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**DU:
HEALTH AND PUBLIC HEALTH
ISSUES ARISING FROM THE USE
OF DEPLETED URANIUM
MUNITIONS**

October 2005

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DU: Health and the Public Health Issues Arising from the Use of Deplete Uranium Munitions

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Introduction

The 1991 Persian Gulf War saw the use of advanced U.S. weaponry that devastated targets in Iraq while allowing the coalition forces to declare victory with limited military losses. Numerous developments in technology, including the use of depleted uranium (DU) have been contributed to U.S. General Norman Schwarzkopf's success. The U.S. military claims that DU used by the coalition forces secured a significant advantage over the Iraqi military. This technology has since been used in Kosovo, in Afghanistan, and again in Iraq in 2003.

DU provides an effective armor for tanks and other military equipment, as it is exceptionally dense. DU munitions are also able to pierce a greater depth of enemy armor with more consistency than conventional munitions. As Colonel James Naughton of the Army Material Command has testified, "Nobody goes to war and wants to be even with the enemy. We want to be ahead and DU gives us that advantage."¹ With DU weaponry, the colonel emphasized, "we can hit them, but they can't hit us."²

Four years following the victory of the first Gulf War, the acclaim of DU evolved into controversy as thousands of U.S. and coalition forces began suffering from an array of unexplained ailments, such as impaired cognition, fatigue, muscle ache, sleep disorders, and memory loss. Critics of DU attributed the mysterious symptoms, collectively known as the *Gulf War Syndrome*, to the radioactivity and chemical toxicity of depleted uranium. Some have suggested that chemo-prophylaxis and pesticides might be linked to Gulf War Syndrome.³

Uranium & Depleted Uranium

Natural uranium is a chemically toxic heavy metal composed of three distinct radioactive isotopes: U-238 (99.27%), U-235 (.72%) and U-234 (.01%). Because U-238 decays by emitting alpha particles and has a half-life of 4.5 billion years, uranium is modestly radioactive. Most of the radiation emitted is composed of alpha particles which are unable to penetrate most materials, including paper and skin.

Uranium is present in the air, minerals, water, and plants around us. In fact, the average human body contains 90 micrograms of uranium. Nuclear power plants use enriched uranium as fuel. Enriched uranium is created by increasing the proportion of the more radioactive isotopes.

DU is the by-product of the enrichment process, termed "depleted" uranium because it is 40% less radioactive than natural uranium. It shares uranium's chemical toxicity as a heavy metal, which is independent of its radioactivity. It is classified in the lowest hazard class of radioactive materials. DU is not a nuclear weapon because its use does not trigger a nuclear chain reaction.

Uranium from which the more highly radioactive isotopes have been removed for use in weapons or reactor fuel is called "depleted." Natural, depleted, and weapons-grade uranium are chemically identical, but each has a very different isotopic composition. Highly Enriched Uranium (HEU) is 93% U-235, while DU contains only 0.2% of that element. Depleted uranium is both a radiological and chemical toxic hazard. As an emitter of alpha radiation, it is potentially carcinogenic and mutagenic. Because DU is also a heavy metal, it can produce kidney damage. The biology and toxicology of uranium have been carefully studied in animals and humans.⁴ The studies of uranium mine workers are particularly noteworthy.⁵

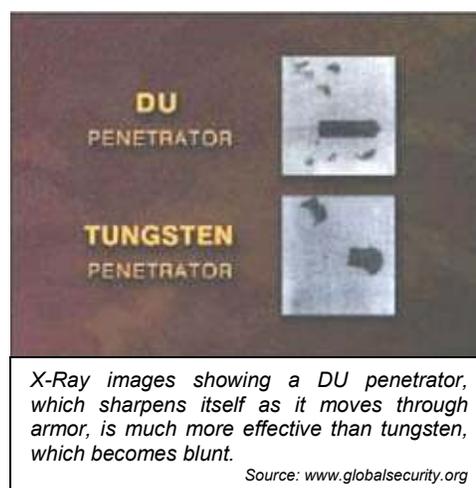
The Pentagon, in conjunction with NATO and the British Armed Forces, has officially repudiated all claims that DU munitions play a formative role in the Gulf War Syndrome or the maladies in Iraq.⁶ Independent research by RAND, the World Health Organization (WHO) and other groups has also failed to clearly identify the toxicity of DU used in battlefield conditions, thus failing to put an end to the controversy surrounding DU use by the military.⁷ The U.S., British, and NATO forces have used DU in Bosnia, Yugoslavia, Afghanistan, and in both wars in Iraq without apparent concern for exposure of either troops or civilians. Maps indicating the sites of DU ordinance use are not available from the Coalition Provision Authority (CPA) for use by Ministry of Health or NGO public health programs. No specific efforts have been taken by the CPA to prevent or limit the exposure of Iraqi children. Despite this seeming disregard to the disturbances, the UK Ministry of Defense (MOD) is monitoring the situation with regard to British troops in Iraq.⁸ The lack of conclusive research on the long-term health effects of DU and the multiple factors that may have contributed to the soldiers' ailments (Gulf War Syndrome), leave the health and environmental costs of DU weaponry mired in controversy and lacking in definitive evidence. PSR emphasizes the need for both exposure and health effects research in civilian as well as military populations. These activities will be essential to nurture a greater understanding of the medical and public health implications of DU weaponry.

