Military Toxics Project
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"Depleted" Uranium Munitions: Nuclear Waste as a Weapon

Enrichment of uranium for use in nuclear weapons and reactors produces various waste byproducts, including so-called "depleted" uranium (DU). For over twenty-five years, the U.S. Department of Defense has produced ammunition using this nuclear waste, which is both radioactive and chemically toxic. Evidence of environmental and human health damage caused by "depleted" uranium has steadily increased, despite Pentagon assertions that such impacts would not occur. There is now significant evidence that DU can cause or accelerate cancer, mutate genes, and affect the kidneys, immune system, nervous system, respiratory system, and reproductive system, The United Nations Human Rights Commission considers DU munitions to be "weapons of mass destruction or with indiscriminant effect" incompatible with international humanitarian law.

What is "Depleted" Uranium?

"Depleted" uranium (DU) is a waste byproduct of the enrichment of natural uranium for use in nuclear reactors and nuclear weapons. Uranium is a naturally occurring metallic element that is both radioactive and toxic. There are fourteen known isotopes of uranium, of which three – uranium-238, uranium-235, and uranium-234 – occur in nature. U-238, the most common isotope, has a half-life of about 4.5 billion years. Only U-235 can sustain the chain reaction essential for nuclear power or nuclear weapons. Natural uranium is processed to increase the percentage of U-235 for these uses. The resulting waste from which most of the U-235 has been extracted is called "depleted" uranium.

The term "depleted" uranium is misleading and does not mean that DU is not radioactive or that it is harmless. DU is mostly comprised of moderately radioactive U-238, but also contains small amounts of more highly radioactive U-235 and U-234 (under 1% in total). Various U.S. military statements imply that DU is less radioactive – and therefore less dangerous – than uranium that occurs naturally in soil and water throughout the world; this implication is completely untrue. "Depleted" uranium emits about 60% as much alpha radiation as naturally occurring uranium that has been processed and concentrated, about 85% as much gamma radiation, and essentially the same amount of beta radiation. However, DU (or any other form of uranium that has been removed from the ground and concentrated) is much more radioactive than uranium in its natural state spread throughout rock in very small quantities. DU’s chemical toxicity is the same as that of natural uranium.

DU is also created when spent nuclear reactor fuel is recycled. Spent fuel has been recycled since about 1950 and was often intentionally blended into mined uranium. Spent fuel contains highly radioactive substances including plutonium, neptunium, technetium, and U-236. Some amount of these "transuranic" substances remains in DU created by reprocessing spent fuel. Concentrations vary substantially among different spent fuel tailings, and data on them is incomplete. It is known that plutonium is 200,000 times more radioactive than U-238, so contamination of DU with these substances presents an even more serious danger than "depleted" uranium itself.

Human Health Hazards

Both military personnel and civilians may be exposed to DU throughout its life cycle. Most public attention to "depleted" uranium has focused on its radioactivity. However, DU poses health hazards to people both as a radioactive substance and as a toxic heavy metal. DU emits alpha, beta, and gamma radiation, which can damage many parts of the body and cause cancer and genetic mutations. Tiny dust-like DU particles – formed when shells impact and burn – can be inhaled and lodge in the lungs, bones, and kidneys, where they damage cells and organs through radiation or toxic effects. Human and animal studies have linked DU exposure and damage to the kidneys, immune, nervous, respiratory, and reproductive systems, and to cancer and genetic mutation.

Regulation of "depleted" uranium in the United States is not structured to protect human health and the environment. DU is regulated as a radioactive substance by the Nuclear Regulatory Commission, which is widely known to cater to the interests of nuclear power companies and the military. To date, DU has not been regulated as a toxic heavy metal by the Environmental Protection Agency. The U.S. Department of Defense (DoD) has consistently denigrated public concern about the health and environmental consequences of "depleted" uranium throughout its life cycle. U.S. Gulf War veterans have been denied health care and disability benefits because of the Pentagon's denial of any possible link between DU exposure and health problems. Despite the fact that tens of thousands of U.S. personnel were exposed to DU during the first Gulf War, the Department of Defense (DoD) DU program has only examined sixty veterans since that conflict.

There is widespread agreement that more research is needed into the health hazards posed by DU. For many years, a near-complete lack of appropriate data and studies allowed the Pentagon, NATO, the British government, and others to claim that there was no evidence that "depleted" uranium is dangerous to humans. More recently, as veterans, community organizations, scientists, and elected officials have demanded research or conducted it themselves, alarming evidence has emerged to corroborate the experiences of Gulf War veterans and others exposed to DU. Additional research – especially rapid independent health screening of military personnel exposed to DU in the second Gulf War – is still needed, along with treatment and compensation for those affected.

Exposure to "depleted" uranium can occur by inhalation of DU dust; ingestion of DU directly or in contaminated food, soil, and water; embedding of DU fragments in the body; contamination of open wounds with DU dust; and absorption through contact with the skin. Injection of fragments and inhalation of DU dust are considered to be the routes of exposure most likely to cause health effects. However, there is a lack of data on DU exposure during and after conflict, and post-conflict civilian ingestion of DU is also considered a significant risk. External exposure to DU is not considered a significant health hazard unless a DU shell or fragment is kept next to the skin for many days.

When a "depleted" uranium shell hits a hard target – such as a tank or building – the DU burns and about 20% vaporizes into a fine dust that can be inhaled by those in the immediate vicinity (up to 400 meters) or by personnel who work in, on, or around the impact site at a later date. DU particles can travel at least twenty-five miles on air currents, and can re-suspend into the air years later when disturbed by wind, people, or machinery.

The U.S. Nuclear Regulatory Commission believes that a breathed intake of .01 grams of DU can cause health problems and requires automatic testing. The U.K. says .008 grams of DU is hazardous for workers, and more than .002 grams are unacceptable for the general public. The World Health Organization (WHO) has set a Tolerable Daily Intake Level for ingested uranium of 0.6 micrograms per kilogram of body weight (a 150 pound adult would therefore have a daily intake limit of .00004 grams). By comparison, one 120mm DU tank round impacting against a hard target will create about 950 grams of DU dust, and one burst of 30mm shells fired by an A-10 aircraft might create 960 grams. In some cases, the amount of dust created may be much higher.

