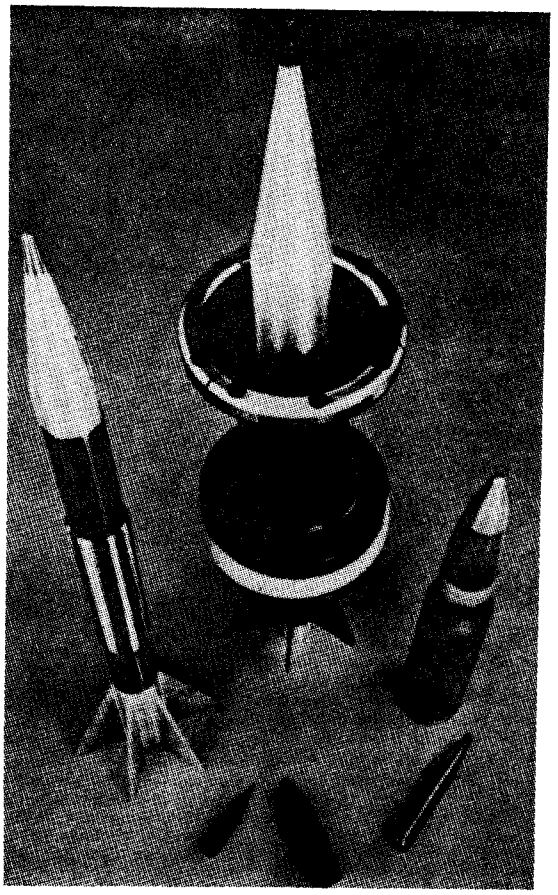
FRIENDLY FIRE

THE LINK BETWEEN DEPLETED URANIUM MUNITIONS AND HUMAN HEALTH RISKS



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The New Mexico Progressive Alliance for Community Empowerment (PACE)
and
The National Depleted Uranium Citizens' Network of the
Military Toxics Project (MTP)

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Friendly Fire - April 13, 1995

The Link Between the Gulf War Illness and Depleted Uranium Munitions Contamination

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Public attention has been focused on a possible radiological/toxicological link between the multitude of unexplained illnesses experienced by many returning Gulf War veterans and the hundreds of tons of depleted uranium (DU) bullets used for the first time in history during Desert Storm. Soldiers were unaware that they were being exposed to low-level radiation. The aerosolizing nature and pyrophoric properties of DU weapons make it possible to inhale or ingest DU oxide particles. Army Colonel John M. Taylor of the Aberdeen Proving Ground has reported that "as much as 60 percent may become aerosolized...during hard impact testing of depleted uranium."[1] DU munitions are currently batch tested on military-controlled test firing ranges across the country.

An Army fact sheet states, "When a DU penetrator impacts a target surface, a large portion of the kinetic energy is dissipated as heat. This results in smoke which contains a high concentration of DU particles. These uranium particles can be inhaled or ingested and are toxic."[2] According to radiation health expert John Gofman, "Particles in the general range of less than 5 microns in diameter are considered respirable, meaning they will pass the upper respiratory airway and may be deposited in segmental bronchi, bronchioles, and alveolar tissues."[3] The DU particle becomes a radioactive hot spot in the lung. [Former Knolls Atomic Power Laboratory Scientist Leonard A. Dietz states, "For a 5 micrometer diameter depleted uranium oxide particle the estimated dose is 1,360 rem, or 272 times the maximum permissible dose to a radiation worker."[4]]

Policy recommendations to tackle this growing public and military health problem include pursuing an international agreement to ban DU munitions, and establishing a peer review committee of leading radiation health experts from the civilian sector to oversee all U.S. government studies on soldiers and civilians who may have been exposed to DU contamination. These studies should be conducted for the life span of each affected person who inhaled or ingested a significant quantity of DU to determine the long-term health effects of DU contamination. Furthermore, an epidemiological study should be done of their spouses and their children conceived and born after the Gulf War for examination of radiation-induced genetic damage.