The intention of this brief is to inform medical and public health professionals on the use of depleted uranium, to summarize the related health issues and to make recommendations for specific actions by the U.S. government and its agencies.

MILITARY USES OF DU

DU has been utilized in both civilian and military practices because it shares natural uranium's substantial density and strength. In civilian applications, DU is routinely used for counterweights in aircrafts, racing sailboat keels, and in routine medical procedures for blocking X-rays or gamma radiation from equipment and patients during radiation therapy.

Militaries, on the other hand, employ DU to create heavy dense shells capable of penetrating armored vehicles. Unlike traditional tungsten alloy munitions, bullets tipped with DU do not blunt and mushroom upon impact. Rather, the properties of DU allow the bullet to preserve its shape, self-sharpen, and pierce through enemy tanks with ease and unsurpassed precision. Additionally, DU munitions will penetrate approximately 20% more armor than the tungsten alloy shells they replaced.⁹



DU is not only used as ammunition; it is also used to shield military vehicles and platforms. The density and durability of the DU armor deflects enemy fire from entering covered tanks, thus protecting the soldiers inside. Days before President George W. Bush declared war in Iraq, U.S. Army Col. Naughton described the potency of DU munitions:

During the Gulf War [the U.S.] had tanks engaged in situations with multiple Iraqi tanks that were shot, hit -not penetrated- and proceeded to destroy all three of the targets that engaged them, including shooting through a sandbag and destroying one of the Iraqi tanks...That's how much advantage it gives us.¹⁰

However, in *Science or Science Fiction? Facts, Myths and Propaganda In the Debate Over Depleted Uranium Weapons* (2003), Dan Fahey carefully dissected the record regarding the alleged contribution of DU to the military success of the Allied forces in the First Gulf War, claiming that the "real tank killer" in Desert Storm was the Maverick missile.¹¹ He argues that DU rounds had hit only one out of every seven destroyed tanks on the battlefield, citing the following:

- A-10s destroyed 900 Iraqi tanks with Maverick missiles but just 100 with 30mm DU ammunition.
- U.S. tanks destroyed approximately 400 Iraqi tanks, 45 mainly with DU rounds.
- AV-8Bs primarily targeted Iraqi artillery with Rockeye missiles, but artillery as well as some tanks and other targets were likely targeted by DU ammunition.

Although we know the potential effects of prolonged DU exposure to, the limited research concerning military use of DU has primarily generated speculations, while offering little facts. The paucity of research, in conjunction with the innumerable variables accompanying the use of DU on the battlefield, makes determining the actual effects of DU munitions difficult.

ISSUES REGARDING THE POTENTIAL EXPOSURE TO DU

- Troops in the Gulf War were exposed to additional hazardous chemicals, such as anti-nerve gas pyridostigmine (PB) tablets, insect repellent with high concentrations of DEET, other pesticide applications, Iraqi chemical warfare agents either released intentionally or inadvertently during the conflict, as well as by fumes from burning oil fields -- all substances that could have contributed to their symptoms

- The DoD estimated that heavy DU contact during
- Possibly 80% or more of War, mostly within the hit a hard target, instead ploding. This minimized the immediate post Kuwait and Iraq, although over time could present a risk.¹³



U.S. soldier using a DU shell.
Source: Department of Defense.

932 soldiers had moderate to and after the Gulf War I.

DU shot during the first Gulf southern desert region, did not hitting the ground and not ex- the creation of DU dust and re- war health risk posed by DU in deterioration of unspent rounds future environmental health

- After twelve years of examination, remaining members of an initial cohort of 90 Gulf War veterans who were in or on an armored vehicle when hit by depleted uranium in friendly fire have not been diagnosed with kidney damage or lung cancer, the organs most likely to be affected by DU exposure. However, Fahey contends that the DoD has covered-up information regarding cases of non-Hodgkins lymphoma and an unspecified bone tumor, possibly rep

representing effects of DU. According to Dr. Michael Kilpatrick of the Deployment Health Support Directorate, out of the 90 observed veterans, 20 have shards of DU ammunition embedded into their muscle tissue, none have health disorders that could be attributed to DU.¹⁴

Military Use of Depleted Uranium					
	Iraq, Kuwait (1991)	Bosnia (1994-95)	Kosovo, Serbia, Montenegro (1999)	Afghanistan (2001-03)	Iraq (2003)
Weapons Delivery Systems	U.S. aircraft and tanks; UK tanks	U.S. aircraft	U.S. aircraft	U.S. aircraft (and maybe fighting vehicles)	U.S. aircraft, tanks, fighting vehicles; UK tanks
Quantity	286 metric tons	3.2 metric tons	9.5 metric tons	Uncertain	Uncertain (possibly 100-300 metric tons)
Information compiled by Dan Fahey ¹²					

