Nuclear Weapons and the Threat They Pose



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There are two countries that are presently engaged in nuclear weapons development: Iran and North Korea. Both of these countries represent significant threats to their immediate region—the Arab countries on the southern shores of the Persian Gulf and Israel, in the case of Iran; and South Korea and Japan, in the case of North Korea.

This monograph provides some background information on nuclear weapons: how they operate and what it takes to build them.

Nuclear weapons come in a variety of shapes and sizes with differing degrees of impact. Weapons can be classified based on their purpose and yield, as follows.

Strategic Weapons

Strategic nuclear weapons are the big children on the block. These are weapons designed to disrupt the enemy's capacity to wage war, and they are focused on either attacking the enemy's cache of strategic weapons so that they are not used (known as a "counterforce" attack) or on attacking the enemy's cities (a "countervalue" attack) in order to disrupt their ability to build weapons, disrupt their economy to bring about economic collapse making it impossible for the enemy to wage war, and/or create popular pressure within their population to end the war.

The destructive power of the nuclear device is measured in equivalents of millions of tons of TNT, also known as megatons, or in equivalents of hundreds of tons of TNT, or kilotons. Strategic nuclear weapons tend to have higher yields and can be sent to their target via three different delivery vehicles: Intercontinental Ballistic Missiles (ICBMs), long-range bomber aircraft (such as the B-1 or B-52 bombers), or via Sea-Launched Ballistic Missiles (SLBMs) launched from ships or submarines.

Many ICBMs are MIRVed, meaning they have Multiple Independent Re-entry Vehicles, or, in plain English, they carry multiple warheads and can release warheads at different times when they are in space so each warhead will follow a different trajectory toward a different target. An ICBM is propelled outside the earth's atmosphere by the missile's engines (which drop off when their fuel is exhausted) so the warhead or warheads (depending on whether it is a MIRVed missile or not) then fall back to Earth along a certain trajectory, which can be calculated with remarkable accuracy to within a few hundred meters. An ICBM typically has a range of 4,000 km—it can hit a target on the other side of the planet. A standard ICBM warhead is 1 megaton and, as noted above, some missiles are MIRVed and carry multiple warheads of this size.

Theater Nuclear Weapons

Theater nuclear weapons are designed to disrupt enemy movements, logistical operations, planning activities, etc., in support of active warfare occurring on the actual battlefield or front line. The theater of war is the area that is directly or potentially may be involved in war operations.

For example, during the Second World War there were two primary theaters of war: Europe and the Pacific. Depending on the size of the theater in question, Intermediate-Range Ballistic Missiles (IRBMs) or Medium-Range Ballistic Missiles (MRBMs), both with nuclear warheads, could be used. IRBMs have a range of up to 2,000 km and MRBMs have a range of about half that.

Theater nuclear weapons are designed to hit targets behind the front lines in order to disrupt the support structure (logistics, etc.) that makes it possible for the troops, tanks and artillery to fight on the battlefield. Most of the day-to-day activities of military operations involve planning and logistics. It is important to understand that warfare involves a large infrastructure of supplies, vehicles and troops in support of a much smaller group of the men and women doing the actual fighting. Theater nuclear weapons are designed to disrupt those logistical and support activities so the troops fighting in the front run out of fuel, supplies and ammunition and are unable to continue fighting. Theater nuclear weapons typically have smaller yields than strategic weapons.

Battlefield Nuclear Weapons

Battlefield nuclear weapons (or tactical nuclear weapons) are typically small devices with low yields ranging from a kiloton or less to around 100 kilotons. These include short range missile warheads, artillery shells, and even nuclear land mines and depth charges. These are designed to give soldiers fighting on the front line an advantage against the enemy troops they are facing on the battlefield by killing and wounding enemy troops, destroying enemy equipment, and generally disrupting enemy operations on the battlefield with a bigger "bang for the buck" than they would get from weapons with conventional explosives. Not to mention the fear factor involved in using nuclear weapons, given the release of radiation.

Atomic Versus Thermonuclear (Hydrogen) Weapons

Nuclear weapons can also be classified according to their internal operations in terms of whether they are atomic or thermonuclear (hydrogen) weapons. The first nuclear devices, including the ones dropped on Hiroshima and Nagasaki, were atomic bombs. They utilized the process of nuclear fission. Certain types of atoms are less stable in terms of the positive and negative charge attraction between the positively charged protons (which, along with neutrons that do not carry a charge, make up the nucleus of the atom) and the negatively charged electrons.