Inhaled DU dust will settle in the nose, mouth, airways, lungs, and gut. Because the ceramic DU dust particles created when a shell impacts a hard target are not soluble (will not dissolve in water or other fluids), they remain in the body much longer than other soluble forms of uranium. Many reviews of the possible health impacts of DU have not accounted for this fact. Over time, DU particles will be swallowed or absorbed by the body, but some may remain in the lungs for years. DU absorbed into the blood will be excreted from the body, primarily in urine, while DU taken into the gut will be excreted in feces. Up to 75% of DU absorbed into blood may be excreted during the first week, followed by slow excretion for up to a year. "Depleted" uranium not quickly removed from the body will deposit in bones and organs, especially the kidneys. DU will remain in the kidneys for at least three months and in bones for at least twenty-five years.

The generally expected health effects caused by the toxic properties of DU as a heavy metal occur in the kidneys, where it may disrupt kidney function, damage the organs, or in high doses even cause renal failure. Symptoms of DU effect on the kidneys may include nausea, tiredness, and anemia. However, in young adults (such as most soldiers) up to two-thirds of kidney function may be affected before obvious symptoms appear. Uranium concentration of 50 micrograms per gram of kidney will likely cause kidney failure within days, while short-term exposure of 1 microgram of uranium per gram of kidney may cause dysfunction, and much less may cause kidney problems in the case of long-term exposure. However, claims that DU's toxic properties will primarily affect the kidneys are based on research involving soluble uranium (which is mostly a renal toxicant), rather than on insoluble uranium such as DU dust (which is a lung chemical toxicant and systemic radiological hazard). The toxicity of DU particles may in fact affect human organs and systems other than kidneys, and the combination of toxic and radiological effects has not been studied.

Radiation is the spontaneous emission of energy from an unstable atom – such as U-238 – resulting in the formation of a new element. Radiation can damage or kill cells, initiate or accelerate cancer, mutate genes, and cause a variety of other health problems. Radiation from "depleted" uranium is primarily associated with "stochastic" health effects caused by longer exposure to lower levels of radiation, rather than effects caused by acute (short-term, high-level) exposure.

DU emits alpha, beta, and gamma radiation as it decays. Alpha particles are larger and heavier than beta particles or gamma rays, and can cause more damage to human tissue, but do not travel as far. Alpha particles can be stopped by human skin, gloves, or clothing, so alpha radiation is generally not harmful unless ingested, inhaled, or absorbed through wounds or cuts. Most public discussion of "depleted" uranium munitions has focused on the danger from alpha radiation.

Beta particles are smaller and lighter than alpha particles, are not as highly charged, move faster and farther (up to one centimeter through tissue), but are thought to be less damaging. Beta particles can penetrate the skin, but are generally stopped by clothing. A DU shell kept close to the body can produce a skin dose of 200 millirem per hour compared to the maximum recommended exposure .06 millirem per hour. Gamma rays – pure energy with no mass – are the most penetrating form of radiation and can pass through the entire body or be absorbed by and damage tissue. Several inches of lead or several feet of concrete are required to stop gamma rays.

"Depleted" uranium is primarily an alpha emitter. Alpha particles have been shown to cause a variety of effects on cells, including cell death, gene mutation, chromosome aberrations, and malignant transformation leading to cancer. Beta particles and gamma rays also damage cells. The lungs will receive the highest radiation dose from inhaled uranium, followed by bones. DU may also lodge in and irradiate other organs. Health effects caused by DU radiation may not appear for years.

DU can reside in soft body tissues and gonads where it emits radiation that may cause genetic health effects, birth defects, and spontaneous abortion. The U.S. military has found DU in the semen of Gulf War veterans. Male veterans are twice as likely, and females three times as likely, to have children with birth defects, possibly due to damage to the ovum and sperm caused by "depleted" uranium. Urine testing has confirmed the presence of DU in the urine of Gulf War veterans and civilians eight years after exposure. Iraqi doctors say they have seen a dramatic increase in babies born with severe congenital malformations in the last ten years, which some attribute to DU exposure. According to Dr. Janan Ghalib Hassan, nearly one-fourth of the babies at Basra Teaching Hospital in 2002 were born with some type of malformation.

Now that more aggressive research into the health effects of DU is occurring, a whole variety of dangers are coming to light. A recent animal study found DU at highest concentrations in the kidneys and bones, but also in the lymph nodes, brain, heart, liver, spleen, and testicles. Other animal studies found that DU crosses the blood brain barrier, causes electrical changes in an area of the brain important to learning and memory, crosses the placenta to the fetus, and is correlated with mutagenicity. One study of Gulf War veterans found that DU fragments embedded in the body may cause health effects years or decades after exposure, including kidney and liver damage; a depressed immune system; cancer of the lungs, bones, and other organs; leukemia; tissue decay; anemia; reproductive problems; and birth defects. Most recently, a U.S. military study found that DU damages bone marrow chromosomes. Alexandra Miller of the Armed Forces Radiobiology Research Institute, who led the study, stated that "people have always assumed low doses are not much of a problem, but they can cause more damage than people think."

The Uranium Life Cycle

Uranium exists in soils throughout the world at an average concentration of 3 parts per million (ppm), the visual equivalent of a tablespoon of uranium in a truckload of dirt. Concentrated deposits of uranium (called uranium ore) contain more, but are still only between 0.1% and 0.2% uranium. Canada is currently the leading producer of uranium. Other countries with substantial reserves include Australia, the United States, South Africa, Namibia, Brazil and Kazakhstan. Uranium must be removed from the ground, processed, and concentrated before it can be used for power generation or in nuclear weapons. Each stage of the uranium life cycle produces toxic and/or radioactive waste along with environmental and human health damage. Indigenous communities and communities of color in the U.S. and around the world bear a disproportionate burden of these costs. For example, lands of the Navajo nation contain almost 1/3 of all tailings from abandoned mills. During the first Gulf War, almost 50% of front line U.S. personnel (those most likely to be exposed to DU) were soldiers of color, while at home DU manufacturing and testing sites are primarily located in or near communities of color and low income communities.

Mining and Milling

For over half a century, large amounts of uranium have been mined to produce nuclear weapons and fuel nuclear reactors. Until the 1960s, most uranium was mined from open pit surface mines. More recently, underground mining and in situ leach mining (injecting solutions that dissolve uranium into the ground) have been employed. Because of the small percentage of uranium contained in the ore (0.1-0.2%), large amounts must be processed to produce relatively small amounts of uranium. The mining, processing, and milling of uranium produces large volumes of hazardous byproducts including waste rock (mining), waste solution (leaching and processing), and mill tailings (milling).