DU and Coalition Armies

- Tens of thousands of U.S. veterans from the 1991 Gulf War and thousands of allied troops complain of symptoms that appear to be a consequence of military service. However, not all of these soldiers were exposed to DU munitions.
- The U.S. government has not yet conducted a comprehensive study of the health of all the Gulf War Veterans exposed to DU.
- Campaigners initially blamed DU weaponry for causing the deaths of Italian, Belgian, Spanish, Portuguese, and other NATO troops occupying Bosnia or Kosovo who had leukemia. Nevertheless, the WHO reports that there is no proven link between DU and leukemia in these aforementioned cases, as the time between exposure to DU and onset of leukemia was too short to be a causal relationship. Moreover, there was no statistically significant excess incidence of these diseases among these soldier populations. However, it should be noted that the latency period for leukemia in populations exposed to DU has not been widely studied.¹⁵

- In January 2001, Turkey, Germany, and Spain reported that they found no cases of DU poisoning among troops who served in NATO peacekeeping forces in Kosovo.¹⁶
- The Institute for Radiation Protection at the National Research for Environment and Health in Germany examined 122 German soldiers deployed in the Balkans and found no indications that DU contamination results in health problems. Other assessments executed by NATO countries with troops in the Balkans failed to find evidence of either widespread DU exposure or DU related health anomalies.¹⁷

In a recent paper, *Unresolved Issues Regarding Depleted Uranium and the Health of U.S. Veterans of Operation Iraqi Freedom and Operation Enduring Freedom*, Dan Fahey examines issues regarding potential exposures of soldiers in Central Asia and Iraq since 2001.¹⁸ He poses questions that the Department of Defense has yet to answer, and which could have significant repercussions for veterans' health, particularly given the reported wide geographic distribution of exploded DU weaponry since the commencement of the second Gulf War.

In particular, Fahey asks:

1. Is the DoD identifying specific units for targeted DU testing, in addition to using the post-deployment questionnaire to identify troops potentially exposed to DU dust and debris? (p. 3)
2. Does the risk communication statement in DoD's DU testing policy (HA 04-004)¹⁹ provide a realistic and accurate appraisal of the risks of DU exposure? (p. 4)
3. When will the DoD provide an estimate of the quantities and locations of DU munitions expended since the start of Operation Iraqi Freedom? (p. 6)
4. Does it make sense to refer Operation Iraqi Freedom veterans to a Veterans Affairs program that has withheld information about the health of Operation Desert Storm veterans exposed to DU? (p. 8)

5. Have DU munitions been used during Operation Enduring Freedom, and have any veterans who served in Afghanistan been tested for exposure to DU? (p. 13)
6. Have U.S. troops who served at K-2 (Stronghold Freedom) in Uzbekistan been tested for exposure to DU? (p. 14)
7. Have government civilian employees, contractors, or others been tested for DU exposure, in accordance with HA 04-004? (p. 15)²⁰

These are all questions, which deserve a serious response from the DoD. In order to achieve a satisfactory response to these questions, and to protect the health of U.S. veterans, Fahey proposes a series of actions:

1. Federal investigators should ascertain, through review of relevant records and interviews, whether the services are properly implementing HA 04-004 by proactively identifying individuals and units for targeted DU bioassays.
2. The DU risk communication message in HA 04-004 should instruct health care providers to deliver one of three unique messages based on the exposure level (Level I, II, or III). Like the risk communication messages for lead exposure in HA 04-004, each DU message should provide a realistic appraisal of the potential for health effects as well as the need for continued monitoring.
3. DoD should publicly release an accounting of the amount of DU ammunition expended in Iraq during combat, as well as the amount released as a result of aircraft crashes, ammunition truck explosions, breaches of DU tank armor, tank or fighting vehicle fires, and all other causes and weapon uses. In addition, DoD should publicly describe its efforts to assess the health and environmental effects of the use of DU munitions in Iraq, including an explanation of the process to identify, transport, and dispose of contaminated equipment.
4. The DU Program should be restructured and expanded into a cohort study that assesses the health of the approximately 900 veterans identified by DoD as having had Level I and II exposures during and after the 1991 Gulf War. The VA should create a new DU study, under new leadership, that reports all relevant health effects in a timely and accurate way.

5. The DoD should either confirm or deny that U.S. forces have shot DU munitions in Afghanistan. If DU munitions have been used, DoD should release an accounting of the quantities and locations of expenditure, and make publicly available the results of self-reported exposures from DD 279621,²¹ information about proactive identification of the troops exposed to DU, and results of a bioassays.

6. Federal investigators should ascertain whether U.S. troops who served at K-2 in Uzbekistan have been tested for exposures to DU. Make publicly available the results of self-reported exposures from DD 2796 as well as the results of bioassays for DU exposure and any plans for the future monitoring.

