The History of the Global Hibakusha

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Introduction: Who are the Global Hibakusha?

Hiroshima and Nagasaki were directly attacked with nuclear weapons in 1945. People suffered and died from the blast wave, the incredible heat and the radiation released by the detonations.[1] Both cities are, in many ways, still recovering from these attacks almost 80 years later. Nuclear weapons have never again been used in a direct attack on human beings. However, more than 2,000 nuclear weapons have been detonated by Nuclear Weapon States (NWS) since 1945.[2] While not used to attack people directly, the effects of nuclear explosions, and especially the explosions of thermonuclear weapons (H-bombs) are so immense that many people have experienced harm just from the testing. Additionally, millions more have been exposed to radiation from nuclear accidents, both with weapons and reactors, and also from the production of nuclear materials, especially nuclear fuel to power reactors to make both weapons and electricity. These millions of people, spread around the world, are the "global hibakusha."[3]

To understand the global hibakusha, it is important to understand how people are exposed to radiation.[4] Here in Hiroshima, and in Nagasaki, there were two ways people experienced harm from radiation. When the nuclear weapons detonated, intense waves of energy radiated out from the hypocenter. These energies included blast waves and high heat, but also waves of gamma and neutron radiation. Similar to the blast and heat energy, the radioactive waves burst outward from the detonation and caused immense harm to those nearby. These waves remained harmful out to about 3–4 km from the hypocenter, becoming less energetic as they extended further. For all of those within this area, the waves penetrated through their entire bodies, harming cells and organs as they passed through. Radiation in this form lasted less than a minute; you can think of it like a giant x-ray, it is on, and then it is off—when it is off, there is no more radiation present. Many people were killed instantly, and many more died in the subsequent days, weeks and months from the damage done by their exposures to this external radiation; even more developed sicknesses over the coming decades. The Atomic Bomb Casualty Commission (ABCC) and its descendant laboratory the Radiation Effects Research Foundation (RERF) have continued to track the harm to health from these exposures even today.

However, people were also harmed by the Black Rain. This was a different means of exposure to radiation. When the nuclear weapon detonated, it produced many radioactive particles called fission products. The mushroom cloud filled with these particles, along with uranium-235 or plutonium that had not split (the Hiroshima weapon used uranium-235 and the Nagasaki weapon used plutonium).[5] Additionally, particles were ionized by the detonation and made radioactive. All of these particles were drawn up into the mushroom cloud as the fireball of the detonation cooled: it is the presence of all this material at the top that "mushrooms" the cloud. After the attack, the mushroom cloud drifted, and as it drifted, these radioactive particles fell from the cloud and drifted to Earth. This is radioactive "fallout." Because there was also so much soot from the fires burning in Hiroshima, when rain stripped these particles out of the drifting cloud, the rain was black. This Black Rain contained a lot of radioactive particles. Different particles have different chemistries, with some remaining radioactive only for hours or days, and other radioactive particles remaining radioactive for hundreds or thousands of years. Plutonium remains dangerous for over a million years, and uranium-235 for billions of years. These particles are primarily dangerous if they get inside of our bodies, which they do via inhalation, swallowing or cuts in the skin. Once internalized, they may be expelled from the body, or they may be retained and used by the body just like the chemicals in our food. Depending on their chemistry, the body uses them for different things. For example, strontium-90, which is produced in nuclear explosions, is similar to calcium, so when it deposits inside of the body it is most often placed in the bones or teeth like calcium would be. Individual particles do not give off high levels of energy, but if deposited inside the body, this energy affects the cells nearby 24 hours a day. Over years this can cause damage and disease. And for long-lived particles, these risks continue over multiple generations.

It has taken a long time for scientists and the courts to recognize those who were exposed to Black Rain and who developed subsequent disease as "hibakusha." It is easy to know who was exposed to the external radiation of the nuclear detonation: whoever was within a 3–4 km area around the hypocenter. However, it is very difficult to determine who has internalized radioactive particles and who has not after fallout deposits these particles in a community downwind. This uncertainty has made it hard for those exposed to Black Rain to be recognized as suffering from radiation exposures from the nuclear detonation.