Waste rock is produced by open pit mines when the top layers of rock are removed in order to expose the ore, and by underground mines when tunnels are dug through minerals other than uranium ore. Uranium ore is taken to a mill, and waste rock, usually left in piles near the mine, may also be leached to extract uranium. Waste rock piles can release radon gas and radioactive or toxic seepage to the environment. Rock with low ore content is sometimes utilized by pouring a leaching liquid (such as sulfuric acid) on the top of the pile, and collecting the uranium-rich leachate on a liner below the pile for processing at a plant. Leaching piles may release dust, radon gas, and leaching liquid, and in certain conditions can produce uranium contamination of groundwater for centuries.

Uranium may also be removed from the ground through a process known as in situ leach mining. A leaching solution such as sulfuric acid is pumped into uranium deposits and then the leachate is pumped up to the surface for processing. In situ leaching can only be employed to extract uranium from deposits located in an aquifer in permeable rock which is confined in non-permeable rock, increasing the danger of widespread groundwater contamination. Although in situ leaching does not produce tailings piles, it does produce waste water and sludge. It is not possible to restore the leached area to natural conditions.

Ore removed from the ground is crushed and leached at a uranium mill using a chemical process involving either sulfuric acid or an alkaline substance. The milling process produces a powder known as "yellowcake" that consists of about 90% uranium oxide (U_3O_8) and various impurities. Because less than 1% of uranium ore is generally usable, milling produces large amounts of radioactive "tailings." This waste is usually dumped in ponds or piles and abandoned. As much as 99.99% of the original ore may remain as tailings containing heavy metals and various long-lived radioactive substances. Mill tailings present serious dangers to humans and the environment.

Uranium miners and millers – particularly Indigenous workers such as the Navajo – have suffered serious health effects related to their exposure to radon, uranium, heavy metals, and other hazardous substances. Dramatically increased rates of health problems including lung cancer and other respiratory diseases have been well documented in these workers.

Conversion and Enrichment

Uranium yellowcake must be enriched to increase the proportion of U-235, and then converted to uranium metal or uranium dioxide (UO_2), before it can be used in nuclear weapons and reactors. Approximately 4 pounds of concentrated uranium oxide is extracted from one ton of uranium ore. The solid yellowcake produced in the milling process is converted to uranium hexafluoride (UF_6) gas at a uranium processing plant so that it can be enriched. The enrichment process increases the percentage of U-235. U.S. naval reactors, nuclear weapons, and some research reactors all use "highly enriched uranium" (HEU), which is composed of over 90 percent U-235, while commercial reactors use fuel that is 3-5 percent U-235. The enriched UF_6 gas can then be chemically converted into uranium metal or uranium dioxide for use in reactors and weapons. Almost 90% of the material that begins the enrichment process remains at the end of the process as waste in the form of "depleted" uranium hexafluoride (DUF_6) gas.

Both UF_6 and DUF_6 are radioactive and chemically toxic. Both react with moisture (including humidity in the air) to form highly dangerous hydrogen fluoride or hyrdrofluoric acid. Both enriched and "depleted" UF_6 pose dangers to workers and neighbors of conversion and enrichment facilities. In 1986, an accident involving uranium hexafluoride at the Sequoyah Fuels conversion plant in Gore, Oklahoma killed one worker and sent 42 workers and 100 residents to the hospital. Health and environmental damage at the U.S. Department of Energy facilities in Oak Ridge, Tennessee; Paducah, Kentucky; and Portsmouth, Ohio has been severe.

A U.S. Department of Energy study of occupational exposures at the Gaseous Diffusion Plants concluded that the "climate of secrecy and urgency to produce nuclear weapons often took precedence over environmental safety and health." A 2001 study of radiation exposure to workers at the Paducah plant, prompted by worker concerns, found that "2,500 to 4,000 workers worked in areas considered "moderate" to "high" for increased internal and external radiation exposures." Paducah workers were exposed to plutonium and other transuranic substances without their knowledge, were not provided protective clothing, and were issued useless "radiation measurement badges" that contained no film to measure radiation. One worker's bones contained 1700 times the expected level of uranium. Radioactive and toxic waste was dumped both inside and outside the fence at Paducah for 50 years, contaminating groundwater to a depth of 400 feet and poisoning drinking water wells with plutonium. In 1978 and 1979 alone, over 300,000 pounds of radioactive waste was dumped onsite each year.

About 1.5 billion pounds of DUF_6 (equal in weight to 70 Ticonderoga-class Navy cruisers or eight Nimitz-class aircraft carriers) is stored outside in 57,600 steel cylinders at the uranium enrichment facilities in Portsmouth, Paducah, and Oak Ridge. These cylinders – mostly containing 14 tons of DUF_6 – are initially filled to 95% of capacity with liquid depleted uranium hexaflouride. The DUF_6 contracts as it cools and forms a crystalline solid. After cooling, about 60% of each cylinder is filled with DUF_6 solid and the rest with DUF_6 gas.

The volatility of DUF_6, the age of the storage cylinders, and outdoor storage combine to create significant dangers. Cylinder leaks can release DUF_6 and hydrogen fluoride gas into the air. At least ten cylinders have breached during the last 40 years. In 1978, a cylinder was dropped at the Portsmouth Gaseous Diffusion Plant in Ohio, releasing 20,000 lbs of uranium hexafluoride. The badly corroded state of many cylinders makes additional failures likely. Much of the stored DUF_6 is contaminated with plutonium and other transuranics, posing further danger. DOE plans to eventually convert the DUF_6 stockpile to a more stable form at one or more plants.

Nuclear Weapons, Reactors, and Waste

A thorough assessment of the environmental and human health impacts of nuclear power, nuclear weapons, and nuclear waste is well beyond the scope of this fact sheet. However, the extent of these impacts is large. Uranium is mined, milled, and enriched primarily because of its use in nuclear weapons and power-generating reactors. Over 128,000 nuclear warheads have been built worldwide since 1945. The U.S. retains almost 11,000 intact nuclear warheads, including 7,000 operational strategic nuclear weapons and 800 operational tactical nuclear weapons.

