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Risks of the Military uses f Depleted Uranium on Humans and the Environment

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Abstract

Great Development in the military industry had been witnessed in the past two decades, especially in depleted uranium weapons. These weapons were first used by USA and its allies in 1991 in Iraq. Later they were used in Bosnia (1995), Kosovo and Serbia (1999) Afghanistan (2001) and finally Iraq (2003).
The manufacturers and users of these weapons continued to blackout the nature of these weapons and deny the harm caused on the public health, animals and the environment.
After a short period of time, facts were revealed by the investigations and research executed by large number of scientists and investigators.
This paper highlights the important effects caused by the use of depleted uranium weapons on human health and environment.

Keywords: Uranium, Enrichment, Depleted uranium, Military applications, DU Weapons, Effectiveness, Chemical and radiological toxicity, Human health hazards: Cancer and Birth deformities.

1 Introduction

Uranium (U) is a natural, radioactive and chemo toxic heavy metal (Figure 1), which is found in traces in rocks, soils, plants and water [1, 2, 3] .

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Figure 1: Uranium ore.

Uranium is a silvery-white metallic chemical element in the actinide series of the periodic table, with atomic number 92. The Chemical symbol for uranium is ”U”. A uranium atom has 92 protons and 92 electrons, of which 6 are valence electrons. The uranium nucleus binds between 141 and 146 neutrons, establishing six isotopes (U-233 through U-238), the most common of which are uranium-238 (146 neutrons) and uranium-235 (143 neutrons).

Uranium has the second highest atomic weight of the naturally occurring elements, lighter only than plutonium-244 [4]. Its density is about 70% higher than that of lead, but not as dense as gold or tungsten. It occurs naturally in low concentrations of a few parts per million in soil, rock and water, and is commercially extracted from uranium-bearing minerals such as uraninite.

Uranium occurs in nature as a decay product as Pitchblend, Uraninite and Carnotite. It can also be found within phosphate deposits in concentrations reaching 50/300 mg/kg. Its concentration in top soil is 0.1 to 20 mg/kg. In sea water, air and surface and ground water it occurs in very low concentrations [5].

Uranium-238 is the most prevalent isotope in uranium ore, having a half-life of about 4.5 billion years. Uranium-238 decays by alpha emission into thorium-234, which itself decays by beta emission to protactinium-234, which decays by beta emission to uranium-234, and so on. The various decay products, (sometimes referred to as "progeny" or "daughters") form a series starting at uranium-238 [6]. The half-life of uranium-235 is 704 million years [7], which is useful in dating the age of the Earth [8-12].

2 Uranium Enrichment

The enrichment process increases the percent of fissionable fuel in the reactor core, leaving the residual depleted uranium with reduced content of ^{235}U and ^{234}U, which is not a fissible material (Figure 2). The chemical and metallic properties of depleted uranium (DU) are largely identical with natural uranium ore of uranium oxides. Natural uranium has a specific activity of 6.77x10-7 A/g, whereas depleted uranium has a specific activity of 3.6x10-7 A/g of uranium material. The isotopic content of ^{238}U in natural uranium is 99.27%; 235U is 0.72 percent, and ^{234}U is 0.006%. The isotopic composition of enriched

uranium is ^{238}U=97.01%, ^{235}U=2.96% and ^{234}U=0.03%. DU contains ^{238}U=99.75%, ^{235}U=0.25% and ^{234}U=0.005%. All three isotopes decay in a cascade of daughter products. However, most of the decay products of ^{238}U are removed in the gaseous diffusion process [13].

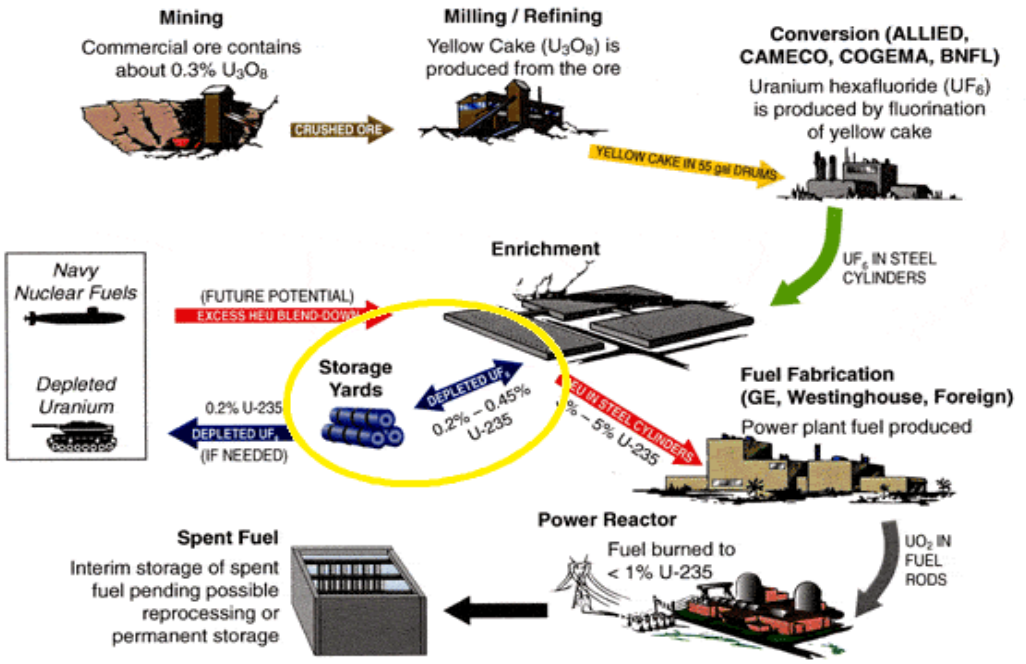


Figure 2: Process of Uranium Enrichment

Uranium enrichment is used to increase the percentage of the fissile U-235.Nuclear reactors typically require uranium fuel enriched to about 3% to 5% U-235. Nuclear bombs typically use ‘Highly Enriched Uranium’, enriched to 90% U-235, although lower levels of enrichment can be used [14].To be considered 'enriched', the uranium-235 fraction should be between 3% and 5%.

The enrichment processes for nuclear weapons and nuclear fuel create about 7 metric tons of depleted uranium for each metric ton of enriched uranium produced [15]. The result is that very large quantities of depleted uranium are produced as waste streams. In 1996, worldwide production of DU was estimated by the European Parliament's Science and Technology Options Assessment (STOA) panel at about 35,000 metric tons [16].

As a result, it is estimated that over 1.2 million metric tons of DU are currently stockpiled worldwide, mostly in the United States [17](Table 1).

Table 1: Isotopic composition of natural, enriched and depeleted uranium

Country	million kgs	%
United States	732	54
Russia	430	32
France	135	10
Urenco*	29	2
United Kingdom	30	2
China	20	1.5
Others**	5	0.3

* Urenco operates plants in Germany, the Netherlands, and the United Kingdom, **Japan, South Africa, etc

Over the past-half century, 732,000 metric tons of DU- more than half of all the uranium ever mined in the world - was produced at three uranium enrichment plants in Oak Ridge, Tennessee, Paducah, Kentucky, and Portsmouth, Ohio [15]

3 Depleted Uranium (DU)

Uranium 235 is by far the most radioactive isotope. This is the one that the nuclear fuel and weapons industries try to extract from the naturally occurring metal. When extracted it called "*enriched uranium*". This is what is used in fuel rods and nuclear weapons. What is left over after the extraction process is called "*depleted uranium*". Depleted Uranium is still a mixture of the 3 isotopes of uranium, but it is mainly made up uranium 238.

This process produces huge quantities of uranium that is depleted of uranium-235 and with a correspondingly increased fraction of uranium-238, called depleted uranium or 'DU' [18]. To be considered 'depleted', the uranium-235 isotope concentration should be no more than 0.3%. The price of uranium has risen since 2001, so enrichment tailings containing more than 0.35% uranium-235 are being considered for re-enrichment, driving the price of DU hexafluoride above $130 per kilogram in July, 2007 from $5 in 2001[19].

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 [20].

The US Nuclear Regulatory Commission (NRC) classifies DU as a source material, governed by general and specific licenses. General license governs the use and transfer of DU in the amount of a maximum of 15 pounds at a given time and a maximum of 150 pounds in a calendar year. The specific license applies to larger quantities of DU. The licensing requirements include written documentation of the intended use of DU equipment, environment and health and safety compliance as well as the training of personnel [21].

The US Nuclear Regulatory Commission defines depleted uranium when it contains U-235 less than 0.711% (Abdulfatah, 2003). The Us military are using DU having U-235 concentration of about 0.4% [22]. Table 2 shows the Uranium isotopes.

Table 2: Uranium production in different countries.

Percent in uranium			
Isotope	**natural**	**Enriched**	**depleted**
U-238	99.2739	97.01	99.745
U-235	0.72	2.96	0.250
U-234	0.9957	0.03	0.005

3.1 Military Applications of DU

According to the International Atomic Energy Agency (IAEA) in Vienna, **Uranium (U)** is mined in at least 25 countries; this figure will likely expand to over 30 countries in the future)IAEA 2008(.The United States has the Word's Largest Inventory of Depleted Uranium (Table 1) [15].

The building projected for the storage of depleted uranium in oxide form at Urenco's Gronau enrichment plant is to be completed by 2014. Its capacity will be 50,000 t U, or approx. 60,000 t U_3O_8. According to the current plans, dating back to 2005, the building will not be designed to withstand an airplane crash [23].

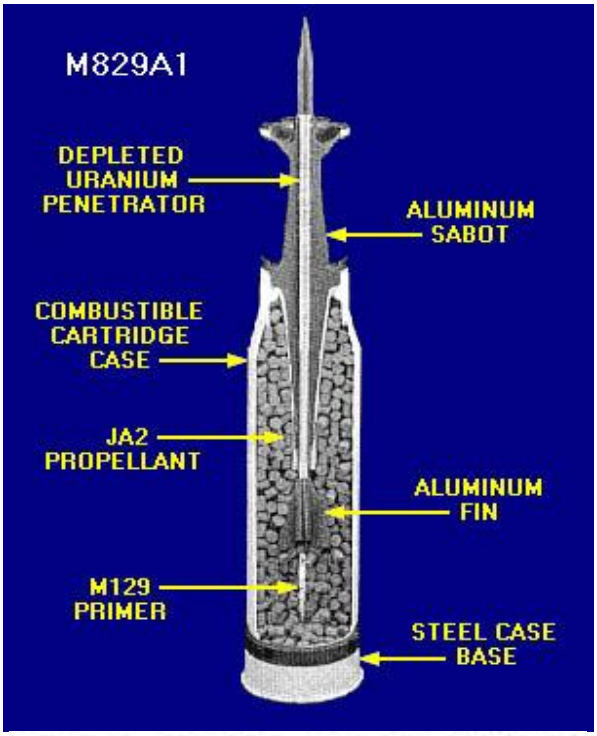
As mentioned earlier, very large quantities of depleted uranium are produced as waste streams. For nuclear weapons, one kilogram of highly enriched uranium creates about 200 kilograms of depleted uranium. Effective management of waste uranium compounds is necessary to prevent exposure to avoid adverse health effects on the population. DU is also used in non-military products such as cement, fertilizers and certain paints [24].