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Definitions, Abbreviations & Acronyms

AFRRI:	Armed Forces Radiobiology Research Institute.
DVA:	Department of Veterans Affairs.
DOE:	U.S. Department of Energy.
DU:	Depleted Uranium is natural uranium in which the U-235 isotope content has been reduced from 0.7% to 0.2%. It is a waste product of uranium enrichment plants.
D-38:	A term sometimes used by government and industry instead of U-238.
GAO:	Congress' General Accounting Office.
kg:	Kilogram: 2.205 pounds.
LANL:	Los Alamos National Laboratories.
NMIMT:	New Mexico Institute Of Mining and Technology.
Pa-234:	Protactinium-234 has a half life of 6.69 hours. Is a beta and gamma emmiter.
PACE:	The New Mexico Progressive Alliance for Community Empowerment.
TERA:	Terminal Effects Research and Analysis Group.
Th-234:	Thorium-234 has a half life of 24.1 days. Is a beta and gamma emmiter.
LAKA Foundation:	A Dutch national center for critical documentation on nuclear energy.
µm:	Micron or micrometer, a unit of length equal to one millionth of a meter.
U-235:	A high level radioactive material used to make nuclear weapons and fuel for nuclear power plants. Has a half life of 704,000,000 years.
U-238:	A low level radioactive material with a half-life of 4,470,000,000 years. U-238 is the principal isotope of depleted uranium (99.75% of DU weight).
µCi/g:	Micro curies per gram.
URENCO:	Uranium enrichment plants in Western Europe.
USAEPI:	U.S. Army Environmental Policy Institute.

Summary and Recommendations

For the first time in history, munitions and armor made with depleted uranium (DU) were used in war during Desert Storm. DU is a man-made uranium byproduct that results when the valuable isotope U-235 is extracted from natural uranium. The substantial use of hundreds of tons of DU bullets in the Persian Gulf coupled with a multitude of unexplained illnesses experienced by many returning Gulf War veterans has focused public attention on a possible link between these illnesses and the health hazards associated with DU munitions.

A bill was introduced in the U.S. House of Representatives in May 1994 that would compensate veterans suffering from illnesses attributed to service in the Persian Gulf. The Bill would also provide research into the illnesses of these veterans. Congress noted in support of the bill that, "During the Persian Gulf War, members of the Armed Forces were exposed to numerous potentially toxic substances, including fumes and smoke from military operations, oil well fires, diesel exhaust, paints, pesticides, depleted uranium, infectious agents, and indigenous diseases, and were given multiple immunizations."[1]

This paper explores the association between human health risks and the use of DU munitions, the radioactivity and dangers of DU, the reasons it is used in weapons, and the amount of DU currently in use. It concludes that the DU problem should not be underestimated. The military use of DU poses health threats to soldiers and civilians alike. The expense of DU cleanup will be immense. By virtue of its huge volume, DU is the largest radioactive waste problem in the world today. For policy, health, financial, and environmental reasons, we must move quickly to implement the following recommendations:

1. Pursue an international agreement to ban DU munitions.

2. Issue appropriate radiation clothing to soldiers and workers who are exposed to DU oxide particles until DU weapons are banned.

3. Have President Clinton join in the call for a *Blue Ribbon White House Commission To Review All Radioactive Waste Programs and Policies.*

4. Conduct independent health studies of Persian Gulf War veterans that determine the toxic and radiological effects of exposure to DU and explain the differences between DU health effects and the "Gulf War Syndrome." An epidemiological study should be done of veterans and their families. Health studies should also include military and civilian personnel at or near DU manufacturing sites and DU test sites across the United States.

5. Establish a peer review committee of leading radiation health experts from the civilian sector that would act as a "Citizens Watchdog Authority." They would have the responsibility over all U.S. government studies on people who may have been exposed to DU contamination. The studies should be conducted over the life span of each affected person.

