International Network of Engineers and Scientists Against Proliferation

Depleted Uranium Weapons

Lessons from the 1991 Gulf War

Dan Fahey

Reprinted from: Depleted Uranium - A Post-War Disaster for Environment and Health, Laka Foundation, May 1999. With contributions by: Felicity Arbuthnot, Rosalie Bertell, Ray Bristow, Peter Diehl, Dan Fahey, Henk van der Keur, Daniel Robicheau.
Address: Ketelhuisplein 43, 1054 RD Amsterdam, The Netherlands, tel +31-20-6168294, fax -6892179, email laka@laka.antenna.nl. **Complete Report at http://antenna.nl/wise/uranium/dhap99.html**

The 1991 Persian Gulf War included an array of the twentieth century's most frightening and devastating weapons. Nuclear, chemical, and biological weapons were all poised for use, each with the ability to cause massive casualties among friend and foe alike. When hostilities subsided in March, 1991, the world breathed a collective sigh of relief that weapons of mass destruction had not been used. Or had they?

During the Gulf War, American and British forces introduced armor-piercing ammunition made of depleted uranium, a radioactive and toxic waste. By war's end, more than 290,000 kilograms (640,000 pounds) of depleted uranium contaminated equipment and the soil on the battlefields of Saudi Arabia, Kuwait, and southern Iraq.[1] Though investigations are ongoing and additional research is needed, it now appears that some veterans and civilians exposed to depleted uranium contamination are suffering health problems including kidney damage and cancers.

The use of a radioactive and toxic waste in ammunition heralds a dangerous new era in land warfare, one in which the line between conventional and unconventional warfare is irreversibly blurred. The increasing proliferation and use of depleted uranium weapons ensure their part in armed conflict for the foreseeable future. Accordingly, we must learn from the lessons of the use of depleted uranium weapons in the Gulf War and take steps to minimize and prevent the adverse effects on soldiers, civilians, and food and water supplies.

Depleted uranium (DU) is the waste product of the process to enrich uranium ore for use in nuclear weapons and reactors. Depleted uranium is chemically toxic like other heavy metals such as lead, but it is also primarily an alpha particle emitter with a radioactive half-life of 4.5 billion years.[2] The U.S. Army Environmental Policy Institute states "DU is a low-level radioactive waste, and, therefore must be disposed in a licensed repository."[3]

In the 1950's, the United States Department of Defense became interested in using depleted uranium metal in weapons because it is extremely dense, pyrophoric, cheap, and available in huge quantities in the United States.[4] During the 1960's and 1970's, research and open-air testing at various locations in the United States demonstrated the effectiveness of using depleted uranium in kinetic energy penetrators, which are rods of solid metal shot from guns. Kinetic energy penetrators do not explode; they fragment and burn through armor "due to the pyrophoric nature of uranium metal and the extreme flash temperatures generated on impact."[5] In the 1980's, depleted uranium was also developed for use in tank armor.

During Operation Desert Storm, American M1A1, M1, and M60 tanks and British Challenger tanks fired thousands of large caliber depleted uranium penetrators.[6] American A-10 and AV-8B aircraft shot hundreds of thousands of small caliber depleted uranium rounds.[7] American snipers shot 7.62mm and possibly .50 caliber depleted uranium bullets.[8] In addition, one-third (654) of the American tanks used in the war (2,054) were equipped with depleted uranium armor.[9] Depleted uranium penetrators enhanced the tactical advantage of American and British forces over the Iraqi Army's inventory of tanks, but the effectiveness of depleted uranium tank armor was never tested on the field of battle.[10] Iraq did not have DU armor or munitions in its inventory.[11]

Amidst post-war hype over the success of expensive, high-tech weaponry, depleted uranium weapons received surprisingly little public praise from Pentagon and U.S. defense industry officials. A possible motivation for this cautious silence is expressed in pre-war U.S. Army reports which warned the use of DU weapons could have severe health and environmental consequences and create "adverse international reaction."[12] However, post-war reports have promoted a policy of "proponency" to guarantee the unrestricted use and proliferation of depleted uranium weapons. The Pentagon's focus on proponency has forestalled investigation and research of illnesses among veterans of the American-led expeditionary force and populations in southern Iraq possibly related to exposure to depleted uranium.

The lessons of the use of depleted uranium weapons in the Gulf War are unsettling, but understanding them will enable us to prevent or minimize the effects of depleted uranium weapons in the future.

LESSON 1

Depleted uranium weapons contaminate impact areas with extremely fine radioactive and toxic dust.

