to keep their programs going in order to ensure that they are not attacked. Current nuclear treaties were developed with the intension of stopping new nuclear development by the preventing of testing. Nuclear modernization presents serious challenges to complete disarmament because it keeps weapons that would naturally stop working operational.

#### Internal Citation Sources:

<sup>[1]</sup> Norris, Robert S., and Hans M. Kristensen. "Russian nuclear forces, 2008." *Bulletin of the Atomic Scientists* 64(2008): 54-57.

<sup>[2]</sup> Norris, Robert S., and Hans M. Kristensen. "U.S. nuclear forces, 2008." *Bulletin of the Atomic Scientists* 64(2008): 50-53.

[3] "Quality Assurance & Non-Nuclear Testing." Nuclear Matters: A practical Guide. United States Military. 10 Mar 2009 <<http://www.acq.osd.mil/ncbdp/nm/nmbook/chapters/ch6.htm>>.

[4] Drell, S. "Science Based Stockpile Stewardship." the MITRE corporation (1994)

## **Table Sources:**

### # Of Weapons

US & Russia - Previously discussed.

France - "Government announces intention to maintain the UK's Nuclear Deterrent." Defense news. 4 December 2006. Federation of American Scientists. 10 Mar 2009 <<http://www.fas.org/nuke/guide/uk/doctrine/sdr06/index.html>>.

China & UK - "Global Stockpiles, 1945-2006." Nuclear Notebook (2006)

### Modernization

Russia - Isachenkov, Vladimir. "AP News." 25 February 2009 10 Mar 2009 <<http://www.google.com/hostednews/ap/article/ALeqM5ia2ELy71D8upyHQMB-4TOWsJVvqQD96IL6D00>>.

United States - "Quality Assurance & Non-Nuclear Testing." Nuclear Matters: A practical Guide. United States Military. 10 Mar 2009 <<http://www.acq.osd.mil/ncbdp/nm/nmbook/chapters/ch6.htm>>.

France - Flaherty, Ted. "Current World Nuclear Arsenals." 02 January 1997. Center for Defense Information. 10 Mar 2009 <<http://www.cdi.org/nuclear/database/nukestab.html>>.

China - Cirincione, Joseph. "China's Nuclear Modernization." Carnegie Endowment for International Peace. 10 Mar 2009 <<http://www.carnegieendowment.org/publications/index.cfm?fa=view&id=93&prog=zgp&proj=znpp>>.

UK - Daalder, Ivo. 05 December 2006. Brookings. 10 Mar 2009 <[http://www.brookings.edu/opinions/2006/1205nuclearweapons\\_daalder.aspx](http://www.brookings.edu/opinions/2006/1205nuclearweapons_daalder.aspx)>.

## Keeping Nuclear Weapons Secure and Reliable (Objective III Activity #3,4)

Following the end of the Cold War, there were over 50,000 nuclear weapons in the world, with 97% of them in the United States and former Soviet Union.<sup>[1]</sup> As the world reduced its stockpiles, worries grew that as the nuclear weapons aged, they would become unreliable and potentially dangerous.<sup>[2]</sup> In response, the U.S. government created the Stockpile Stewardship Program to address the problem of the aging nuclear arsenal.<sup>[3]</sup> This legislation, passed in 1992, ended nuclear testing and specified three safeguards to implement: Enhanced Nuclear Detonation Safety (ENDS), a system that prevents the electrical system from accidentally detonating; Insensitive High Explosives (IHE), a form of explosives that is unlikely to accidentally explode and spread nuclear fuel; and fire resistant pits (FRP), a coating around the plutonium making it able to withstand fire.<sup>[4][5]</sup>

Change in the U.S. Nuclear arsenal was swift. The plan for the arsenal in 1993 included the retirement of all warheads that lacked ENDS.<sup>[6]</sup> Following the failure of the START II (Strategic Arms Reduction Treaty), the retirement dates were postponed.<sup>[7]</sup> However, following the Moscow Treaty in 2003, further progress was made to eliminate warheads without ENDS.<sup>[8]</sup> Weapons without IHE form a significant part of the stockpile, and because of the increased risk associated with conventional explosives, the National Nuclear Security Administration (NNSA) is more cautious when transferring them.<sup>[9]</sup> To limit the danger inherent in weapons without IHE, three of the four types of weapon systems that do not include IHE utilize FRP to reduce risk of a fire damaging the pit and spreading nuclear material.<sup>[10]</sup> The NNSA estimates that these measures limit the likelihood of an accident involving a warhead resulting in a nuclear yield to be less than one in a million.<sup>[11]</sup>