The properties of DU (high density and pyrophoricity in particular), have made DU ideal for military applications of armor-plating and armor-piercing munitions [25].It is highly valued by the military, who use it in the tips of armour-piercing weapons. The material's high density and self-sharpening properties help it to penetrate the armor of enemy tanks and bunkers. DU is 1.7 times denser than lead, giving DU weapons increased range and penetrative power. It belongs to a class of weapons called kinetic energy penetrators. The part of the weapon that is made of DU is called a penetrator: this is a long dart weighing more than four kilograms in the largest examples: it is neither a tip nor a coating **.**

The penetrator is usually an alloy of DU and a small amount of another metal such as titanium and molybdenum. These give it extra strength and resistance to corrosion [26]. DU armour-plating is also more resistant to penetration by conventional anti-tank munitions.

3.2 DU Weapons

The Gulf War marked the first battlefield use of armor-piercing munitions and reinforced tank armor that incorporated DU, and the Balkans War marked another one. The use of DU in military weapons is mainly for two reasons. First, there are huge quantities of DU produced (US has 800 000 ton of DU) and getting rid of the waste is highly expensive process. Secondly, DU has high density which enables DU to penetrate armored tanks and vehicles (Figures 3 and 4).



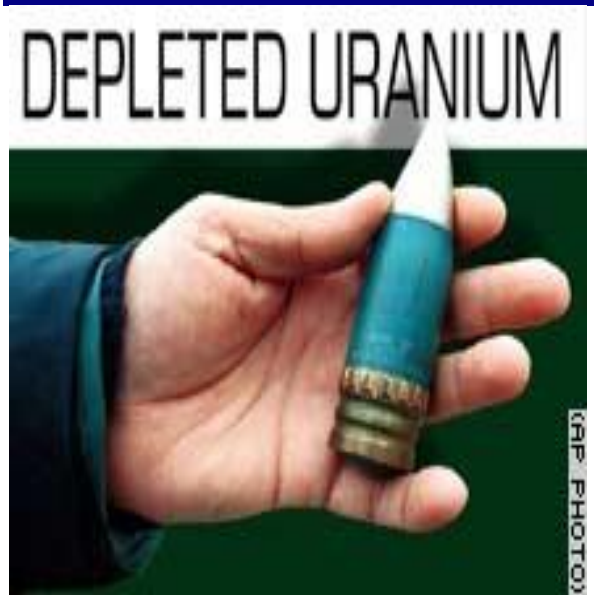


Figure 3: DU shell.

Figure 4: Types of depleted uranium shells

3.2.1 Effectiveness of uranium ammunition against target

Physically, DU is extremely dense and pyrophoric, spontaneously igniting and burning upon impact. Its pyrophoricity gives it an edge unlike other metals with similar densities, such as tungsten. The temperature on impact might reach 6000^0C (Figure 7).The Pentagon uses DU shells because their high density allows them to effectively penetrate steel armor. They have devastated thousands of Iraqi tanks in both wars, cutting through their armor like a hot knife through butter. An otherwise useless by-product of the uranium-enrichment process, DU is also attractive to military contractors because it is so cheap, often offered for free by the government. But DU is an environmental and health disaster [27]. The problems occur because DU shells burn on impact, releasing microscopic, radioactive and toxic dust particles of uranium oxide that can travel hundreds of miles with the wind. [28]. The material's high density and self-sharpening properties help it to penetrate the armour of enemy tanks and bunkers.Its hardness and density also makes it ideal for anti-tank missiles (4 or 5 kg tank -fired shells and 0.3 kg 'penetrators' fired from aircraft). On penetration, DU rapidly burns spontaneously to a fine aerosol smoke of uranium oxide. About 20% is burned, so that a large penetrator

generates about 1 kg of uranium oxide dust [29].
In addition to armour-piercing penetrators, DU is used as armour in US M1A1 and M1A2 battle tanks and in small amounts in some types of landmines (M86 PDM and ADAM), both types contain 0.101g of DU in the resin cases of the individual mines. 432 ADAM antipersonnel landmine howitzer shells were used on the Kuwaiti battlefields during the 1991 Gulf War (Table 3). Both M86 PDM and ADAM mines remain in U.S. stockpiles. Patents exist for the use of a 'dense metal' as ballast in large 'bunker busting' bombs; such weapons have been deployed but it is unclear whether they contain DU, tungsten or a third high density substance, as their contents remain classified [26].

Table 3: Selected DU ammunition in the US arsenal

Ammunition type	Caliber [mm]	DU weight [lb.]	DU weight [g]	Weapons system	Branch
M829A1, M829A2 (APFSDS-T)	120	11.8	5,350	M1A1, M1A2 Abrams Tanks	US Army US Marine Corps
M900 (APFSDS-T)	105	9.4	4,246	M1 Abrams Tank	US Army
M833 (APFSDS-T) M774 (APFSDS-T)	105	8.1 7.4	3,668 3,355	M60A3 Tank	Obsolete
PGU-14 (API)	30	0.66	298	A-10 Thunderbolt II Aircraft **(same as A-10 Warthog Aircraft)**	US Air Force
M919 (APFSDS-T)	25	0.21	97	M2, M3 Bradley Fighting Vehicles LAV-AT Light Armored Vehicle	US Army US Marine Corps
PGU-20 (API)	25	0.33	148	MK-38 Heavy Machine Gun AV-8B Harrier II Aircraft	US Navy US Marine Corps
MK149-2 (APDS)	20	0.15	70	Phalanx CIWS Missile Defense Gun	US Navy
MK149-2 (APDS)	20	0.15	70	Phalanx CIWS Missile Defense Gun	US Navy
MK149-2 (APDS)	20	0.15	70	Phalanx CIWS Missile Defense Gun	US Navy

APFSDS-T: Armor Piercing Fin Stabilized Discarding Sabot with Tracer
APDS-T: Armor Piercing Discarding Sabot with Tracer
APDS: Armor Piercing Discarding Sabot
API: Armor Piercing Incendiary

The major application of uranium in the military sector is in high-density penetrators. This ammunition consists of depleted uranium (DU) alloyed with 1–2 % other elements. Depleted uranium as used by the US military contains the isotope U-236 , which is not present in natural uranium. This isotope arises only in nuclear reactors and its presence indicates that the DU batch contains some uranium from the waste streams of reprocessing spent nuclear fuel-carried out mainly by France, the Russian Federation, the United Kingdom and the United States. Thus there are two types of depleted uranium—both come from the enrichment process, but one includes small amounts of reprocessed uranium from spent nuclear fuel [17] DU is hardened by reduction of the carbon content and by alloying with 0.75% by weight (3.7% by stoichiometry) of titanium[30, 31].

The high density of DU (19 g/cm3) makes it a superior armor-penetrating material [32]. In the US Air Force DU is alloyed with 0.75% titanium. The US Navy has used the alloy of 2% of molybdenum, whereas the Army has used an alloy (QUAD), containing 0.5% titanium, 0.75% molybdenum, 0.75% zirconium, and 0.75% niobium. DU metal does not differ from natural uranium in its chemical properties and internal contamination with DU poses the same chemical toxic hazard as natural uranium. It oxidizes at room temperature as well as in water vapor, which necessitates the use of aluminum protective coating [33].

The aluminum sabot of a DU tank round drops off within the first 100 m of the trajectory and the bare DU projectile then moves with velocity 1.5 km/sec. Surface of a DU penetrator ignites on impact (especially with steel), partially liquefies due to the high temperature generated by the impact and relatively low melting point of uranium (1132ºC), and the projectile sharpens as it melts and pierces the heavy armor [34].

Depleted uranium impacts are often characterized by a small, round entry hole(Figure 6). If the penetrator goes through the target, the exit hole is also round and slightly larger than the entry hole [35]. For example, 30 mm DU rounds from GAU-8A automatic cannon mounted on A-10 Warthog aircraft can pierce steel armor up to 9 cm (3.5 in.) thick. Selected DU penetrators in the US arsenal are listed in table 3 taken from [35] and [36] and updated [37].Table 3 shows some of DU ammunition in the US arsenal.

Submunitions such as the PDM and ADAM whose structural body contains a small proportion of DU. Many other countries now produce or have acquired DU munitions. DU is also used as armor, ballast or counter weights, radiation shielding, and as proposed by the U.S. Department of Energy as a component of road and structural materials. All of these current or proposed uses are designed to reduce the huge U.S. Department of Energy stockpiles left over from the uranium enrichment process.

DU munitions were first used extensively in the First Gulf War (1991), in Bosnia (1995) and Kosovo (1999) and continue to be used in Iraq since 2003 and perhaps in Afghanistan since 2001[17] . In Iraq, The UN Environment Programme (UNEP) estimates that shells containing 1700 tonnes of the material were fired during the 2003 war [38].

The use of DU became politically and environmentally contentious after the use of DU munitions by the US, UK and other countries during wars in the Persian Gulf and the Balkans raised questions of uranium compounds left in the soil (see Gulf War Syndrome, The Gale Group, Inc).

3.2.2 Perfect weapon for killing lots of people

The use of battlefield uranium weapons (Figure 5) has been classed by some as weapons of indiscriminate effect; as such they would be implicitly illegal under various

conventions of war [39]. Nichols [40] asked Marion Fulk if the main purpose for using depleted uranium was for destroying things and killing people, Fulk, a consultant physicist at The Lawrence Livermore Nuclear Weapons Lab, is one of the original Manhattan Project scientists was more specific: "I would say that it is the perfect weapon for killing lots of people" [41].According to famed former Lawrence Livermore Nuclear Weapons Lab scientist Leuren Moret :" Since 1991, the continued U.S. military use of dirty bombs, dirty missiles and dirty bullets threatens humanity and all living things ... and is turning Planet Earth into a death star." [42]

Figure 5: DU ammunition are dangerous.