U.S. Army testing found that 18 to 70% of a depleted uranium penetrator rod burns and oxidizes into extremely small particles during impact.[13] The impact of one 120mm depleted uranium penetrator fired from an American Abrams tank therefore creates between 900 and 3,400 grams (roughly 2 to 7 pounds) of uranium oxide dust. U.S. Army testing further found "[t]he DU oxide aerosol formed during the impact of DU into armor has a high percentage of respirable size particles (50 to 96%)," and 52 to 83% of those respirable size particles are insoluble in lung fluids.[14] Respirable size particles (less than 5 microns in diameter) are easily inhaled or ingested. Insoluble particles are not readily excreted from the body, and may remain in the lungs or other organs for years.[15]

U.S. Army research recently found that some respirable size uranium dust remains suspended in the air for hours after an impact.[16] As demonstrated in the 1970's by the release of depleted uranium during the manufacture of DU ammunition near Albany, New York, depleted uranium dust can be carried downwind for 40 kilometers (25 miles) or more.[17] Most of the dust created by an impact comes to rest

inside, on, or within 50 meters of the target. However, U.S. Army testing also discovered depleted uranium dust can be resuspended by the wind, or the movement of people and vehicles.[18]

The long-term dangers of depleted uranium contamination are discussed in a U.S. Army Chemical School training manual:

"DU's mobility in water is due to how easily it dissolves. Soluble compounds of DU will readily dissolve and migrate with surface or ground water. Drinking or washing or other contact with contaminated water will spread the contamination . . . The end result of air and water contamination is that DU is deposited in the soil. Once in the soil, it stays there unless moved. This means that the area remains contaminated, and will not decontaminate itself."[19]

No cleanup of depleted uranium in the soil has taken place in Iraq or Kuwait. Surprisingly, the U.S. Department of Defense claims it tested soil in Kuwait and found no presence of depleted uranium contamination.[20] However, in 1995 and 1997, documentary film teams detected depleted uranium contamination on destroyed vehicles and in the soil in southern Iraq.[21]

In addition to the fine uranium dust created by impacts, depleted uranium fragments and intact DU penetrators also pose a hazard. In March, 1991, an internal U.S. Defense Nuclear Agency memorandum noted: "Alpha particles (uranium oxide dust) from expended rounds is a health concern but Beta particles from fragments and intact rounds is a serious health threat, with a possible exposure rate of 200 millirads per hour on contact."[22] One depleted uranium penetrator found in April, 1991 at the Port of Dammam, Saudi Arabia had a radiation reading of 260-270 mrad/hour.[23] The corrosion rate for a DU penetrator in soil depends upon the chemical makeup of the soil and other environmental conditions. Weathered DU penetrators principally corrode into uranium dust that is soluble in water.[24]

Established limits on intake of depleted uranium dust attest that just a small amount poses a serious health threat. The limit for intake by an occupational worker has been set at 0.01 gram/one week (U.S. Nuclear Regulatory Commission) and 0.008 gram/one year (UK Ministry of Defense). The limit on intake for a member of the public is set at 0.002 gram/one year (UK Atomic Energy Authority).[25]

The route of depleted uranium in the body depends upon the method of exposure (inhalation, ingestion, implantation, or wound contamination), and the size and solubility of the particles. Recent research found depleted uranium particles may remain in the lungs if inhaled, or travel in the bloodstream and deposit in the brain, kidney, bone, reproductive organs, muscle and spleen.[26] Insoluble depleted uranium particles (up to 83% by volume of the total dust created by an impact), if inhaled, "pose primarily a radiological, as opposed to a chemical, toxicological hazard."[27] In 1997, depleted uranium was found in the semen of five out of twenty two American veterans who had been wounded by depleted uranium fragments in 1991.[28]

Though additional studies on depleted uranium's health effects are needed, internalized DU is acknowledged to cause kidney damage, cancers of the lung and bone, non-malignant respiratory disease, skin disorders, neurocognitive disorders, chromosomal damage, and birth defects.[29] A July, 1990 report from the U.S. Army Armament, Munitions, and Chemical Command notes depleted uranium is a "low level alpha radiation emitter which is linked to cancer when exposures are internal, [and] chemical toxicity causing kidney damage."[30] In August, 1993, the U.S. Army Surgeon General's Office confirmed the "[e]xpected physiological effects from exposure to DU dust include possible increased risk of cancer (lung or bone) and kidney damage."[31] A June, 1995 U.S. Army Environmental Policy Institute report adds: "The radiation dose to critical organs depends upon the amount of time that DU resides in the organs. When this value is known or estimated, cancer and hereditary risk estimates can be

determined."[32]

The end result of the use of depleted uranium weapons is contamination of damaged equipment and the environment with dangerous levels of depleted uranium dust and debris. Respirable size particles formed during impacts and soluble uranium oxide dust formed by corroding penetrators may be transported by the wind or water, and may contaminate food and water supplies. Friend and foe alike may inhale or ingest depleted uranium dust and suffer severe short and long term health problems.

