METAL OF DISHONOR

DEPLETED URANIUM

How the Pentagon RADIATES soldiers & civilians with DU weapons

Including selections by

Rosalie Bertell Helen Caldicott Ramsey Clark

Jay M. Gould Michio Kaku

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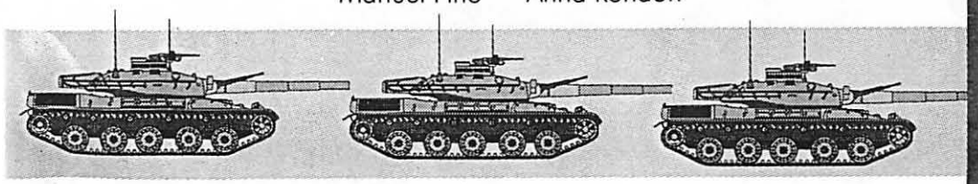

Metal of Dishonor
Depleted Uranium
How the Pentagon Radiates Soldiers and Civilians with DU Weapons

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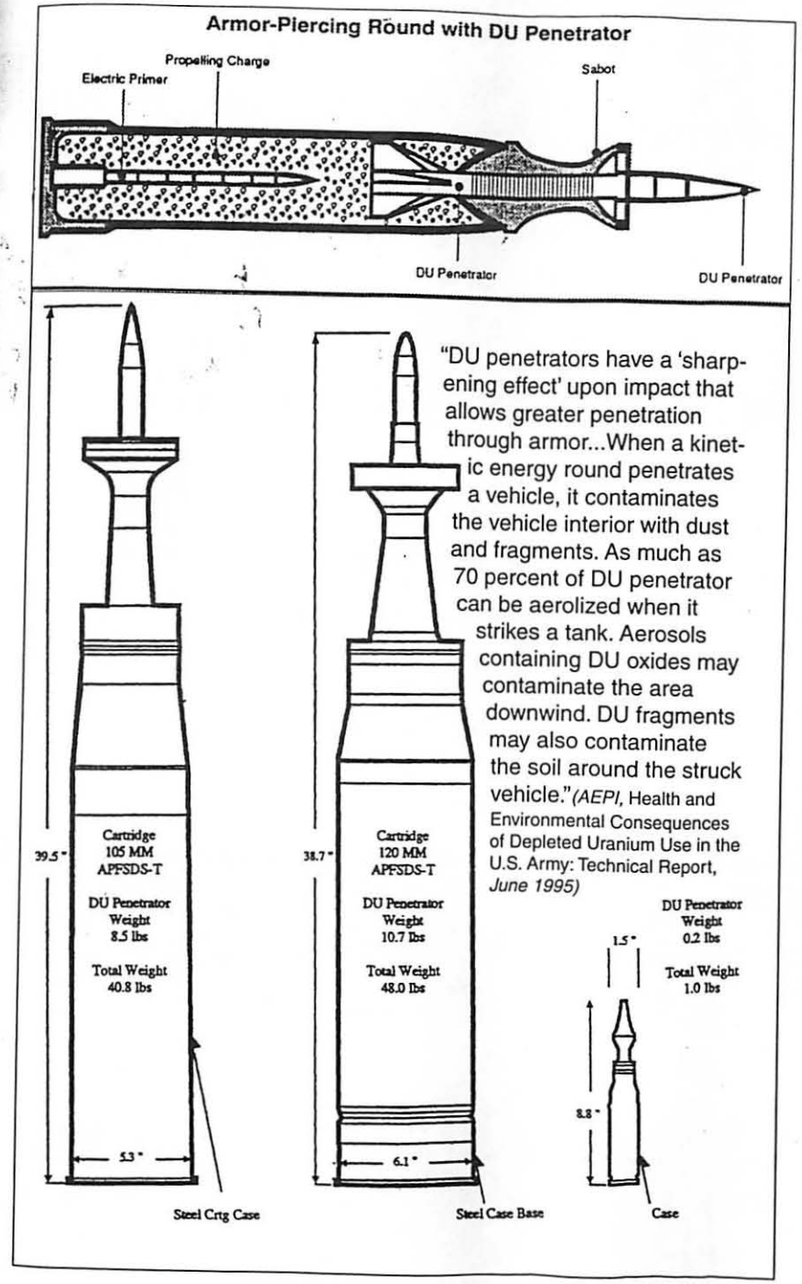
We dedicate this book to the victims of depleted-uranium weapons, and we dedicate ourselves to the struggle to stop these weapons from being used again.

Contents

The M1A1 tank fires 120–millimeter anti-tank rounds which contain a 10.7-pound depleted uranium penetrator core. The dense DU core increases the firing range of the M1A1 tank to between 3,000 and 3,500 meters (up to two miles). The Bradley Fighting Vehicle, the M1 and M60 series tanks, the XM8 Armored Gun System and the M1A2 Abrams tank also use DU artillery ranging in size from 25mm to 120mm. *Photo courtesy of Grace Bukowski,* Uranium Battlefields Home and Abroad: Depleted Uranium Use of the U.S. Department of Defense, *March 1993*



"DU penetrators have a 'sharpening effect' upon impact that allows greater penetration through armor...When a kinetic energy round penetrates a vehicle, it contaminates the vehicle interior with dust and fragments. As much as 70 percent of DU penetrator can be aerolized when it strikes a tank. Aerosols containing DU oxides may contaminate the area downwind. DU fragments may also contaminate the soil around the struck vehicle."*(AEPI,* Health and Environmental Consequences of Depleted Uranium Use in the U.S. Army: Technical Report, *June 1995)*

19 | Nine-Legged Frogs, Gulf War Syndrome and Chernobyl Studies

Desert Storm veterans along with the people of Iraq and Kuwait were victims of one of the latest military experiments on human beings. I believe that the ignorance was culpable and criminal.

DR. ROSALIE BERTELL

I first heard about the military using depleted uranium for bullets from the Native Americans for a Clean Environment (NACE) in Gore, Oklahoma. Kerr Magee was operating a factory there, and in a liquid waste spill a young man, about twenty-one years old, was sprayed with the mixture and died. Many members of the public were also exposed, and were taken to the University in Oklahoma City for medical examination and feces analysis. It seems that the liquid waste contained primarily uranium and other heavy metals.

Local people had found this factory to be very polluting. When I visited the town to see what was happening and to decide whether or not I could help, they showed me rust marks scattered over the surface of their automobiles where the toxic corrosive spray released from the factory routinely had impacted on the paint. People complained of burning throats and eyes, some with even more serious complaints, but little systematic information which would show that the factory was the source of their problem.

I met a young boy who showed me a frog he had caught—the frog had nine legs. It was in a bottle of formaldehyde. I wanted to take it for some tissue and bone analysis but it was his prize possession and he would not part with it.

I learned that the Kerr Magee plant had been disposing of its waste by deep-well injection in this rural, primarily farming area. The people, becoming alarmed at this practice which threatened the water table, got a court injunction to stop it. In an action, which seemed to the local farmers to be a retaliation, Kerr Magee had applied to the Nuclear Regulatory Commission to call their waste an "experimental fertilizer" and just spread it over the top of the land. The stories were quite strong evidence that this so-called fertilizer was sometimes just released into the local river, or released in one place on the factory property, with no pretense even to spread it.

The young boy had found his nine-legged frog on the hill which served as the "experimental plot." Hunters had found a rabbit with two hearts, and the local taxidermist told me that he had tried to

mount two deer heads and the fur came off in his hands in clumps. He had never seen anything like it in his whole career.

As local people became sick and started to complain, Kerr Magee bought them out, and took over their land. The Native people, who were determined to preserve their land, formed a Coalition of Whites and Natives Concerned, and began the long legal fight with the company. They learned about environmental assessment hearings, licensing hearings, etc. and began to seriously participate. They also undertook a human health survey of all families—there were about four hundred of them—living within four miles of the factory. Every family was included in the survey, which was very comprehensive and carefully administered.

The International Institute of Concern for Public Health agreed to analyze this data for the citizens. The outstanding illnesses in the area were respiratory and kidney problems. There were significantly more persons with respiratory illnesses downwind of the plant, and significantly more with kidney problems downstream of the plant.

We intended to do a clinical follow-up of this survey, and designed the study with the cooperation of the Occupational Health and Respiratory Units at the University Medical School of New Jersey. We were not able to obtain funding for this study. Nevertheless, with the health survey and a great deal of local perseverance, Kerr Magee moved out. A second multinational tried to take over the factory—I think it was General Dynamics—but it failed.

I learned much about uranium bullets during this research:

- They are incendiary; that is, after piercing the object they can burst into flame.
- They are fragmentary; they disintegrate into small fragments inside the body, and cannot be removed.
- They are more dense than lead, and can pierce a bullet-proof vest, or a light armored car or tank.
- Because the "enemy" might also use them, the military made uranium armor as a protection.
- They were cheap, because the depleted uranium was a waste product of the nuclear-bomb program.
- They were radioactive, which meant that even handling them was risky, but no one seemed to be worrying about this!

Research into Gulf War Syndrome

Six years after the Gulf War there is still deep controversy over the causes of the severe health problems observed in the veterans. Reluctantly, the U.S. government has been slowly releasing data on possible Iraqi chemical exposures of the veterans, but many physicians, some of whom have reported that their jobs are being threatened, have said that this information does not explain the variety of symptoms observed.