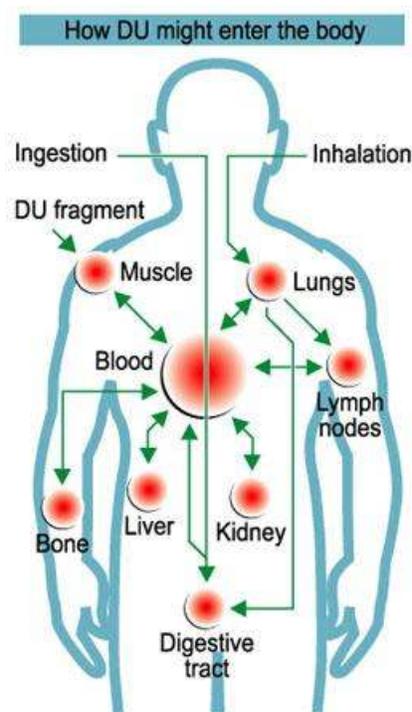
7. Verify that the process for selecting non-military personnel for DU testing is being properly followed, and publicly release information about the number of people tested as well as the test results and any future monitoring plans.²²

POTENTIAL HEALTH EFFECTS FROM DU ON THE IRAQI POPULATION

Health Effects

Since the conclusion of the first Gulf War, there have been numerous photographs and reports coming out of Iraq contending that DU is the most likely cause of reported increases in fetal birth deformities and childhood cancer incidences. Due to resistance from, and constraints with confronting the Hussein regime, widespread environmental sampling, and testing of the Iraqi population to determine contamination by uranium was never performed, and independent studies were discouraged. Since the fall of Hussein, the United States has explicitly forbidden the UN Environmental Program from doing the requisite environmental sampling to determine the extent of DU contamination that in the second Gulf War was spread into numerous Iraqi cities involved in military operations.

Such restrictions by the U.S. authorities impede any ability to obtain exposure data that would be necessary to better understand the potential toxicity of DU. More importantly, it



Source: Campaign Against Depleted Uranium

has made it impossible to design and implement any program to protect any exposed Iraqi population from the known heavy-metal and radiological hazards of DU.

When weighing the potential hazards to the Iraqi population from DU exposure, other possible contributing factors must also be considered. Even before the first Gulf War, Iraq experienced a period of rapid industrialization with associated significant pollution of air, soil and water that would likely contribute to negative health outcomes to workers and the population at-large. In addition, a range of environmental health hazards marked the two ensuing Gulf Wars, a fact which is attributable to modern warfare. These included: oil fires and leaks emitting carcinogens and other toxicants, possible exposures from intentional or inadvertent release of chemical warfare agents (beyond those used in the prior Iran-Iraq war), and destruction of the power grid and other components necessary for safe drinking water and sewage disposal. In addition, the combination of economic sanctions and diversion of limited resources away from public health needs to the perquisites of the Hussein regime was associated with widespread malnutrition that, in addition to leading to a striking increase in infant mortality rates, would likely be a contributing cause of immune-suppression and related impacts on chronic disease and cancer.

DU and the ENVIRONMENT

WHO states, "measurements of depleted uranium at sites where depleted uranium munitions were used indicate only localized (within a few tens of meters of the impact site) contamination at the ground surfaces."²³ Similarly, a study performed by The Royal Society, the UK's national academy of science, concluded that approximately 70-80% of all DU penetrators remain buried in the soil of Iraq and the Balkans. Although "measurements of environmental contamination in Kosovo have not shown widespread contamination with DU...hot spots of contamination are present around penetrator impacts."²⁴ This is also likely to be a concern in Baghdad and other cities in Iraq where DU was used during the recent U.S.-led invasion.



Serbian tank destroyed in Kosovo by NATO forces using DU ammunition.

Source: NATO

UNEP studies "identified a number of remaining scientific uncertainties that should be further explored. These include the extent to which DU on the ground can filter through the soil and eventually contaminate groundwater, and the possibility that DU dust could later be re-suspended in the air by wind or human activity, with the risk that it could be breathed in."

Potential Health and Environmental Effects of DU on the Battlefield

Health Effects

When outside the human body, DU poses little threat to individuals due to its alpha particle radioactivity. According to a study by the RAND Corporation, "the effects of acute dermal exposure to ionizing radiation, including erythema (redness of the skin) and epilation (loss of hair) will not be observed...since alpha particles emitted by uranium will not penetrate the dead outer layer of the skin."²⁶

It is also important to note, however, that DU is pyrophoric by nature, meaning that when finely divided it burns and releases potentially hazardous oxides upon impact. The danger from DU is greater when oxides are released in the air as particulates because alpha particles can be inhaled into the human body. Consequently, the direct radiation of internalized DU makes organs more vulnerable to DU's radiation. The WHO speculates that there is a "theoretical possibility" that exposure to alpha and beta radiation from inhaled insoluble depleted uranium particles might lead to lung tissue damage and increase the probability of lung cancer."²⁷ Likewise, the "absorption [of DU particulates] into blood and retention in other organs, notably the skeleton, is assumed to carry an additional risk of cancer."²⁹

Some observers have contended that the processing by the body of DU in both insoluble and soluble forms poses a more formidable cancer risk than previously appreciated by radiological health agencies. Some researchers have also put forward the idea that DU can affect a number of organs in the body, and the combination of these different exposures produces a multiplier effect that can explain many of the conditions experienced by Gulf War veterans and others.