Prof. Rosalie Bertell, a respected scientist who serves on a variety of Pentagon committees, an epidemiologist with 30-years experience in the field of low level radiation, a consultant to the US Nuclear Regulatory Commission, the US Environmental Protection Agency, and to Health Canada, and was president of International Institute of Concern for Public Health, says: about 1.3 billion people have already been killed, maimed or diseased since the nuclear age started. Is this the Pentagon's purpose for using uranium munitions and rejecting the legally mandated task to treat and clean? Most reasonable people would agree that racking up 1.3 billion people killed or maimed since the beginning of the nuclear age and the American uranium bombing tragedy... The plain purpose of exposing hundreds of millions of people would seem to be to kill and sicken more people. As a rare Pentagon admission said, "The properties of uranium do not change" [43].

Trends toward increased use of DU by industry and, more recently, in warfare suggest that there are large and growing numbers of exposed people worldwide, both at production sites and in areas where DU weapons are deployed. While there is no clear basis for estimating the number of people who have been breathing and ingesting food and water in areas contaminated with aerosolized DU particles, the ever-expanding exposure of humans and the environment to DU particles necessitates a sense of urgency to better understand this hazard.

3.2.3 What are the DU shells?

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 12 cm 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 [20].

A major characteristic of DU munitions is that they are radioactive weapons.

Prof. Seigwart Horst-Günther, a Germany physician and expert radiation and nuclear medicine, her investigations following the cease fire in Iraq 1991 showed that the radiation dose on the surface of DU shells used in the war was 11 μSv (Microsievert) per hour, while the radiation dose allowed in Germany is 300 μSv per year. This suggests that the annual dose allowed in Germany is given in one day in Iraq [44]. On January 16th 2002 the American Secretary for Defense Donald Rumsfield in a briefing confirmed that "high levels of radioactive counts" had been confirmed due to the result of DU shells [45].Prof. Katsuma Yagasaki had calculated that 800 tons of DU to be the atomicity equivalent to 83 thousands Nagasaki bombs. With each round fired by an Abrams tank containing over 4,500 grams of solid uranium it was estimated the amount of DU used in Iraq is equivalent to 250 thousands Nagasaki bombs. Scientist Leuren Moret stated that "DU dust is now everywhere. A minimum of 500 – 600 tons now litter Afghanistan, and several times that amount are spread across Iraq. In terms of global atmospheric pollution the US had already released the equivalent of 400 thousands Nagasaki bombs" [5].

Prof. Asaf Durakovic a retired U.S. Army colonel in the US Army Medical Corps,was put in charge of Nuclear Medicine Service at the Department of Veterans Affairs Medical Center at a veterans' hospital in Wilmington, Delaware, an scientist who recovered of the real reasons of Gulf War Syndrome, stating that the legacy of radioactive waste, environmental and health hazards in the nuclear industry, and, more recently, the military use of depleted uranium in the tactical battlefield necessitates further insight into the toxicology of depleted uranium. The present controversy over the radiological and chemical toxicity of depleted uranium used in the Gulf War warrants further experimental and clinical investigations of its effects on the biosphere and human organisms [18].

On impact, when DU projectiles penetrate armored vehicles, it breaks up and causes secondary explosions (Figure 7). Uranium penetrates burn fiercely to give an aerosol of sub micron diameter oxide particles, which are largely insoluble and remain in the environment for many years. When a DU shell hits a hard target, the projectile "sharpens as it melts and pierces heavy armor". Upon impact, it ignites and aerosolizes, forming tiny particles suspended in air and dispersing them over an area. Depending on several conditions, anywhere between 18-70% of the DU penetrator oxidizes to form suspended aerosols comprised of 50-96 % respirable DU report 4 pm 7,4-size particles. Alloying DU with a small amount of other metals, such as titanium, reduces its carbon content [37]. The invisible metal fume created at extremely high temperatures when a DU shell hits a

tank. DU ignites pyrophorically on impact and at temperatures reaching 3,000-6,000 degrees Centigrade [46].Some of the uranium vaporizes into extremely small particles, which are dispersed into the atmosphere where they remain until they fall to the ground with the rain. In fact, particles of DU oxides were detected more than ten miles from a National Lead DU munitions plant in Colonie, NY years ago, causing the State of New York to shut down the plant for excessive release of radioactive materials into the environment [28]Respected scientists reported on the unrevealed gas cloud after conducting research on specialized high volume air filters in England. Chris Busby and Saoirse Morgan stunned Europe in scientific paper, released 2006 [39].
When tanks are struck by DU projectiles(Figure 6), depending on the material and thickness of their armour, about 70 % is volatilized into an aerosol that immediately burns to uranium oxides (Figure 7) that may remain in high concentrations in enclosed spaces, i.e. tanks and bunkers, when a cloud of uranium oxide dust size less than 5 microns [46]. Mohammed Al-Shekhly ,a nuclear scientist, emphasizes its 44% of the uranium oxides have sizes less than 1 micron [47].

Figure 6: Shoot of DU bullet.

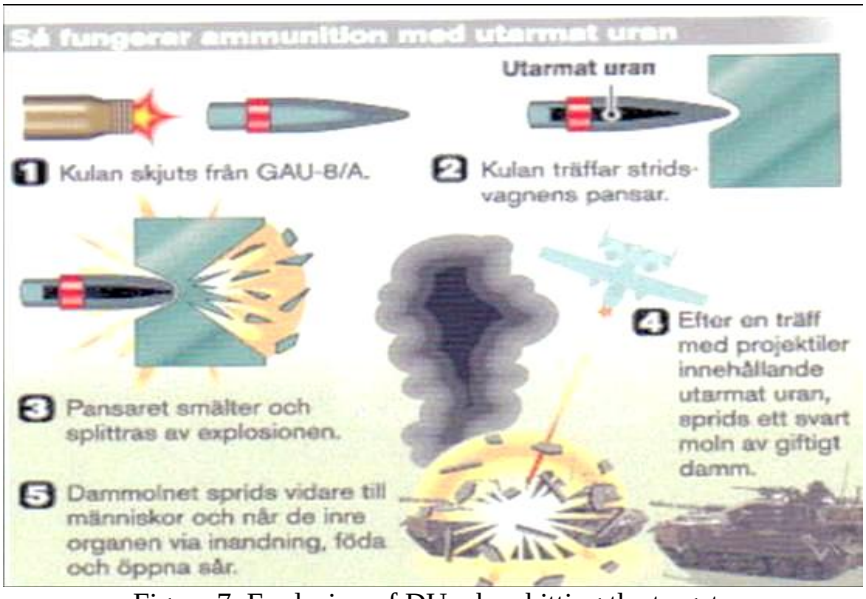


Figure 7: Explosion of DU when hitting the target.

An impact of a 150 mm DU penetrator releases 2.4 kg of airborne DU(Figure 8). Half of the airborne DU particles sampled during the testing of 105 mm DU projectiles were in the respirable range. They reached the non-ciliated portion of the bronchial tree. An aerodynamic equivalent diameter (AED) of 10 micron is considered non-respirable, 5 micron being 25%, 3.5 micron 50%, 2.5 micron 75%, and 2.0 micron 100% respirable [48].Uranium oxide is considered relatively insoluble, whereas uranium dioxide is moderately soluble) Durakovic[18] (..The small DU particles, (<10 ím) can be inhaled deeply into the lung, leading to longer retention and thus longer exposure.

Figure 8: Emission of uranium oxide particles

The radioactivity as a result of the decay progeny of 238U poses a ionizing radiation hazard of inhalation. Uranium isotopes and their decay products are alpha (α), beta (β), and gamma (γ) emitters, with spontaneous fission below the level of criticality. In the decay process of 238U, its daughter products 234Th and 234Pa reach secular equilibrium with their parent isotope in approximately 6 months, decaying at the same rate as 238U [18].

The reality of the legacy of DU waste and its use in the recent tactical warfare warrants detailed studies regarding its effect on the biosphere and the human population. One milligram of DU generates over a billion alpha and beta particles per year, which, together with gamma emitted radionuclides of 238U progeny (234Th, 234Pa), causes internal radiation hazards [18]. Prof. Bertell confirms that One milligram of U-238 can give off more than one million alpha particles in one day . Each alpha particle releases over 4 MeV (million electron volts) of energy, in a spherical direction, which will hit cells randomly up to 6 or so cells away in an organ or tissue. Just 6-10 eV (electron volts) are needed to cleave the nuclear DNA strand in a cell [46].

4 Chemical and Radiological Toxicity of Depleted Uranium

Exposure to the isotopes of uranium produces both chemical and toxic hazards to humans and has been studied extensively from the early data on uranium miners to the most recent controversy of depleted uranium in the Gulf War. Radioactive ore dust inhalation and its risk due to internal contamination with ^{238}U, ^{234}U, ^{230}Th and ^{226}Ra, have been well documented in the literature in studies from different parts of the world [49]. Uranium

dust may do permanent damage to the lungs resulting in chronic respiratory problems [50, 51].

4.1 Radiation Hazards of Alpha Particles

Alpha decay is one example type of radioactive decay, in which an atomic nucleus emits an alpha particle, and thereby transforms (or 'decays') into an atom with a decrease in mass number and atomic number by 4 and 2 respectively (Figure 8). Many other types of decays are possible [8-12].

Modern scientific studies reveal that the particles are the primary radiation hazard(Figure 9). These 'α' particles do pose a potential hazard upon inhalation, ingestion, or contamination of open wounds. 'β' and 'γ' radiation, although present in much lower activities, do represent a potential external radiation hazard [52]. These complicate the radiobiology considerably, because beta particles have much longer ranges in tissue, affecting large numbers of cells to a minor (possibly carcinogenic) extent, as opposed to the small number of cells heavily affected (probably killed) by the alpha particles. It should be notaed that the first daughter nucleus of both uranium -235 and uranium-234 is relatively long lived, so neither contributed significantly to the radioactivity of natural uranium. Thus DU is actually quite as harmful as natural uranium in terms of beta radiation [53].