Shortly after the Gulf War, at the request of Staff Sergeant Carol Picou, San Antonio, Texas, who was herself a victim, Patricia Axelrod undertook research into the possible causes of this illness.

The research was jointly sponsored by the U.S. National Institutes of Health, Office of Women's Health. It was submitted to the Department of Health and Human Services on May 10, 1993, and was labeled, "for internal distribution only." The research was intended to be a guide to further research into the problem, so its limitation to internal distribution did not make sense.

Our journal, *International Perspectives in Public Health,* published the document in full in 1994.

At the time, the U.S. Department of Defense was treating this illness as Post Traumatic Stress Disorder (PTSD) and advising military doctors to treat it with muscle relaxants and sleeping pills, while ordering a mental illness assessment. Most of the information in Ms. Axelrod's *Guide to Gulf War Sickness* comes from interviews with Dr. Thomas Callender, a toxicologist; Dr. Barry Wilson, of Battelle Pacific Northwest Laboratories; and Commissioner Rudy Arredondo, Maryland's Commission on Black and Minority Health. Ms. Axelrod also interviewed many veterans and reviewed the journal articles and reports available in the public press. Information on leishmaniasis was provided by the World Health Organization.

Potential Causes of Gulf War Syndrome

In this complex situation, any or all of the following factors may have interacted to bring about specific symptoms in veterans. Obviously, the combinations of factors differ with individuals, hence it is likely that there is not one single explanation of the whole spectrum of symptoms. However, the following main categories are candidates for causal relationships with illnesses reported by veterans:

- Administration of three vaccines intended as protection against

nerve and biological warfare agents. These were:

1. Pyridostigmine, normally prescribed for myasthenia gravis and known to have serious side effects, especially when the person taking it is exposed to heat. It is also known that exposure to pesticides and insecticides (Baygon, Diazinon and Sevin) should be avoided when taking pyridostigmine because they can accentuate its toxicity. Some women who took this drug during pregnancy and have breast-fed infants have seen side effects in their child.

2. Botulinum Pentavalent, an unproven vaccine intended to counteract botulism. It is unlicensed in the United States.

3. Anthrax, to protect against the disease anthrax. This was apparently selectively administered to troops during the war, and women receiving it were warned not to have children for three or four years.

- Depleted uranium was used for the first time in this war. It was incorporated into tank armor, missile and aircraft counterweights and navigational devices, and in tank, anti-aircraft and anti-personnel artillery. The scientific information on this deadly chemical has been reported in "Radium Osteitis With Osteogenic Sarcoma: The Chronology and Natural History of Fatal Cases" by Dr. William D. Sharpe, *Bulletin of the New York Academy of Medicine*, Vol. 47, No. 9 (September 1971). There was no excuse for this human experimentation because the effects of this exposure were known.

- Smoke and chemical pollutants released by the continuous oil-well fires. Levels of soot, carbon monoxide and ozone have been studied by an Environmental Protection Agency Task Force. The National Toxics Campaign, Boston, Massachusetts, found five different toxic hydrocarbon products in the smoke (1,4-dichlorobenzene, 1,2-dichlorobenzene, diethyl phthalate, dimethyl phthalate and naphthalene), any one of which could induce serious health effects.

- Old World leishmaniasis, a parasitic disease transmitted by the bite of many species of sand fly indigenous to the region. Non-indigenous people who enter an infected area are known to be more seriously affected by this parasite than the inhabitants. If left undiagnosed, and therefore untreated, it can be fatal. Diagnosis requires bone and spleen biopsy, and the disease can have a three-year incubation period without causing symptoms. It can be transmitted by blood transfusion, and transmitted by a woman to her unborn child. Leishmaniasis was reported as widespread in Iraq and Saudi Arabia. This disease is thought to be responsible for the Pentagon ban, November 1991, against blood donations from Gulf War veterans. This ban was lifted, for unknown reasons, on January 11, 1993.

- Pesticides and insecticides were used extensively throughout the war to protect against pestilence. It is known that large quantities of DDT, malathion, fenitrorthion, propuxur, deltamethrin and permethrin were used. They are all toxic nerve agents, and many are suspected carcinogens and mutagens.

- Destruction by allies of Iraqi chemical, nerve and biological warfare weapons resulting in widespread distribution of these toxins in the environment. This problem has now been, at least in part, documented by the U.S. Department of Defense. They are focusing on this potential cause as if it were the only candidate cause.

- The electromagnetic environment which permeated the battlefield during the war. Veterans were exposed to a broad spectrum of electromagnetic radiation created by electricity generated to support the high-tech instruments, thousands of radios and radar devices in use. This intense electromagnetic field causes both thermal and non-thermal effects, and potentially interacts with the other hazardous exposures and stresses of the battlefield. Electromagnetic radiation can alter the production of hormones (neurotransmitters), interact with cell membranes, increase calcium ion flow, stimulate protein kinase in lymphocytes, suppress the immune system, affect melatonin production required to control the "body clock," and cause changes in the blood-brain barrier.

The Hazards of Low Level Radiation

In the past few years the information available on the health effects of exposure to low levels of radiation has increased. We are no longer

dependent on the commercial or military nuclear researchers who since 1950 have claimed that studies of the effects of low-level radiation are impossible to undertake. The new information is unsettling because it proves the critics of the industry to have been correct as to its serious potential to damage living tissue.

There have also been significant new releases of findings from the atomic bomb research in Hiroshima and Nagasaki, the self-acclaimed "classical research" of radiation health effects. I will list these documents toward the end of this article, along with studies from the nuclear industry.

In reviewing these research papers one is struck by the high-dose response when the radiation is delivered slowly, with low total dose. The conventional wisdom has claimed that at low dose/slow-dose rate the body is well able to repair most of the harm caused by the radiation. Some nuclear apologists go so far as to claim such exposures are "beneficial."

Because the nuclear industry has always maintained that the effects of low-dose radiation exposure are so small that it is impossible to study them, they proposed extrapolating the effects from those observed at high dose, using a straight line to zero (zero dose, zero effect), together with "correction factors" for low dose/slow-dose rate.

The effect of this "correction" is to reduce the fatal cancer estimates calculated by D.L. Preston, then Director of the Radiation Effects Research Foundation at Hiroshima, using the new dosimetry, from seventeen fatalities per million people per rad exposure, to five fatalities per million people per rad exposure. The corresponding estimates based on actually observed rates for nuclear workers is between ten and thirty fatalities per million per rad. Obviously, for the adult healthy male, the dose-response estimate should be about twenty for fatal cancers per million per rad. The official estimate used by nuclear regulators is four fatal cancers for workers (or military personnel) and five fatal cancers for members of the public from one rad exposure to one million people. (One rad is about the dose of radiation received from a major diagnostic medical X-ray).

However, although we can make a strong case for increasing the "official" estimates of harm by a factor of four, this fails to deal with non-fatal cancers, depressed immune systems, localized tissue damage (especially the respiratory, digestive and urinary tracts), damage to skin, and reproductive problems. Radiation can cause brain lesions, damage to the stem cells which produce the blood and, when the

radioactive material is carried in a heavy metal (uranium), it can be stored in bone, irradiating body organs and nerves within its radius.

Consequences of Chernobyl

Detailed studies of dose-response at the low dose/slow-dose rate level:

Dr. E. B. Burlakova has provided me with a copy of the book, of which she is editor: *Consequences of the Chernobyl Catastrophe: Human Health.* In one Chapter of this book, Dr. Burlakova and fourteen other scientists publish their findings on animal and human studies of the health effects of low dose/slow-dose rate, exposure to ionizing radiation. They examined carefully the following biological phenomena under ionizing radiation exposure situations:

- alkaline elution of DNA of lymphocytes and liver
- neutral elution and adsorption of spleen DNA on nitrocellulose filters
- restriction of spleen DNA by EcoRI endonuclease
- structural characteristics (using the ESR spin probe technique) of nuclear, mitochondrial, synaptical, erythrocyte and leukocyte membranes
- activity and isoforms of aldolase and lactate hydrogenase enzymes
- activity of acetycholine esterase, superoxide dismutase, and glutathione peroxidase
- the rate of formation of superoxide anion radicals
- the composition and antioxidizing activity of lipids of the above mentioned membranes
- the sensitivity of cells, membranes, DNA, and organisms to the action of additional damaging factors.

"For all of the parameters a bimodal dose-effect dependence was discovered, i.e. the effect increased at low doses, reached its [low-dose] maximum, and then decreased (in some cases, the sign of the effect changed to the opposite, or "benefit" effect) and increased again as the dose was increased" (Burlakova, page 118).

Dr. Burlakova has speculated that at the lowest experimental doses used in this research, the repair mechanism of the cells was not triggered. It became activated at the point of the low-dose maximum, providing a "benefit" until it was overwhelmed and the damage began

again to increase with dose. This may well be the case.

However, the unexpected effects of low dose/slow-dose rate exposure to ionizing radiation can also be attributed to biological mechanisms, other than the direct DNA damage hypothesis usually used by radiation physicists. These secondary mechanisms are specific to the low-/slow-dose conditions. Three such secondary mechanism have been observed by scientists: the Petkau effect, monocyte depletion, and deformed red blood cells.