Introduction

In 1991, for the first time in history, weapons armed with depleted uranium (DU) were used in combat. The use of DU munitions and armor during Desert Storm was extensive. Writing in *The Bulletin of the Atomic Scientists*, William Arkin estimates that Allied forces fired 300 tons of DU bullets in the Persian Gulf.[2] The LAKA Foundation of Amsterdam set the figure at 800 tons.[3]

The veterans who returned from the Persian Gulf War have experienced a number of unexplained ailments. Although the causes of these mysterious illnesses remain unknown, the publicity has focused attention on the health hazards which military personnel encountered in the Gulf, including DU munitions. There have been numerous investigations into the use of DU since Desert Storm, including investigations by the military, the U.S. Department of Veterans Affairs (DVA), and the congressional General Accounting Office (GAO). None of these probes has found conclusive links between the disabilities and DU, nor have they recommended significant policy changes in the manufacture, deployment, and use of DU weapons.

This paper explores the association between human health risks and the use of DU munitions. It also describes the purpose of DU weapons and considers how prevalent the use of DU is. Finally, it evaluates national policies related to the use of DU and makes recommendations for changes in those policies.

What Is DU ?

The *Handbook of Chemistry and Physics* states, "Uranium is a silvery metal, which is pyrophoric [i.e., capable of igniting spontaneously] when finely divided. It has fourteen isotopes, all of which are radioactive. Naturally occurring uranium nominally contains 99.283% by weight Uranium 238..."[4]

U-238 is a low-level radioactive isotope. U-235, for which there is the greatest demand, is a high-level radioactive isotope. The U.S. Department of Energy (DOE) uses U-235 for nuclear weapons. Public utilities also use U-235 for nuclear fuel in commercial power plants. The separation of U-235 from natural uranium involves a gaseous diffusion process that creates a man-made byproduct. This remaining uranium has been given the name "depleted uranium."

The difference between natural uranium and DU is that the U-235 content has been reduced approximately 0.5%, from about 0.7% in natural uranium to 0.2% in DU. The content (weight) of U-238 has increased by the same amount – approximately 0.5% – raising it from 99.283% to 99.75%.

Alpha particles in natural uranium are emitted primarily from the U-234 and U-238 isotopes; both have identical radioactive decay rates. The specific activity for alpha particle emission from natural uranium is 0.68 μCi/g (microcuries per gram). During the process of enriching U-235, most of it and all but a trace of the U-234 is removed from natural uranium, leaving DU as a waste with a specific activity of 0.39 μCi/g for alpha particles, about half that of natural uranium.

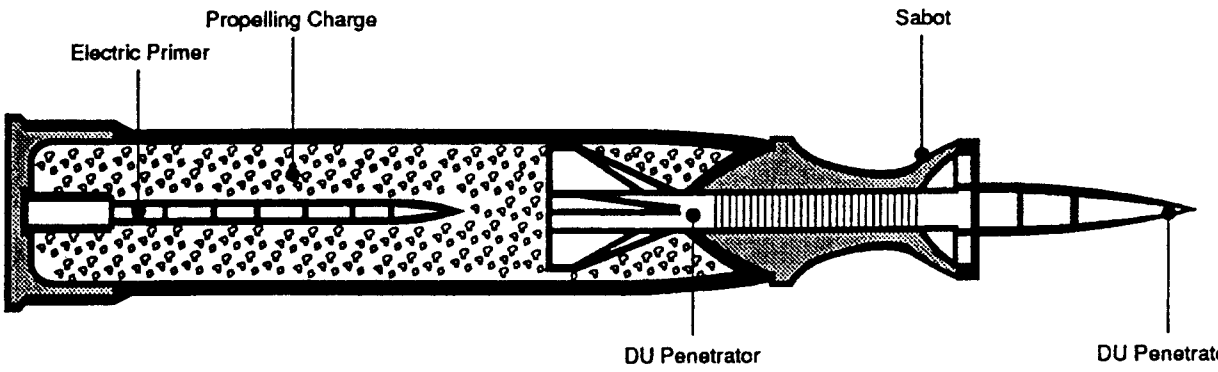
As the *Handbook of Chemistry and Physics* notes, "New uses are being found for 'depleted' uranium, i.e. uranium with the percentage of U-235 lowered to about 0.2%. Uranium and its compounds are highly toxic, both from a chemical and radiological standpoint."[5]