The president has the sole authority to deploy the United States nuclear arsenal. There is a variety of methods and processes that serve to ensure that. Nuclear command and Control (known as NC<sup>2</sup>) refers to the communication channels and authorized process designed so that the president, and the president alone, may order nuclear strikes.<sup>[12]</sup> Should the president order a nuclear strike, he first sends an Emergency Action Message (EAM), which is a coded message to mobilize nuclear forces. Service members would then use the code to arm the nuclear weapon through the Permissive Action Link (PAL).<sup>[13]</sup> Many nuclear weapons are fitted with a Command Disablement System (CDS) to disable the weapon if “loss of control seems imminent”.<sup>[14][15]</sup> Unlike the CDS, which requires human initiation, the Active Protection System (APS) guards against unauthorized use by automatically destroying its critical weapon components.<sup>[16]</sup> Some weapons also include an Environmental Sensing Device (ESD), which prevents the detonating circuits from operating until certain conditions, such as acceleration, are met.<sup>[17]</sup>

PAL, CDS, APS, ESD, ENDS, FRP, and IHE are the component technologies in a weapon that help nuclear weapons fulfill the requirements of safety the NNSA have in place. The current warheads have been designed to not accidentally detonate or spread radioactive material. Nuclear weapons are expected to survive normal conditions with no degradation of operational capabilities. Normal conditions are defined broadly as the range of conditions that could happen during peace or wartime up to the point of intended detonation.<sup>[18]</sup> Normal conditions includes temperature variations of -82° to 68°, a force of 10 g's and the shock from a container being dropped a couple of inches. Under these circumstances, the NNSA estimates the risk of accidental detonation to be one in one billion.<sup>[19]</sup>

The NNSA has a varied approach to protecting the nuclear stockpile. These efforts consist of: protective forces, consisting of armed uniformed guards; physical security systems, consisting of cameras, fences and barriers; safe secure transportation of nuclear materials; information security, namely for the protection of classified information and personal security, including the methods used to decide who should have access to sensitive information and have access to weapons.<sup>[20]</sup> Because of the extreme danger associated with nuclear weapons, some of the most exhaustive security is used to protect them.<sup>[18]</sup> NNSA operates Nuclear Emergency Support Team (NEST), an agency dedicated to supplying support and advice during nuclear emergencies.<sup>[21]</sup>

All this security and technology is expensive. According to a study by Stephen I. Schwartz and Deepti Choubey, the total cost of the nuclear weapons program, including direct costs, health and environmental costs, missile defense, nuclear threat reduction, and nuclear incident management, was 52.4 billion dollars in 2008.<sup>[22]</sup> The direct costs, the costs of upgrading and maintaining nuclear weapons, delivery systems and associated infrastructure of the nuclear weapons program, were over 29 billion dollars.<sup>[23]</sup>

The United States' nuclear arsenal is expensive but well cared for. Fifty billion dollars is a large sum of money to spend each year on nuclear technology that the public does not want to use. However, as long as the United States' and its allies' perception of their security is incumbent on a strong, credible, nuclear arsenal, they must bear the costs.

#### **Internal Citation Sources:**

<sup>[1]</sup> Kaysen, Carl, Robert S. McNamara , and George W. Rathjens. "Nuclear Weapons After the Cold War." Foreign Affairs Fall 1991 09Mar2009

<sup>[2]</sup> Gates, Robert. "Nuclear Weapons and Deterrence in the 21<sup>st</sup> Century" Carnegie Endowment for International Peace. 28 Oct 2008.