Nuclear reactors use fuels such as enriched uranium to sustain a fission chain reaction that produces nuclear energy. Over 16% of the world's electricity is generated from uranium in 430 nuclear reactors operating in over 31 countries. Thirty additional reactors are under construction, and another seventy are in the planning stage. The USA has over 100 reactors, supplying 20% of its energy. Nuclear reactors also power many U.S. naval vessels.

As should be apparent, radioactive and toxic waste are generated at each stage of the uranium life cycle. Production of the amount of nuclear fuel necessary to fuel one 1300 Megawatt reactor for one year can produce the following amounts of waste: mining – 597,907 tons of waste rock; milling – 119,311 tons of mill tailings; conversion – 159 tons of solid waste and 47,447 cubic feet of liquid waste; enrichment - 295 tons of depleted uranium hexafluoride; fuel fabrication – 448 cubic feet of solid waste and 8,080 cubic feet of liquid waste; power generation – 31 tons of spent fuel.

Spent fuel from the end of the process is initially far more radioactive than other waste products such as waste rock, mill tailings, and DUF_6. However, over time the radioactivity of spent fuel falls fairly steadily, dropping below that of other radioactive wastes after approximately 100,000 years. Depleted uranium represents the major source of radioactivity from these wastes over the very long term, although radon released by mill tailings and carbon-14 released by power plants account for the largest known radiation exposures to the general public.

Lax handling of radioactive wastes – including DU – is common. For example, at the Sandia National Laboratory mixed waste landfill in New Mexico, tons of DU were dumped into shallow unlined pits and trenches that sit above Albuquerque's drinking water aquifer. The large volumes of waste generated throughout the uranium life cycle, combined with the toxicity and radioactivity of these wastes and irresponsibly handling, have caused widespread damage to humans and the environment, particularly in Indigenous communities.

"Depleted" Uranium Weapons

Since the 1970s, the U.S. Department of Defense has used "depleted" uranium for a variety of military applications, including armor-piecing shells, bomb casings, missiles, tank armor plating, aircraft ballast, and anti-personnel mines. DU is used in munitions and other military applications for three primary reasons: the U.S. government already owns huge stockpiles of it; it would otherwise have to be stored and monitored; and it produces an effective armor-piercing weapon because of its density and pyrophoricity (it burns on impact).

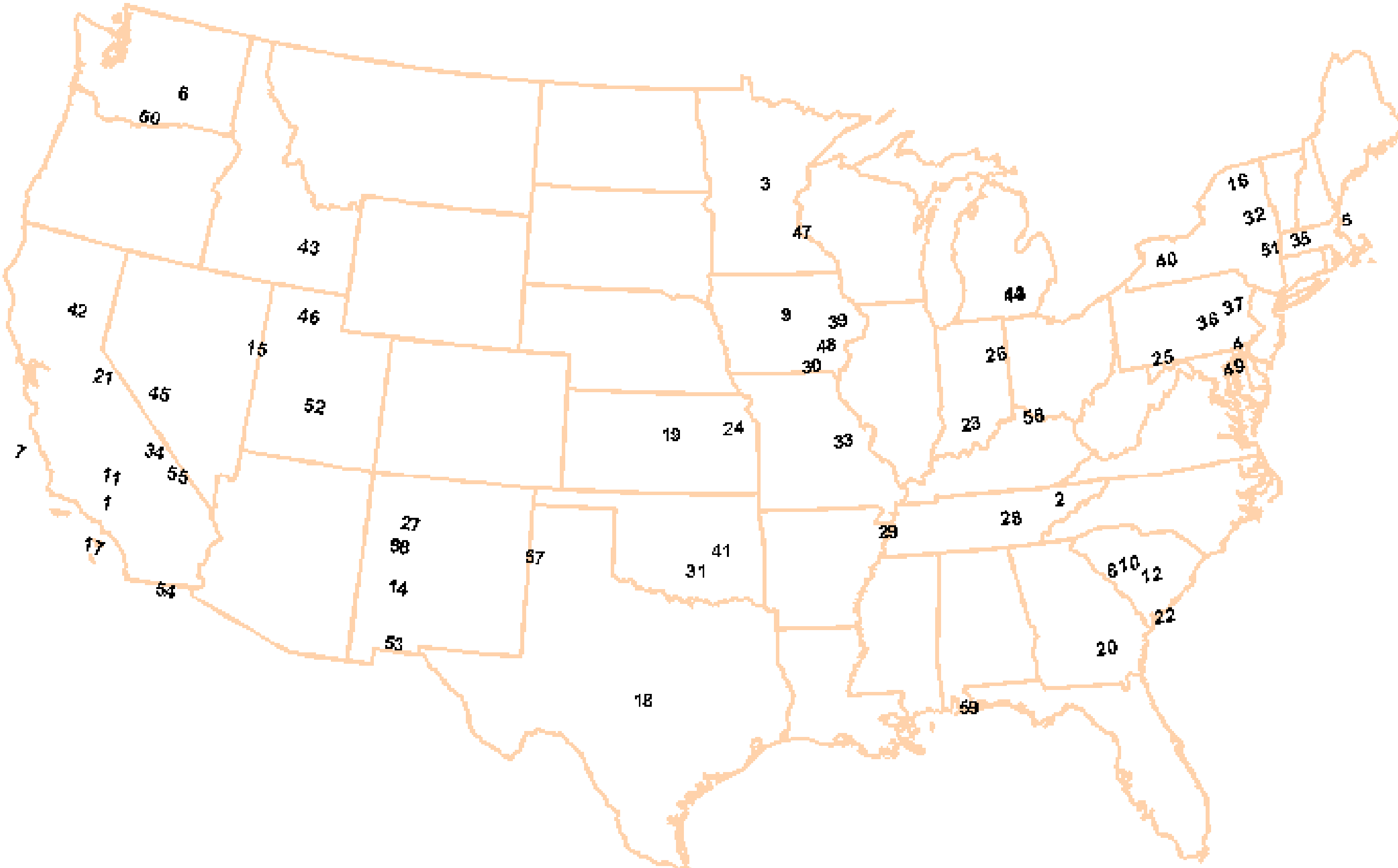
The principal U.S. munitions containing DU are 105mm and 120mm rounds fired by M60A3 and M1A1/M1A2 Abrams tanks, which contain four and five kg of DU respectively, and 30mm rounds fired by the Gatling gun on the A-10 aircraft, which contain about 0.3 kg of DU each. DU rounds have also been fired by M2/M3 Bradley fighting vehicles, AV-8B Harrier aircraft, AH-1W Super Cobra helicopter, and the Navy's Phalanx missile defense gun. At least seventeen countries – including the U.K, Russia, Turkey, Saudi Arabia, Pakistan, Thailand, Israel, and France – have developed or are developing DU weapons. These weapons are also being sold on the world arms market by U.S. manufacturers and others.

