Depleted Uranium Shells, The Radioactive Weapons
- Perpetuation of War Damage by Radiation -

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(Abstract)

Depleted uranium shells are “steel-penetrating arrows” made of uranium metal. Upon impact, they would punch a hole through the target, while uranium burns itself into tiny particles spreading out in the atmosphere. Inhaled or ingested, they would enter human bodies, causing disastrous damage due to internal radiation exposure and heavy metal poisoning. Radioactive contamination of the environment by DU would remain almost indefinitely, producing Hibakusha among the residents in the area over the generations. The heartbreaking image of Iraqi children suffering from illness caused by DU exposure is a prelude to a tragedy we will encounter in the days ahead.

If humankind wishes to treasure civilization it has created, it must forever renounce the use of force as means of conflict resolution. It is of great importance in human history that each individual voices “No” to the path toward war and to the mobilization of science in arms development. Above all, sinister weapons must be banned without a moment’s delay. DU shells are atrocious radioactive weapons, which must never be allowed to use.

1. Depleted Uranium Shells

(1) What are DU shells?

The term “depleted” seems to give the impression that DU is uranium that does not contain radioactivity any more, which is not the case. DU ammunition can cause serious radioactive contamination and is no less atrocious than nuclear weapons. Nuclear power plants are really dangerous facilities put in practical use on stipulation that they can “completely seal in radiation,” while radioactive weapons commit an impermissible crime scattering radioactive materials in the environment.

DU weapons were developed as ordnance that could penetrate armored tanks and bounce around inside, burning and destroying them from within.

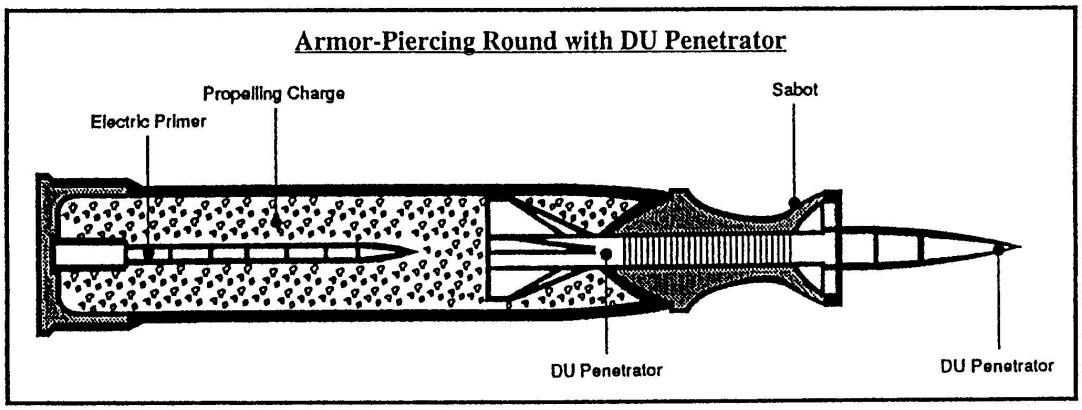
Ordinary shells contain detonating powders, which will explode on impact. Their purpose is to destroy steel-plated tanks from outside, but they are quite inefficient in terms of destructiveness. Steel bullets can hit, punch a hole and penetrate materials softer than steel,

but they are not destructive enough to pierce steel-armored tanks, for they are not effective against bulky steel. This is how DU rounds, “steel-penetrating arrows” were developed as a weapon that could punch a hole through tanks, burn and destroy them from inside, taking advantage of the physical properties of DU – it is extremely hard and dense.

DU metal is the hardest and densest material of all. The density of DU is 19g/cm^3, 2.4 times higher than that of iron, which is 7.9g/cm^3. To enhance the degree of hardness, some 1 percent of molybdenum and titan are put to DU to make an alloy. Slender-shaped DU shells, upon impact, will punch a hole through the target, while becoming shorter with their heads scraped.

(2) DU Weapons as Armor-Piercing Incendiary Ammunition

DU shells are called armor-piercing firebombs, because they not only break through a steel armor but also burn up intensely. As armor-piercing rounds, they would punch out the bulky iron plate of tanks, invade their interior, and bounce around inside killing the combat crew, destroying tank facilities and burn them out. They would hit the target with their enormous momentum and pierce a hole with their kinetic energy. Compared to steel bullets of the same size, which have less density than DU rounds, the latter can make a hole in the target 2.4 times deeper than the former. And, while steel bullets must have the length of 30 cm, DU bullets only have to be 12cm to suite their purpose. Further, when fired, although DU shells receive the same air resistance as steel ones, they have less reduction of speed because they are 2.4 times heavier, which gives them longer range and bigger velocity in impacting the target. Consequently, DU bullets can destroy the target from a distance unreachable for the foe. See Figure 1 for the structure of DU rounds.