<sup>[3]</sup> *ibid*

<sup>[4]</sup> Haeckel, Ronald. "Statement of Brigadier General Ronald Haeckel" Senate Armed Services Committee Hearing. December 13, 2001

<sup>[5]</sup> "Nuclear Matters: A Practical Guide." Office of the Deputy Assistant to the Secretary of Defense for Nuclear Matters. 2008. United States Defense Department. 8 Mar 2009<[http://www.acq.osd.mil/ncbdp/nm/nmbook/references/NM\\_APracticalGuide.pdf](http://www.acq.osd.mil/ncbdp/nm/nmbook/references/NM_APracticalGuide.pdf)>. 9

<sup>[6]</sup> *ibid* 9

<sup>[7]</sup> *ibid* 9

<sup>[8]</sup> *ibid* 9

<sup>[9]</sup> *ibid* 9

<sup>[10]</sup> Haeckel, Ronald. "Statement of Brigadier General Ronald Haeckel" Senate Armed Services Committee Hearing. December 13, 2001

<sup>[11]</sup> *ibid*

<sup>[12]</sup> "Nuclear Matters: A Practical Guide." Office of the Deputy Assistant to the Secretary of Defense for Nuclear Matters. 2008. United States Defense Department. 8 Mar 2009 <<http://www.acq.osd.mil/ncbdp/nm/nmbook/index.htm>>. 31

<sup>[13]</sup> *ibid* 78

<sup>[14]</sup> *ibid* 78

<sup>[15]</sup> Haeckel, Ronald. "Statement of Brigadier General Ronald Haeckel" Senate Armed Services Committee Hearing. December 13, 2001

<sup>[16]</sup> "Nuclear Matters: A Practical Guide." Office of the Deputy Assistant to the Secretary of Defense for Nuclear Matters. 2008. United States Defense Department. 8 Mar 2009 <<http://www.acq.osd.mil/ncbdp/nm/nmbook/index.htm>>. 78

<sup>[17]</sup> *ibid* 78

<sup>[18]</sup> *ibid* 67

<sup>[19]</sup> *ibid* 68

<sup>[20]</sup> *ibid* 74

<sup>[21]</sup> Haeckel, Ronald. "Statement of Brigadier General Ronald Haeckel" Senate Armed Services Committee Hearing. December 13, 2001

<sup>[22]</sup> Schwartz, Stephen I. and Deepti Choubey. "Nuclear Security Spending; Assessing Costs, Examining Priorities." Carnegie Endowment for International Peace Jan 2009 6-7. 12 Mar2009.

<sup>[23]</sup> *ibid* 7

## Bibliography

- “About IAEA:History.” International Atomic Energy Agency. IAEA.org. 10 Mar 2009  
<http://iaea.org/About/history.html/>>.
- "A/RES/48/57. Strengthening of the coordination of humanitarian emergency." 14 Dec 1993. United Nations General Assembly. 15 Mar 2009
- "Disarmament Treaties." NWIP Fact Sheet. International Student Movement of IPPNW. 15 Mar 2009 <<http://www.ippnw-students.org/NWIP/factsheets/treaties.html>>.
- "FAO:FAO Home." Food and Agriculture Organization of the United Nations. 13 Mar 2009  
<<http://www.fao.org/>>.
- “Global Stockpiles, 1945-2006." Nuclear Notebook (2006)
- "Government announces intention to maintain the UK's Nuclear Deterrent." Defense news. 4 December 2006. Federation of American Scientists. 10 Mar 2009  
<<http://www.fas.org/nuke/guide/uk/doctrine/sdr06/index.html>>.
- “IAEA-NAML-Marine Environment Laboratories." International Atomic Energy Agency. IAEA.org. 13 Mar 2009 <<http://www-naweb.iaea.org/naml/>>.
- "India-Pakistan: Troubled relations." BBC News. 2001. British Broadcasting Corporation. 8 Mar 2009  
<[http://news.bbc.co.uk/hi/english/static/in\\_depth/south\\_asia/2002/india\\_pakistan/timeline/2001.stm](http://news.bbc.co.uk/hi/english/static/in_depth/south_asia/2002/india_pakistan/timeline/2001.stm)>.
- "International Atomic Energy Agency." International Atomic Energy Agency. IAEA.org. 12 Mar 2009 <<http://iaea.org/>>.
- "NRC: Fact Sheet on the Three Mile Island Accident." Fact Sheet on the Three Mile Island Accident. United States Regulatory Commission. 13 Mar 2009  
<<http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/3mile-isle.html>>.
- "Nuclear Matters: A Practical Guide." Office of the Deputy Assistant to the Secretary of Defense for Nuclear Matters. 2008. United States Defense Department. 8 Mar 2009<[http://www.acq.osd.mil/ncbdp/nm/nmbook/references/NM\\_APracticalGuide.pdf](http://www.acq.osd.mil/ncbdp/nm/nmbook/references/NM_APracticalGuide.pdf)>.
- "Nuclear Non-Proliferation Treaty." Atomic Archive. 2008. AJ Software & Multimedia. 9 Mar 2009 <<http://www.atomicarchive.com/Treaties/Treaty6.shtml>>.
- “Our Work: Work at the IAEA.” International Atomic Energy Agency. IAEA.org. 10 Mar 2009  
<<http://www.iaea.org/OurWork/index.html/>>.