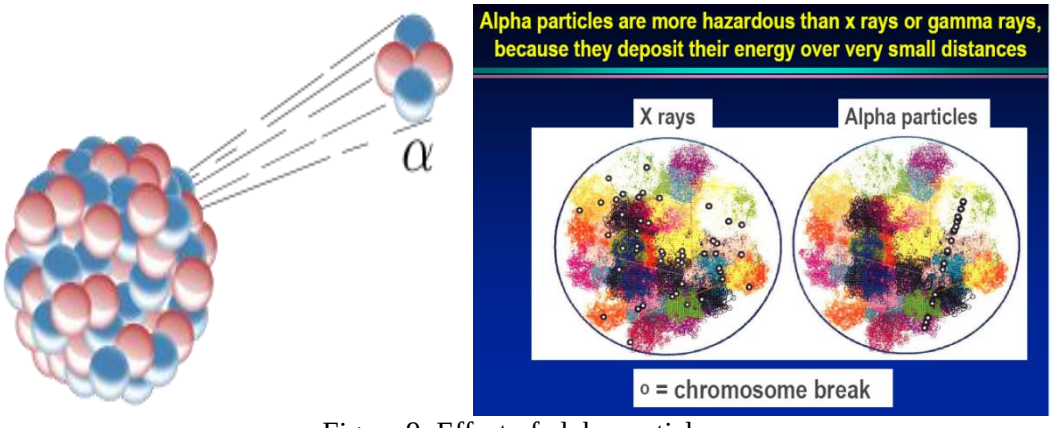


Figure 9: Effect of alpha particles.

Explosions and fires involving the DU products result in DU dust, which leads to significant inhalation of DU particles [54]. Uranium dust may do permanent damage to the lungs resulting in chronic respiratory problems [50, 51]. There are 3 major uranium oxides produced by burning, these are UO_3, U_3O_8 and, known as uranium trioxide, triuranium octoxide and uranium dioxide, UO_2. Although uranium is one of the densest metals known, the oxides in the smoke and dust are not so dense and remain suspended in the air for a long time. These aerosols can contain very small particles of uranium oxide of between 0.1 and 10 microns in diameter, which can be inhaled and deposit in the lungs. White blood cells scavenge these particles and transport them to tracheo-bronchial lymph nodes for lengthy periods. These particles are usually insoluble, and are unlikely to be detected in urine samples [26]. Therefore the practice of routine urine sampling of returning soldiers may be ineffectual at detecting uranium oxide exposure [17].

In their search for cellular and molecular mechanisms involved in depleted uranium toxicity, Pourahmad and colleagues concluded that Uranyl acetate (UA) cytotoxicity is associated with mitochondrial/ lysosomal toxicity by the reduced biological metabolites and ROS [55]. Goldman and colleague found that uranyl acetate caused a decrease in glucose transport in BBMV. This is the first report showing a direct inhibitory dose and pH dependent effect of uranyl on the glucose transport system in isolated apical membrane from kidney cortex)[56] .

Very small particles of UO_2 (<0.01 micron) seem to dissolve relatively fast and are absorbed from lung as quickly as soluble uranium compounds [57]. Particles of either UO_2 or U_3O_8 with average diameter of 0.5 microns cause much greater lung damage in animals than particles with average diameter of 2.3 microns or larger [58]. Larger particles tend to get removed from the lungs in phlegm. The toxicity depends on many factors, including not only size of the particles, but how the particles were prepared, how they are administered (dry or in a liquid) and many other factors [59].

Periyakaruppan et al [60] have shown in previous study the effectiveness of antioxidant system response to the oxidative stress induced by uranyl acetate (UA) in rat lung epithelial (LE) cells. They investigated the mechanism underlying when LE cells are exposed to different concentration of UA. Oxidative stress may lead to apoptotic signaling pathways. The cytochrome-c leakage may trigger the apoptotic pathway. TUNEL assay performed in LE cells treated with 1 mM of UA showed significant incorporation of dNTPs in the nucleus after 24 h. In the presence of the caspase inhibitors, they observed the significant decrease in the activity of caspases-8 and -3 in 0.5 and 1 mM UA-treated LE cells [60].

4.2 New Properties

It is now known that the alpha particles of DU have some characteristic properties , such as bystander affects, even that no safe low level radiation. It can be concluded that there is no safe dose for uranium and there is no so-called “no-observed adverse-effect level (NOAEL) for uranium [3]. It is important to acknowledge that neither natural background radiation, nor man-made artificial radioactivity have any positive effect on health and environment [61].

Results in epidemiology show strong evidence that even low dose irradiation causes serious diseases [62]. According to EU guideline (67/548/ EWG), U and U compounds must be labelled as “very toxic” for inhalation and ingestion [63].

Radioactive wars with low level radiation will mutilate the DNA of all exposed living things. This is not just a war against people; it is a war against the environment. Few living things will escape the slow radioactive poisoning which mutilates DNA and is passed on to all future generations [42].

Even low doses of low-level radiation can cause some damage to the DNA in living cells (Figure 9),. Evidence has emerged recently that the cell may also exhibit the phenomenon of “genomic instability”, where the progeny of an irradiated cell may unexpectedly become highly susceptible to general mutation. This may also occur in the progeny of cells close to the cell which is traversed by the radiation track but which themselves are not directly hit ("bystander effect").

4.3 The Bystander Effects

The Radiation-Induced Bystander Effect (Bystander Effect) is the phenomenon in which unirradiated cells exhibit irradiated effects as a result of signals received from nearby irradiated cells (Wikipedia, the free encyclopedia). This bystander effect suggested that irradiated cells secreted a molecule into the culture medium that was capable of killing cells when that medium was transferred into unirradiated cells (Figure 10). By contrast, medium irradiated in the absence of cells had no effect.

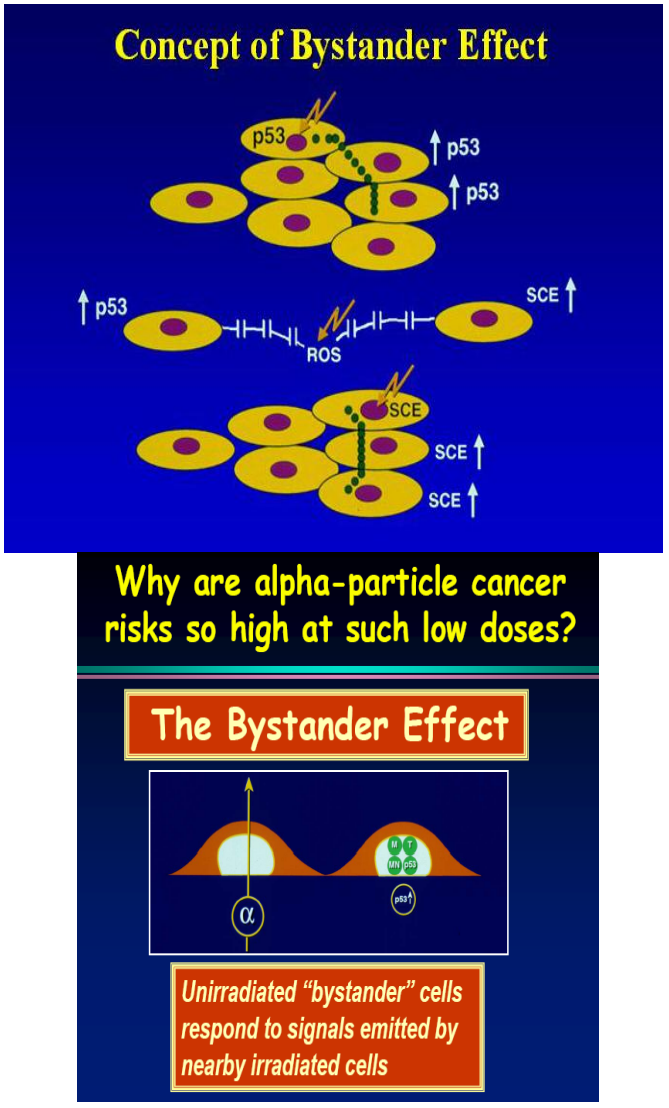


Figure 10: The Bystander effect.

The bystander effect refers to the induction of biological effects in cells that are not directly traversed by a charged particle. Bystander studies imply that the target for the Bio -logical effects of radiation is larger than the cell and this could make a simple linear extrapolation of radiation risks from high to low doses of questionable validity [64-67].
In the radiation field, following a low dose of alpha particles, a larger proportion of cells

showed biological damage than were estimated to have been hit by an alpha particle [65](Fig.11).
There is evidence that targeted cytoplasmic irradiation results in mutation in the nucleus of the hit cells [68, 69]. Cells that are not directly hit by an alpha particle, but are in the vicinity of one that is hit, also contribute to the genotoxic response of the cell population [70, 71]. This effect may also contribute to the final biological consequences of exposure to low doses of radiation [72, 73].
Lung cancer risks associated with low level alpha particle damage have been established through epidemiological studies on radon [74, 75]. Results in epidemiology show strong evidence that even low dose irradiation causes serious diseases [62, 76].

4.4 The Toxicity of Depleted Uranium

Before the war in the 1991 there was a little information is available on the mechanisms of DU toxicity at the molecular level. But now the DU is becoming a major international concern as a possible health hazard and carcinogen. Little is currently known about DU mechanisms of effect, but reported data indicate that DU may cause many cytotoxicity & genotoxicity, lung cancer [54, 77, 78, 79] embryotoxicity and teratogenicity [80], reproductive and developmental damage [81], genomic instability [82], and single strand DNA breaks [83]. These results suggest that the DNA damage caused by U is reversible at low concentration (200-400 microM) but becomes irreversible and leads to cell death for higher concentrations (500-800 microM) [84](Fig.9).
Hexavalent chromium, a known human lung carcinogen, causes a similar spectrum of chromosome aberrations including chromatid and isochromatid lesions [85-87]. DU may directly target the mitochondria, leading to apoptosis [88, 89, 90]. The carcinogenicity and genotoxicity of DU aws investigated by [25]. Radiation, in general, may induce both deterministic and stochastic health effects [91, 92].
Most of the epidemiologic data with regard to human exposure to U that show increases in cancer morbidity and mortality are associated with either radon or other chemical confounders [79]. Chromosomal analysis performed on blood samples from war veterans exposed to DU 10 years prior shows aberrations typical of exposure to ionizing radiation [93]. Studies in human osteosarcoma cells indicate that DU can induce transformation [94, 95, and 96] and cause cytotoxicity, genomic instability, and micronuclei formation [82].
Animal studies with DU fragments were found to induce mutations in several key oncogenes, to induce serum mutagenicity, and to cause soft tissue sarcomas in muscle tissue [97-100].