Source: U.S. Army

Fig. 1

(3) DU Used in Bunker Busters

Further development has been made in DU weapons. Large-sized munitions called “Bunker Busters,” which penetrate and blow up hard, concrete fortifications located several meters below the surface, have already been used in actual warfare. They are guided weapons in the form of bombs and cruise missiles designed to break through concrete hardened bunkers and other targets. They are loaded with DU penetrators, each of which weighing several tons. It is said that these bombs were used in huge amounts in Afghanistan to wipe out Al Qaeda fighters hiding in mountain caves, and then in Iraq to destroy Iraqi command centers located deep underground. The amount of DU used in Afghanistan and Iraq is estimated at more than 500 tons respectively.

2. Horrible Consequences of Internal DU Exposure

A major characteristic of DU munitions is that they are radioactive weapons. DU is radioactive metal emitting alpha ray, atomic nucleus of helium, accompanied by gamma ray. Energy of an alpha particle emitted from DU amounts to as much as 4.1 MeV (million electron volts), with which it can blow up 100,000 electrons bounding molecules and ionized pairs. However, it only flies short distance, a few centimeters in atmospheric air and not more than 40 micrometers, equivalent to the thickness of one sheet of paper, in body tissue or water. Consequently, the degree of danger of alpha radiation largely differs according to what form of and from where one has been exposed to DU. We should examine each case according to: (A) when DU is outside the body either as cake, or as dust or particles; and (B) when DU dust or particles enter the body.

(A) External Exposure

When DU is in the state of metal, alpha ray, emitted from the uranium atoms existing at a distance of one-sheet of paper thick from the surface of the cake, will not come out of the metal cake. The only alpha ray given out will be the one emitted from the atoms located in the surface of the cake. Solid uranium cake of a few centimeters in diameter only emits several tens of millionths of the total amount of alpha radiations released by the atoms existing inside the solid. To cover up the danger of external exposure I will refer to later, one only has to speak about the state of radiation emitted from solid uranium. Here is an actual example of this: In 1997, when the fact about the U.S. firing of DU shells in Torishima island,

Okinawa Prefecture was disclosed, the U.S. military first tried to clean things up with lies saying “DU is not a radioactive material.” Grilled over the issue, they later had to restate that DU emits less radiation than a television set does.

Uranium burns intensely when heated in the air, and it spontaneously ignites when it becomes dust. This is why DU shells, hitting the target, burn in intense fire upon impact and by the heat created. As long as they stay “outside the body even after becoming particles,” they are not very hazardous. Although the whole alpha rays disintegrate into a size that can effectively be emitted out of the particles, the detected radiation dosage will be far less than the actual dosage, because alpha particles are blocked by environmental substances. Even when emitted over the human body, alpha rays will not go through the skin, slightly affecting the internal organs. In the case of DU existing outside the human body, the exposed dose measured per weight will be low. The nature of slow decay and this is why such DU is considered to be “low-level radioactive,” with its danger often underestimated. This holds true only for the case of DU remaining outside bodies, and it in no way represents the actual danger DU can pose to human bodies. DU dust-like particles can enter human bodies, and once taken into the body, they will become tens of millions times more hazardous. Newly released data indicate that low-level radiation is more likely to cause biochemical abnormalities than intensive high-level radiation (“Consequence of the Chernobyl Catastrophe” edited by E. B. Burkova). It is wrong to make light of the hazard of low-level radiation.

(B) Internal Exposure

When uranium burns into particles, it will enter human bodies ingested with drinking water and food, or inhaled with air. In this case, the whole radiation and chemical toxicity will be released in the body. Effects of chemical toxicity differ according to the state of uranium, whether it is water-soluble or not, but there is no difference in its harmfulness as radiation. A depleted uranium particle of ten micrometers in diameter would release one alpha particle in every 2 hours, totaling more than 4,000 in a year. Alpha rays continue to injure human cells, giving no time for the injured cells to heal. Further, Uranium-238 decays into a daughter nucleus thorium-234, whose half-life is 24.1 day, and Th-234 decays into a granddaughter nucleus protactinium-234, whose half-life is 1.17 days. Pa-234 then becomes another element (U-234; 0.24 million years of half-life), forming a radioactive chain. Th and Pa release electrons to decay (beta decay). Six months later, Th and Pa will have reached “radioactive equilibrium,” having the same radiation dose as U-238. At this stage, the penetrated DU particles now emit alpha particles, beta particles twice as much as alpha,

and gamma rays accompanied with each decay.