The Military Use of DU

DU has been used for several military and civilian purposes, such as counter-weight balances for aircraft and ships, as well as wing material for commercial airplanes. Its most controversial use, however, has been in the use of munitions and tank armor.

In 1972, scientists at Los Alamos National Laboratory (LANL) began to research and develop DU as a tank penetrator material. The density of DU makes it possible to have a smaller bullet with the same mass as previous non-DU bullets but with less air-drag, producing a higher velocity and extended range. "DU is 2.45 times heavier than iron, 2.14 times heavier than copper, and 1.68 times heavier than lead."[6] In fact, the chemical effects of DU on the human body are similar to those of lead which are known to cause acute toxic effects when ingested or inhaled.

Armor-Piercing Round with DU Penetrator



Source: U.S. Army

Today DU ammunition is being batch tested on military controlled test firing ranges across the U.S. The primary interests in DU are that it is available in large quantities, it is cheap, and it has high density and pyrophoric qualities desirable in armor penetrators.

These pyrophoric properties cause it to burn on impact, melting the assaulted metal. DU munitions also have the ability to kill and injure those not subject to the weapons' immediate impact. An Army fact sheet states, "When a DU penetrator impacts a target surface, a large portion of the kinetic energy is dissipated as heat. This results in smoke which contains a high concentration of DU particles. These uranium particles can be inhaled or ingested and are toxic."[7]

DU In the Persian Gulf

DU bullets killed 35 U.S. soldiers and wounded 72 others during the Desert Storm operation. Twenty-two of the wounded were left with embedded DU fragments. As Navy Commander James Helmkamp said, most of these casualties resulted from so-called friendly fire which "involved crews of armored vehicles struck by high-velocity, nonexplosive tank rounds that rely on the force of impact to destroy the target." In fact, our own DU bullets disabled 14 U.S. Abrams tanks and 15 U.S. Bradley Fighting vehicles.[8] Crews of Bradley Fighting Vehicles told GAO investigators that, "they feared friendly fire from Abrams tanks more than they feared the enemy."[9]

The number of DU rounds involved in friendly fire incidents is minuscule compared to its total use in the Gulf War. According to a report by the United States Army Environmental Policy Institute (USAEPI), "More than 14,000 large caliber DU rounds were consumed during Operation Desert Shield/ Desert Storm. As many as 7,000 of these rounds may have been fired in practice. Approximately 4,000 rounds were reportedly fired in combat. The remaining 3,000 rounds are losses that include a substantial loss in a fire at Doha, Saudi Arabia."[10]

William Arkin reported on other Allied forces' use of DU ammunition: "Documents released under the Freedom of Information Act indicate that the U.S., British, and possibly the Saudi, armies fired about 4,000 depleted uranium-tipped tank rounds, and that U.S. Air Force A-10 aircraft fired some 940,000 30-millimeter uranium-tipped bullets. About half were fired in Kuwait and half in Iraq."[11]

The Link Between DU Munitions and Human Health Risks

The aerosolizing nature and pyrophoric properties of DU weapons make it possible to inhale or ingest DU oxide particles. Although a LANL study found that the amount of DU aerosolized in a hydrodynamic test was 10%,[12] Army Colonel John M. Taylor of the Aberdeen Proving Ground has reported that "as much as 60% may become aerosolized... during hard impact testing of depleted uranium."[13]

The Citizens' Research and Environmental Watch (CREW) of Concord, Massachusetts described the dangers of aerosolized DU particles in a 1994 report:

> The most serious threats to health from particulate DU are through inhalation and ingestion. According to pioneering radiation biomedical researcher Dr. J. W. Gofman, particles of uranium smaller than 5 micron in diameter can become permanently trapped in the lungs. Once trapped, a single particle of this size can expose the surrounding lung tissue to 1,360 rem per year (the DU particle is a radioactive hot spot in the lung). This is 800 times the annual radiation dosage permitted by federal regulations for external whole body exposure. Present DOE and NRC [Nuclear Regulatory Commission] regulations do not even take into account the irradiation of internal tissue by inhaled or ingested particles. Particles not trapped in the respiratory system may be ingested and find their way into the kidneys and reproductive organs.[14]

John W. Kolmer, the Military Assistant for Medical and Life Sciences to former Knolls Atomic Power Laboratory scientist Leonard A. Dietz affirmed the potential health risks of lung cancer and kidney disease caused from DU. In an August 15, 1991 letter, Kolmer wrote:

> As you are no doubt aware since this material is a source of ionizing radiation, the potential for carcinogenicity is real. The same holds true for nephro-toxicity which, in most of the literature available to me, seems to be the greater limiting health endpoint of concern, protection from which requires a much lower ambient concentration in drinking water or foodstuffs. The potential risk to human health from exposure to depleted uranium is, of course, dose and time related, both of which must be measured, approximated or assumed. Let me assure you that we feel that your concern, which parallels our own, is real.[15]

Dietz had posed the question:

> Have you investigated the probability that lung cancer could develop in someone who has thousands of μm depleted uranium particles trapped permanently in his or her lungs? For example, I calculate that a single 2.5 μm UO_2 particle of depleted uranium (38 alpha particles/yr. approximately) will cause a surprisingly high radiation dose of 17 rads/yr. to lung tissue surrounding the particle and within the range of the alpha particles. What is the probability that several thousand such high localized radiation doses in the lung will cause lung cancer to develop in 20 to 30 years?[16]

Some recognition exists of DU hazards in the workplace. In a publication regulating the handling of DU at its facility, the New Mexico Institute of Mining and Technology (NMIMT) states, "Protective clothing will include coveralls, cotton gloves, shoe covers, dust-particle masks, and head covers..."[17] Nevertheless, it is highly questionable as to what extent protection policies are actually enforced or practiced in the workplace. The question arises from the numerous reports, lawsuits, and workers' compensation claims that DU workers have filed in facilities such as Fernald Feed Materials Plant, Aerojet Heavy Metals, and Sequoyah Fuels. At a minimum, soldiers and all persons exposed to DU should wear basic radiation protection clothing.

Treatment and Health Studies of Persian Gulf War Casualties

Policies which address DU exposure to workers in the civilian sector have been haphazard in application and random in enforcement. Generally, the issue of long-term health effects from military personnel exposure to DU is an issue that the military would like to ignore. On June 11, 1993, the office of the Assistant Secretary of Defense stated, "As far as the office of the Surgeon General is aware, none of the soldiers with possible depleted uranium shrapnel fragments in their bodies have demonstrated the symptoms associated with the illness that some people are calling the Gulf War Syndrome."[18]

The tenor of this conclusion was almost inevitable, given the military's own study of DU exposure to Gulf War veterans. A 1992 Armed Forces Radiobiology Research Institute (AFRRI) report concluded:

"Based on available data, in almost all cases, we recommend that standard medical criteria should be used to determine the advisability of the removal of embedded DU fragments without regard to the radiological characteristics of the fragment."[19] Two years later, a report by the USAEPI referred to the AFRRI study, which, it said, "cited two as-yet undefined key uncertainties that could change this recommendation: (1) the long-term radiation effects on the tissues surrounding the fragment and (2) the long-term toxicological effects of embedded DU."[20] If these health issues are uncertainties, then why would AFRRI make a recommendation to disregard the radiological characteristics of DU when making a determination on whether to remove embedded DU fragments from a soldier's body?