Production

Two U.S. companies produce large caliber "depleted" uranium tank rounds: Alliant Techsystems (120mm shells) and the former Primex Technologies, now General Dynamics Ordnance and Tactical Systems (105mm and 120mm shells). Four other companies – located in the United Kingdom, France, the former Soviet Union, and Pakistan – also produce large caliber tank rounds. Primex and Alliant also produce small caliber rounds (20mm, 25mm, 30mm) for guns on U.S. aircraft, ships, and fighting vehicles.

Workers producing "depleted" uranium munitions and neighbors of these facilities may be exposed to both soluble and insoluble uranium. Communities and production workers have struggled for decades with DU environmental contamination and with health effects that they believe to be associated with production of DU weapons. For example, the National Lead Industries factory in Colonie, New York was forced to close in 1980 after uranium particles were found 26 miles downwind of the facility and DU was found in soil at levels 500 times higher than surrounding communities. At the time of closure, the plant was discharging DU at more than ten times the state limit.

From 1958 to 1985, the Starmet Corporation (formerly Nuclear Metals, Inc.) DU penetrator production facility in Concord, MA dumped 400,000 pounds of "depleted" uranium and other toxic wastes into an unlined pit. In 2001, the U.S. Environmental Protection Agency added the facility to the federal Superfund National Priorities List as one of the most dangerous contaminated sites in the country. DU has contaminated soil and groundwater, migrated off site, and is moving in groundwater toward the Assabet River. Independent research conducted by the community organization Citizens Research and Environmental Watch (CREW) found DU in soil as high as 18 times background levels as far as nine-tenths of a mile from the site. Concord experienced levels of thyroid cancer more than twice the state average from 1982-1992. Levels of multiple myeloma and other cancers were also elevated.



1 – Aerojet Ordnance Company; Chino, CA
2 – Aerojet Ordnance Tennessee; Jonesboro, TN
3 – Alliant Tech Systems; Elk River, MN
4 – Army Research Laboratory; Aberdeen Proving Ground, MD
5 – Army Research Laboratory; Watertown, MA
6 – Battelle Pacific Northwest Labs; Richland, WA
7 – Camp Roberts; Bradley, CA
8 – Carolina Metals; Barnwell, SC
9 – Chamberlain Manufacturing; Waterloo, IA
10 – Chem-Nuclear Systems Waste Management; Barnwell, SC
11 – China Lake Naval Weapons Center Alliant Tech Systems; Ridgecrest, CA
12 – Defense Consolidation Facility; Snelling, SC
13 – Detroit Army Tank Plant; Warren, MI
14 – Energetic Materials Research & Technology Ctr.; Socorro, NM
15 – Envirocare of Utah; Clive, UT
16 – Ethan Allen Firing Range; Burlington, VT
17 – Ford Aerospace and Communications Corp.; San Juan Capistrano, CA
18 – Fort Hood; Killeen, TX
19 – Fort Riley; Junction City, KS
20 – Fort Stewart; Hinesville, GA
21 – Hawthorne Army Ammunition Plant; Hawthorne, NV
22 – Hunter Army Airfield; Savannah, GA
23 – Jefferson Proving Ground; Madison, IN
24 – Lake City Army Ammunition Plant; Independence, MO
25 – Letterkenny Army Depot; Chambersberg, PA
26 – Lima Army Tank Plant; Lima, OH
27 – Los Alamos National Laboratory; Los Alamos, NM
28 – Manufacturing Sciences Corp.; Oak Ridge, TN
29 – Milan Army Ammunition Plant; Milan, TN
30 – Iowa Army Ammunition Plant; Middletown, IA
31 – McAlester Army Ammunition Plant; McAlester, OK

32 – National Lead Industries; Colonie, NY
33 – National Manufacturing Corp.; St. Louis, MO
34 – Nevada Test Site; Mercury, NV
35 – Nuclear Metals Inc. (now Starmet); Concord, MA
36 – Olin Ordnance Corp.; Red Lion, PA
37 – Picatinny Arsenal; Dover, NJ
38 – Sandia National Laboratories; Albuquerque, NM
39 – Savanna Army Depot; Savanna, IL
40 – Seneca Army Depot Activity; Romulus, NY
41 – Sequoyah Fuels Corp.; Gore, OK
42 – Sierra Army Depot; Herlong, CA
43 – Specific Manufacturing Capability Facility Idaho National Engineering Laboratory; Idaho Falls, ID
44 – Tank Automotive Command; Warren, MI
45 – Tonopah Test Range; Tonopah, NV
46 – Tooele Army Depot; Tooele, UT
47 – Twin Cities Army Ammunition Plant, Alliant Tech Systems; New Brighton, MN
48 – U.S. Army Armament Munitions and Chemical Command; Rock Island, IL
49 – U.S. Army Combat Systems Test Activity; Aberdeen Proving Ground, MD
50 – U.S. Ecology; Hanford, WA
51 – Watervliet Arsenal; Albany, NY
52 – White Sands Missile Range; Green River, UT
53 – White Sands Missile Range; White Sands, NM
54 – Yuma Proving Ground; Yuma, AZ
55 – Nellis Air Force Base; Las Vegas, NV
56 – Kirkland Air Force Base; Albuquerque, NM
57 – Pantex Plant; TX
58 – Portsmouth Uranium Enrichment Plant; Portsmouth, OH
59 – Eglin Air Force Base; Valpareso, FL

Testing and Training

Testing of DU munitions and training with them has produced significant contamination at a variety of sites across the country. Because "depleted" uranium is a radioactive material, handling and test firing of DU may only legally occur at sites licensed by the Nuclear Regulatory Commission (NRC). Identifying all DU handling, testing, and training sites is somewhat difficult. The U.S. Army holds 14 different NRC licenses for DU, while the Navy and Air Force hold "master" licenses that cover many different sites. DU firing sites have included: Yuma Proving Ground in Arizona; Camp Roberts in California; Eglin Air Force Base in Florida; Jefferson Proving Ground in Indiana; Aberdeen Proving Ground in Maryland; Nellis Air Force Base in Nevada; and Ethan Allen Firing Range in Vermont.