As alpha particles does not travel farther than 40 micrometers, the whole damage will be given to the flesh 40 micrometers in radius. The annual radiation dose received by the exposed area of the flesh 40 micrometers in radius would amount to 10 sievert (as described later) only by alpha ray emitted from a depleted uranium particle of ten micrometers in diameter, ten thousand times higher than the dose limit.

One alpha particle passes hundred thousand atoms before it stops, blowing out hundred thousand electrons constituting a molecule. The destruction (ionization) of molecules will damage DNA, or will induce mutation in the cellular structure itself. There will be a great possibility of only one depleted uranium particle causing cancers and organ disorder. With the half-life of DU being 4.5 billion years, there will be almost no change in the rate of alpha emission 10,000 or 100,000 years later. This means once DU is inside the body, one will remain exposed to radiation as long as he/she lives unless it is discharged, while the environment continues to be polluted forever.

Regrettably, investigations carried out by the World Health Organization and other institutions do not go deep into the realities of internal exposure. For example, the U.S. Department of Defense states that it does not find relationship between DU and the cancer incidence in Iraq (from a scientific report made by the Research and Development Corporation on cancers and DU on the Pentagon budget). The investigations conducted by the WHO and European Community made the same conclusion. These researches determine that the radiation level found in Balkan and Iraq is not harmful to health. Yet in reality in both places there are many cases of babies born with birth defects and the high incidence of cancers. What is the purpose of those researches? It is fair to say that their role is to cover up the facts about the damage caused by DU and the responsibility for the use of atrocious weapons. Meanwhile, a non-governmental organization called Uranium Medical Research Center conducted a urine test instead of the environmental research, and found the presence of high levels of uranium in Afghan citizens.

3. Difference between DU Munitions and Nuclear Weapons

(1) Nuclear Weapons

Nuclear Weapons take out immense energy generated by atomic fission of U-235 and plutonium-239 (atomic bombs), or by nuclear fusion converting hydrogen nucleus into helium nucleus (hydrogen bombs). Hydrogen bombs use as detonators high temperature and high pressure produced by atomic bombs. The horrible damage caused by the atomic

bombing of Hiroshima and Nagasaki more than fifty years ago is widely recognized as a testimony to foolishness of humankind.

In Hiroshima and Nagasaki, in terms of activity, several dozen kilograms of radiation were dispersed (this is a simplified explanation, while the activity should be expressed by the number of radioactive atoms to be accurate). This amount of radiation caused tremendous damage. A-bomb radiation is characterized by the process in which an atomic nucleus of uranium is split up into almost exact halves, and the newly produced daughter nucleus with excessive neutrons release electrons from neutrons transforming into protons one after another, so that they can become stable. This process is called beta decay and the electrons produced are named beta rays. Their half-life is very short, and most of them disintegrate violently. This is how extraordinary radiations rushed about in the air immediately after the atomic bomb was dropped, creating a state that could be well described as a melting pot of radioactivity. But these radiation rays rapidly decay with the passage of time, and after weeks, months and years they would finally vanish.

(2) DU Munitions as Radioactive Weapons

Contrary to nuclear weapons, DU munitions do not use either nuclear fission or fusion. Since they are not weapons that cause destruction by producing extraordinary amount of energy, they should be distinguished from “nuclear weapons”. Yet they will disperse radiation in the environment causing grave damage.

Looking into DU munitions in terms of radiation they produce, they have two characteristics.

(A) First, the used amount of radioactive atoms of DU weapons dispersed into environment in the real wars was far beyond that of the atomic bombs dropped on Hiroshima and Nagasaki. It is estimated that in the First Gulf War, 320 to 800 tons of DU were used, scattering indeed 14,000 to 36,000 times more radiation than in Hiroshima. In the recent wars in Afghanistan and Iraq, at least 500 tons of DU shells were said to be dropped.