4.5 Synergism between the Chemical and Radiation Effects of DU

Toxicological synergy is of concern to the public and regulatory agencies because chemicals individually considered safe might pose unacceptable health or ecological risk in combination. The United States Environmental Protection Agency has one of the more detailed and precise definitions of toxic interaction, designed to facilitate risk assessment. In their guidance documents, the no-interaction default assumption is dose addition, so synergy means a mixture response that exceeds that predicted from dose addition. The EPA emphasizes that synergy does not always make a mixture dangerous, nor does antagonism always make the mixture safe; each depends on the predicted risk under dose addition [8-12].

Many studies clearly indicate that DU has both chemically and radiation induced effects. An important question is whether synergism exists between these two effects, i.e. whether they potentiate one another. There is suggestive evidence for this:

• synergistic responses when nickel exposures are combined with gamma radiation [101];

• bystander cells (i.e. unirradiated) are vulnerable to both radiation-induced and chemical induced effects [102].

Scientist Alexandra Miller and her team specifically proposed that DU's radiological and chemical effects might play tumor-initiating and tumor-promoting roles [103]. In addition, the Royal Society stated: One could speculate … that the potential for synergistic effects between the radiation and chemical actions of DU would be greatest in the vicinity of particles or fragments of DU, from which essentially all the surrounding cells are chemically exposed and may thereby be sensitized to the occasional radioactive decay particle[77].

Regarding to the chemical and radiological toxicity of DU have been reported to cause genotoxic effects in short term [25, 79, 101,103-109]. Further studies were required to examine the possibility of synergy between the chemical effects and radiation effects of DU. The NRC report also recommended that studies be conducted to determine the relative contribution of chemical and radiological mechanisms of uranium carcinogenesis. It added that if the chemical contribution were found to be substantial, studies should then be undertaken to calculate cancer risks resulting from DU's combined chemical and radiological effects [17].

4.5.1 Wide range of Human Health Hazards

Exposure to the DU is both chemical and radiological toxic. Routes of individual exposure to DU are inhalation, ingestion, dermal contact or injury (e.g. uranium shrapnel) (Figure 13). The solubility and particle size of the DU and the route and duration of exposure determine its radiochemical toxicity [22]. It may cause many toxic effects – direct: roasted the Human and smelting the Iron (Figure 11) and indirect (Figure 12) in human cell: cytotoxicity, clastogenicity, DNA damage, genomic instability, chromosome mutations, teratogenicity, embryo and others reproductive and developmental damage. micronuclei formation. DU hazards the lung, kidney, brain, bone, CNC, immunosystem, and others.

Figure 11: Effects of DU dust: Direct effect: roasted the Human and smelting the Iron

Figure 12: Effects of DU dust: Indirect: by the inhalation, ingestion, dermal contact or injury

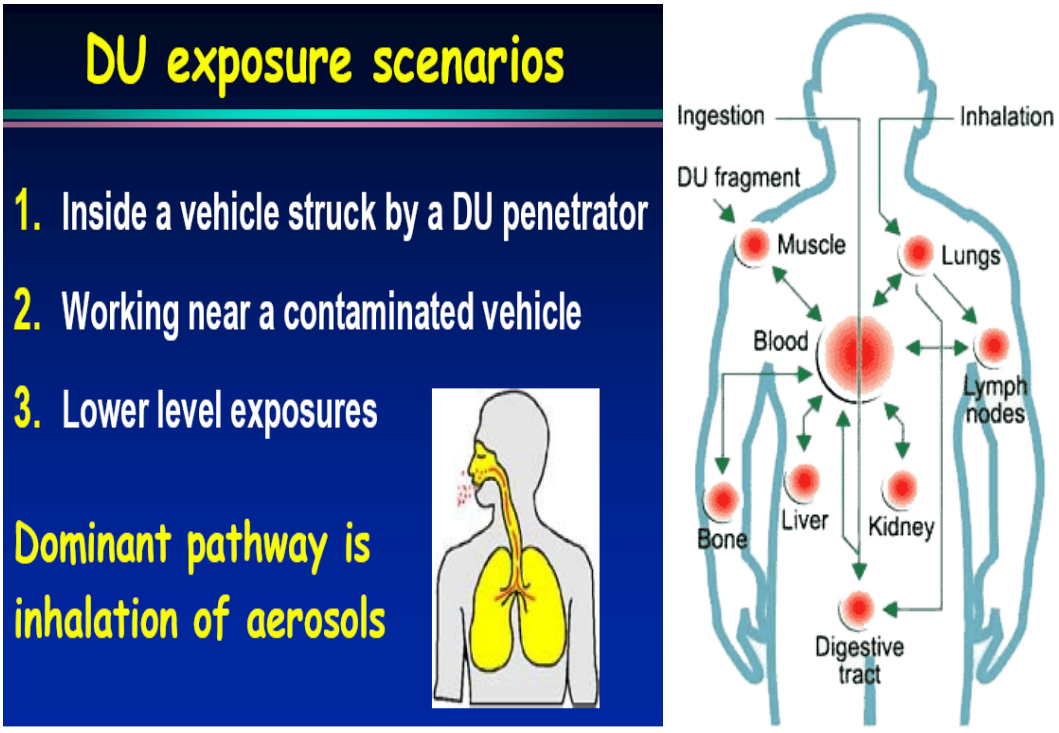


Figure 13: Internal exposure to DU.

The exposure is being acute (Figure 15) and chronic.Exposure of soldiers and non-combatants to DU is potentially frequent and widespread. Military personnel, civilians and the DU muni -tions producers are being exposed to the DU aerosols that are generated. Uranium compounds are toxic. Their toxicity is mediated either by their radioactivity or their chemical properties. The risk of either hazard depends upon the

amount and route of exposure, solubility and length of stay of the residues in the body. Objective assessments are difficult as no measurements of the amounts of DU in the body were made soon after the Gulf war, even in those at particular risk, and measurements of amounts in urine may not reflect amounts of dust in the lungs. While concerns have been raised about whether DU exposure could have caused some of the symptoms many of the veterans experience, a scientific understanding of the effect of DU on health is still evolving. The radiation effects of internally deposited DU depend on the quantity, particle size, solubility, portal of entry, and physiological pathways that determine its metabolic fate [18].The major route of exposure to DU is through inhalation (Figure 13) of particles [77, 79]. Thus human bronchial cells (HBC) are a primary target of DU's effects; however, the effects of DU in the lung (Figure 14) are poorly characterized [110]. Less soluble uranium compounds are not as readily absorbed in the respiratory system [111].

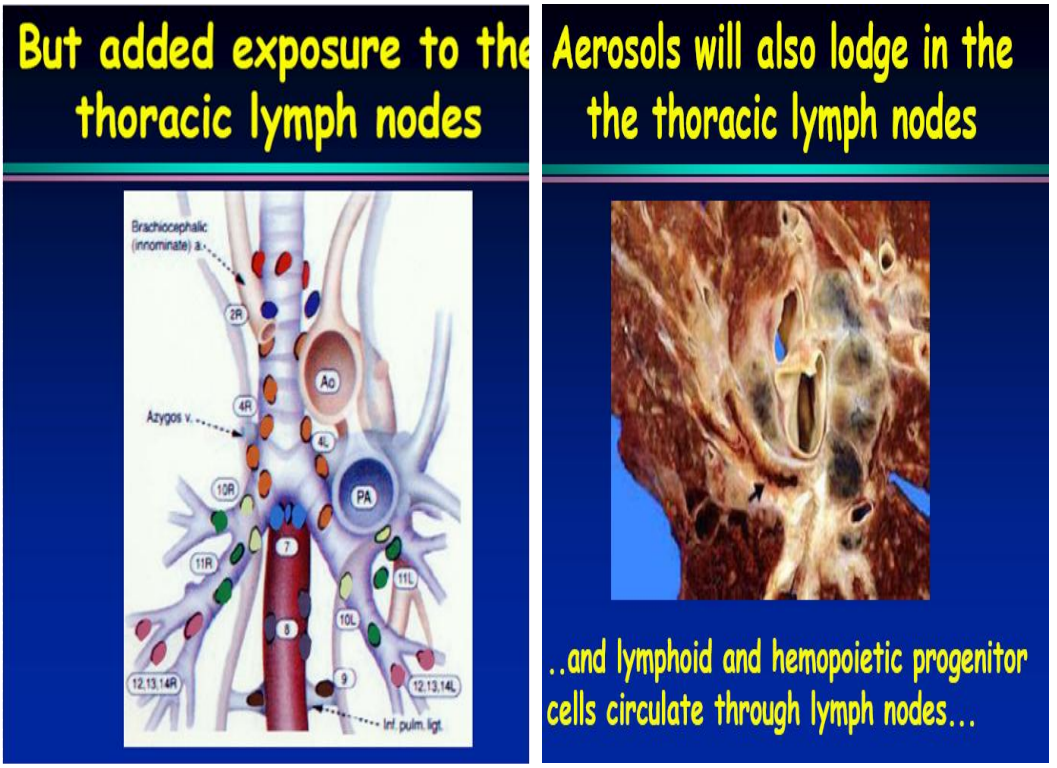


Figure 14: DU effect on lungs: Aerosols of DU oxides lodge in the thoracic lymph nodes.