A map of known "depleted" uranium storage, use, testing, processing, and disposal sites appears on the previous page of this fact sheet.

Use of DU munitions has also occurred in areas not licensed by the NRC. In December 1995 and January 1996, U.S. Marine Corps Harrier aircraft training near Okinawa, Japan fired about 1,520 DU rounds. The Japanese government was not notified for almost a year. In February 1999, two U.S. Marine Corps Aircraft expended 263 DU rounds at the U.S. Navy firing range in Vieques, Puerto Rico, which is not licensed for DU munitions. This "accidental" release was only discovered through a Freedom of Information Act request by the Military Toxics Project. In January 2003, the Navy admitted routinely firing DU from its Phalanx guns in prime fishing waters off the coast of Washington state since 1977.

Some licensed DU firing sites – including Picatinny Arsenal in New Jersey, and Jefferson Proving Ground in Indiana – are in the process of being decommissioned. The Army is taking as little responsibility as possible for cleanup of these sites. At the former Jefferson Proving Ground (JPG) in Madison, Indiana, the U.S. Army is attempting to walk away from DU contamination without conducting any cleanup or environmental monitoring. DU was fired at JPG from 1984 to 1994, and over 150,000 pounds of DU rounds and fragments remains on the range (along with 1.5 million rounds of unexploded conventional ordnance). In July 2001, the Army proposed a decommissioning plan for the DU impact area to the NRC as a step toward termination of the DU license for the site. The Army's plan would rely entirely on "institutional controls" (fences, deed restrictions, etc.) and include absolutely no cleanup of DU fragments or contaminated soil and no ongoing environmental monitoring. In February 2003, on the eve of a court hearing on a challenge to the decommissioning plan, the

Army proposed a plan to retain its DU site license as a "possession-only" license. Such a license would still require no cleanup of DU contamination, and would not necessarily require thorough environmental monitoring.

Use in Conflicts

Iraq 1991 – DU was first used extensively in combat during the 1991 Gulf War. U.S. tanks and aircraft and British tanks fired about 850,000 small caliber and 9,600 large caliber DU shells containing over 286,000 kg of DU during operation Desert Storm and on U.S. Army bases in Kuwait. The bulk of DU shells expended during the war (83% by weight) were fired by U.S. A-10 aircraft, although DU was also fired by U.S. M60A3 and Abrams tanks, A-16 jets, AV-8B Harrier jets, Navy Phalanx guns, and by British Challenger tanks.

Bosnia 1994-1995 – U.S. A-10 aircraft shot approximately 10,800 DU rounds containing 3,260 kg of DU as part of North Atlantic Treaty Organization (NATO) operations in Bosnia and Herzegovina during 1994 and 1995.

Kosovo, Yugoslavia 1999 – U.S. A-10 aircraft fired DU during NATO action in the Yugoslavian province of Kosovo in 1999. Approximately 31,300 rounds containing 9,450 kg of DU were fired at targets in Kosovo, Serbia, and Montenegro during this conflict.

Afghanistan 2001-2003 – It appears likely that U.S. forces used some DU munitions against Taliban forces in Afghanistan, although conclusive evidence has not yet been presented. The U.S. Department of Defense has neither confirmed nor denied the use of DU weapons, although several actions occurred involving weapons systems known to fire DU. There were at least seven attacks in 2002 and 2003 by U.S. A-10 aircraft, which normally fire a mix of high explosive and "depleted" uranium rounds. The Marine Corps deployed light armored vehicles and Harrier aircraft known to fire DU to Afghanistan, some of which were involved in combat.

There is some limited evidence that Al Qaeda or Taliban forces may also have possessed DU rounds. Defense Secretary Donald Rumsfeld stated on several occasions that the U.S. found radioactivity that appeared to indicate depleted uranium. No further information has been released.

Iraq 2003 – DU munitions were used in Iraq during the second Gulf War in 2003. An initial Pentagon disclosure stated that A-10s – which normally fire a mix of four DU shells to one conventional shell – shot about 300,000 total bullets. As much as 75 tons of DU may remain in Iraq from A-10 expenditure alone. No estimates are available for use of DU by tanks or other weapons.

Environmental Contamination

Immediate battlefield exposures of combat and cleanup personnel to "depleted" uranium are only the tip of the toxic and radioactive iceberg. Continuing environmental exposures present a much longer-term danger to civilians in post-conflict areas. The Royal Society (the British national academy of sciences) recently concluded that because DU may move into the environment – especially water sources – over many decades, "contaminated land might be a concern for hundreds of years" and "contamination of water supplies or other sensitive components of the environment…might only become apparent after a number of years or more likely decades." Environmental contamination at production and testing sites is addressed above; here we review conflict and post-conflict exposures.

Firing of DU munitions can immediately contaminate air, soil, and water with ingestible particles of toxic and radioactive "depleted" uranium. Unless shells and fragments are removed from areas of use, they will continue to release DU into the environment for years or decades. Corrosion of spent shells adds to amounts of mobile DU dust in environment. If not cleaned up, it may contaminate food or water supplies, or be resuspended into the air and carried by wind. Activities such as construction or plowing may be hazardous to people in the area. Children living in affected areas are particularly at risk of playing in DU contaminated areas, and ingesting contaminated soil.

Combat Exposures

Gulf War 1991

According to Department of Defense (DoD) and Veterans Affairs (VA) data, tens or hundreds of thousands of

U.S. military personnel may have been exposed to DU during the first Gulf War, and close to 1,000 soldiers definitely suffered moderate to heavy exposures. Exposures to DU occurred for troops inside vehicles struck by friendly fire with DU shells; personnel who collected and transported vehicles hit by DU; personnel who entered vehicles and bunkers hit by DU shells; and in other situations. An independent survey of over 10,000 Gulf War veterans found that 82% came into contact with captured Iraqi equipment, possibly exposing them to DU dust. Civilian populations in areas contaminated with DU have also likely been exposed.

U.S. troops were provided no DU safety training before or during the conflict, despite the existence of training materials. Only a handful of battle damage assessment and radiation control personnel were aware of the need to wear protective clothing around DU contamination. Two-dozen soliders from the 144^{th} Army National Guard Service and Supply Company on and inside DU-contaminated vehicles for at least three weeks before they were informed (by a visiting radiation contamination team) about DU contamination or advised to wear protective equipment. Military commanders consciously ignored regulations in place during Operation Desert Storm, which required medical testing and care for veterans exposed to DU. The vast majority of troops did not receive medical screening or undergo blood or urine testing for DU and other contaminants before or after the war.