LESSON 2

Armed forces are unlikely to be protected from exposure to depleted uranium contamination.

As far back as 1974 - seventeen years before depleted uranium weapons were used in the Gulf War - a U.S. Department of Defense study group predicted: "In combat situations involving the widespread use of DU munitions, the potential for inhalation, ingestion, or implantation of DU compounds may be locally significant."[33] In July, 1990, a U.S. Army contractor further warned: "Aerosol DU exposures to soldiers on the battlefield could be significant with potential radiological and toxicological effects . . . Under combat conditions, the MEI's [most exposed individuals] are probably the ground troops that re-enter a battlefield following the exchange of armor-piercing munitions, either on foot or motorized transports."[34]

Despite the blunt admonitions of pre-war U.S. Army reports, no warnings about the dangers of depleted uranium were provided to the U.S. and coalition forces expected to encounter DU contamination on Gulf War battlefields. Combatants and support personnel were not informed of the need to check soldiers' wounds for depleted uranium contamination, or told of the requirement to don full protective suits during contact with contaminated equipment and soil.[35] In violation of operative U.S. Army and U.S. Nuclear Regulatory Commission regulations, no medical testing or follow-up was provided to soldiers who were wounded by depleted uranium fragments, or who may have inhaled or ingested DU dust.

Though American military commanders have never offered an explanation for their failure to warn troops about the hazards of depleted uranium weapons, it appears their inaction was inspired by a desire to avoid creating concern within the ranks and among the public. After a 1992 inquiry, U.S. General Accounting Office investigators reported that "[U.S.] Army officials believe that DU protective methods can be ignored during battle and other life-threatening situations because DU-related health risks are greatly outweighed by the risks of combat."[36] When it became clear U.S. military commanders disregarded all DU protective methods during and after the Gulf War, the U.S. Army Environmental Policy Institute expressed concern about the costs of providing medical care to exposed veterans: "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."[37]

In January, 1998, the U.S. Department of Defense expressed its first and only admission of responsibility for Gulf War depleted uranium exposures:

"Our investigations into potential health hazards of depleted uranium point to serious deficiencies in what our troops understood about the health effects DU posed on the battlefield . . . Combat troops or those carrying out support functions generally did not know that DU contaminated equipment, such as enemy vehicles struck by DU rounds, required special handling . . . The failure to properly disseminate such information to troops at all levels may have resulted in thousands of unnecessary exposures."[38]

A map released by the U.S. Department of Defense in November, 1998 shows both the primary areas where depleted uranium was released during the Gulf War, and the movements of hundreds of thousands of American and coalition fighting forces through these contaminated areas.[39] Though the U.S. Department of Defense admits "thousands" of American forces may have been unnecessarily exposed to depleted uranium contamination, it also asserts that not even one American veteran could possibly be sick from a depleted uranium exposure.[40]

The case of the July, 1991 munitions fire at the U.S. Army base in Doha, Kuwait illustrates the hazards of accidental releases of depleted uranium. Among the large quantity of equipment and munitions destroyed in the twenty-four hour fire were 660 tank rounds containing 3,200 kg (7,000 lbs) of depleted uranium. While the fire raged, the U.S. Central Command acknowledged that "burning depleted uranium puts off alpha radiation. Uranium particles when breathed can be hazardous. 11ACR [The U.S. Army command at Doha] has been informed to treat the area as though it were a chemical area, i.e. stay upwind and wear protective mask in the vicinity."[41] Despite this and other warnings, U.S. soldiers were not informed of DU's hazards or instructed to wear protective gear, even during post-fire cleanup operations.[42] Further, the smoke from the fire drifted toward nearby Kuwait City, potentially exposing downwind populations to airborne depleted uranium.[43]

Adequately protecting armed forces from exposure to depleted uranium contamination requires training, use of protective suits in a contaminated environment, and distribution of radiation detection devices to medical personnel. Unfortunately, since cancers and other health problems related to a depleted uranium exposure may not develop until after a battle or war is over, military commanders have little incentive to adhere to safety procedures which could impinge on a soldier or Marine's battlefield performance. The Gulf War proved that military commanders will not be held accountable for the uncontrolled release of a radioactive and toxic waste, or for violating safety regulations requiring medical testing and care of exposed troops.

The 1991 Gulf War demonstrated that members of armed forces are unlikely to receive adequate protection from exposure to depleted uranium during or after future conflicts or accidental releases. In addition, governments are unlikely to provide long-term medical care for depleted uranium-related health problems among war veterans.

LESSON 3

Local civilian populations are unlikely to be warned when depleted uranium weapons are used - even if depleted uranium contaminates their food or water supplies.