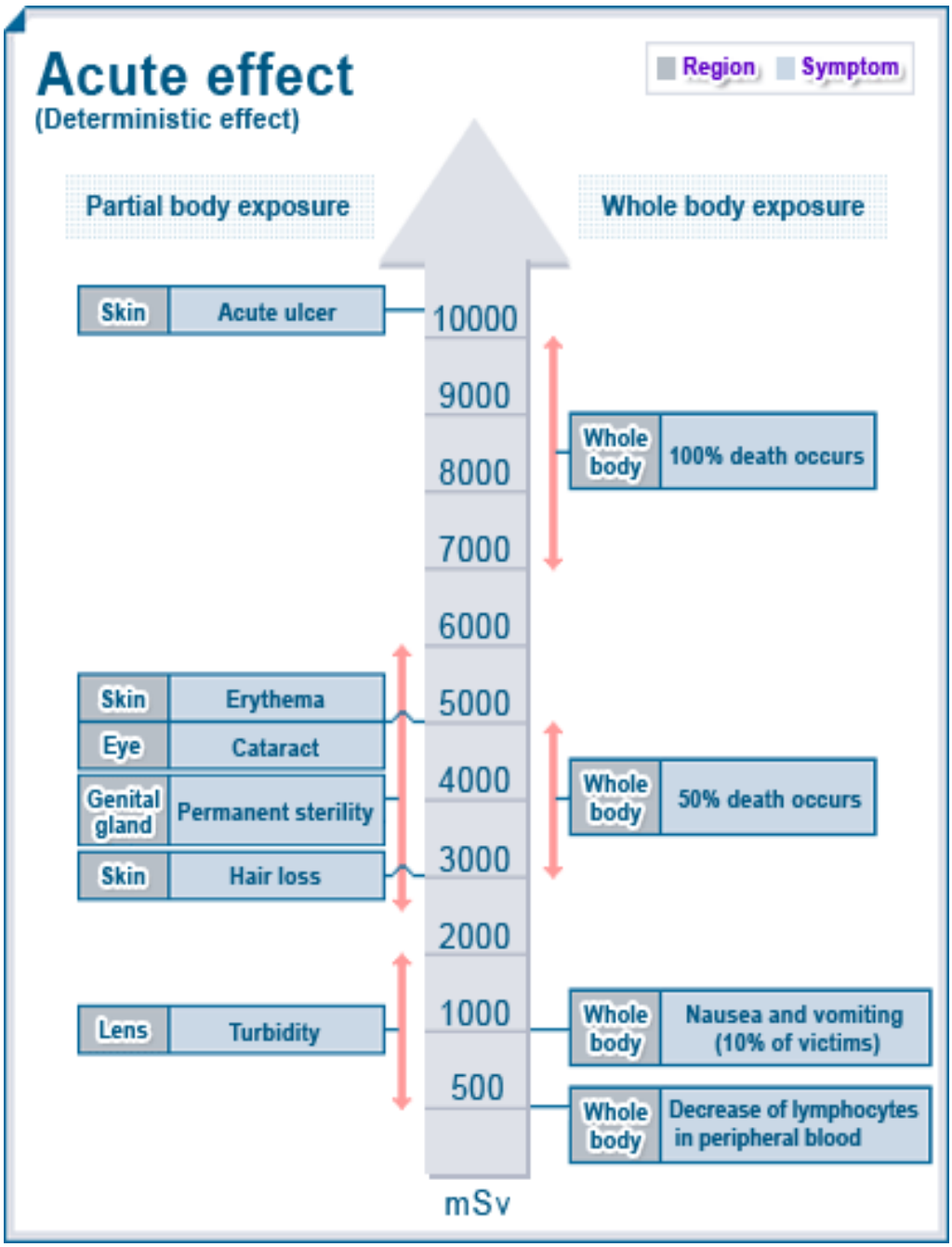
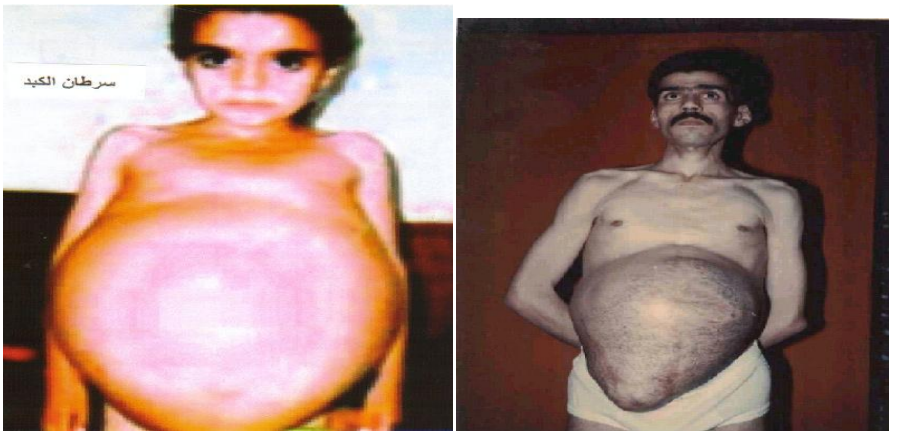


Figure 15: Acute effect of DU

Since DU is an osteotrophic radioactive material, its incorporation in the crystals of non-exchangeable bone will result in long biological retention. This results in a high probability of malignant alterations of the radiosensitive components of target organs (Figure 16). This is due to its long physical half-life and particulate radiations (alpha and beta) [18].

Figure 16: Thousands Iraqi children suffering and died from Leukemia after the War



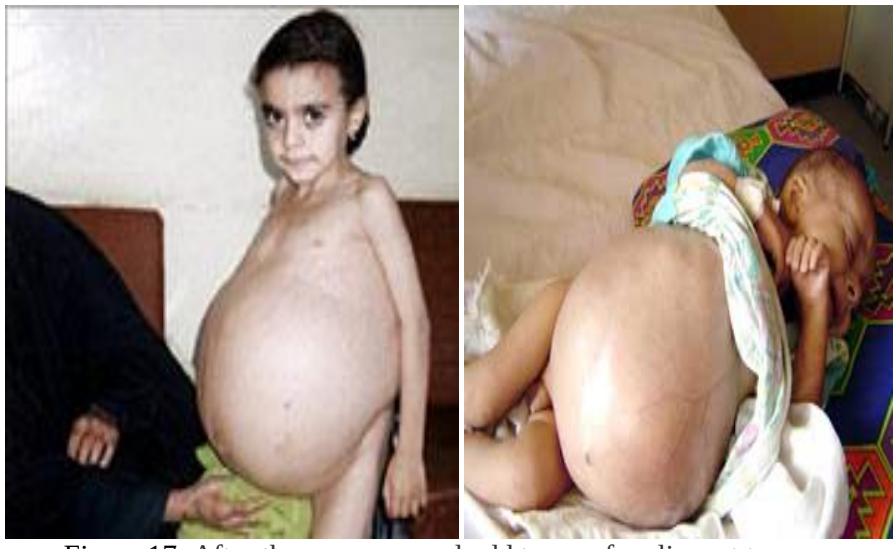


Figure 17: After the war appeared odd types of malignant tumors

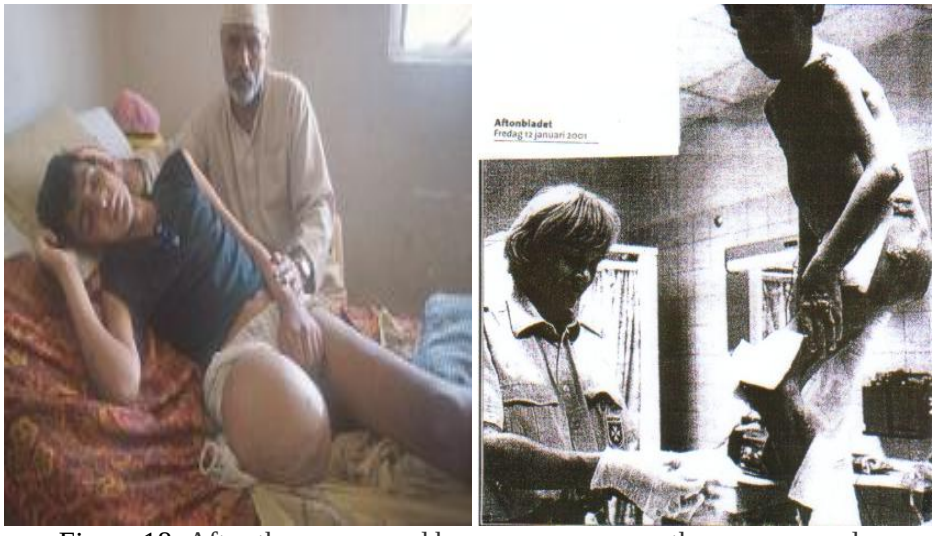


Figure 18: After the war spread bone cancer among the young people

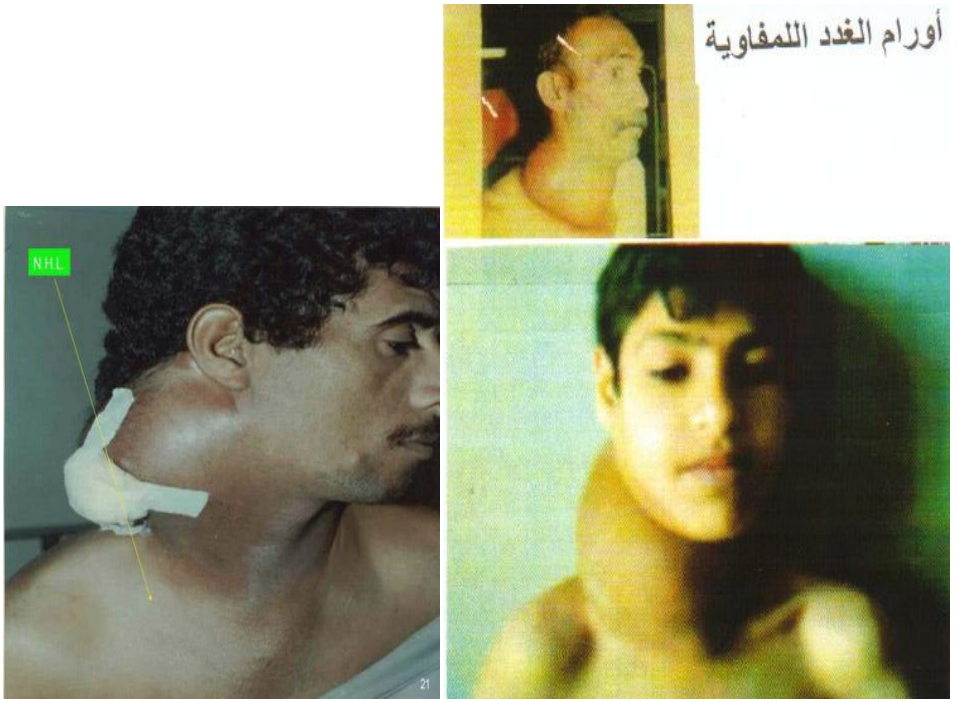


Figure 19: Malignant lymphomas

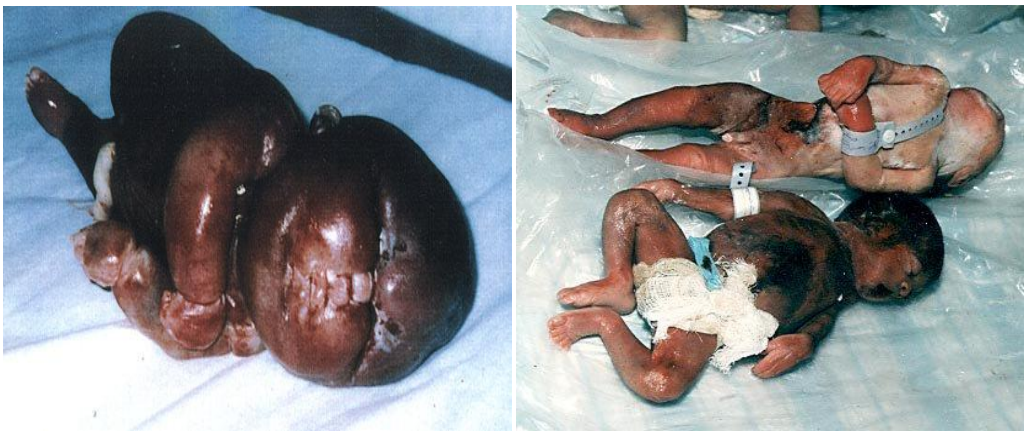


Figure 20: Babies died by DU weapons in Iraq.