Post-war military studies have been woefully – some say intentionally – inadequate to determine DU exposures during the war and possible health consequences. The Pentagon’s unwritten policy for ten years has been "don’t look, don’t find." In fact, DOD consistently misled other agencies and authorities about the extent and consequences of DU exposures. The Pentagon repeatedly underreported the number of veterans possibly exposed to DU, despite the fact that it possessed evidence of more widespread exposures. The Presidential Special Oversight Board that monitored DOD investigations of various Gulf War exposures called DOD’s exposure estimates "incomplete and misleading," and a General Accounting Office Report agreed, concluding that the estimates were "unreliable."

Only a small number of veterans definitely or likely exposed to DU have ever been tested for DU contamination, and conclusions from these tests have been limited due to small sample size, the release of false information about the health of veterans in the DU Program, and failure to include DU-exposed veterans who have reported health problems including birth defects. DOD officials have repeatedly claimed in recent years that no cancers have been observed in (the extremely small number of) DU-exposed U.S. Gulf War veterans studied by the Pentagon. In fact, at least one veteran in the DU program had Hodgkin’s disease, a rare lymphatic cancer.

The Pentagon’s failure to investigate the health status of Gulf War veterans led to a Congressional mandate in the Fiscal Year 1998 National Defense Authorization Act. These provisions require the Secretary of Defense to set up a system to assess the medical condition of troops deployed outside the United States during combat or contingency operations. Congress directed that the assessment system must include predeployment and postdeployment medical examinations, including both mental health assessments and blood samples.

Gulf War II 2003

Various independent agencies began calling for disclosure, investigation, and cleanup of DU munitions use in the second Gulf War as early as March 2003. In early April, the United Nations Environment Programme (UNEP) recommended that a scientific study of sites targeted with DU weapons be conducted as soon as possible "to protect human health in a post conflict situation."

During the war, the Royal Society (the British national academy of sciences) released two statements about "depleted" uranium. In the first statement, Brian Spratt, chairman of the Royal Society’s working group on DU, said that "we recommend that fragments of depleted uranium penetrators should be removed, and areas of contamination should be identified and, where necessary, made safe. We also recommend long-term sampling, particularly of water and milk, to detect any increase in uranium levels in areas where depleted uranium has been used." Spratt noted that soil around impact sites may be heavily contaminated and could be harmful to children, and that "large numbers of corroding depleted uranium penetrators embedded in the ground might pose a long-term threat if the uranium leaches into water supplies."

In a second statement, the Royal Society called on coalition forces to disclose DU use and clean up DU munitions and contamination in Iraq. According to the Society, "the coalition needs to acknowledge that depleted uranium is a potential hazard and make in-roads into tackling it by being open about where and how much depleted uranium has been deployed." The statement also noted that "impact sites in residential areas should be a particular priority. Long-term monitoring of water and milk to detect any increase in uranium levels should also be introduced in Iraq."

The Society also recommended comprehensive studies of exposure to DU in Iraq, concluding that "it is highly unsatisfactory to deploy a large amount of a material that is weakly radioactive and chemically toxic without knowing how much soldiers and civilians have been exposed to it" and that "we also need to know the exposures of Iraqis living in any residential areas where DU munitions were deployed." The statement called for specific studies of veterans, noting that "it is only by measuring the levels of DU in the urine of soldiers that we can understand the intakes of DU that occur on the battlefield, which is a requirement for better assessment of any hazards to health. It is vital that this monitoring takes place and that it takes place within a matter of months."

The Pentagon seems intent on continuing its "don't look, don't find" policy by failing to test personnel who served in Iraq in 2003 for DU contamination using methods that might actually find something. The DOD ignored legal requirements noted above that troops deployed for combat outside the U.S. receive medical examinations and submit blood samples before deployment. Military officials only agreed to abide by the law's requirement to conduct postdeployment examinations and blood tests after two Congressional hearings and public pressure by veterans' organizations. Even examinations and blood tests are not enough to determine DU exposure, which – as the Royal Society noted – would require testing of urine samples.

Post-Conflict Exposures

The United Nations Environment Programme (UNEP) Post Conflict Assessment Unit has conducted three field studies of DU contamination remaining two to seven years after conflicts. These studies have not suggested widespread health impacts caused by "depleted" uranium, but have found significant DU contamination in the environment – including drinking water and indoor air – up to seven years after its use. The reports also recommend precautionary measures, including immediate disclosure of locations where DU is fired, cleanup and decontamination, education of civilian populations, and ongoing environmental monitoring.

Kosovo, Yugoslavia

An October 1999 UNEP "Desk Study" recommended that NATO disclose "if, how, and where" DU was used in Kosovo so that appropriate investigation could be made and precautionary actions taken. The report also recommended thorough sampling of DU sites, removal of DU shells and fragments, limiting public access to contaminated sites, education of residents, decontamination, and health examinations.

UNEP's first post-conflict field study of DU, conducted in November 2000 and published in March 2001, occurred in the Yugoslavian province of Kosovo. UNEP analysis of recovered DU shells and soil samples containing "depleted" uranium found U-236, confirming that some of the DU shells were made with recycled uranium. Additional analysis of recovered DU shells and fragments by the Swedish Radiation Protection Institute also found plutonium. The study found that DU dust could still be detected in soil and bio-indicators such as lichen more than two years after the conflict. The study did not observe widespread DU contamination, but did find large numbers of localized points of concentrated contamination showing U-238 at 10,000 times normal and evidence of airborne movement of DU dust. This contamination poses some risks related to inhalation of DU particles, contamination of groundwater, and ingestion of soil. Areas where DU was fired heavily could have increased risk for uranium contamination of groundwater by a factor of 10 to 100, and uranium contamination might exceed World Health Organization drinking water standards.

UNEP recommended investigation of all sites where DU was fired; collection and disposal of penetrators and jackets; decontamination where necessary, especially close to inhabited areas; and ongoing drinking water monitoring. The report also recommended that additional field study be done in Bosnia-Herzegovina to explore persistence of DU in the environment over many years.