After the end of World War Two, many people feared that the next “world war” would be fought with nuclear weapons. There were fears that many people might experience a direct nuclear attack as had the people of Hiroshima and Nagasaki. Instead, the more than 2,000 nuclear weapon tests exposed millions of people to radioactive fallout similar to those exposed to the Black Rain. Fallout, not nuclear detonations, would become the “normal” of the Cold War period. And just as it has taken a long time to acknowledge what happened to those exposed to Black Rain, the harm that has come to the global hibakusha has similarly been denied, and their suffering has similarly been rendered invisible.

Nuclear Weapon Testing

The United States began testing nuclear weapons less than a year after the nuclear attacks on Japan.[6] They tested two weapons in June and July of 1946 in the Marshall Islands, which they held as a Trust Territory from the United Nations. They continued to test in the Marshall Islands for over 10 years, including developing hydrogen bombs with their immensely larger fallout clouds. Once the former Soviet Union developed nuclear weapons in 1949, the United States opened a second nuclear test site inside of the U.S., in Nevada. The Nevada Test Site would become the location with the most detonations of any location on Earth, more than 900 nuclear weapons. It remains an active military site today and is where the U.S. developed the depleted uranium weapons that it has used in warfare since the 1990s, which like nuclear weapons, leave residual radionuclides in the ecosystem after their use. Both U.S. test sites exposed people to significant amounts of fallout radiation. So many fallout clouds crossed the United States from atmospheric tests in Nevada that radiation can still be found today thousands of kilometers downwind. The U.S. has recently begun to pay small amounts of compensation to those who lived within 1,000 km of the test site during the period of heavy contamination, even though many born since live in areas with residual radiation that continues to pose risks to their health.

The Marshall Islands experienced vast fallout clouds, especially from hydrogen bomb testing in the mid-1950s. The test of the first functional hydrogen bomb, the

Bravo Test on 1 March 1954, irradiated hundreds of Marshallese living on atolls hundreds of kilometers away, all of whom experienced health effects. The contaminated atolls are still largely uninhabitable from the ongoing radiation levels. This test also blanketed the *Daigo Fukuryu Maru* with fallout, sickening the entire crew and resulting in the death of crew member Aikichi Kuboyama six months later. The anniversary of the Bravo Test is observed today as a national holiday in the Republic of the Marshall Islands to remember the suffering of those who died and the hardships of those who survived this disaster.

The former Soviet Union developed nuclear weapons four years after the United States.[7] They established their first test site in the Kazakh Soviet Socialist Republic. There they developed both fission weapons and also fusion, hydrogen bombs. Multiple villages are within 50 km of the Polygon (as the test site is known) and fallout radiation is estimated to have affected over 1,000,000 people living downwind from the test site. The Soviet Union tested in multiple other locations, including a test near the Ural Mountains that involved the participation of over 50,000 troops on contaminated training grounds. A test site was established in the late 1950s in the Soviet Arctic at Novaya Zemlya where the largest nuclear detonation in history was conducted in 1961. The Tsar Bomba had a yield that was more than three times larger than the Bravo Test, the largest U.S. test.

The next nation to test nuclear weapons was the United Kingdom.[8] They began testing nuclear weapons in Australia in 1952. The British tested in three locations in Australia, as well as conducting multiple tests of, what would today be called, dirty bombs. Most of these tests took place on the traditional lands of several aboriginal communities in the outback of South Australia. However, the Australian government refused to allow the British to test hydrogen bombs in Australia because of the vast fallout clouds. The British then developed a nuclear test site on Christmas Island in the Pacific nation of Kiribati. In 1957 and 1958 they tested multiple hydrogen bombs on Christmas Island. The British conducted 45 tests in total.

France began its testing of nuclear weapons in Algeria in 1960.[9] Long a French colony, these tests took place during the Algerian War of Independence and, knowing that they were likely to lose the war and therefore the ability to test in Algeria, even as the tests were being conducted the French were developing a second nuclear test site in a second colonial territory, French Polynesia. Here the French would conduct almost 200 nuclear weapon tests, including all of their hydrogen bombs.

The final nation to test nuclear weapons in the atmosphere, and thus to produce downwind fallout, was China.[10] The Chinese tested all of their weapons at their test site in Lop Nur in Xinjian Province. There they tested 45 weapons in total, including both fission and fusion bombs.