However, a number of scientists believe that the health threats posed by heretofore expected exposures to DU are relatively minor, due to the large amount (2,000 µg) of DU that must be inhaled to exceed the current dose taken in from other natural exposures.

As RAND indicates, "it is unlikely that any munitions explosion involving DU could have sustained air concentrations of DU in the mg/m³ range (1,000 µg/m³) for any length of time. Outside of struck vehicles dispersion of airborne material by normal wind speeds and ground deposition (fallout) dilute any clouds of material rapidly."³⁰ In *After the Dust Settles*, Steve Fetter and Frank von Hippel elaborate:

*For soldiers outside struck vehicles, the aerosol inhaled in the minutes immediately after a vehicle struck by DU munitions would be greatly reduced by the fact that the kinetic energy was turned into heat by the impact. For a heavy penetrator, the released energy would be equivalent to the explosion of as much as a kilogram of TNT, lifting the DU aerosol upward on a column of hot air. Because of this vertical dilution, the amount of depleted uranium inhaled by a nearby person would probably not exceed .1 milligrams. The dose to a person a mile away directly downwind would be about ten times less.*³¹

WHO reports, "approximately 95% of uranium entering the body is not absorbed, but is eliminated in human feces."³² The kidneys' processing of DU poses a significant health hazard, as of "the uranium that is absorbed into the blood approximately 67% will be filtered by the kidney and excreted in the urine (within) 24 hours."³³ The heavy-metal toxicity of DU could prove detrimental to the kidneys. The alkalization of urine increases urinary uranium excretion, and a large amount of DU intake could potentially result in DU deposits in the renal tubules producing uranium nephritis and impaired kidney function.

Just as an exorbitant amount of DU is needed to cause lung cancer, significant cell death in the kidneys does not occur until the concentration of uranium surpasses three parts per million in the kidney tissue (one milligram of uranium). Fetter and Von Hippel express why this is an unlikely outcome:

Such a loading would not be easily accomplished. The International Commission on Radiological Protection model assumes that about one-eighth of the uranium that finds its way into the bloodstream will deposit in the kidneys. The rest will either be rapidly eliminated in the urine or attach itself temporarily to bone surfaces. For one milligram of uranium to be deposited in the kidneys, the blood would have to absorb about eight milligrams of soluble uranium compounds. If the fraction of soluble uranium oxides were one-third of the total uranium oxides released in the DU attack, then about 50 milligrams would have to be inhaled.

This threat is particularly acute for soldiers inside vehicles when hit or entering the vehicle immediately after impact, but outside a struck vehicle the amount of uranium inhaled by a person nearby is unlikely to exceed 0.1 milligram. Soldiers who participate in extensive clean-up efforts in the interior of the vehicle without proper respiration gear also face elevated exposures.

Moreover, in light of continued uncertainties of the health impacts of low-level radiation, a precautionary approach is warranted. Recent radiobiological studies at the cellular level indicate that very low level radiation – even a single “hit” may interfere with intercellular signaling and produce changes in cell behavior at doses far below those necessary to produce cell death. “Bystander” cells may get a chemical message from the “hit” cell telling them to change their organization and behavior.³⁴

A World Health Organization report that was commissioned, but never released due to political pressure from the United States and other allied nations, also noted the likely interaction of radiological and chemical toxic effects of DU. The report, *Radiological Toxicity of DU*, states that:

*As DU has been shown to be capable of transforming human cells to a tumorigenic phenotype without the involvement of radiation, such particles present a unique radiological/chemical toxic hazard. The bystander effect may be of relevance where an alpha-particle emitter of low specific activity is distributed over the lung.*³⁵

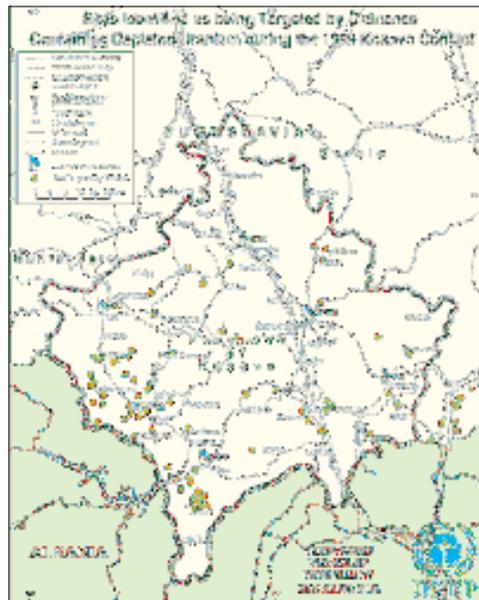
The report concludes that:

*The health risks of exposure to DU/RU are likely to be only partially reflected by the radiation dose received. Further work on the chemical transforming ability of DU, the potential for interaction between its chemical and radiological toxicities and the significance of the bystander effect in this context is required to fully estimate the public health significance of exposure to DU.*³⁶

ENVIRONMENTAL HEALTH EFFECTS: THE KOSOVO MODEL

Following the war in Kosovo, the UNEP and the United Nations Human Settlement Programme (UNCHS) examined the potential threat that depleted uranium munitions could impose on the environment. The concentration and severity of DU contamination is contingent upon the size of the region, precipitation levels, and rate of corrosion and soil type. The numerous variables add some complexity in assessing depleted uranium's environmental impact.