The Army and the DVA, with the assistance of AFRRI, have initiated a medical peer-review program to monitor the soldiers suspected of incurring injuries or internal exposure to DU. According to the USAEPI report, these soldiers will be monitored for at least five years. This limit on the length of the study raises serious questions concerning its objectivity. A life-time monitoring system of the affected soldiers must be developed to have medical validity.

Uranium and its compounds are highly toxic, both from a chemical and radiological standpoint... In fact, the chemical effects of DU on the human body are similar to those of lead which are known to cause acute toxic effects when ingested or inhaled.

Another section of the USAEPI report states, "It is unlikely that significant internal exposure occurred to other individuals who either had incidental contact with contaminated vehicles or breathed smoke from the plume from burning vehicles impacted by DU penetrators. These scenarios, however, should be evaluated to quantify the risk."[21] No basis is given to indicate the absence of internal exposures. The Army admits in the above quotation that an evaluation of the individuals who came in contact with DU was not done.

But publicity over the mysterious Gulf War Syndrome has led Congress to take action on the health effects of DU, at least as it concerns returning Desert Storm personnel. In late 1993, Congress authorized a competitive grant of $1,700,000 to a medical research institute for the purpose of studying the possible health effects of battlefield exposure to DU.

The purpose of the study is to investigate the pathology of DU fragments under controlled conditions, and to explore the possible short-term and long-term health effects of DU, including exposure through ingestion, inhalation, or bodily injury. The specific objectives of this study are:

1) Assessment of the toxic-kinetic properties of the various chemical forms of depleted uranium that could be inhaled, ingested or embedded;

2) Examination of whether there are depleted uranium cancer induction mechanisms similar to those observed in Thorotrast-specific liver cancers;

3) Determination of whether the radiogenic effects described in paragraphs (1) and (2) occur and, if so, at what fragment densities and latent periods;

4) Assessment of long-term, low-dose irradiation of specific tissue such as those of the nervous system;

5) Determination of the potential for chronic nephro-toxicity as a function of the organ exposed to depleted uranium; and

6) Conduct of pathological studies of the tissue surrounding depleted uranium particles.[22]

Dr. James P. Keogh of the Baltimore VA Medical Center and the University of Maryland School of Medicine has treated 36 U.S. soldiers who were in vehicles struck by DU munitions, including the 22 soldiers suspected of retaining embedded DU fragments. His study of soldiers who survived the friendly fire from DU weapons is funded with a $1.2 million, two-year DVA grant.[23]

DU and Radioactive Waste Issues

Another reason for using DU in munitions may be its ability to chip into the nation's mountain of nuclear waste. The process of extracting U-235 for weapons and energy production has created a vast and expensive radioactive waste problem. According to a U.S. Nuclear Regulatory Commission (NRC) Policy Issue dated January 25, 1991, "The U.S. (DOE) now has about one billion pounds of depleted uranium hexafluoride tails in storage."[24] A DOE notice states that the agency "is seeking expressions of interest from firms which would be interested in acquiring, at no cost for the material, depleted and normal uranium that, while surplus to DOE and other Federal Government programmatic needs, could be useful in other applications."[25] In Western Europe, the URENCO enrichment plants store over 30 million kilograms of DU in UF_6 tailings.[26]

Disposal and storage of this polluting low-level radioactive substance had been a growing problem since the development of the nuclear bomb. The cost of shipping for storage and disposal is expensive. According to a New Mexico Institute of Mining and Technology (NMIMT) report, it would cost $248,000 to ship DU waste from Socorro, New Mexico to Beatty, Nevada. The costs would include labor, material, transportation, surcharges, burial fee, and administrative support to dispose of 498 fifty-five gallon drums containing 3,735 cubic feet of surface soil contaminated with DU.[27]