It is clear that nuclear colonialism played an essential role in the choice of nuclear weapon testing sites. Two Nuclear Weapon States (NWS), the U.K. and France, never tested one weapon inside of the borders of their own nation; they only tested in colonial, or post-colonial locations. While the U.S. conducted tests both inside the United States and also in "trust" territories, it concentrated all of its H-bomb tests outside of the continental United States, to spare its domestic population from the larger fallout clouds produced by hydrogen bombs. Even when domestic sites were chosen, they were invariably located near ethnic or religious minority communities, far from the centers of dominant ethnic groups. In the United States this meant Native American, Hispanic and Mormon communities. In the former Soviet Union, the primary test site was in Kazakhstan, both ethnically and religiously distinct from the Russian majority. In China, all tests were conducted in the traditional lands of Uyghur people, an ethnic and religious minority who experience extreme repression even today.

Those "selected" to be irradiated were chosen because they were politically powerless to prevent it. Rather than selecting test sites based on military or security requirements, the lack of political consequences on the part of the testing nations was of primary importance. This was a form of nuclear colonialism: not a colonialism of resource extraction but a colonialism of places being considered "empty," and being populated by "nobody." In these "empty" spaces millions of actual people were exposed to fallout radiation by the nuclear weapon testing of the P5, and millions more remain living on contaminated lands today.

Nuclear Production

To manufacture nuclear weapons, and to generate nuclear electricity are both very technologically intensive processes. These steps are collectively referred to as the "nuclear fuel cycle." Each node of these processes has resulted in contaminations of workers, and also of those living nearby the production sites. Also, each step of these processes generates nuclear waste: low, moderate and high-level waste. Hence each step both creates risk onsite, and also generates risk for those in the stream of waste management.

All nuclear technologies begin with uranium mining.[11] Uranium mining is similar to other types of mining in that uranium is a natural ore that is embedded in rock at various locations around the world, and mining, both underground and strip mining, are used to obtain the ore. The first uranium mines were at sites already engaged in mining, in which uranium became an additional ore for extraction. Many had been working silver mines. Since then, uranium mines have been dug all around the world. Once thought to be a rare ore, it is now understood to be widely distributed in abundant quantities.

The first people to be exposed to radiation in the nuclear fuel cycle are the uranium miners. Many inhale uranium particles in the closed confines of the mines, hence uranium miners have long suffered high levels of lung cancer. Miners also have tracked uranium dust into their homes on their clothing and shoes, resulting in high levels of uranium radionuclides being found in the dwellings of uranium miners and those living near uranium mines. The mining process produces a lot of waste material which is contaminated with uranium, and this is left behind beside the mines. It is called “tailings” and is either stored in in large piles, or dumped into large ponds. Virtually no uranium tailing pile or pond has been cleaned up by mining companies when they have closed mines. The largest release of radiation in U.S. history was the Church Rock disaster in which a dam broke and a uranium tailing pond spilled into a nearby creek bed in New Mexico in 1979.[12]

Uranium is made up of several different isotopes, and only U-235 can be made to fission. U-235 makes up less than 1% of raw uranium, so the material must be refined through multiple steps to end up with uranium made up of sufficient U-235 to be usable, or as it is known—enriched uranium. The steps to obtain this material include putting it through various enrichment processes such as centrifuges or turning it into a gas to separate the U-235 from the heavier U-238 which comprises most of the raw material. The U-235 is used directly in nuclear weapons while the U-238 is used in making fuel rods to power nuclear reactors.[13]

Nuclear reactors were invented by the Manhattan Project. Nuclear reactors were designed and first operated as factories to manufacture plutonium for nuclear weapons.[14] In the Manhattan Project this was done at Hanford, Washington. The United States operated plutonium production reactors at Hanford (and later at Savannah River in South Carolina) generating sufficient material to build more than 70,000 nuclear weapons.[15] Plutonium is manufactured by "burning" nuclear fuel rods. Some of the U-238 is transformed into plutonium, then the fuel rods are dissolved in sulfuric acid and the plutonium is chemically separated from the other materials. The waste left behind from this process is both chemically toxic and highly radioactive. It is stored in large tanks buried into the ground. Most of this material at Hanford is still sitting in the tanks. One of the first large scale accidents at a nuclear reactor happened when an explosion occurred in just such a tank at the Mayak site in the former Soviet Union.[16] Mayak was where the Soviet Union manufactured plutonium for nuclear weapons. On 29 September 1957, an explosion in one of these tanks sent a plume of radiation that spread across more than 50,000 square kilometers, where more than 250,000 people lived. The area still has very high levels of radioactive particles more than 60 years later. Because the accident happened in the complex of Soviet military reactors, no information was given to local people, or the global community, about the incident or the risks to health.