The long-term damage to public health and the environment is difficult to evaluate given that 1kg of uranium metal broken into 1g pieces will oxidize over approximately 400 years in a humid environment. Likewise, a solid DU penetrator from a tank shell with a mass of 1.345 kg has a reported corrosion lifetime of 2,100 years.³⁷ For a depleted uranium penetrator of 300 g, as fired by an A-10 air- plane in Kosovo, a corro- reasonably estimated to This slow rate of corro- protracted leaching of is precisely this property point in time a very small DU dissolved rapidly, it supplies and from the GI stream, posing a much



Source: United Nations Environment Programme

The gradual leaching of has contributed to fears the continuous intake of may lead to DU poisoning and jeopardize the food chain in a particularly heavily contami- nated area.

as fired by an A-10 air- sion lifetime may be around 500 years.³⁸ sion reflects the equally uranium into the soil. It that makes DU at this hazard for ingestion. If would go into water system into the blood- larger health risk.

uranium into the soil of the UN agencies that uranium by residents

The contamination of soil creates an additional threat to curious children who may play with DU polluted soil. Dr. Mike Repacholi of the WHO testifies, "Young children could receive greater depleted uranium exposure when playing within a conflict zone because of hand-to-mouth activity that could result in depleted uranium ingestion from contami- nated soil."³⁹

In summary, twelve years after their first use in the battlefield, the health and environmental effects of exposure to DU in fired munitions have not been clearly established. Many thousands of U.S. and other soldiers have been exposed to DU in smoke, dust, and shrapnel. DU exposure may contribute to the Gulf War syndrome of U.S. veterans. Several investigations of health outcomes in American soldiers exposed to DU are continuing. It is reasonable to expect that civilian populations have also been exposed to DU in fashions similar to soldiers. Children who play at battle sites on abandoned weapons or who scavenge abandoned ordinance may be at particular risk. As indicated above, studies of DU exposures in Kosovo are in process and may contribute to a greater understanding of related health effects.

The Iraqi Studies of Childhood Cancer and Birth Defects in Basra 1900-2000.

In the entire world literature, the *only* reported studies of population health outcomes of DU exposure in civilian populations have been conducted in Iraq by Drs. Alim Yacoub of Mustansirayah School of Medicine in Baghdad Iraq, Genan Hassan of the University of Basra, and their colleagues.

Their work, while not published in a peer-reviewed scientific journal to date, has been widely reported. For example, the *Seattle Post-Intelligencer* cites reports that in 2001 the Saddam Teaching Hospital in Basra delivered 116 deformed babies for every 100,000 births, a notable hike from the eleven deformities in 1989.⁴⁰ The reported cancers in the hospital showed a similar trend with cancer deaths increasing from 34 in 1988 to 450 in 1998 and 603 so far this year.⁴¹

This research has also been presented at several conferences in Iraq and in Europe. These studies are widely understood by Iraqi health professionals and citizens and were the basis for the claims by the Saddam Hussein government that exposure to DU from American ordinance of the first Gulf War has caused increased rates of childhood cancer and birth defects.⁴²

In these studies all cases of childhood cancer and all cases of birth defects that presented at the Basra Women's and Children's Hospital per year are determined from hospital records. The assumption is made that admission to this hospital, the only pediatric hospital in Basra, captures all cases of childhood cancer. Similarly as the hospital is the major obstetrical service for the city, it is assumed that all incident cases of birth defects in Basra

are captured in the delivery floor records. The denominator for the calculation of rates is a five-year-old-and-under population number "estimated" for the city and each of its five regions. Incidences of childhood cancer, leukemia and birth defects appear to increase between 1995 and 2000, according to the most recent data. The authors claim that these increases are real and that they are due to exposure to DU. The conclusion that DU caused the increased rates is supported, the authors claim, by the observations that DU is present at the 1991 battle sites to the west of the city, and that the city regions closest to the DU had the higher disease rates. However, it is important to point out several features of these studies that limit our ability to interpret their results.

These are ecological studies. They test a hypothesis but by definition are observational experiments in uncontrolled environments and as such can suggest risk but do not imply a cause-effect relationship. They examine these relationships on a population level but their findings cannot be generalized to apply back to individual cases. The methods and analysis sections of these papers are very brief and do not help the reader consider important alternatives to the authors' claims. The fact that DU is a health hazard is clear from existing knowledge. It is also clear that DU was used in the 1991 battlefield west of Basra. The exposure model is less clear. The authors cite studies finding uranium in soil and plants. Uranium is not measured in either outdoor or indoor air. No biomonitoring of uranium in urine or blood was done. As a result, no dose estimation is possible and therefore no exposure or dose-response information is known.