(B) Second, while most of the radiation released by the atomic bombs in Hiroshima and Nagasaki had very short half-life periods, DU has an extremely long half-life of 4.5 billion years. Dose amount of DU will last in the same level of as ever even after tens of thousands years. Residents in the DU-affected area will have to live forever, for generations to generations, under threat of radiation. Humankind has never experienced such horrible damage of war. Any radioactive weapons, as well as nuclear weapons,

must never be allowed to use.

4. DU and Radiation

(1) Enriched Uranium and Depleted Uranium

Nuclear weapons and power use tremendous energy produced by atomic fission. Atomic fission is an atomic reaction induced when a neutron bounces into an atomic nucleus. Only particular nuclei are fissionable, and those that have been put into practical use are uranium-235 and plutonium-239. Plutonium is produced in nuclear reactors, while U-235 is extracted from natural uranium. Elements with 92 protons in atomic nucleus are called uranium, which has three isotopes according to the number of neutrons in atomic nuclei: U-235 has 143 neutrons; and U-238, 146. Natural uranium contains only 0.7 percent of fissionable U-235 (Table 1), so that in order to cause consecutive fission, it is necessary to enrich U-235. To be used in nuclear power generation, it has to be enriched 2 to 4 percent, and almost 100 percent to be used to make nuclear weapons. The product is called enriched uranium.

After the removal of U-235 in the enrichment process, the content of U-235 in the uranium would be reduced to 0.2 percent. This kind of uranium is so called depleted uranium (DU), because it has minimum fissionable uranium. Most of DU is U-238.

	Characteristic Property	Radioactive Half-life period	Content
^{234}U U-234	Not fissile	2.45 hundred thousands years	0.0054%
^{235}U U-235	Fissile	0.704 billion years	0.711%
^{238}U U-238	Fissile only with high velocity neutron. Transform to plutonium by absorbing a neutron	4.47 billion years	99.283%

Table 1 Natural Uranium

(2) Radioactivity

Radioactivity and Radiation

Atoms consist of a nucleus with electrons surrounding it. Radioactivity is a property of an atom trying to release materials (helium nucleus and electron) and energy from its unstable nucleus to become another atom with more stable nucleus. It is used also intensity of atomic disintegration per second. (Japanese term of “Hoshano” has been used commonly for the meaning of radioactivity and radioactive materials.) This process of the transformation of atom by the release of radiation is called decay. The materials and energy discharged from nucleus are called radiation. There are three kinds of radiation: alpha ray produced by the release of helium from the nucleus of an atom; beta ray, produced by the release of electrons; and gamma ray, produced by the release of energy as electromagnetic wave (Table 2). All uranium is a radioactive element that emits alpha rays, together with gamma rays.

	Emitting material	Electric Charge of emitting material	Penetrating power
Alpha ray	Nucleus of helium	positive bivalent	Small Stopped with thickness of a sheet of paper
Beta ray	Electron	Negative monovalent	Small Stopped with thickness of several sheet of paper
Gamma ray	Electromagnetic wave	Non	Very large

Table 2 Category of Radiation

Half-Life Period

Atomic disintegration always takes place in proportion to the number of atoms existing at the time. A half-life is a period that the number of atomic disintegration (or the number of the

radioactive atoms) is reduced to half. Radioactive half-life for uranium isotopes is placed in Table 1. Comparing different kinds of radioactive materials of the same atomicity, those with more atoms decaying per unit time have shorter half-lives. All radiations, by blowing off the electrons in molecules, change the nature of cells and defunctionalize them, inducing birth defects and cancers. It is said that radiation with greater penetrating power is less effective in blowing electrons.

Biological half-life is a period that the number of atoms ingested inside body is reduced to half by discharging. It was reported that half-period of water-soluble DU compounds is almost one year, while, insoluble particle is much more difficult to go out. The smaller the size of particles, the more difficult to be discharged. To measure biological half-life is very difficult, as only a small part of radiation can be detected from outside of body..

Radioactive Chain

Daughter nuclei produced by the uranium decay are still more radioactive, and granddaughter nuclei produced as their parent nuclei disintegrate are radioactive as well. In this way, uranium forms “radioactive chain,” as it decays. In time, the numbers of chain atoms become balanced if the half-life of daughter nuclei is shorter than that of mother nuclei (radioactive equilibrium), which will lead to a simultaneous or a same ratio of decay of all elements along the line of the chain, just like the flow of the river. In the case of DU, it will reach the equilibrium with daughter and granddaughter nuclei in about six months, with threefold increase of radiation dosage, which makes DU in this stage further hazardous, as described at the section of internal exposure..