A second nuclear reactor accident happened 11 days later, 10 October 1957, when a fire broke out inside of one of the reactors used to produce plutonium by the U.K. at the Windscale facility in Cumbria.[17] The Windscale Fire burned for three days, with smoke carrying radiation up into the winds and spreading through the atmosphere. At the time of the accident the British government acknowledged the fire but assured the public there was no danger or risk, and that little radiation had escaped the facility. Later assessments that took into account the weather and rain patterns of the time have revised the estimates of radiological distribution to show that fallout spread across most the U.K., Ireland and Northern Europe. A 2007 study estimated that the Windscale Fire releases were responsible for approximately 240 cancers and up to 200 cancer deaths in nearby downwind communities alone.[18]

Nuclear Accidents

There were nuclear accidents in the Manhattan Project, and there have been accidents involving production and weapons since. However, the worst accidents have been those at nuclear power plants, especially accidents involving the melting of nuclear fuel. There have been fuel melting incidents every decade since nuclear power plants began operating, but the largest accidents have been the two at Chernobyl and Fukushima.

In 1986 a combination of design flaws and human error led to an explosion in the #4 unit of the Chernobyl Nuclear Power Plant in the Soviet Union, located on the border of present-day Ukraine and Belarus.[19] The explosion propelled much of the nuclear fuel in the reactor core into the atmosphere, settling onto nearby land and dispersing downwind in the plume. The remaining nuclear fuel completely melted and flowed down into the basement below the reactor vessel. A fire burned in the reactor core for more than two weeks, creating an ongoing release of radionuclides that contaminated vast swaths of Europe. It took two days for the Soviet authorities to evacuate the town of Pripyat, three kilometers from the plant and hometown to most of its workforce. No news about the accident was released and those outside of the government only became aware of it when radiation monitors at a Swedish nuclear reactor picked up the particles a week later. Soviet authorities monitored the fallout cloud as it swirled around Europe. They did not cancel a May Day parade scheduled a week and half later, as the fire continued to burn, in nearby Kyiv. They did, however, seed clouds to bring the fallout down in heavy amounts onto Belarus to keep the fallout from reaching Moscow and other large cities in the Russian Soviet Republic.

Millions of people were exposed to radiation from the Chernobyl accident. Over 500,000 people worked as “liquidators,” performing labor from putting out the fire in the reactor to clearing up the reactor complex and the abandoned town of Pripyat in the ensuing years. Fallout contaminated areas all around Europe. Heavy contamination fell on Scandinavia, in Slavic communities, and in Germany, France and Italy. Extremely heavy amounts fell on Ukraine and Belarus. A large area was created as an Exclusion Zone that remains empty today, with hundreds of villages being emptied, and 100,000s of people evacuated. Special units were established in Ukraine and Belarus hospitals to deal with the widespread radiation sickness. Even today, more than 30 years later, radioactive food continues to make its way to the marketplace in Europe, including jams, mushrooms and boar.

Beyond the epidemiological consequences, one can also see the social and familial legacies in Scandinavia. The fallout fell in heavy amounts in the traditional lands of the Sámi people, in Norway, Sweden and Finland. Sámi culture is built around reindeer herding, and because a primary food of reindeer in lichen, which is a bio-accumulator of radiation, the reindeer became, and remain very radioactive. Not only did this take a toll on the health of community members, but it began to alter community cultural practices.[20] It has problematized a sustainable economic, food and social system that has been ongoing for millennia.