- "Putting Down the Sword." South Africa's nuclear weapons program. 7/9/2001. Nuclear Weapons Archive. 8 Mar 2009 <<http://nuclearweaponarchive.org/Safrica/SADisarming.html>>.
- "Quality Assurance & Non-Nuclear Testing." Nuclear Matters: A practical Guide. United States Military. 10 Mar 2009 <<http://www.acq.osd.mil/ncbdp/nm/nmbook/chapters/ch6.htm>>.
- "Summary of the Comprehensive Nuclear Test-Ban Treaty." 2008. CTBTO Preparatory Commission. 9 Mar 2009 <<http://www.ctbto.org/the-treaty/the-comprehensivenuclear-test-ban-treaty/summary-of-the-treaty/summary-of-the-comprehensivenuclear-test-ban-treaty/>>.
- "The Comprehensive Nuclear-Test-Ban Treaty: CTBTO Preparatory Commission." The Comprehensive Nuclear-Test-Ban Treaty. CTBTO Preparatory Commission. 13 Mar 2009 <<http://www.ctbto.org/the-treaty/the-comprehensivenuclear-test-ban-treaty/>>.
- "The New World Screwworm." Stop Screwworms. National Agricultural Library. 13 Mar 2009 <<http://www.nal.usda.gov/speccoll/collect/screwworm/Start.htm>>.
- "Treaty on the Non-Proliferation of Nuclear Weapons." Article III. 1968 United Nations General Assembly. 14 Dec 1993. International Student Movement of IPPNW. 15 Mar 2009 <<http://www.un.org/documents/ga/res/48/a48r057.htm>>.
- Aftergood, Steven. "Nuclear Weapons Program." Federation of American Scientists. 16/11/2006. Federation of American Scientists. 8 Mar 2009 <<http://www.fas.org/nuke/guide/dprk/nuke/index.html>>.
- Aftergood, Steven. "Nuclear Weapons - Israel." Federation of American Scientists. 8/1/2007. Federation of American Scientists. 8 Mar 2009 <<http://www.fas.org/nuke/guide/israel/nuke/index.html>>.
- Bakanic, Elizabeth. "The End of Japan's nuclear Taboo." Bulletin of the Atomic Scientists. 9/6/2008. Bulletin of the Atomic Scientists. 8 Mar 2009 <<http://www.thebulletin.org/web-edition/features/the-end-of-japans-nucleartaboo>>.
- Bunn, Anthony. "Securing the Bomb: Ending Production of Nuclear Missiles: Fissile Material Cut-off Treaty." Nuclear Threat Initiative. 01 AUG 2006. The President and Fellows of Harvard College. 9 Mar 2009
- Bunn, Mathew. "Introduction: Monitoring Nuclear Stockpiles and Reductions." Nuclear Threat Initiative. 28 Oct 2002. 9 Mar 2009 <[http://www.nti.org/e\\_research/cnwm/monitoring/index.asp](http://www.nti.org/e_research/cnwm/monitoring/index.asp)>.
- Cirincione, Joseph. "China's Nuclear Modernization." Carnegie Endowment for International Peace. 10 Mar 2009