Finally, the case definitions are all cancer and birth defect cases seen at one hospital in Basra. The assumption that all childhood cancer cases get care and get care at one hospital is claimed but not clearly established. Furthermore, in some cases the diagnosis appears to be made clinically and in other cases to be based on histopathology reports. There would appear to be many opportunities for bias in case definition. Perhaps most importantly one does not know the source or quality of the "estimated" Basra under-5-years-old population numbers.

PUBLIC HEALTH AND DU IN IRAQ

In post-war Iraq, the urgent issues of security, electrical power, safe drinking water, and sanitation are not adequately being addressed by the CPA, the Iraq government-in-formation, NGOs and, to a limited degree, the United Nations, in the context of persistent and widening violent conflict. Public health priorities in Iraq are sanitation, child and

maternal health, control of epidemic disease, and municipal and medical waste. But three critical public health issues are not evident in CPA plans: the need to integrate environmental protection into post-conflict clean-up and reconstruction, the rapid reconstruction of public health infrastructure particularly disease surveillance and tracking, and a public health response to DU.

Even when measured against the innumerable challenges facing Iraqi reconstruction, a public health response to the DU hazard is a priority activity. Such coordinated action will be essential to address the extensive use of DU in populated areas of Iraq, and the widespread belief held by large numbers of Iraqi citizens and health professionals that Americans have used radioactive weapons twice in Iraq, causing childhood cancer and birth defects. The Basra studies have been widely reported over the last three years in Iraqi media. For the CPA or a new government to neglect the issue and not to mount a visible response to the presence of DU in Iraq would discredit Iraq's emerging public health program. Sound public health programs are based on a credible response to indigenous health beliefs, ideas that in this case are rooted in a clear record of wanton environmental contamination.

A public health response to DU in Iraq would include the following:

1. Measurement of environmental levels of DU including surface water;
2. Definition of potential routes of exposure;
3. Definition of at-risk and susceptible populations, particularly children;

Development of appropriate surveillance systems:

Public health policy and program development should include:

1. Efforts to reduce population exposures: fence off DU weapons use sites, post warning, clean-up contaminated sites;
2. Assessment of population exposures: check uranium in drinking water, offer urine uranium screening and other testing to potentially exposed groups;
3. Improvements in the recognition and treatment of cancer, kidney disease, and birth defects.

The Precautionary Principle requires that Coalition Forces, now in conjunction with the Provisional Iraqi Government, accept responsibility for anticipating and preventing harm from DU to Iraqi citizens.

INTERNATIONAL LAW AND DU

In 1994, the U.S. Army reviewed the legality of depleted uranium munitions under international humanitarian law (also referred to as the law of armed conflict). The Army established that,

Post-Desert Storm studies by environmental and health officials conclude that the health risk in the use of DU is negligible (...) DU ammunition violates neither the customary law of war prohibitions on unnecessary suffering and poison or poisonous materials, or the new prohibitions contained in the 1977 Additional Protocol I against methods or means of warfare that are intended, or may be expected, to cause widespread, long-term and severe damage to the natural environment. [Thus] the M829A2 Cartridge, 120mm, APFSDS-T Depleted Uranium Tank Round is consistent with the law of war obligations of the United States.⁴³

While the DoD invokes humanitarian law to defend depleted uranium munitions, DU opponents argue that DU munitions breach the 1907 Hague Convention and Regulations, the 1949 Geneva Convention, and the 1977 Protocols.⁴⁴ As human rights lawyer Karen Parker, contended to the UN Sub Commission,

[DU] cannot be "contained" to legal fields of battle and thus fails the territorial test. [DU] continues to act after hostilities are over and thus fails the temporal test. [DU] is inhumane and thus fails the humaneness test. DU is inhumane because of how it can kill by cancer, kidney disease, etc. long after the hostilities are over. DU is inhumane because it causes birth (genetic) defects thus affecting children (who may never be a military target) and who are born after the war is over. The use of DU weapons may be characterized as genocidal by burdening gene pools of future generations. DU cannot be used without unduly damaging the natural environment and thus fails the environment test.⁴⁵

The legality of depleted uranium remains under debate. Avril McDonald of the TMC Asser Institute for International Law, highlighted the inconclusiveness of DU illegality at a 2003 symposium on the health impacts of depleted uranium munitions, stating:

It cannot be said with confidence that the use of DU weapons is clearly illegal under existing Hague or Geneva law. Nor is their use prohibited, unless in circumstances which themselves constitute a clear violation of a rule or principle of international, humanitarian law. However, DU weapons could theoretically be used in a manner, which is unlawful. Given that DU munitions are designed to be used in an anti-material capacity, if they were used as an anti-personnel weapon other than against targets of opportunity it might be considered as unlawful under the principle of superfluous injury or unnecessary suffering. In this case, there would be no military necessity favoring their use, as the disablement of the enemy troops can be better achieved using other easily available weapons. Where DU weapons were deliberately employed in an anti-personnel capacity, the question of criminal responsibility might also arise. Obviously, use of DU weapons against the civilian population would be unlawful and possibly criminal, just as any other attack against the civilian population is prohibited.⁴⁶