In 2011, an earthquake and tsunami led to the full meltdown of three nuclear power plants at the Fukushima Daiichi Nuclear Power Plant in Northern Japan. The plant experienced a complete site blackout, it had no electricity to power the cooling systems that cooled both reactor fuel and spent nuclear fuel. Without cooling these fuel elements continued to heat until they melted. Fires started in the spent fuel pools where old fuel was being cooled, and the hot fuel inside the reactor vessels melted out and into the basements below the reactors. As the fuel melted it vented hydrogen gasses which built up inside the reactor buildings, and eventually led to four explosions in the days after the earthquake. Large plumes of radiation rose out of the buildings and drifted downwind, ultimately depositing immense loads of radionuclides onto the towns, rice fields, forests and mountains below.[21]

The government of Japan denied that any fuel melting had occurred at the plants, even though it was clear there had been full meltdowns on the 3rd and 4th days after the accident. It took the government three months to acknowledge to the public what it knew from the start. Hundreds of thousands of people were slowly evacuated from around the plant and put into "temporary" housing. Over the next two years, as the parameters of the contamination from the fallout clouds became more defined, people were evacuated from more distant areas as well.

In areas where nuclear power plant accidents occur, two particularly problematic radionuclides that are distributed in high amounts are iodine-131 and cesium-137. Iodine-131 is a relatively short-lived particle, remaining dangerous for slightly less than three months. However, it travels a fast route into human bodies, through consuming dairy products. The iodine-131 particles deposit onto fields and are consumed by cows; humans then consume dairy products made from the milk of these cows. The quick distribution of local milk into markets allows for the internalization of iodine-131 particles during those three months of danger. The body uses iodine in the thyroid gland, and if a person internalizes particles of iodine-131, they are frequently put into the thyroid gland where they can damage nearby cells. This is particularly dangerous, as are all exposures to radiation, for children. Children's bodies are growing rapidly and damage from radiation effects development as well as harming cells or organs. Often after an accident, thyroid cancers, especially in children (but not exclusively) are the first disease presentation from internalizing fallout. This was the case nearby Chernobyl and also Fukushima.

Cesium-137 remains dangerous for approximately 300 years. It is particularly adept at migrating in an ecosystem once it has deposited, moving easily from soil to water to plants to animals. Once a significant amount of cesium-137 has deposited into an ecosystem, the contamination will remain. This presents multiple long-term problems, during the 300 years that cesium-137 remains dangerous, any wildfires will aerosolize the particles release them to spread, once again, downwind. Even when areas are "decontaminated" such as schoolyards, rice fields or homes, subsequent rains and wind will transport particles from nearby forests and soil into the area and re-contaminate them. Their long life means that they may pass through multiple individuals, outliving each one.

Nuclear Waste

When towns are decontaminated in Fukushima that simply means that the contaminated material is moved to someplace else. The contaminated soil in the ubiquitous black plastic bags in the region contain soil that is still as radioactive as it was when it was filled. All of the areas where the bags are stacked are now radioactive waste sites. When a nuclear power plant that has had no problems is decommissioned and shut down, a long process begins of dismantling the building and equipment—all of it is now nuclear waste. Nuclear waste is generated at every step of the production and use of all nuclear technologies. This waste is classified as low-level, medium-level and high-level nuclear waste. The nature of the containment it must be placed in, and the length of time it must be contained differs based on these designations and the nature of the waste. The most concerning is high-level nuclear waste.[22]

A large portion of high-level nuclear waste is spent nuclear fuel rods from the operation of nuclear reactors, to produce either plutonium for weapons or electricity.[23]

Spent nuclear fuel rods have a very high temperature, and also extremely large amounts of both chemical toxins and radioactive particles. They all contain heavy amounts of uranium and plutonium, both of which will remain extremely dangerous for hundreds of thousands and even millions of years. These must be contained sufficiently that they do not come into contact with water or living creatures for millennia. Currently there are almost 300,000 metric tons of spent nuclear fuel, with thousands of additional tons generated every year in the world. Some of these spent nuclear fuel rods date back to the reactor that produced the plutonium for the weapon used in the nuclear attack on Nagasaki in 1945.

The global consensus on how to contain spent nuclear fuel is to build vast underground storage sites, known as deep geological repositories (DGRs). The concept is to build containment structures 500 meters underground, place the spent nuclear fuel in copper canisters and fill the facility in with bentonite clay, a form of clay that expands when it is wet. To date, not one spent nuclear fuel rod has been placed into a DGR.[24] The only fully developed facilities are in Finland and Sweden, where spent fuel is expected to begin to be placed into storage in the next 10–20 years. The Onkalo site in Finland, which will hold the spent fuel from the small Finnish complex of four nuclear reactors, was one of the largest construction sites in Europe for the more than 20 years. Building such sites for the hundreds of global reactors, plus the spent nuclear fuel from plutonium production by NWS will be a massive worldwide construction effort that will have a substantial carbon footprint.