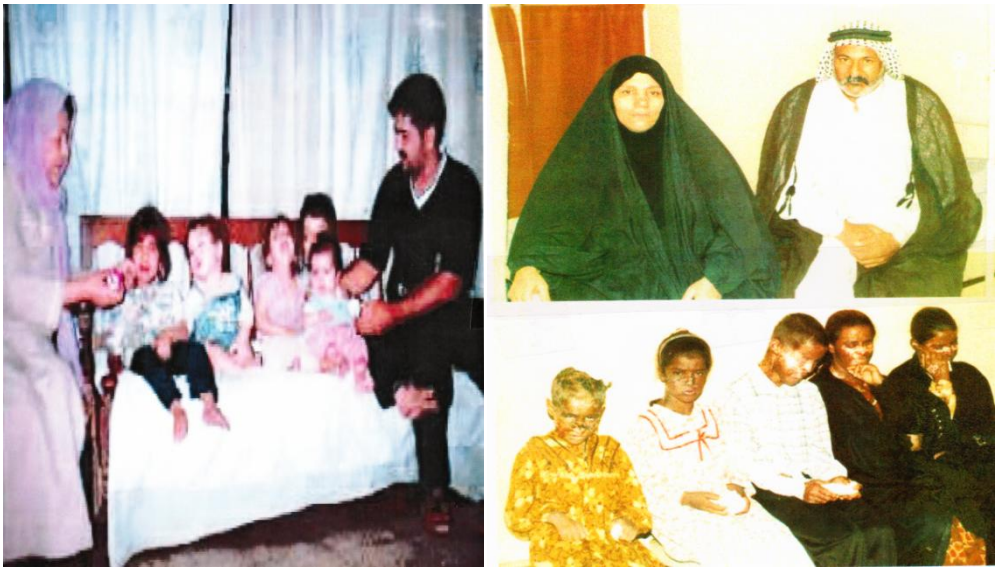


Figure 21: Birth deformaties in more than one child per family.

Figure 22:Gulf War Troops are victims of DU Weapons

Figure 23: DU Weapons kills Gulf War Veterans

According to Prof. Asaf Durakovic Uranium toxic effects after inhalation largely depend on the size of respirable particles. It is the portion of inhaled dust deposited in the non-ciliated portion of the lung. Depending on the solubility of the U salt administered, systemic absorption of uranium from the gastro -intestinal tracts is from 0.02 to 6 %. Respirable U particles in air may be deposited in the respiratory tract. Approximately 95% of inhaled particles with aerodynamic equivalent diameter (AED) larger than 10 micrometers deposit in the upper respiratory tract, most of these clear to the pharynx and thus to the GI tract. Particles <10 micrometers can reach deeper pulmonary regions (bronchioles and alveoli) and stay there for considerable time [54]. The deposition of DU particles on the alveolar surfaces will result in their absorption, depending on their solubility, with approximately 10% of the particles retained in the lungs and reaching systemic circulation, and the remaining 15% ascending to the nasopharynx by expectoration and ending in the gastrointestinal tract. Soluble components of uranium absorbed from the pulmonary tree are deposited in the skeleton within a few weeks, with a biological half-life in the lungs of 120 days. A considerably longer pulmonary retention of 1,470 days is expected in the case of inhalation of uranium oxides [18].

Particles of 10 mm in size are not respirable, while particles of 2 mm have almost complete access in the alveolar compartment (Figure 14). Commonly encountered aerosols associated with uranium oxide are much larger in AED than the sand in the Arabian desert, and over 80% are deposited in the alveolar portion of the lungs, 10% in the thoracic lymph nodes, whereas the rest is deposited in the upper respiratory tree. This illustrates the significance of the respiratory port of entry in the Gulf War. Studies of the Persian Gulf Syndrome and Al-Eskan disease points to the small size (<1 mm) and uniformity of fine dust particles in the Arabian desert as a contributing factor in the Desert Storm Illness.Durakovic explained that the inhalation pathway of internal contamination with depleted uranium is the most important route of entry to the extracellular fluid via the bronchoalveolar tree. According to Abrams and colleagues bronchoalveolar deposition of radioactive particles has been actively studied for decades [112].Scott et al [113] confirm that the radiation hazard of inhaled radioactive particles was studied with different actinides. The general model of their metabolic behavior in the respiratory system was introduced in 1955 by the International Commission of Radiation Protection (ICRP), with recommendations of the parameters for studies of respiratory contamination pathways [114].

Studies of the Persian Gulf Syndrome and Al-Eskan disease points to the small size (<1 mm) and uniformity of fine dust particles in the Arabian desert as a contributing factor in the Desert Storm Illness. Durakovic explained that the inhalation pathway of internal contamination with depleted uranium is the most important route of entry to the extracellular fluid via the bronchoalveolar tree. Inhaled DU particles are absorbed in the upper bronchial tree, and on the alveolar surface. If soluble, they gain access into systemic circulation [18].

Two studies have considered the interaction of uranium and HBC [115, 116]. One study found that insoluble DU induced neoplastic transformation of HBC with chronic exposures [115]. The other reported that uranium ore dust induced lipid peroxidation and micronuclei formation. No studies have considered the clastogenicity of DU in HBC. Accordingly, the purpose of one study of Prof. Durakovic was to improve our current understanding of DU by studying the clastogenicity of both particulate and soluble DU in human bronchial cells[18].

The most recent results of an ongoing AFRRI showed that when cultured human bone

cells are exposed to DU, the cells had tumorigenic potential both in their growth and biochemical traits. In one study, DU induced tumor-like transformations in bone cells that are similar in magnitude to that of nickel, a known heavy metal carcinogen [103]. The Guardian updated the results of the study in an article describing some of Miller's unusual findings. Not only did the bone cells transform but some underwent instant genetic damage in which "fragments break off chromosomes…and form tiny rings of genetic material." This was not as unexpected as the finding that cells undamaged by DU were dividing into new cells which contained genetic damage or broken chromosomes. DU appears to have a "delayed effect;" even a month after the DU was removed new cells exhibited damaged genes. Miller believes that the study which examined "tiny" amounts of DU, small enough to be radioactively and toxically insignificant, shows that it is the radioactive and toxic combination which catalyzes significant genetic damage. "You can get more than an eight-fold greater effect then you'd expect," Miller says. This means that eight times as many cells can be genetically damaged than previously foreseen [117]. The bone may be a target of chemical toxicity of uranium in humans, and more detailed evaluation of bone effects of natural uranium is warranted [118].

Exposure to particulate DU may pose a significant genotoxic risk and could possibly result in lung cancer [18]. Later, DU is becoming a major international concern as a possible health hazard and carcinogen [54, 77, 79, 119]Human autopsies have revealed that tracheobronchial and other pulmonary related lymph nodes had unexpectedly high concentrations of retained actinides (atomic number between 90 and 103, like Pu, U and americium) [120].

Alexandra Miller and her team specifically proposed that DU's radiological and chemical effects might play tumour-initiating (Fig.17) and tumour-promoting roles [103].

Prof. Marion Fulk is investigating how DU affects the human body. Fulk said that 8 malignancies out of 20, in 16 months, "is spectacular – and of serious concern." The high rate of malignancies found in this unit appears to have been caused by exposure to DU weapons on the battlefield. If DU were found to be the cause, this case would be "critical evidence" of Fulk's theory on how the DU particulate affects DNA. Such quick malignancies are caused by the particulate effect of DU, according to Marion Fulk [121].

Given the widespread use of uranium for military application and the present worldwide deployment of the United States military, it is imperative that Prof. Sandra Wise and colleagues investigated the carcinogenicity and genotoxicity of DU. Accordingly, they determined the cytotoxicity and clastogenicity of both particulate (water-insoluble) and soluble DU in human bronchial fibroblasts (WTHBF-6 cells)[25].

Prof. Keith Baverstock focused on DU's carcinogenicity, discussing the findings of a range of studies that indicate that DU's alpha radiation is a carcinogen, a fact noted by the WHO's International Agency for Research on Cancer.The International Agency for Research on Cancer (IARC) have developed a protocol for identifying carcinogenic agents(Figures 18 and 19). All radioactive compounds are Group I carcinogens because radiation is a Group I carcinogen [122].

The Royal Society in 2001 concluded that DU is radioactive and poisonous. Exposure to sufficiently high levels might be expected to increase the incidence of some cancers, notably lung cancer, and possibly leukaemia, and may damage the kidneys [93]. To allow better health risk assessments in April 2001 the World Health Organization recommended further research in key Areas [119].

The decrease in cell proliferation was attributed to loss of total glutathione and superoxide dismutase in the presence of uranium. Thus the results indicate the ineffectiveness of

antioxidant system's response to the oxidative stress induced by uranium in the cells [60]. Results of the study indicate that human bronchial cells are transformed by DU and exhibit significant chromosome instability consistent with a neoplastic phenotype [109].A study was performed with rats exposed to DU at 40 mg/l by chronic ingestion during 9 months.To conclude, a chronic ingestion of DU leads mainly to kidney deterioration that is probably responsible for red blood cell (RBC) count decrease in rats. Spleen erythropoiesis and molecules involved in erythrocyte degradation were also modified by chronic DU exposure [123].

About 10 years after their deployment in the Gulf War, veterans with retained uranium shrapnel (embedded fragments) still excrete measurable levels of uranium with the urine [124, 125]. Fatal cases of uranium poisoning by the respiratory route have been described in humans with nephrotoxic syndrome, including glomerular and tubular damage, apothecia, albuminuria, and tubular necrosis) [18].

The toxicity of uranium has been demonstrated in different organs, including the kidneys, skeleton, central nervous system, and liver. However, few works have investigated the biological effects of uranium contamination on important metabolic function in the liver. In vivo studies were conducted to evaluate its effects on cytochrome P450 (CYP) enzymes involved in the metabolism of cholesterol and xenobiotics in the rat liver [126].