Serbia and Montenegro

UNEP conducted a second field study of DU contamination in Serbia and Montenegro, where DU was fired during the 1999 Kosovo conflict. This study, conducted in October 2001 and published in March 2002, also detected DU in soil and lichen more than two years after the conflict. UNEP found "widespread, but low-level, DU contamination," DU particles in air, and rapidly corroding penetrators that might contaminate groundwater. Investigators also found airborne DU particles at two sites, concluding that "DU dust was widely dispersed into the environment." UNEP warned that "any soil disturbance at these sites could risk releasing DU particles into the air."

The report recommended field investigations at all sites where DU was used; cleanup and decontamination when necessary and feasible; collection and disposal of DU shells, jackets, and fragments; ongoing monitoring of drinking water; education of the local population; and prompt disclosure of correct locations and coordinates for sites where DU is used.

Bosnia

UNEP's third DU field study - conducted in October 2002 and published in March 2003 – investigated contamination in Bosnia and Herzegovina more than seven years after the conflict. The report "confirms for the first time that depleted uranium (DU) from weapons used in Bosnia and Herzegovina in 1994 and 1995 contaminated local supplies of drinking water." Investigators also found DU contamination of air at two sites, including inside two buildings, confirming that particles can re-suspend into the air for many years. The study also found that DU penetrators buried in the ground corrode quickly, and that DU contamination of soil near impact sites remains very localized (1-2 meters). In March 2003, UNEP recommended investigation of all sites where DU was used to determine contamination, cleanup of DU sites, cleaning of contaminated buildings, ongoing testing of drinking water, and release by NATO of all DU-attack coordinates.

The Future of DU Weapons

Thanks to the questionable leadership of the United States, "depleted" uranium munitions have now proliferated into the arsenals of at least seventeen countries, and are produced and sold on the world arms market by several nations. Hundreds of tons of DU shells, fragments, and dust remain in the air, soil, and water of battlefields in the Middle East and former Yugoslavia. Uranium continues to be mined and enriched around the world, producing even greater stockpiles of "depleted" uranium waste, which is manufactured into weapons and tested at sites across the United States. The U.S. Army persists in its attempt to avoid cleanup or environmental monitoring of DU contamination at the former Jefferson Proving Ground in Indiana. The toxic properties of DU remain largely unregulated.

Tens of thousands of military personnel who may have been exposed to DU are returning from Iraq. Although the Pentagon finally agreed – under public pressure – to comply with the federal law that requires post-conflict health screening for troops involved in conflict overseas, those screenings will apparently not include urine tests, which are essential to detect DU in the body. The military's failure to screen troops before deployment – required by the same federal law – means there will be no baseline measurements to compare to post-conflict screening. Veterans of the first Gulf War and civilians exposed to DU in the United States, Iraq, the former Yugoslavia, and elsewhere continue to be denied adequate testing, treatment, and compensation.

Fortunately, domestic and international opposition to the indiscriminate production, sale, and use of DU munitions is growing. Tens of thousands of activists and dozens of organizations and coalitions in many countries have spoken out to demand justice for veterans and communities harmed by "depleted" uranium and an end to the manufacture and use of DU weapons. Legislation currently under consideration in the U.S. Congress would mandate comprehensive independent health studies of DU. And ongoing research around the world is documenting the damage done by DU to human bodies. The U.S. government may have been correct after all when it predicted that public opposition to the environmental and human health damage caused by DU weapons might eventually bring an end to their use.

Resources

Campaign Against Depleted Uranium – UK-based organization devoted to achieving a ban on DU weapons. Much information including an introduction to DU online at http://www.cadu.org.uk/ and available by phone (in England) at +44 (0)161 273 8293 / 8283.

Department of Energy DUF_6 Information Network – DOE's page on depleted uranium hexafluoride can be found at http://web.ead.anl.gov/uranium/index.cfm

Department of Veterans Affairs Depleted Uranium Focus Area – DVA's response to DU (be warned!) at http://www.gulflink.osd.mil/medsearch/FocusAreas/depleted_uranium.shtml

Depleted Uranium Lists and Links – Good compendium of DU discussion lists and web sources on line at http://www.energyjustice.net/nuclear/du/ as part of the Energy Justice Network site.

DU Link – Extensive information on DU and the Gulf War originally compiled by Gulf War veteran Chris Kornkven, online at http://www.ngwrc.org/Dulink/du_link.htm

Institute for Energy and Environmental Research - An online technical training classroom and fact sheets on uranium and nuclear issues are available at http://www.ieer.org and (301) 270-5500.

International Coalition to Ban Uranium Weapons – Founded in October, 2003 by grassroots organizations and experts. Can be found on the web at http://www.bandepleteduranium.org

International Depleted Uranium Study Team – Dedicated to stopping the use of DU in military weapons by 2010. Can be reached at http://idust.net/ on the web and info@idust.net by email.

Laka Foundation – Extensive information on nuclear issues including DU online at http://www.laka.org/ and by phone (in Holland) at +31 20–6168294.

Low Level Radiation Campaign – Includes information on DU and health effects of low level radiation, found online at http://www.llrc.org/ and by phone (in England) at +44 (0) 1597 824771.

Military Toxics Project DU List Serve – Email discussion list about DU. To join, go to http://groups.yahoo.com/group/du-list/ or send an email to du-list-subscribe@yahoogroups.com

Nuclear Policy Research Institute – Uses mass media to educate about dangers from nuclear weapons, power, and waste (including DU)**;** at http://www.nuclearpolicy.org or (202) 822-9800.

Trail of a Bullet – Series of articles about DU published in the Christian Science Monitor newspaper, available online at http://www.csmonitor.com/atcsmonitor/specials/uranium/index.html

United Nations Environment Programme Post-Conflict Assessment Unit – Includes reports and statements about DU in the former Yugoslavia and Iraq at http://postconflict.unep.ch/

U.S. Department of Defense

Deployment Health Support Directorate DU Library - http://deploymentlink.osd.mil/du_library/
GulfLINK (Office of the Special Assistant for Gulf War Illnesses) - http://www.gulflink.osd.mil/
(Note: GulfBLINK at http://www.gulflink.org/ rebuts various misinformation on the above site)

WISE Uranium Project – Tremendous amount of information about DU, radiation, and related issues online at http://www.antenna.nl/wise/uranium/ and by phone (in Germany) at +49-35200-20737.

Women's International League for Peace and Freedom (Australia) – Great basic information on DU and its impacts available online at http://www.wilpf.org.au/

Click here to go to MTP's Depleted Uranium page

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