The atoms used in nuclear devices are uranium-235 or plutonium-239 because they are stable enough and do not degrade too quickly, *which means* they can be stored for decades. However, at the same time, these atoms can be broken apart if enough energy is applied to them. An atomic bomb harnesses this ability to apply energy to one or another of these two atoms to cause these atoms to break apart releasing protons, electrons and neutrons (in other words, energy).

When enough atoms are squeezed into a small area and bombarded with the energy produced by conventional explosives all firing at once and compressing the uranium or plutonium core of the bomb, these atoms split, resulting in a chain reaction known as nuclear fission. This causes the almost instantaneous release of huge amounts of energy, producing a nuclear explosion.



Thermonuclear (hydrogen) bombs are even more sophisticated and include an atomic bomb core, but they additionally make use of the process of nuclear fusion. Scientists found that by using energy to hurl unstable hydrogen atoms at each other (deuterium and tritium), these unstable atoms easily fuse and release excess energy. If this process occurs immediately and in a very limited area, it will produce a massive release of energy. Consequently, a thermonuclear bomb is, in some ways, like two bombs wrapped together, and it allows devices to be built with even larger payloads. Warheads on strategic nuclear weapons are invariably thermonuclear weapons whereas tactical weapons, or primitive weapons created by countries such as North Korea, tend to be atomic bombs.²

The Impact of Nuclear Weapons

It should be borne in mind that nuclear weapons have not been used in war since the US attacks on Hiroshima and Nagasaki at the close of the Second World War. In large part this is because only a few countries had nuclear weapons of their own. Only the United States and the Soviet Union had the ability to employ tens of thousands of strategic warheads, as well as large numbers of theater and battlefield devices. These countries were very cognizant of the cost involved in a nuclear war.

If we take a standard one-megaton warhead as an example, when that device is ignited, the first thing released is energy in the form of high-energy waves (X-rays and gamma rays) that create an intense flash of light and release heat that will set fire to anything that burns within a radius of about 14 km. The heat is most intense, of course, within a few kilometers of the actual site of the explosion ("ground zero"). There, most everything that is not made out of thick concrete or heat-resistant metals will simply vaporize. Immediately after the blast, a large fireball will form in the air and, as the heat of this fireball reaches the surrounding air, that air will rush away as it tries to cool down, creating a huge blast wave that will destroy even steel-reinforced concrete buildings in a radius of up to 2 km and brick or wood houses as far as 8 km away.

Almost immediately the wind will come rushing back in at gale force level. Because of the heat, the air molecules rushing outward from ground zero will then rush back in. A vacuum has been created around ground zero, removing any air. The heat created by the initial release of energy will lead to flash fires, fed by the rushing winds that will burn anything flammable, creating such huge conflagrations of fire that they will suck the oxygen from the immediate area—people in underground bomb shelters will have the oxygen literally sucked out of their lungs.

Finally, as if that was not enough, the explosion will release huge quantities of radioactive isotopes (variants of regular atoms) that will not only contaminate the area impacted by the blast, thus hampering any rescue efforts, but also will be blown by the winds far afield so that they will impact peoples' health in the larger region and even on other continents for years to come. Depending on how many nuclear explosions have occurred, these isotopes will produce heightened cases of cancer and birth defects, as well as radiation poisoning in the case of those exposed to large doses of radiation.³

In short, the use of nuclear weapons, especially in large numbers, is too horrible to contemplate and yet, by the logic of nuclear deterrence, they would need to be built in large numbers and made ready to use in order to deter their use by the other side.

Building a Nuclear Bomb

There are essentially two ways of developing a nuclear weapon. These weapons are based on a core of fissile material consisting primarily of either enriched uranium or plutonium, though there are different



processes used to obtain enriched uranium as opposed to plutonium. There are essentially three or four parts of the process, depending on whether one desires to build an atomic bomb or a thermonuclear bomb. Arguably, the most complicated part of the process involves obtaining fissile materials; that is, enriched uranium (uranium-235) or plutonium (plutonium-239). These can be obtained through either the "front end" of the nuclear cycle, in the case of enriched uranium, or through the "back end" of the nuclear cycle, in the case of plutonium.