Verified adverse health effects from personal experience, physicians, and from personal reports from individuals with known DU exposures include-according to Prof. Doug Rokke, a scientist physics, professor of environmental science, geosciences of Jacksonville State University, and retired army major, was recalled from academia and sent to the Gulf as part of the army's Depleted Uranium Assessment team. The former director of the Pentagon's Depleted Uranium Project:

* Reactive airway disease
* Neurological abnormalities
* Kidney stones and chronic kidney pain
* Rashes
* Vision degradation and night vision losses
* Gum tissue problems
* Lymphoma
* Various forms of skin and organ cancer
* Neuro-psychological disorders
* Uranium in semen
* Sexual dysfunction, and
* Birth defects in offspring. [127]

Uranium is also a bone seeker and is incorporated into the bone matrix by displacing calcium to form complexes with phosphate groups [128] Uranium exposure affects neurological function. Rats exposed to uranium had impaired nerve cell function [129, 130].

In addition, several published results have shown depleted uranium causes DNA damage, mutagenicity, cancer and neurological defects [60].

Damage to the mitochondria, which provide all energy to the cells and nerves, can cause chronic fatigue syndrome, Lou Gehrig's disease, Parkinson's disease and Hodgkin's disease." Damage to the mitochondria, which provide all energy to the cells and nerves, can cause chronic fatigue syndrome, Lou Gehrig's disease, Parkinson's disease and Hodgkin's disease" [131].

Total oxidative stress causes failure of protective enzymes, leaving cells vulnerable to viruses and mycoplasmas (bacteria without a cell wall). Damage to the cellular communication system and the mitochondria (where cellular respiration takes place), heavy metal replacement of magnesium in molecules that normally function as antioxidants, and destruction of the body's repair mechanisms have serious consequences, including chronic disease and tumorigenesis" [46].

4.5.2 Dramatic increase in the malignancies and birth malformaties after the war

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 [20].

Children in Iraq are dying in epidemic numbers from malignancies (Figures 16 and 17). In most nations cancer in children is uncommon. This makes depleted uranium shells and bombs an ideal vehicle to diminish the world population. The absence of media to expose this genocidal program makes DU warfare a low risk program for lowering world population. One of the attractive features of using radioactive uranium for biologic warfare and population lowering is that there are no known effective ways to heal an individual who develops a malignancy after radioiodine iodine exposure.

Al-Muqdadi warned, through Arabic and Iraqi media, about the danger of DU after the 1991 and 2003 wars (See the references). This was confir-med recently by Dr Leqaa Alyassin, MP in Iraqi parliament, that the cancer cases in Iraq reached 700 000 case and is increasing. The incidence of deforma -ties in newborns are increased due to the remnants of war.

A dramatic increase in the number of babies born with birth defects (Figures 20 and 21) was recently reported by doctors working in Basra and Falluja [132]. One of the proposed causes for this alarming situation is radiation exposure to the population produced by uranium weapons (Figure 15). The international radiation protection community dismisses this explanation as completely unreasonable because: the radiation dose to the population of Iraq was too low, and no evidence of birth defects was reported among offspring born to survivors of the atomic bombings of Hiroshima and Nagasaki. This so-called scientific explanation is deeply disturbing, for it is out of touch with the current knowledge base. Abundant evidence exists which clearly demonstrates that birth defects are being induced by levels of radiation in the environment deemed safe by the radiation protection community. In light of this knowledge, uranium contamination cannot be summarily dismissed as a hazard to the unborn. How are we to make sense of these contradictions?

Chromosome studies conducted in the contaminated regions provide the answer [133]. Little research exists regarding the effects of the radiation emitted specifically by DU, there is medical knowledge regarding the effect of general radiation exposure to pregnant women and children. The Center for Disease Control points out that "the human embryo and fetus are particularly sensitive to ionizing radiation, and the health consequences can

be severe, even at radiation doses too low to affect the mother." These consequences can consist of "growth retardation, malformations, impaired brain function, and cancer." (CDCPE).
The CDC points out that "if a pregnant woman ingests or inhales a radioactive substance that subsequently is absorbed in her blood stream (or enters her bloodstream through a contaminated wound), the radioactive substance may pass through the placenta to the fetus…". However, the irradiating effects on the unborn baby continue well after birth and can boost that individuals risk of cancer later in life (CDC).

4.5.3 Health effects on military personnel

Gulf War veterans(Figures 22 and 23) who were(1991) excreting high levels of uranium in their urine showed some impairment in cognitive function [134]. McDiarmid et al [134] were the first investigators to apply chromosome aberration analysis to a group of veterans of the Gulf War with retained DU shrapnel. In their results all 'chromosomal aberrations' are pooled without any further specification, a meaningful comparison with their results is not possible [134]. Chromosomal analysis performed on blood samples from war veterans exposed to DU 10 years prior shows aberrations typical of exposure to ionizing radiation [93]. Heike Schröder and his colleagues observations are consistent with two previous studies of uranium in HBC [115, 116] (The first study found that "uranium dust" caused lipid peroxidation and micronuclei formation; however, chemical analysis of the dust revealed that there was no uranium component in the dust, and thus, these results are likely due to the other chemical components of the dust or to the particles themselves [116]. The other study found that insoluble DU induced neoplastic transformation of HBC consistent with the possibility that exposure to particulate DU may cause lung cancer, although that study did not consider specific genotoxic events that may have led to the transformation [115]. More specifically, the increased rate of these aberrations is proportional to the dose of radiation received. Studies of this type were conducted in Europe subsequent to the Chernobyl accident [135].
A variety of studies in the USA [136-140] have shown that men and women who served in the Gulf War in 1990 to 1991 suffer from considerably more ill health than their non-deployed peers. Besides epidemiological studies, some surveys on haematological parameters revealed differences in veterans' blood samples compared with their controls, such as findings of amplicons in sera of Gulf War veterans that were homologous to regions of human chromosome 22q11.2, suggesting that genetic alterations in this region may have played a role in the pathogenesis of Gulf War syndrome [141] a significantly decreased number of immune competent cells [142] and a decreased capacity to detoxify organophosphate insecticides and chemical warfare nerve gases observed in serum samples [143].
Dr. Rosalie Bertell mentions a large epidemiological study of the health of the children of Gulf War veterans by Kang of the Department of Veterans Affairs. Under 21,000 veterans participated in the study which dealt with the first born child conceived after the end of deployment after the Gulf War – the control group of veterans did not serve in the theater of the Gulf War. Male Gulf War veterans were twice as likely, and female veterans almost three times as likely, to report children with birth defects than their counterparts who did not serve in the first Gulf War. Birth defects included webbed fingers and toes, heart murmurs, chromosomal abnormalities, and brain tumors." Male Gulf War veterans also reported more miscarriages, a difference that was statistically significant whereas women

Gulf War veterans reported more miscarriages but as the numbers were small the differences were not statistically significant. The Kang study did not deal with causes of the results of the study. Bertell also mentioned research done at the Baltimore, Maryland Veterans' Hospital where DU was found in the semen of Gulf War veterans" [46].

Rita Hindin and colleagues carried out an extensive literature review of congenital malformations following DU exposures in US military personnel and concluded that the human epidemiological evidence was consistent with increased risk of birth defects in offspring of persons exposed to DU. Possible synergism between radiation effects and chemical effects. McDiarmid et al. observed a statistically significant increase in mutations in peripheral lymphocytes in three US Gulf War veterans with embedded DU fragments reflected in measurements of uranium in urine. However, their continuing surveillance (for 14 years) has yielded no evidence of reproductive system dysfunction in males, abnormalities in sperm or alterations in neuroendocrine function [144].Nevertheless, it should be recalled that soldiers are a healthy subset of the wider population,and the numbers of exposed soldiers in these studies are relatively small. Monleau et al. found that repeated uranium inhalations tended to potentiate, that is, increase the effect of or act synergistically with uranium's genotoxic effects [100].

Zaire and collegues [145] observed the induction of chromosome aberrations in uranium mineworkers in Namibia. Such rearrangements of genetic material in chromosomes are involved in the carcinogenic process [17].

Keith Baverstock confirmed that DU dust from munitions is a clear hazard and because it can be systemically incorporated presents a risk. How large that risk will be depends on the specific circumstances. In dry arid climates it could be considerable but where there is high rainfall it might be quite small and limited in duration [146].

The association of depleted uranium with human mutagenesis, carcinogenesis, and diseases of the immune system has been postulated in the environmental measurements of radioactivity at the DU testing ranges in the United States [18]. Diseases associated with the breakdown of chromosomal stability, "chromosome instability syndromes", include malignancy, immunodeficiency, neurological disorders, and growth and development abnormalities. Wright's studies document radiation-induced genomic instability, "raising questions" regarding potential connections to "human disease processes" [74].

According to the latest reports suffering from Gulf War syndrome are currently more than 300 thousand of the total 720 thousand combatants who participated in the 1991 Gulf war, and more than 30 thousand from American veterans have died from cancer.

A frightening aspect of depleted uranium warfare is that there is no way to protect oneself from this hazard. Clothing and gas masks are easily penetrated. The key persons running the New World Order are brilliant planners. They (Figure 23) would not want themselves to die from lung cancer along with the rest of humanity [148].

5 Summary

The United States has generated the largest amount of depleted uranium (DU) in the world 732,000) metric tons) – representing more than half of all uranium mined worldwide.The properties of DU (high density and pyrophoricity in particular), have made DU ideal for military applications of DU shells, 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. DU bullets can destroy the target from a distance unreachable for the foe.

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 is a byproduct of the production of enriched uranium for use in nuclear reactors and in the manufacture of nuclear weapons. 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. the degree of danger of alpha radiation largely differs according to what form of and from where one has been exposed to DU.

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.

Exposure to the DU is both chemical and radiological toxic. It may cause many toxic effects in human cell: cytotoxicity, clastogenicity, DNA damage, genomic instability, chromosome mutations, teratogenicity, embryo and others reproductive and developmental damage. micronuclei formation. DU hazards the lung, kidney, brain, bone, CNC, immunosystem, and others.

The use of battlefield uranium weapons has been classed by some as weapons of indiscriminate effect; as such they would be implicitly illegal under various conventions of war. It is the perfect weapon for killing lots of people. The continued U.S. military use of dirty bombs, dirty missiles and dirty bullets threatens humanity and all living things ... and is turning Planet Earth into a death star.

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