CURRENT ACTION IN CONGRESS

The fear of what may arise from the unknown long-term health and environmental effects of depleted uranium weaponry has prodded the UNEP, the British Royal Society, the World Health Organization (WHO) and others to demand further research. This call for more scientific research and DU cleanup is currently being discussed in Congress. On March 27, 2003, Representative Jim McDermott (D-WA) introduced legislation requiring studies on the health and environmental consequences of DU. He subsequently reintroduced this legislation in the 109th Congress. The Depleted Uranium Munitions Study Act of 2005 (H.R. 2410), has attracted 22 cosponsors in the House as of August 2005 (having attracted 31 cosponsors in the 108th Congress), and proposes cleanup and mitigation of DU contamination where DU has been used or produced in the United States. According to McDermott, a physician, "the need for these studies is imperative and immediate. We cannot knowingly put the men and women of our armed forces in harm's way."⁴⁷

An additional bill, introduced by Rep. Serrano (D-NY) is H.R. 202, the Depleted Uranium Screening and Testing Act of 2005. Introduced in January 2005, this bill concentrates on mitigating the health impact of DU on U.S. service personnel. Although these bills, in particular McDermott's, signify progress in the DU debate, they fail to address the potential risk that civilian populations may face in territories where DU munitions were actually used in combat. Despite this, PSR recommends that these bills be adopted into law and imple-

mented without delay, as an important starting point for establishing accountability for the use of these weapons.

RECOMMENDATIONS

Although there is currently insufficient evidence to directly implicate DU use with causing the Gulf War Syndrome in soldiers, or cancer and birth defects in Iraqi civilian populations, no adequate assessment of the level of health risk associated with DU munitions and waste has been made. PSR believes the Precautionary Principle applies in the case of battlefield use of DU. In this context, the proponent of an activity, rather than the public, should bear the burden of proof. Waiting for undeniable and incontrovertible proof of harm can otherwise result in undeniable and incontrovertible harm to human health and the environment by the time that proof is available. The process of applying the Precautionary Principle must be open, informed, and democratic and must include potentially affected parties. It must also involve an examination of the full range of alternatives.

As an organization concerned about public health, PSR recommends that:

1. Depleted uranium weaponry be withdrawn from military arsenals, until a risk analysis can be undertaken.
2. The UNEP be allowed to conduct a survey of the environmental disposition of DU, currently forbidden by the U.S. military, which could be useful as a preliminary step to evaluating health effects.
3. The U.S. military support independent studies of the longer-term health effects of battlefield use of DU on combatants and on the Iraqi population exposed to DU in the 1991 Gulf War and the 2003 war in Iraq.
4. DU contaminated weapons be removed from battle sites to preclude possible long-term radiation contamination of the environment.
5. The Iraqi Ministry of Health initiate a prevention-oriented DU public health program, outlined above, with support from CPA and the WHO.

Congress and the Department of Defense have a duty to ensure that the putative military advantages of depleted uranium do not come at the expense of the health of soldiers and civilians. They must ensure that the health and environmental effects of battlefield use of DU do not violate the Geneva Convention and international law.

As physicians and health professionals dedicated to the survival of a healthful and sustainable planet, we believe that the use of DU weapons that leaves a persistent noxious environmental and public health hazard is unconscionable. We owe it to future generations to stop their use and attend to their cleanup immediately.

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⁴¹ Ibid.

⁴² In January of 2003 a PSR physician was in Iraq as part of a public health survey project (Lancet, CESR Report). During that visit he had occasion to meet alone with Alim Yacoub MD Dean and Professor of Medicine of the Mustansirayah School of Medicine and co-author of the Iraq DU studies. After a lengthy discussion of public health, medicine and medical education in Iraq, Dr Yacoub presented his DU manuscripts in paper and on CD to Dr McCally. He described the several protocols, their methods and conclusions. He argued that they observed significant increases in cancer in children under 15 and in birth defects. He argued that the results were due to DU exposure, claiming that the disease incidence was highest in the areas of the Basra municipality closest to the battlefields where environmental DU concentrations were also likely to be the highest. Dr Yacoub, who died in a highway traffic accident early in 2004, was an internist specializing in Community Medicine. He has had post-graduate training in epidemiology at the London School of Hygiene and Tropical Medicine.

⁴³ Quoted by Avril McDonald, *The International Legality of Depleted Uranium Weapons*. Background paper for presentation on 'The international legal ramifications of the use of DU weapons', Symposium on The Health Impact of Deplete Uranium Munitions.' Held at the New York Academy of Medicine, 14 June 2003, p. 33.

⁴⁴ Humanitarian law can be summed up by Part III, Section I, Article 35 of Additional Protocol I to the Geneva Convention: '1) In any armed conflict, the right of the Parties to the conflict to choose methods or means of warfare is not unlimited. 2) It is prohibited to employ weapons, projectiles and material and methods of warfare of a nature to cause superfluous injury or unnecessary suffering. 3) It is prohibited to employ methods or means of warfare which are intended, or may be expected, to cause widespread, long-term and severe damage to the environment.' Taken from Avril McDonald, *The International Legality of Depleted Uranium Weapons*. (U.S. not a signer of Protocols but still holds itself under its obligation due to international customary law).

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