The Petkau effect was discovered by Abram Petkau at the Atomic Energy of Canada Ltd. Whiteshell Nuclear Research Establishment, Manitoba, Canada in 1972.[1] Dr. Petkau discovered that at 26 rads per minute (fast-dose rate) it required a total dose of 3,500 rads to destroy a cell membrane. However, at 0.001 rad per minute (slow dose rate), it required only 0.7 rad to destroy the cell membrane. The mechanism at the slow-dose rate is the production of free radicals of oxygen (O2 with a negative electrical charge) by the ionizing effect of the radiation.

The sparsely distributed free radicals generated at the slow-dose rate have a better probability of reaching and reacting with the cell wall than do the densely crowded free radicals produced by fast-dose rates. These latter recombine quickly. Moreover, the slight electrical charge of the cell membrane attracts the free radicals in the early stages of the reaction (low total dose). Computer calculations have shown that the attraction weakens with greater concentrations of free radicals. The traditional radiation biologist has tested only high-dose reactions, and looked for direct damage to the membrane by the radiation.

Monocyte depletion: Nuclear fission produces radionuclides which tend to be stored by humans and animals in the bone tissue. In particular, strontium-90, plutonium, uranium and the transuranics have this property. Stored in bone, near the stem cells which produce the white blood cells, these radionuclides deliver a chronic low/slow dose of radiation which can interfere with normal blood-cell production. A few less neutrophils or lymphocytes (the white blood cells which are most numerous, and are usually "counted" by the radiophysicist) are not noticeable. In the normal adult, there are about 7,780 white cells per microlitre of blood. Of these, about 4,300 are neutrophils and 2,710 are lymphocytes. Only 500 are monocytes.

If, for example, stem cells in the bone marrow are destroyed so as to reduce total white blood count by 400 cells per microlitre due

to the slow irradiation by radionuclides stored in the bone, this would represent a depletion of only five percent in total white cells, an insignificant amount. If all of the depletion was of neutrophils, this would mean a reduction of only 9.3 percent, still leaving the blood count well in the normal range. The lymphocytes would also be still in the normal range, even though they were depleted by 400 cells per microlitre, or 14.8 percent. However, there would be a dramatic depletion of the monocytes by 80 percent. Therefore, at low doses of radiation, it is more important to observe the monocytes, than to wait for an effect on the lymphocytes or neutrophils (as is now usually done). The effects of serious reduction in monocytes are:

- Iron deficient anemia, since it is the monocytes which recycle about 37-40 percent of the iron in the red blood cells when they die;
- Depressed cellular immune system, since the monocyte secretes the substance which activates the lymphocyte immune system.[2]

Deformed red-blood cells: Dr. Les Simpson, of New Zealand, has identified deformed red-blood cells, as observed under an electron microscope, as causing symptoms ranging from severe fatigue to brain dysfunction leading to short-term memory loss. He has identified such cells in elevated number in chronic fatigue patients, and speculated that because of their bloated or swollen shape, they are obstructed from easily passing into the tiny capillaries, thus depriving muscles and the brain of adequate oxygen and nutrients. The chronic fatigue syndrome has been observed both at Hiroshima and Nagasaki, called bura bura disease, and at Chernobyl.[3]

In the official approach to radiobiology, only direct damage to DNA has been recognized as "of concern," and only high dose/fast-dose rate experiments or observations have been accepted for use in estimating the dose-response rate. As was noted, it is the "common wisdom" that effects of low doses/slow-dose rates cannot be studied, but must be extrapolated from the officially accepted high dose/fast-dose rate studies. This approach is rejected by the work of Dr. Burlakova, and the other research noted below.

Basing one's theory on claims that it is impossible to study the phenomenon is certainly a peculiar way to do science! This myth has now been clearly shown to have been rash and criminally negligent.

Unfortunately, the Desert Storm veterans were victims of one of the latest military experiments on human beings. The people of Iraq

and Kuwait were also the victims of this misguided experiment. I believe that the ignorance was culpable and criminal.

Recent Reports on Low-Level Radiation

I would like to bring your attention to the following significant new reports on the effects of low-level radiation:

Health Consequences of the Chernobyl Accident, Results of the IPHECA Pilot Projects and Related National Programs, Scientific Report, World Health Organization, Geneva 1996.

Consequences of the Chernobyl Catastrophe: Human Health, E.B. Burlakova, ed. Co-published by the Center for Russian Environmental Policy and the Scientific Council on Radiobiology Russian Academy of Science, ISBN 5-88587-019-5, Moscow 1996.

Volume 137, Supplement, *Radiation Research 1994*, which published for the first time the dose-response data on cancer incidence rate observed in the atomic bomb survivors of Hiroshima and Nagasaki. Prior to this publication, only cancer death data was reported.

Biological Effects of Ionizing Radiation V (BEIR V), U.S. National Academy of Sciences, Washington 1990. This provides new radiation risk estimates based on the newly assigned doses of radiation in this atomic bomb survivor study.

Also available now are the long term follow-up of workers in the nuclear industry. This industry has now been operating more than fifty years in the United States and about fifty years in the United Kingdom. These include:

"Inconsistencies and Open Questions Regarding Low-Dose Health Effects of Ionizing Radiation", by R. Nussbaum and W. Kohnlein. *Environmental Health Perspectives*, Vol. 102, No. 8, August 1994.

RERF Technical Report TR9-87, by D.L. Preston and D.A. Pierce, Hiroshima 1987.

"The Effects of Changes in Dosimetry on Cancer Mortality Risk Estimates in Atomic Bomb Survivors" *Radiation Research*, Vol. 114, 1988.

"Mortality and Occupational Exposure to Irradiation: First Analysis of the National Registry for Radiation Workers" by G.M. Kendall. *British Medical Journal*, Vol. 304, 1992.

"Mortality Among Workers at Oak Ridge National Laboratory" by S. Wing. *Journal of the American Medical Association*, Vol. 265, 1991.

"Reanalysis of the Hanford Data, 1944-1986 Deaths" by G.W. Kneale and A. Stewart. *American Journal of Industrial Medicine*, Volume 23, 1993.

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1. Graeub, Ralph, *The Petkau Effect, Revised Edition*, 1990, Translated from German by Phil Hill, and Published by Four Walls Eight Windows, New York, 1994. ISBN: 1-56858-019-3.
2. Bertell, R. "Internal Bone Seeking Radionuclides and Monocyte Counts," International Perspectives in Public Health, Vol. 9, 1993, pp. 21-26.
3. Simpson, Les, has published several papers in the New Zealand Medical Journal, and wrote a Chapter in the *Medical Textbook on Myalgic Encephalomyelitis* (MI), edited by Dr. Byron Hyde.

5 | Collateral Damage: How U.S. Troops Were Exposed To Depleted Uranium During the Persian Gulf War

"When DU is indicted as a causative agent for Desert Storm illness, the Army must have sufficient data to separate fiction from reality. Without forethought and data, the financial implications of long-term disability payments and health-care costs would be excessive."
—U.S. Army Environmental Policy Institute[1]

DAN FAHEY

Introduction

One of the legacies of the 20th Century will undoubtedly be the frightening evolution of weapons capable of killing or injuring large numbers of people both during and after their intended wartime use. With the passage of time, the variety of these weapons only grows: chemical and biological agents, land mines, nuclear weapons, and poisonous herbicides. In the wake of the Persian Gulf War, we must add to this list weapons made of a nuclear waste product called depleted uranium.

Tank armor and armor-piercing rounds made of depleted uranium proved highly effective in their first wartime use, but because depleted uranium weapons were so effective, dozens of countries now have or are developing depleted uranium weapons for their arsenals. The rapid proliferation of depleted uranium weapons will, in the near future, level the playing field and eliminate any battlefield advantage they currently provide.

Unfortunately, spreading depleted uranium in an uncontrolled fashion across battlefields can have severe health consequences for friend and foe alike. During the Persian Gulf War, most U.S. troops were unaware of the presence and dangers of depleted uranium on the battlefield. As a result, thousands of servicemen and women came in contact with contaminated vehicles which had been hit by depleted uranium rounds. The Pentagon is reluctant to discuss the dangers of depleted uranium weapons because of their effectiveness in combat and the prospect of costly health care and disability compensation for U.S. veterans who have been and are being exposed.

However, the impact of depleted uranium weapons is felt far beyond the veterans of the Persian Gulf War. Workers in the domestic uranium industry who mine and process uranium and manufacture depleted uranium weapons, in addition to civilians who

live near processing plants, manufacturing plants, testing ranges and contaminated battlefields, are also affected. This paper focuses on the use of depleted uranium weapons in the Persian Gulf War, and the ways in which U.S. troops were exposed to them.

What is Depleted Uranium?

Depleted uranium (DU) is the highly toxic and radioactive byproduct of the uranium enrichment process. "Depleted" uranium is so called because the content of the fissionable U-235 isotope is reduced from 0.7% to 0.2% during the enrichment process. The isotope U-238 makes up over 99% of the content of both natural uranium and depleted uranium. Depleted uranium is roughly 60% as radioactive as naturally occurring uranium, and has a half life of 4.5 billion years.[2] As a result of 50 years of enriching uranium for use in nuclear weapons and reactors, the U.S. has in excess of 1.1 billion pounds of DU waste material.[3]

In the early 1970s, the government began exploring ways to dispose of DU which would relieve it of the burden of having to store it in low-level radioactive waste repositories. DU has several characteristics which make it attractive for use in munitions: it is extremely dense, available in large quantities, and given for free to arms manufacturers.