- <<http://www.carnegieendowment.org/publications/index.cfm?fa=view&id=93&prog=zgp&proj=znpp>>.
- Daalder, Ivo. 05 December 2006. Brookings. 10 Mar 2009  
<[http://www.brookings.edu/opinions/2006/1205nuclearweapons\\_daalder.aspx](http://www.brookings.edu/opinions/2006/1205nuclearweapons_daalder.aspx)>.
- Daalder, Ivo and Jan Lodal. "The Logic of Zero: Toward a World Without Nuclear Weapons." Foreign Affairs November/December 2008 3 Mar 2009 .  
<<http://www.foreignaffairs.org/20081001faessay87606/ivo-daalder-jan-lodal/the-logic-of-zero.html>>
- Drell, S. "Science Based Stockpile Stewardship." the MITRE corporation (1994)
- Dunlop, Sean and Jean du Preez. "The United States and the CTBT: Renewed Hope or Politics as Usual?." Issue Brief. Feb 2009. Nuclear Threat Initiative. 15 Mar 2009  
<[http://www.nti.org/e\\_research/e3\\_ctbt\\_united\\_states.html](http://www.nti.org/e_research/e3_ctbt_united_states.html)>.
- du Preez, Jean. "Avoiding a Perfect Storm: Recharting the NPT Review." Arms Control Association Oct 2008
- Ferguson, Charles D.. "Issue Brief: Nuclear Posture Review." Nuclear Threat Initiative August 2002 13 Mar 2009 <[http://www.nti.org/e\\_research/e3\\_15a.html](http://www.nti.org/e_research/e3_15a.html)>.
- Fernandez-Vazquez, Eugenio. "Latin America rethinks Nuclear Energy." Americas Program. 12/09/2005. Americas Program. 8 Mar 2009 <<http://americas.irconline.org/am/558>>.
- Flaherty, Ted. "Current World Nuclear Arsenals." 02 January 1997. Center for Defense Information. 10 Mar 2009 <<http://www.cdi.org/nuclear/database/nukestab.html>>.
- Gates, Robert. "Nuclear Weapons and Deterrence in the 21<sup>st</sup> Century" Carnegie Endowment for International Peace. 28 Oct 2008.
- Haeckel, Ronald. "Statement of Brigadier General Ronald Haeckel" Senate Armed Services Committee Hearing. December 13, 2001
- Isachenkov, Vladimir. "AP News." 25 February 2009 10 Mar 2009  
<<http://www.google.com/hostednews/ap/article/ALeqM5ia2ELy71D8upyHQMB-4TOWsJVvqQD96IL6D00>>.
- Kaysen, Carl, Robert S. McNamara , and George W. Rathjens. "Nuclear Weapons After the Cold War." Foreign Affairs Fall 1991 09Mar2009
- Keinon, Herb. "Yadlin: Iran has crossed nuclear 'technological threshold'." The Jerusalem Post (2009): Israel <http://www.fas.org/nuke/guide/israel/nuke/index.html>

Maettig, Thomas. "Issue Brief: Tactical Nuclear Weapons in Germany: Time for Withdrawal?"  
Nuclear Threat Initiative March 2008 09 Mar 2009  
<[http://www.nti.org/e\\_research/e3\\_tactical\\_nuclear\\_weapons.html](http://www.nti.org/e_research/e3_tactical_nuclear_weapons.html)>.

Norris, Robert S., and Hans M. Kristensen. "Russian nuclear forces, 2008."  
Bulletin of the Atomic Scientists 64(2008): 54-57.

Norris, Robert S., and Hans M. Kristensen. "U.S. nuclear forces, 2008."  
Bulletin of the Atomic Scientists 64(2008): 50-53.

Pike, John. "Libyan Nuclear Weapons." Global Security.org. 21/11/2008.  
Globalsecurity.org. 8 Mar 2009  
<http://www.globalsecurity.org/wmd/world/libya/nuclear.htm>

Schwartz, Stephen I. and Deepti Choubey. "Nuclear Security Spending; Assessing Costs,  
Examining Priorities." Carnegie Endowment for International Peace Jan 2009 6-7.  
12Mar2009.

---