The International Use of DU

The USAEPI study justifies the use of DU weapons by stating, "To give the U.S. soldier the best battlefield advantage, the United States must continue fielding superior weapon systems." It then defends continued development and deployment of the weapon by declaring that the DU genie is out of the bottle and cannot go back. "Even a unilateral decision by the United States to eliminate DU weapons would not remove DU from the battlefield."[28]

The report then adds that, "DU munitions are sold in the world arms market."[29]

It's true; a world DU arms race has begun. And the United States has led the charge in development, use, and proliferation of the market. As Lieutenant Colonel Eric Daxon stated at the April 1994 National Institutes of Health Assessment Workshop on the Persian Gulf Experience, "Desert Storm was great advertisement for the DU penetrator."[30] Today the United Kingdom, Russia, Turkey, Saudi Arabia, Pakistan, Thailand, Israel, France and others have developed or are developing DU-containing weapon systems for their inventories.[31]

Today the United Kingdom, Russia, Turkey, Saudi Arabia, Pakistan, Thailand, Israel, France and others have developed or are developing DU-containing weapon systems for their inventories.

Conclusions

This controversy pits military interests against the health of U.S. citizens and soldiers. The military's decision to use DU in spite of the obvious health problems of DU is a foolish and cruel approach to human life, and will generate long-term financial losses. It is essential that the expense involved in cleanup of this radioactive material with a half life of 4,470,000,000 years is not underestimated. By virtue of its huge volume, DU is the world's largest radioactive waste problem. The use of DU in bullets, tank armor on battlefields, and DU test ranges throughout the world proliferates radioactive waste, endangering the health of soldiers and civilians alike.

Health studies and the treatment of DU wounded soldiers should recognize and evaluate the radioactive health effects of DU munitions in addition to the toxic risks associated with DU. Studies should be conducted over the soldiers' lifetimes to determine if there is an association between the inhalation and/or ingestion of DU and the incidence of cancer or any other possible acute or chronic toxicology health risks.

A peer review committee of leading radiation health experts from the civilian sector should be established as a "Citizens Watchdog Authority." The committee would monitor DU health studies to ensure that appropriate rules of research are adhered to, and that biased information or elimination of the study of radioactivity associated with DU does not drive policy concerning health and environmental issues related to the use and production of DU weapons.

There is evidence that the use of DU weapons places an unacceptable and excessive risk on human health and the environment. We must move quickly to implement the recommendations below to stop this senseless tragedy.

Recommendations

1. Pursue an international agreement to ban DU munitions.

2. Issue appropriate radiation clothing to soldiers and workers who are exposed to the possible inhalation or ingestion of DU oxide particles during production, testing, training, or wartime exercises until DU weapons are banned.

3. Have President Clinton join in the call for a *Blue Ribbon White House Commission to Review All Radioactive Waste Programs and Policies.*[32]

4. Conduct independent health studies of Persian Gulf War veterans that determine the toxic and radiological effects of exposure to DU and explain how these effects differ from the "Gulf War Syndrome." Examine the soldiers and civilians who were in locations where they could have been exposed to DU (e.g., soldiers or civilians within a radius of at least 25 miles of the DU ammunition fire in Doha, Saudi Arabia should have a urinalysis test for DU). Furthermore, an epidemiological study should be done of veterans who ingested a significant quantity of DU and their families. This should be done not only for discharged veterans, but for those still on active duty as well. Additionally, their children conceived and born after the Gulf War should be examined for evidence of radiation-induced genetic damage. Health studies should also include military and civilian personnel at or near DU manufacturing sites and DU test sites across the United States.

5. Establish a peer review committee of leading radiation health experts from the civilian sector that would act as a "Citizens Watchdog Authority" over the U.S. Army, DVA, and the AFRRI on all studies conducted by the U.S. government on U.S. Persian Gulf War veterans, Iraqi soldiers, or civilians who may have been exposed to DU contamination. Such a peer review committee could ensure that appropriate rules of research are applied, that the studies are free from bias, and that they fully account for the latency of the radiological health effects of DU in the human body. The studies should be conducted over the life span of each affected person.

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