During the 1970s and 1980s, testing at more than a dozen domestic sites including Aberdeen Proving Ground in Maryland, Jefferson Proving Ground in Indiana, and Yuma Proving Ground in Arizona demonstrated that large and small caliber rounds made of depleted uranium were highly effective in piercing armor. At the same time, the Army found that incorporating depleted uranium metal into tank armor made tanks less vulnerable to penetration from conventional rounds. But while the Army conducted many tests to evaluate the effectiveness of DU bullets and armor, they failed to "closely coordinate the planning and performance of experiments for DU health and environmental assessments."[4] After years of research, development and testing, Operation Desert Storm provided the first opportunity for the Pentagon to test DU munitions in combat.

Depleted Uranium Weapons in the Persian Gulf War

The Tomahawk Cruise Missiles launched on the first day of Operation Desert Storm, and used during the September 3, 1996, attack on Iraq during Operation Desert Strike, contain DU in their tips to

provide weight and stability. When they impact a target or other hard surface, the resultant area can become contaminated by the DU. A U.S. Navy instruction manual notes that teams involved in the recovery of Tomahawk missiles which crash during testing must have radiological protection clothing, gloves, respirators, and dosimeters.[5]

The Navy also uses DU in ammunition for its Phalanx Close-In Weapons System gun. While this gun is primarily designed for missile defense, it is also effective against other targets, as was shown in June 1996 when a Japanese ship firing a U.S.-made Phalanx gun accidentally shot down an American jet during training exercises in the Pacific. The Navy's use of weapons containing depleted uranium during Desert Storm was small, however, when compared to their use by the Army, Air Force, and Marines.

The Army and Marine Corps employed more than 1,900 M1A1 Abrams main battle tanks, plus several hundred M1 and M60 model tanks, in combat during Desert Storm.[6] U.S. tanks typically carry a mixed load of high explosive and depleted uranium sabot rounds. The M1A1 tanks fire 120mm rounds, while the M1 and M60 tanks fire 105mm rounds. The weight of the DU penetrator dart in a 120mm tank round is 10.7 pounds; in a 105mm round it is 8.5 pounds.[7] The Army reports that a total of 14,000 DU tank rounds were expended during the war. 7,000 rounds were fired during training before the war into sand berms in Saudi Arabia; 4,000 rounds were fired during combat; and 3,000 were lost due to fires or other accidents.[8] In addition, British Challenger tanks fired at least 100 DU tank rounds in combat.

The extended range of DU penetrators combined with the highly accurate fire control system and gun of the M1A1 provided American tankers with a considerable advantage over their Iraqi counterparts. While Iraqi T-72 tanks had an effective firing range of under 2,000 meters, U.S. tanks had an effective firing range of approximately 3,000 meters. In one case, the frontal armor of a T-72 was penetrated by a 3,500 meter shot (over 2 miles) from an M1A1.[9] But the longest confirmed kill of the war was by a British Challenger tank, which destroyed an Iraqi tank with a DU round over a distance of 5,100 meters (over 3 miles).[10] Even over these extended ranges, the DU rounds proved highly effective in penetrating Iraqi tank armor. In one case, a DU round "hit the turret of a Russian-made Iraqi T-72 tank, passed completely through the turret, and hit (and destroyed) a second T-72."[11]

Though the Army and Marine Corps fired thousands of DU rounds in battle, the Air Force by far fired the majority of DU rounds used during the war. The Air Force's A-10 "tank-killer" aircraft were used extensively against Iraqi armored vehicles and artillery. The A-10 fired approximately 940,000 30mm DU rounds in combat.[12] The weight of the DU penetrator in a 30mm round is 272 grams, so roughly 564,000 pounds of depleted uranium were fired from A-10s during the war.[13]

DU penetrator rounds fired by American aircraft and American and British tanks destroyed approximately one-third of the 3,700 Iraqi tanks lost in battle.[14] In addition, artillery pieces, armored personnel carriers and other equipment destroyed by DU rounds number in the thousands. By war's end, roughly 300 tons of uranium from spent rounds lay scattered in various sizes and states of decay across the battlefields of Iraq and Kuwait.

When a depleted uranium projectile strikes a hard surface, up to 70% of the penetrator is oxidized and scattered as small particles in, on and around the target.[15] A fact sheet issued by the U.S. Army Armament, Munitions, and Chemical Command (AMCCOM) states:

> When a DU penetrator impacts a target surface, a large portion of the kinetic energy is dissipated as heat. The heat of the impact causes the DU to oxidize or burn momentarily. This results in smoke which contains a high concentration of DU particles. These uranium particles can be ingested or inhaled and are toxic.[16]

Of the aerosolized particles produced, 60% are particles less than five microns in diameter (less than 10 microns being considered as respirable size).[17] Army field tests have shown that when a vehicle is struck by a DU penetrator, the heaviest contamination occurs within 5 to 7 meters of the vehicle.[18] However, DU particles thrown into the air by the round's impact, or by resultant fires and explosion, can be carried downwind for 25 miles or more.[19]

The DU armor on the M1A1 tanks proved effective in protecting tank crews from enemy fire, although the tank crews were continually irradiated by their own armor and DU rounds for the months many of them lived with their tanks. For example, a tank driver receives a radiation dose of 0.13 mrem/hr to his head from overhead DU armor.[20] After just 32 continuous days, or 64 twelve-hour days, the

amount of radiation a tank driver receives to his head will exceed the Nuclear Regulatory Commission's annual standard for public whole-body exposure to man-made sources of radiation.[21] Unfortunately, U.S. tank crews were not monitored for radiation exposure during the Persian Gulf War.

During the ground war, only seven M1A1's were hit by rounds fired from the Iraqi's T-72 tanks, with none being seriously damaged. The Army reported that the Iraqi armed forces "destroyed no Abrams tanks during the Persian Gulf War."[22] Nine Abrams tanks were destroyed during the war: seven due to friendly fire and two were intentionally destroyed to prevent capture after they became disabled.[23] One incident in particular demonstrates the effectiveness of armor-piercing rounds and tank armor made of depleted uranium. As allied forces pushed into southern Iraq at the start of the ground war, an M1A1 tank became stuck in the mud.

> The unit (part of the 24th Infantry Division) had gone on, leaving this tank to wait for a recovery vehicle. Three T-72's appeared and attacked. The first fired from under 1,000 meters, scoring a hit with a shaped-charge (high explosive) round on the M1A1's frontal armor. The hit did no damage. The M1A1 fired a 120mm armor-piercing (DU) round that penetrated the T-72 turret, causing an explosion that blew the turret into the air. The second T-72 fired another shaped-charge round, hit the frontal armor, and did no damage. The T-72 turned to run, and took a 120mm round in the engine compartment (which) blew the engine into the air. The last T-72 fired a solid shot (sabot) round from 400 meters. This left a groove in the M1A1's frontal armor and bounced off. The T-72 then backed up behind a sand berm and was completely concealed from view. The M1A1 depressed its gun and put a (DU) sabot round through the berm, into the T-72, causing an explosion.[24]

U.S. forces came in contact with DU on the battlefield in a variety of ways. Some were exposed during combat. Some were exposed during the recovery of contaminated U.S. vehicles which had been hit by friendly fire incidents. Some were exposed during a massive fire in July, 1991, at the U.S. base in Doha, Kuwait. And some who continue to work with DU weapons, or deploy to contaminated areas

in Kuwait, are being exposed today. In most of these scenarios, exposure to DU could have been prevented or minimized if our troops had been warned ahead of time about the use of DU weapons and effective safety measures, and if they had been issued protective clothing including respirators and gloves. No warnings or protective gear were issued before the war, however, because "Army officials believe that DU protective methods can be ignored during battle or other life-threatening situations because DU-related health risks are greatly outweighed by the risks of combat."[25]

Friendly Fire Incidents

During Operations Desert Shield and Desert Storm, 29 U.S. vehicles were contaminated with DU on the battlefield. Twenty-one of these vehicles (six Abrams tanks and 15 Bradley fighting vehicles) were penetrated by DU rounds during friendly fire incidents. A total of 13 soldiers were killed and 50 wounded in friendly fire incidents involving DU rounds.[26] Twenty-two of the wounded soldiers retained uranium shrapnel in their bodies.[27] Thirty of the soldiers wounded in the friendly fire incidents, including most of those with DU shrapnel, are being monitored by the Depleted Uranium Program at the Baltimore, Maryland, VA Medical Center.

Five years after they were exposed to DU on the battlefield, 15 of the 30 still have elevated levels of uranium in their urine.[28] Leonard Dietz, a retired atomic scientist, has noted that "if you've got any indication of it [DU] at this late date, even at low levels, it would indicate you'd had a pretty heavy dose five years ago."[29]

Because the Army failed to conduct even one study about the long term health effects of imbedded DU fragments during its twenty years of DU weapon development, these veterans have unwittingly become the subjects the Army needed for such a study.[30] As part of the study, the Army has recommended periodic examinations of the veterans who retain DU shrapnel "to watch for and catalogue signs of chronic kidney toxicity, granuloma induction, and cancer."[31]

Recovery Personnel

The 144th Army National Guard Service and Supply Company, based in Hammonton, New Jersey, was assigned to recover all damaged and destroyed U.S. combat vehicles, including the 29 contaminated with DU. In 1993, the U.S. General Accounting Office (GAO) disclosed that approximately 27 soldiers from the 144th worked on the

contaminated Bradleys and Abrams vehicles "without prior knowledge of the existence of DU contamination or radiation hazards and without any protective gear."[32] These people worked on and in the contaminated vehicles for three weeks before the Army Armament, Munitions, and Chemical Command informed them that the vehicles were contaminated.