Intensity of Radioactivity

The intensity of radioactivity is measured in the number of decays per second (Bq: becquerel) or units of curie. One curie is one gram of radium radiation, quantity of radioactive material that will have 37,000,000,000 decays in one second.

Absorbed Dose

The effective damage of the radiation to human bodies depends on the number of ionization (the number of electrons in the cell molecules blown by radiations). The number of ionization is measured by the quantity of energy radiations gave to the exposed tissues. A unit called gray is called to measure the absorbed dose; one gray is one joule of energy

deposited in 1kg of a material.

Dose Equivalent: Biological Effects

Biological effects varies according to the kinds of radiations, so that a unit called sievert is used to derive a quantity called equivalent dose. For example, one gray of gamma rays is one sievert, while that of alpha rays equivalents to 20 sieverts. This well explains in estimating probabilities of “irreversible damage” which happens when multiple chains of DNA in chromosomes are injured at once and rejoined erroneously, Alpha rays with larger energy and shorter traveling distance are more likely to cause irreversible damage than gamma rays with greater penetrating force, or density of ionization is much larger for alpha ray than gamma ray.

(3) Problem of DU Disposal

Over fifty-years of nuclear arms race in the postwar period not only resulted in the huge stockpile of nuclear weapons but also produced enormous amounts of deplete uranium as wastes. In 1991 the U.S. Nuclear Regulatory Commission announced that 10 billion pounds (4.5 million tons) of depleted uranium wastes are in storage at the U.S. Department of Energy. At the same time, in the uranium enrichment plant in Western Europe, 0.3 million tons of DU wastes were preserved. The disposal and storage of this radioactive material that required an extraordinary cost had become a grave issue of concern. The DOE announced that it would offer DU for free for its applied use. In 1972, Los Alamos National Laboratory made public that it had started a development research on the use of DU as material for anti-attack cannons.

5. Conclusions

In complete disregard of the United Nations and objective facts, the Bush Administration of the United States pushed ahead with a unilateral preventive war against Iraq, under the pretext of “expelling bandits” who commit acts of terrorism and possess weapons of mass destruction. The U.S. even hinted at expanding the war target to the “axis of evils.” Such a war must never be confirmed.

In the war on Iraq, cluster bombs, fuel-air explosion bombs (Daisy Cutter) and other kinds of atrocious weapons were used. What amounts to an impermissible challenge to human beings is that DU rounds were massively used as one of the key weapons in the war.

After the First Gulf War and the Balkan War, where DU weapons had been used, facts about the DU-caused damage were reported. Such damage as several to twenty folds increase in the incidence of cancers and thyroid abnormalities as well as in the rate of babies with birth defects were not only limited to the residents of the affected countries. Those soldiers who had been sent there also suffered the same damage, referred to as Gulf War Syndrome or Balkan Syndrome.

DU munitions were used in huge amount in the war against Afghanistan, and it has already been revealed that high levels of uranium entered the residents' bodies. Iraq, the already DU- contaminated country as the result of the First Gulf War, was once again exposed to this radioactive toxic material. It is inevitable that this country will face further grave consequences. In 1996, U.S. forces conducted firing exercises using DU shells in Torishima, Okinawa. Residents of Kumejima, an island located near the exercise site, are still tormented by the fear toward radiation.

In the 20th century, humankind experienced two world wars that caused massive killings and destruction. The mass destructions in those two wars, with the exclusion of life and cultural heritage, were in some respect "reversible." However, the war with radioactive DU shells bring about a permanent radioactive contamination to the environment of the combat areas, and continuous destruction of life making the residents Hibakusha over generations. DU will cause fatal damage that human being has never experienced before. DU munitions, together with nuclear weapons, must never be allowed to use any more.

With such highly progressed science as it is, now is the time for humankind, if it wish to treasure the civilization it has created, to become determined to renounce forever the use of force as means of conflict resolution. At the same time, all citizens who wish to live in peace must never allow any horrible act of "mobilizing science in the development of arms, which are means of destruction and killing."

Looking straightly at the images of Iraqi children suffering thyroid abnormalities, birth defects, and with their stomach swollen with abdominal dropsy, each one of us must raise voice against DU weapons and against war.

Let us hand over a green earth with abundant human wisdom and rich cultural heritage to our descendants in the 22nd century. For this, I do hope that this article will be found informative.

(This article is written for an educational text of depleted uranium munitions for Japanese general citizen and is translated to English for the World Uranium Weapons Conference 2003.) (August 2003)