Uranium is a naturally occurring element available in large quantity underground in certain parts of the world. However, most mined uranium is a more stable version of the uranium atom (U-238) and, in fact, on average, only one percent of the uranium dug out of the ground consists of the less stable enriched uranium (U-235). Employing the front end of the nuclear cycle involves taking that uranium and weeding out the one percent that is enriched uranium. The most common way of doing this is by crushing, washing and purifying the uranium ore, creating uranium oxide (or "yellowcake"), and then converting the yellowcake powder to a gas (uranium hexafluoride). That gas is then run through a series of centrifuges to separate the U-235 from the U-238.

Employing the back end of the nuclear cycle involves creating plutonium (which is man-made and does not occur in nature) through the operation of a nuclear reactor. Nuclear reactors, which produce small and controlled nuclear chain reactions that generate heat, burn up uranium and produce a series of byproducts, or nuclear waste that include plutonium. That plutonium then needs to be separated out from the rest of the (highly radioactive) nuclear waste. This requires building and running a reprocessing plant.

As the very brief description above suggests, obtaining the fissile material is an extremely complicated and difficult process. Moreover, obtaining the equipment for these processes is not easy because trade in nuclear components is highly regulated. Going beyond the stage of building an atom bomb also requires obtaining large quantities of the isotopes of hydrogen, deuterium and tritium in order to produce the fusion process that occurs alongside the fission process. Even just sticking with the construction of a more primitive atom bomb, however, involves many more steps.

Almost as difficult as obtaining the core materials of the bomb (uranium or plutonium) are the actual machinery and components needed to construct a bomb. Nuclear bombs are among the most complex devices ever created, and they require extremely specialized materials and equipment that are, just like the fissile materials, heavily regulated and hard to obtain.

In short, countries such as North Korea and Iran with resources and access to experts can embark on nuclear weapons programs, but this will involve much difficulty and a considerable investment in time and resources before they can produce viable weapons. North Korea, at present, has just a few very primitive atomic bombs and Iran is working toward this goal. Terrorist groups will need to rely on trying to steal small nuclear devices, as it is highly unlikely that a terrorist organization will ever be able to build such a weapon. It is also highly unlikely, though, of course, not impossible that they will be able to steal one.

All of this means that there is a much greater likelihood that rogue states, such as Iran and North Korea, will eventually develop a real military capability using nuclear weapons than there is that terrorists will detonate a nuclear device. That does not suggest, however, that the world does not have to worry about the problem.

The North Korean regime's clear disregard for the lives of its citizens and others, and its sometimes irrational behavior could theoretically lead to the use of nuclear weapons on the Korean peninsula, or against Japan sometime in the future. Similarly, Iran's desire to destroy Israel, and the sometimes questionable sanity of some of its leaders, also suggest it would not be inconceivable for Iran to try to use nuclear weapons against Israel. And, even a highly unlikely scenario in which a terrorist organization steals a tactical nuclear weapon and detonates it in a large city is not completely impossible.

The issue with nuclear weapons is that they are a low-probability/high-consequence weapon. They are so difficult to obtain or build that there is a low probability they can be made available; but if someone does get his or her hands on one, the impact will be of extremely high consequence, and the world clearly cannot afford the consequences of the use of nuclear weapons.



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Homeland Security and CTU

The field of homeland security continues to evolve, as does the focus of dedicated professionals seeking advanced knowledge and skills relevant to the protection of United States territories, communities and organizations from a variety of threats, including cybersecurity.

Colorado Technical University is proud to be one of just a handful of universities in the United States to offer a Master's degree in Homeland Security (HLS). CTU's program is designed to provide students with a broad understanding of the homeland security enterprise at the strategic policymaking level. Geared



toward homeland security practitioners, the program provides them with analytical and communication tools that can prepare them to become decision-makers in their chosen area of expertise. It has also been designed to expand students' knowledge of other disciplines within the larger homeland security enterprise, thus helping them understand the roles of given disciplines, such as law enforcement, fire, emergency services, cybersecurity_and public health in the larger homeland security picture.

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Sources

¹ For a quick fact sheet on ballistic missiles, see The Federation of American Scientists (FAS), *Ballistic Missile Basics*, available at: http://www.fas.org/nuke/intro/missile/basics.htm (accessed May 10, 2013).

² For a user-friendly description of how nuclear bombs work, see William Harris, Craig Freudenrich, and John Fuller, "How Nuclear Bombs Work," *How Stuff Works*, available at: http://science.howstuffworks.com/nuclear-bomb.htm (accessed May 10, 2013).

³ For more information on blast effects, see: "The Effects of Nuclear Weapons," *atomicarchive.com*, available at: http://www.atomicarchive.com/Effects/ (accessed May 10, 2013).