At the time of the GAO investigation, the Army Surgeon General's Office reported that 12 of these soldiers had been tested for DU, with none showing elevated levels of internalized uranium.[33] But a comprehensive June 1995 report by the Army Environmental Policy Institute (AEPI), entitled *Health and Environmental Consequences of Depleted Uranium Use in the U.S. Army*, stated that as of May 1994, only 9 soldiers of the 144th had been tested for DU by means of urinalysis, with none showing elevated levels of DU in their bodies.[34]

However, the value of testing these soldiers by means of urinalysis three years after their exposure must by questioned. Urinalysis is effective for testing for DU shortly after exposure, while the body purges some of the heavy metal. However, for the uranium which remains trapped in the lungs, kidneys, bones, or other organs, more sensitive testing methods are needed to accurately determine the amount of uranium which may be retained in the body three years after exposure. If the Army continues to test these and other veterans for DU solely by means of urinalysis, it is unlikely to provide the veterans, or the public, with an accurate assessment of the potential for internalization of DU, or the extent of the current problem.

Contact with Contaminated Vehicles on the Battlefield

It is difficult to say how many troops, or civilians, have come in contact with DU on the battlefields of Desert Storm. Although the U.S. recovered its own vehicles contaminated in friendly fire incidents, virtually none of the thousands of contaminated Iraqi vehicles littering the battlefields have been cleaned up. In addition, thousands of DU penetrators which missed their mark remain on the battlefields in various states of decay.

The Army Surgeon General has stated that troops who breathed smoke from or had incidental contact with vehicles struck by DU penetrators were unlikely to have internalized DU and do not warrant medical follow-up.[35] Despite the Army Surgeon General's assertion, the AEPI report acknowledged that for troops on the battlefield, "the potential for internalization is high enough that the Army should

further investigate and analyze the risks."[36]

Experimental data from testing, and field experience from Desert Storm, indicate that "the potential for DU internal exposure during combat is directly related to the location of the soldiers exposed."[37] Army studies have found that "personnel inside or near vehicles struck by DU penetrators could receive significant internal exposures."[38] In addition, "recovery and maintenance soldiers working in and around DU contaminated vehicles can inhale or ingest resuspended DU particles."[39] In effect, the Army has found that anyone who breathes smoke from, climbs on, or enters vehicles which were hit by DU rounds is at a high risk of inhaling or ingesting DU particles.

In one survey of over 10,000 Gulf vets, 82% indicated that they entered Iraqi vehicles after the war.[40] Some of these soldiers entered the shattered hulks to salvage any usable equipment. Others climbed on and entered the vehicles to look for souvenirs or pose for pictures during informal "battlefield tours." While not all the vehicles on the battlefield had been hit by DU rounds, several thousand of them were in the Army's own word, "contaminated."

It was not until March 7, 1991, after most of the fighting had subsided, that the Army Armament, Munitions, and Chemical Command sent a message to commanders in the Gulf warning that "any system struck by a DU penetrator can be assumed to be contaminated with DU."[41] The same message also warned that "personnel exposed to DU contamination should wash exposed areas and discard clothing."

In June 1991, several months after the end of Desert Storm, the Army Armament, Munitions and Chemical Command sent a fact sheet to Army training centers for use in educating troops about DU. The fact sheet noted:

> If a burned out vehicle must be entered, precautions must be taken to avoid inhaling or ingesting DU particles. Respirator or protective mask should be worn at minimum along with gloves. Ideally protective clothing should be worn as well. After exiting the vehicle, hands should be washed thoroughly. All dust should be brushed off of clothing or protective clothing should be discarded.[42]

The Army has so far offered no explanation as to why these warnings were not issued to troops before they went into battle. Even since the

Persian Gulf War, the Army has done a poor job educating its own troops about the use and dangers of depleted uranium weaponry.[43] Although the Departments of Defense (DoD) and Veterans Affairs (VA) have provided medical exams to more than 85,000 Gulf War veterans who have confirmed health problems, only a handful of these veterans have been tested for DU exposure. Some persistent veterans who breathed smoke from or entered contaminated vehicles have forced the VA to test them for DU, and have shown elevated levels of DU in their urine several years after the war.

Clearly, more widespread testing of Gulf War veterans needs to take place to determine the extent to which veterans were exposed. At this point in time, testing for DU should involve *in vivo* monitoring, in addition to urinalysis, to provide an accurate assessment of the amount of internalized DU. However, the DoD and VA are reluctant to conduct such testing because of the large cost involved and potentially damaging attention which would be brought to a prized weapon.

Doha, Kuwait Fire

On July 11, 1991, a Field Artillery Ammunition Support Vehicle (FAASV) loaded with ammunition caught fire in the motor pool and ammunition storage area of the U.S. Army base in Doha, Kuwait. The fire quickly spread to surrounding vehicles and artillery, which were combat loaded with live ammunition. Severe explosions ensued for six hours and residual fires burned well into the following day. Roughly $15 million in ammunition and $23 million in vehicles were destroyed, along with more than $2 million in damage to property.[44]

At the time of the fire, approximately 3,500 soldiers from the 11th Armored Cavalry Regiment (ACR) were at Doha, along with a contingent of British soldiers. Fifty-two American and six British soldiers, along with two civilian workers, were injured during the fire. Most of the injuries were the result of people being struck by falling debris or injuring themselves while fleeing the explosions.[45]

During the fire four M1A1 Abrams tanks with DU armor were destroyed, along with 660 tank rounds and 9,720 small caliber 25mm DU rounds. These destroyed rounds represent over 9,000 pounds of depleted uranium which potentially burned up in the fire.[46]

A February 1985 report, *Potential Behavior of Depleted Uranium Penetrators Under Shipping and Bulk Storage Accident Conditions*, notes that "under severe fire conditions, the (DU tank) penetrators

remained in the fire and were oxidized to powder rather than being ejected undamaged from the fire."[47] Thus we can expect that a sizable amount of the 9,000 pounds of DU was oxidized to powder and spread around the compound during the hours of violent explosions. In addition, a steady wind of approximately eight knots blowing from the northwest likely carried airborne DU particles many miles from the site of the fire.[48]

The long distances that DU particles can be carried by the wind was discovered following the 1979 release of airborne DU particles by the National Lead factory in Colonie, New York. National Lead was manufacturing 30mm DU rounds for the Air Force at the time of the releases. DU particles of respirable size released by the plant were discovered in air filters at Knolls Atomic Power Laboratory facilities located 11 and 26 miles from the National Lead plant. Unrelated to the discovery of the DU particles in the laboratory's air filters, the State of New York later shut down the National Lead plant because each month they were releasing into the air around Albany, New York, a quantity of DU roughly equal to that contained in one 30mm round.[49] Note that the Air Force fired almost one million of these rounds during Desert Storm.

Most of the troops at Doha were unaware of the risks posed by burning DU rounds, even though an Explosive Ordnance Disposal (EOD) team en route to Doha while the fire was raging warned its commanders of the danger. A Central Command log for July 11, 1991, notes:

> EOD POC (point of contact) states that burning depleted uranium puts off alpha radiation. Uranium particles when breathed can be hazardous. 11ACR has been notified to treat the area as though it were a chemical hazard area; i.e. stay upwind and wear protective mask in the vicinity.[50]

A Radiological Contamination (RADCON) team sent to Doha after the fire confirmed that the fire caused oxidization and dispersal of DU:

> The radiological contamination seemed to be confined to specific locations of the concrete pad surfaces and specific vehicles. ... Elevated levels of localized DU contamination, above normal background levels, were detected. In some instances, verification could not be made that these levels were associated with the DU munitions or from DU armor.[51]

Soldiers involved in cleanup operations several days after the fire were not warned of the presence of DU contamination, and wore no protective gear during or after the fire, despite the warning from the Explosive Ordnance Disposal team. In one incident, several soldiers were sent in to clean the compound with no protective clothing or masks. During the hot summer day, these soldiers repeatedly drew water from a jug which they had placed on some 55 gallon drums. Near the end of the day, several officers appeared and ordered the soldiers to move the water jug. The officers then placed radioactive contamination warning markers on the drums, which contained DU penetrator fragments.[52]

U.S. troops were exposed to DU at Doha during both the fire and subsequent cleanup operations. Although a warning was issued about the dangers presented by burning DU, this word was apparently never passed on to the troops. The Army does not know, or will not release the data, about how much DU was carried downwind, and what threat from unremediated DU exists today for troops deployed to the U.S. base at Doha.[53]

Other Exposures

In addition to the thousands of troops who passed through areas contaminated with DU, many others were more than likely exposed to DU as a result of the war. Soldiers and civilians downwind of burning vehicles on the battlefields could have been exposed to airborne DU. A-10 and M1A1 maintenance crews may have come in contact with DU in the course of their work. Medical personnel may have been exposed to DU when they treated wounded soldiers and civilians. In fact, recent testimony at a meeting of the Presidential Advisory Committee on Gulf War Veterans' Illnesses suggested that some medical personnel were afraid to work on people who had been wounded by uranium shrapnel.[54]

Though the routes of exposure are numerous, the largest numbers of people exposed to DU during and after the Persian Gulf War are those who came in contact with some of the more than 300 tons of DU scattered among the wreckage on the battlefield. The United States has denied any responsibility for the cleanup of DU on battlefields in Kuwait and Iraq, and as a result, virtually no battlefield

cleanup of DU has taken place.[55]

Local populations, and U.S. troops who continue to deploy to Kuwait and train in battlefield areas, are being exposed to DU on an ongoing basis. In addition, because DU particles can be transported by wind or water, the contamination may be migrating to other areas and possibly into the food and water supplies of local populations.