Additionally, we imagine we are building facilities that will successfully contain this spent nuclear fuel for over 100,000 years. This period of time is longer than modern humans have lived anywhere except our origins in Africa. We have only had agriculture for 10,000 years, and only had electricity for less than 300 years. Believing we can design and build canisters that will contain hot, toxic and radioactive fuel rods for tens of thousands of years is certainly not assured, no matter how successful any experiments we conduct in laboratories indicate they may be. Nothing built by human beings has lasted one twentieth of that time period. Believing we will build underground structures that will remain intact, impenetrable and unchanging for 100,000 years is aspirational at best. We have created immense amounts of the most toxic materials ever manufactured which will be a part of our descendants' world. We hope we are not poisoning them, but we won't know if we are. Among the global hibakusha may be untold generations of future human beings, and other creatures, who will have to share their world with our waste.

In our times, the testing of thermonuclear weapons brought radioactive fallout into the upper atmosphere, the troposphere and the stratosphere. There, the particles spent years circling the earth before they slowly fell out to surface of the planet. This had the effect of globally distributing much of the fallout. Currently, fallout from global nuclear weapon testing can be found everywhere on Earth.[25] A 2011 study of the soil three kilometers from Ground Zero in Nagasaki found more radionuclides present from global nuclear testing than from the direct nuclear attack there in 1945.[26] Fallout has been found everywhere from Mount Everest, to the South Pole to the Mariana Trench. Areas nearby to nuclear test sites, or nuclear accident sites have higher levels of fallout because they experienced the immediate fallout of particles in the lower levels of the atmosphere, but the fallout that entered the upper atmosphere was distributed throughout the ecosystem. Even as early as 1953, a secret U.S. government study of the bones and teeth of 20,000 subjects collected from around the world showed a global uptake of radionuclides from weapon testing.[27]

Conclusion

In Hiroshima and Nagasaki in 1945, 100,000s of people were exposed to radiation, both externally through being close to the detonation of nuclear weapons, and many also internalized radioactive particles resulting from the explosion. Thousands more internalized fallout particles that fell in the Black Rain, or downwind from the hypocenter in Nagasaki.[28] Over the subsequent decades, millions more were exposed to radioactive fallout and have internalized radionuclides and experienced sickness and early mortality. Many more have undergone forced displacement from their lands after they were contaminated by radioactive fallout, or have had to depend on contaminated land and seas for the foods they feed their families.

The long-lived nature of these particles means that the risk to human beings, and all creatures, from internalizing radionuclides stretches for many generations in the future. Additionally, the presence of our nuclear waste in the future will subject unknown numbers of people to risks from exposure to radiation for longer than we can imagine. Yet we continue to generate more nuclear waste each year, and the nuclear weapon states are all engaged in modernization programs that will extend the threat of nuclear warfare, and the production of nuclear weapons for decades into the future. This has all been a tragedy, and we are continuing down a tragic road. The ratification of the *Treaty on the Prohibition of Nuclear Weapons* may help us to turn in a different direction, but we need to strategize how to compel compliance by the nuclear weapon states, none of whom have ratified the treaty.[29] Even so, the waste is already here.

As the generation of hibakusha passes here in Hiroshima and in Nagasaki, we all struggle with how to maintain the memory of what they endured and what happened. There are many paths to maintaining and passing on that memory to new generations. Fortifying the bonds between Hiroshima, Nagasaki and the global hibakusha communities helps to broaden and globalize this memory work. People all over the world can testify to the harm done by exposure to radiation, and the risk to living with radiological contamination. This does not limit the need to universally understand what happened in Hiroshima and Nagasaki, but expands this understanding to include the millions more who also suffered from nuclear technology, and the many more who surely will as we continue to produce these materials and the inevitable waste that it generates.

While many global hibakusha are exposed to radiation, the long life of many radionuclides extends the risk and damage that the production and testing of nuclear weapons, and the legacy of nuclear accidents far into the future. The concept of the global hibakusha includes generations of people not yet born, from places far away from nuclear test sites and accident sites, who may come to encounter, and internalize the material scattered across the planet by the careless use of nuclear technologies.

Notes

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