Health Effects

The long term effects of internalized depleted uranium are not fully known, but the Army has admitted that "if DU enters the body, it has the potential to generate significant medical consequences."[56] Inhaled DU particles of respirable size may become permanently trapped in the lungs. Inhaled DU particles larger than respirable size may be expelled from the lungs and ingested.

DU may also be ingested via hand-to-mouth transfer or contamination of water or food supplies. DU which is ingested, or enters the body through wound contamination, will enter the bloodstream and migrate throughout the body, with most of it eventually concentrating in the kidney, bone, or liver. The kidney is the organ most sensitive to DU toxicity.[57]

Much of the ingested DU will be excreted by the body shortly after the exposure, but the DU that remains acts as a chemical and radiological toxin in organs and bones for the remainder of a person's lifetime. Because many of the soldiers exposed to DU during the war were in their twenties, they have many years in which to develop the cancers, kidney problems, and other health problems. Veterans who have shown elevated levels of DU in their urine several years after the war may have received significant internal DU exposures on the battlefield. For those who have not yet been tested, urinalysis may no longer be effective for determining levels of internalized DU.

Reports from Iraq indicate that large numbers of children who lived in or near contaminated areas have developed leukemias and other health problems which may be associated with exposure to DU.[58] In addition, many children of American veterans exposed to DU have been born with birth defects and serious health problems. The relationship between exposure to DU and the health problems affecting American and Iraqi children needs to be further investigated.

The Army admits that it has not fully assessed the risks to troops who are exposed to DU on the battlefield.[59] However, they now have a large soldier and civilian control group in which they will study the long term health effects of internalized DU.

Research

In its rush to field DU weapons for battlefield use, the Army failed to exercise enough vision to consider the health and environmental consequences of DU use. Only since the Persian Gulf War has the Army begun to assess the extent to which even its own troops may be exposed on the battlefield. The 1995 AEPI report noted that "previous studies of the health and environmental consequences of the use of DU have indicated that the Army needs to conduct several additional investigations to more fully understand its consequences."[60]

Additional studies are needed, but we cannot trust the Army to do them. Even the Army's own AEPI report recommended that:

> Reports should be reviewed inside and outside DoD to increase the number of expert reviewers and to enhance the credibility of reports. Independent peer review is crucial because too often studies are performed by or for an organization that has a vested interest in the results.[61]

Unfortunately, most of the current research on DU is being conducted by the military, industrial, and federal organizations which have a "vested interest" in the continued use of DU weapons. In addition to removing all research from the hands of these vested interests, previous studies which are invoked by the Army to deny that troops were exposed to DU should be reviewed for their accuracy.

Though several studies are underway to further investigate the health and environmental consequences of depleted uranium weapons, the motivation behind these investigations is unclear. The following section from the introduction of the AEPI report, which was leaked to the Depleted Uranium Citizens' Network of the Military Toxics Project in late 1995, is particularly enlightening in this respect:

> The potential for health effects from DU exposure is real; however, it must be viewed in perspective. It is unlikely that any of the DU exposure scenarios described in this report will significantly affect the health of most personnel. In several areas, neither the scientific community nor the Army have adequate medical or exposure information to defend this assertion. ... When DU is indicted as a causative agent for

> Desert Storm illness, the Army must have sufficient data to separate fiction from reality. Without forethought and data, the financial implications of long-term disability payments and health-care costs would be excessive.[62]

The Army admits that it lacks the data needed to justify its assertions that few troops were exposed to DU on the battlefield, and that the health effects from battlefield DU exposure will not be significant. In addition, the Army appears to state that the primary motivating force driving their research and positions on DU weapons is a desire to avoid the "excessive" cost of disability compensation and health care for veterans exposed to depleted uranium.

In response to a congressional inquiry, Dr. Stephen Joseph, the Assistant Secretary of Defense for Health Affairs, clearly stated the Pentagon's position on DU:

> The Department of Defense fully recognizes the problems associated with DU in combat. However, the use of this material in shielding designs for combat vehicles substantially increases personnel survivability on the battlefield. In addition, the significant increase in the range of DU munitions provides the kind of tactical advantage that is important in reducing the casualty rate for our forces.[63]

The Pentagon, and the American public, are concerned about reducing battlefield casualties. However, in the process of increasing battlefield survivability, the Pentagon has found it acceptable to sacrifice the long-term health of its own troops by exposing them to depleted uranium. If we allow the Pentagon or other federal agencies to conduct further research about DU, we can expect their "forethought and data" to be driven by a desire to deny and minimize the health and environmental consequences of depleted-uranium weapons.

Conclusion

The Persian Gulf War was the first war in which DU weapons were used, but it will not be the last. DU rounds are being developed for use in an increasing array of U.S. weapons systems, including the Bradley Fighting Vehicle, the Vulcan air defense gun, and a variety of combat helicopters. The AEPI report ominously notes:

> Since DU weapons are openly available on the world arms market, DU weapons will be used in future conflicts. ... The number of DU patients on future battlefields probably will be significantly higher because other countries will use systems containing DU.[64]

Though the U.S. was the first country to use DU weapons in war, the United Kingdom, France, Russia, Sweden, Greece, Turkey, Israel, Saudi Arabia, Jordan, Bahrain, Egypt, Kuwait, Pakistan, Japan, Thailand, Taiwan, South Korea, and other countries are now developing or have already developed DU weapons in their arsenals.[65] The rapid proliferation of depleted uranium weapons will eventually level the playing field and eliminate any battlefield advantage U.S. armed forces currently enjoy. In addition, if past wars give us any insight into the future, American troops may be killed or poisoned on the battlefield by "enemy" forces using DU weapons made in the U.S.A.

DU weapons are a symptom of a larger problem. That problem is war. The causes of war—greed, profit, racism, religion, injustice, and ethnocentrism—have not changed much throughout history. But the tools used to wage wars have changed to such an extent that, in just the last century, the weapons of war now threaten the "survivability" of life on our planet.

Starting today, we must clean up contaminated sites in the U.S., the Middle East, and wherever else DU weapons are being developed, tested and used. We must provide medical care and disability compensation for those who have already been poisoned by DU. And the Pentagon must begin periodic testing of servicemen and women who work with or are otherwise exposed to depleted uranium weapons.

As soon as possible, we must ban the development and use of weapons containing depleted uranium. Like land mines, nuclear weapons, herbicides such as Agent Orange, and chemical and biological weapons, depleted uranium weapons can kill friend and foe indiscriminately, for an extended time after their intended battlefield use. A ban of depleted uranium weapons, and all other weapons of mass destruction, is in the best interests of all Americans, and in the best interests of all the earth's peoples.

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Appendix II: Ordnance Containing DU

"The Army uses alloyed DU in the 25, 105, and 120-millimeter kinetic energy cartridges. The Bradley Fighting Vehicle will use the 25mm cartridge in its chain gun. The M1 and M60 series tanks use the 105mm cartridge; the Army also plans to use the 105mm in the main gun of the XM8 Armored Gun System. The M1A1 and M1A2 Abrams Tank main guns use the 120mm cartridge. ... DU is used as an armor component on the M1 series heavy armor (HA) tanks. Small amounts of DU are used as an epoxy catalyst for the M86 Pursuit Deterrent Munition (PDM) and the Area Denial Artillery Munition (ADAM)." The PDM and the ADAM are land mines. (AEPI, *Health and Environmental Consequences of Depleted Uranium Use in the U.S. Army: Technical Report*, June 1995, p. 26)

The following armor-piercing projectiles are among those in the U.S. military arsenal that use DU:

1. Gau-8: A U.S. Air Force 30mm round with approximately a 300-gram staballoy [DU tailing] penetrator core composed of 99.25% DU and 0.75% TI 9U-TI. (This alloy composition is also used in all the U.S. Army munitions discussed below. The U.S. Navy version (PGU-14 30mm) of this round has a penetrator consisting of 98% DU and 2% Molybdenum. Both versions incorporate metal propellant cases.) Fired at the rate of 4,200 projectiles per minute from Fairchild A-10A Thunderbolt II (Warthog).

2. M735A1: A U.S. Army 105mm round with approximately a 2.2-kg DU penetrator. This round was intended for use in tanks equipped with a M68 gun as an interim round prior to fielding the M774. These rounds are virtually identical to the M774 except for the staballoy penetrator in the projectile assembly of the round.

3. M774: A U.S. Army 105mm round with aproximately a 3.4-kg DU penetrator. Both the M735A1 and M774 have metal propellant cases.

4. M829 [M829E1& M829E2]: U.S. Army 120mm rounds with approximately 4.9-kg (10.7 pound) DU penetrator and combustible propellant cases. M829A1 and M829A2 120 mm APFSDS-T rounds are also produced containing approximately 4.9 kg (10.7 lbs.) of DU.

5. M833: A U.S. Army 105mm round with approximately a 3.7-kg DU penetrator and a metal propellant case. Cartridge used by the EX35 105mm Gun System.

6. XM 919: A U.S. Army 25mm round with approximately a 85-g DU penetrator and a metal propellant case. This round is used primarily in the Bradley Fighting Vehicle.

7. XM900E1: A U.S. Army 105mm round with approximately a 10.0-kg DU penetrator and a metal propellant case.

8. Land Mines: M86 Pursuit Deterrent Munition (PDM) and the Area Denial Artillery Munition (ADAM) contain approximately 0.1 gram of DU. The ADAM is fired as a submunition in the 155mm howitzer.

Chart of Army ammunition items containing DU include:

Cartridge	approximate DU weight
25MM XM919	85 g, 0.2 lb
30MM GAU-8	300 g, 0.66 lb
105MM 735A1	2.2 kg, 4.84 lb
105MM 774	3.4 kg, 7.48 lb
120MM M827	3.1 kg, 6.90 lb
120MM M829[E1 & E2]	4.0 kg, 8.69 lb
120MM M829A1	4.9 kg, 10.7 lb
120MM M829A2	4.9 kg, 10.7 lb
105MM M833	3.7 kg, 8.14 lb

List of ordnance printed with permission from *Uranium Battlefields Home & Abroad: Depleted Uranium Use by the U.S. Department of Defense*, March 1993 by Grace Bukowski and Damacio Lopez, and compiled from June 1995 AEPI report cited above.

Appendix III: Locations Involving DU Research, Testing and Storage

Research and Development and Test Sites Involving DU

SITE NAME & LOCATION:	ACTIVITY:
1. Army Research Laboratory; Aberdeen Proving Ground, MD	R&D of DU penetrators and armor.
2. Battelle Pacific Northwest Labs; Richland, WA	R&D DU metallurgical analyses, environmental, health hazard studies.
3. Energetic Materials Research and Technology Center, formerly known as TERA facility; Socorro, NM	Testing by Alliant Tech Systems, Olin Ordnance and Army.
4. Ethan Allen Firing Range (General Electric); Burlington, VT	Test 25mm DU munitions.
5. Jefferson Proving Ground; Madison, IN	Test DU munitions against soft targets.
6. Los Alamos National Laboratory; Los Alamos, NM	Interior ballistic studies and environmental, health hazard studies.
7. Manufacturing Sciences Corporation; Oak Ridge, TN	Research and Development of DU armor.
8. U.S. Army Ballistics Research Lab, Nevada Test Site; Mercury, NV	Army DU Research & Development.
9. Picatinny Arsenal; Dover, NJ	DU metallurgical studies R&D facility, former test range.
10. Sandia National Laboratories; Albuquerque, NM	Test DU armor and penetrators, weapons containers.
11. Tonopah Test Range; Tonopah, NV	Warhead simulation tests.
12. US Army Combat Systems Test Activity; Aberdeen Proving Ground, MD	Research, development, and testing of DU penetrators and armor.
13. Yuma Proving Ground; Yuma, AZ	Test DU R&D munitions against soft targets.

Fabrication and Assembly Sites Involving DU

SITE NAME & LOCATION:	ACTIVITY:
14. Aerojet Ordnance Company; Chino, CA	Assemble projectiles; Load, Assemble and Pack (LAP) 25mm DU rounds.
15. Aerojet Ordnance Tennessee; Jonesboro, TN	Fabricate 25mm and large caliber DU penetrators.
16. Detroit Army Tank Plant; Warren, MI	Assemble heavy armor turrets.
17. Lima Army Tank Plant; Lima, OH	Assemble heavy armor turrets.
18. Martin Marietta Energy Systems-Milan Army Ammunition Plant; Milan, TN	LAP large caliber ammunition.
19. Mason and Hanger at Iowa Army Ammunition Plant; Middletown, IA	LAP and demilitarize.
20. National Manufacturing Corporation; St. Louis, MO	Assemble projectiles.
21. Nuclear Metals, Inc.; Concord, MA	Fabricate DU penetrators.
22. Olin Ordnance Corporation; Red Lion, PA	Assemble Projectiles.
23. Specific Manufacturing Capability Facility Idaho National Engineering Laboratory; Idaho Falls, ID	Fabricate DU armor.
24. Tank Automotive Command; Warren, MI	Licensee for DU armor.
25. Twin Cities Army Ammunition Plant, Alliant Tech Systems; New Brighton, MN	Machine, LAP 25mm DU penetrators, manufacture molding compound for mines.
26. White Sands Missile Range; Green River, UT	Missile warhead ballast contamination.
27. White Sands Missile Range; White Sands, NM	Missile warhead ballast contamination.

Storage and Storage/Demilitarization Sites Involving DU-Containing Materials

SITE NAME & LOCATION:	ACTIVITY:
28. Defense Consolidation Facility; Snelling, SC	DU waste reduction, decontamination.
29. Hawthorne Army Ammunition Plant; Hawthorne, NV	Store ammunition.
30. Hunter Army Airfield; Savannah, GA	Store 120mm DU ammunition.
31. Letterkenny Army Depot; Chambersburg, PA	Store ammunition.
32. McAlester Army Ammunition Plant; McAlester, OK	Store DU ammunition, contaminated production equipment.
33. Savanna Army Depot; Savanna, IL	Store, demilitarize, maintain ammunition.
34. Seneca Army Depot Activity; Romulus, NY	Store, demilitarize ammunition.
35. Sierra Army Depot; Herlong, CA	Store, maintain, demilitarize ammunition.
36. Tooele Army Depot; Tooele, UT	Store, maintain, demilitarize ammunition.
37. U.S. Army Armament Munitions and Chemical Command; Rock Island, IL	Licensee responsible for bulk storage.
38. Watervliet Arsenal; Albany, NY	DU munitions applications research, currently stores DU contaminated saw, press, shotblast.

DU Processing Sites

SITE NAME & LOCATION:	ACTIVITY:
39. Carolina Metals; Barnwell, SC	Reduction, casting into DU derby.
40. Sequoyah Fuels Corp.; Gore, OK	Convert (UF6 to UF4 for AOT).

Waste Disposal Sites Involving DU

SITE NAME & LOCATION:	ACTIVITY:
41. Chem-Nuclear Systems Waste Management Facility; Barnwell, SC	Waste disposal.
42. Envirocare of Utah; Clive, UT	DU contaminated soil disposal.
43. US Ecology; Hanford, WA	Waste disposal.

Former DU Use or Storage Sites, and Sites Being Decommissioned

SITE NAME & LOCATION:	ACTIVITY:
44. Alliant Tech Systems, Inc.; Elk River, MN	Penetrator testing. Closed, decommissioned, NRC cleared in 1993.
45. Army Research Laboratory; Watertown, MA	Former R&D lab (being decommissioned).
46. Camp Roberts Military Reservation; Bradley, CA	Test firing of 120mm DU rounds for the Army (being decommissioned).
47. Chamberlain Manufacturing; Waterloo, IA	Projectile assembly (since closed).
48. China Lake Naval Weapons Center Alliant Tech Systems; Ridgecrest, CA	Test firing of 120mm DU rounds for the Army (being decommissioned).
49. Ford Aerospace and Communications Corp.; San Juan Capistrano, CA	Developed and tested 25mm DU ammunition.
50. Fort Hood; Killeen, TX	Stored 105mm DU rounds 1989-1990.
51. Fort Riley; Junction City, KS	Stored 105mm DU rounds 1989-1990. Facility improperly destroyed after damaged.
52. Lake City Army Ammunition Plant; Independence, MO	Former LAP, test range of 20mm, 25mm DU ammunition (decontamination planned).
53. National Lead Industries; Colonie, NY[1]	Produced R&D quantities of DU penetrators in 1978-1979. Closed 1980.

Other sites Involving DU Research, Testing, and/or Storage:

54. Aerojet General Corporation; Lockwood, Nevada
55. Armtec Defense Products; Coachella, California
56. Bulova Systems; Valley Stream, NY
57. Chamberlain Manufacturing; New Bedford, Massachusetts
58. Day and Zimmerman; Texarkana, Texas
59. Eglin Air Force Base's Munitions Test Facility; Valpariso, Florida
60. Feed Materials Plant, U.S. Department of Energy; Fernald, Ohio
61. General Defense; Red Lion, PA
62. General Dynamics; Detroit, Michigan
63. Hercules,; Redford, Virginia
64. Honeywell Corporation; Hopkins, Minnesota
65. Honeywell Corporation; Minnetonka, Minnesota
66. Hughes Heliocopter; Los Angeles, California
67. Hughes Heliocopter; Idaho Falls, Idaho
68. Kirtland Air Force Base; Albuquerque, New Mexico
69. Kisco; St. Louis, Missouri
70. NI Industries; Los Angeles, California
71. Remington Arms Company; Blue Springs, Missouri
72. Remington Arms Company; Lake City Army
73. Remington Arms Company Ammunition Plant; Independence, Missouri
74. Stresau Labs; Spooner, Wisconsin
75. Target Research, Inc.; Dover, New Jersey
76. U.S. Ecology, Department of Energy; Beatty, Nevada
77. U.S. Army Aberdeen Proving Ground; Aberdeen, Maryland
78. U.S. Army Camp Grayling; Grayling, Michigan
79. U.S. Naval Surface Weapons Center; Dahlgren, Virginia[2]

1. Source for sites 1-53 listed in the preceeding tables is the Army Environmental Policy Institute report of June 1995, *Health and Environmental Consequences of Depleted Uranium Use in the U.S. Army: Technical Report.*

2. Source for sites listed 54-79 is the book entitled, *Uranium Battlefields Home and Abroad: Depleted Uranium Use by the Department of Defense,* by Grace Bukowski and Damacio Lopez.

Appendix IV: Report from Laka Foundation, Netherlands

Laka Foundation was founded in 1982 as a documentation center on nuclear energy. The documentation center consists of more than 125,000 newspaper clippings, 5,000 books and several periodicals, TV documentaries, etc. Laka gives information on request to scholars, students, journalists, international groups, etc. Laka also does its own research and publishes regularly in magazines and newspapers.

After a visit to Iraq, Laka paid closer attention to the use of depleted uranium. Laka Foundation collects news on DU, writes articles and has several contacts in other countries. Special attention is given to the civilian use of DU. After a literature research, Laka made public the presence of DU counterweights in the 1992 crashed El-Al Boeing 747. Documents on this crash, the risks and the use in civilian airplanes are included in Laka's documentation center.

[The following are excerpts from the Laka article about the 1992 crash, received in time to be included in the appendices.]

Uranium Pollution from the Amsterdam 1992 Plane Crash

HENK VAN DER KEUR

A year after an El Al cargo jet crashed in Amsterdam on October 4, 1992, killing forty-three people, the Laka documentation and research center on nuclear energy in Amsterdam announced that the plane contained counterweights made of depleted uranium (DU).[1] This news considerably upset residents of the Bijlmer suburb (Amsterdam Southeast) who were suddenly confronted with information that the authorities would rather have kept silent about.

Even today, many details of the cause and effects of the disaster remain unclear. It is known that the destroyed Boeing aircraft had on board seventy-five tons of kerosene and ten tons of chemicals, as well as flammable liquids, gases, and caustic substances. We know now that half of these materials and probably some depleted uranium went up in a sea of flames.

The presence of DU on board the plane is based on a

Visit the IAC Web Site

The IAC maintains a web site dedicated to keeping its visitors informed about the latest IAC activities. In the Depleted Uranium Section, visitors can find: reprinted articles from *Metal of Dishonor*; updates on information contained in that book; other articles, lectures and speeches on depleted uranium and related issues.

Other sections of the web site cover issues such as economic sanctions against Iraq and other countries; the Balkans—No to NATO Expansion; The Cuban Blockade; Haiti; Mumia Abu-Jamal and other political prisoners; Organizing Workfare Workers in the group Workfairness; and Labor Solidarity.

Visitors can also learn about upcoming meetings and other political events and activities, order books and videos, link to online videos, volunteer on-line, obtain information about how to support the crucial projects sponsored by the IAC, and link to other relevant sites.

Web Page: http://www.iacenter.org/

Appendix VII: Organizations Concerned with DU Weapons and Uranium Waste

United States

Aberdeen Proving Ground Citizens Superfund Coalition
1443 Gorsuch Avenue, Baltimore, MD 21218
Tel: 410-243-2077; fax: 410-235-5325

Alliance of Atomic Veterans (AAV)
Anthony Guarisco
PO Box 32, Topock, AZ 86436
Tel: 520-768-6623
email:aav1@ctaz.com

Black Veterans for Social Justice, Inc.
686 Fulton St., Brooklyn, N.Y. 11217
Tel: 718-935-1116; fax: 718-935-1629

Center for Defense Information
1500 Massachusetts Ave., NW, Washington, DC 20005
Tel: 202-862-0700; fax: 202-862-0708

Citizen Soldier/Tod Ensign
175 Fifth Avenue, #2135, New York, NY 10010
Tel: 212-679-2250; fax: 212-679-2252
works with veterans and active duty GIs

Citizens Research & Environmental Watch
Judy Scotnicki
52 Prairie St., Concord, MA 01742
Tel: 508-369-7146, 508-369-8480

Citizens for Safe Water Around Badger
Laura Olah
E12629 Weigands Bay, South Merrimac, WI 53561
Tel & fax: 608-643-3124

Books and Videos from the International Action Center

BOOKS

The Fire This Time

by Ramsey Clark

A book by a former U.S. Attorney General that dares to tell the truth about the Gulf War tragedy—a sharp indictment of U.S. foreign policy that led to the Gulf War and its devastating human and environmental consequences. *The Fire This Time* stands out amid the deluge of self-congratulatory accounts which do injustice to history.

"A strong indictment of the conduct of the war and especially the needless deaths of civilians caused by bombing." N.Y. Times

"Not academic...Clark risked his life by traveling through Iraqi cities at a time when the U.S. was staging 3,000 bombings a day." L.A. Times

Thunder's Mouth Press, 1993, 352 pp with footnotes, index, pictures. Hard Cover $22. Soft Cover $12.

The Children Are Dying

The Impact of Sanctions on Iraq

Report of the UN Food and Agriculture Organization, supporting documents and articles by Ramsey Clark, Ahmed Ben Bella, Tony Benn, Margarita Papandreou and other prominent international human rights figures.

The human face of those targeted by the new weapon of sanctions. The UN FAO report shows with facts and statistics that over 500,000 Iraqi children under the age of five have died as a result of US/UN imposed sanctions. The accompanying photos and chapters define the social implications.

World View Forum, 1996, 178 pp with resource lists, photos. Soft Cover $10.

War Crimes: A report on the U.S. War Crimes against Iraq

A book written by Ramsey Clark and others dealing with evidence, eyewitness testimony and graphic photos from hearings in 24 U.S. cities and 20 countries. Presents documentation of the effects of the war on the civilian population of Iraq and sets forth a 19 point indictment of U.S. leaders for war crimes against peace, crimes against humanity. Included are extracts from international laws and conventions the U.S. violated.

Maisonneuve Press, 1992, 275 pp with footnotes, index, pictures, Soft Cover $12.95.

VIDEOS

Nowhere to Hide

Traveling with Ramsey Clark in Iraq in 1991, award winning video journalist Jon Alpert captured what it was like to be on the ground during the allied bombing. In dramatic, graphic scenes, "Nowhere to Hide" shows a different reality from what was on the nightly news. Tom Harpur of the Toronto Star wrote, "Only by knowing the true nature of Operation Desert Storm can similar war be prevented...send for the video."

VHS, 1991, 28 minutes, $20 individuals, $50 institutions.

Blockade: The Silent War Against Iraq

The human suffering caused by the US/UN imposed sanctions has taken the lives of over half a million children. Moving footage taken from hospitals, marketplaces, factories, and Moslem, Jewish and Christian places of worship. Concrete facts on infant mortality, skyrocketing inflation and disease are skillfully incorporated.

VHS, 1994, 25 minutes, $20 individuals, $50 institutions

The Children Are Dying

A companion video to the book, *The Children Are Dying*. A trip by a human rights delegation to Iraq in 1996 includes a view of the hospitals, schools and neighborhoods. The impact of the sanctions from destroyed water purification plants to empty pharmacy shelves takes on a visual form that supplements the statistics and charts of the UN Food and Agricultural team studies.

VHS, 1996, 28 minutes, $20 individuals, $50 institutions

(Videos are excellent for libraries, schools and community groups or for cable access television programs.)

$4 shipping and handling *on first item, (book or video) add $1 for each additional item per order.*

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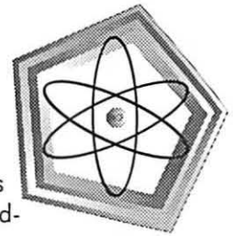

The most crucial task of this book, **Metal of Dishonor**, is to help ban the use of DU. Help us get this information into libraries, schools, community organizations, religious institutions and veterans groups. Political figures, media commentators, veterans and community leaders should see this book. We can send a book or video in your name to individuals or organizations who will benefit from its contents.
$12.95. (add $4 shipping/handling on first item, $1 for each additional item)

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The book, **Metal Of Dishonor,** is also available at discounted bulk rates for organizing, educational, or fundraising use by community organizations. **Bulk orders of 20 or more copies are available at 50% off the cover price.**

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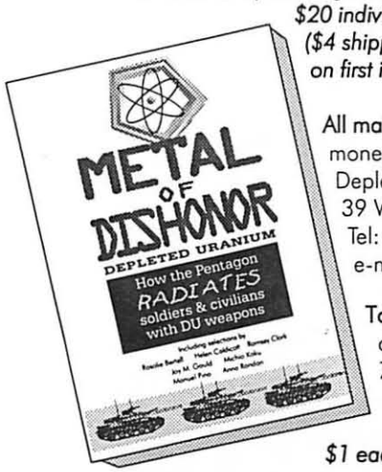
Interviews with noted scientists, doctors and community activists explaining the dangers of radioactive DU weapons. Explores the consequences of DU from mining to production, testing and combat use. An excellent resource for schools, libraries and community meetings. *45 minutes, VHS,*
$20 individuals, $40 institutions. ($4 shipping and handling on first item, $1 additional items)



All mail orders must be pre-paid. Send check or money order to: International Action Center, Depleted Uranium Education Project
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