Prior to the Gulf War, the U.S. Army was aware of the potential for depleted uranium contamination to cause health problems among civilian populations. However, during and after the Gulf War, the U.S. Department of Defense took no steps to warn the inhabitants of Kuwait, Saudi Arabia and Iraq about depleted uranium contamination on their lands. In contrast, U.S. Army reports express more concern about public outcry and future restrictions on the use of depleted uranium weapons than with contaminating foreign lands and poisoning civilians.

A July, 1990 U.S. Army report predicted: "Following combat, the condition of the battlefield, and the long-term health risks to natives and combat veterans may become issues in the acceptability of the continued use of DU kinetic energy penetrators for military applications."[44] This concern was reiterated in March, 1991 just as the war was ending: "There has been and continues to be a concern

regarding the impact of DU on the environment. Therefore, if no one makes a case for the effectiveness of DU on the battlefield, DU rounds may become politically unacceptable and thus, be deleted from the arsenal . . . I believe we should keep this sensitive issue at mind when after action reports are written."[45]

Once hostilities subsided and the scale of the depleted uranium contamination in southern Iraq and Kuwait became known, further concern was expressed by the U.S. Defense Nuclear Agency: "As Explosive Ordnance Disposal (EOD), ground combat units, and the civil populations of Saudi Arabia, Kuwait, and Iraq come increasingly into contact with DU ordnance, we must prepare to deal with the potential problems. Toxic war souvenirs, political furor, and post conflict clean-up (host nation agreement) are only some of the issues that must be addressed."[46]

In April, 1991, the United Kingdom Atomic Energy Authority also expressed concern about depleted uranium contamination in Kuwait:

"It would be unwise for people to stay close to large quantities of DU for long periods and this would obviously be of concern to the local population if they collect this heavy metal and keep it. There will be specific areas in which many rounds will have been fired where localized contamination of vehicles and the soil may exceed permissible limits and these could be hazardous to both clean up teams and the local population. . .Furthermore, if DU gets into the food chain or water then this will create potential health problems."[47]

Potential political problems were also noted:

"The whole issue of contamination in Kuwait is emotive and thus must be dealt with in a sensitive manner. It is necessary to inform the Kuwait Government of the problem in a tactful way and this . . . is probably best done in conjunction with the UK Ambassador to Kuwait."[48]

The United States established a precedent during the Gulf War which permits an armed force to use depleted uranium weapons without warning civilian populations about contamination of the land. The United States is continuing this practice in the Kosovo war. Nations involved in conflicts in which depleted uranium weapons are used may find themselves faced with the "excessive" costs of long-term health care for exposed soldiers and civilians. The health and environmental consequences of depleted uranium weapons will likely receive less attention in nations where the populations are unaware of its use, or unable to voice their concerns and assert their rights.

LESSON 4

Depleted uranium weapons are proliferating and are likely to become commonly used in land warfare.

A 1995 U.S. Army Chemical School training manual notes: "The United States' success with using DU in combat leads us to conclude that other nations, not all of them friendly, will be using DU in the future."[49] Further, "it is likely that DU may also become the primary tank-killing munition for our potential enemies . . . in the next battle, potentially all stricken tanks or fighting vehicles will possibly contain DU contamination."[50]

Another 1995 U.S. Army report 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."[51] American soldiers and Marines are likely to be among the DU patients on future battlefields, as noted in a 1998 U.S. Department of Defense report: "DU's battlefield effectiveness has encouraged its steady proliferation into the arsenals of allies and adversaries alike. There is little doubt, therefore, that DU will be used against our troops in some future conflict."[52]

Since 1991, the United States has led the world in using and proliferating depleted uranium weapons. After Operation Desert Storm, the U.S. started using depleted uranium rounds in the M2 and M3 Bradley Fighting Vehicles (25mm), the Light Amphibious Vehicle (25mm), the Apache attack helicopter (30mm), and the AH-1W "Whiskey Cobra" helicopter gunship (20mm). In 1994 and 1995, American fighter planes fired depleted uranium rounds against Serb targets in Bosnia, and during training near Okinawa, Japan.[53]

In April, 1999, the US Department of Defense would neither confirm nor deny the use of depleted uranium ammunition by the A-10 aircraft in Kosovo.[54] Interestingly, however, the US Army stated the Apache helicopter would not fire depleted uranium rounds because their analysts determined high explosive rounds were sufficient to destroy Serb tanks.[55] Increased public and media interest in the use of DU weapons in the Kosovo war has evidently forced military commanders to reconsider their use of depleted uranium ammunition.

The growing list of nations possessing or manufacturing depleted uranium weapons includes the United States, the United Kingdom, France, Russia, Greece, Turkey, Israel, Saudi Arabia, Kuwait, Bahrain, Egypt, Thailand, Taiwan and Pakistan.[56] The `interoperability' of NATO military forces could also enable armed forces throughout Europe to obtain and use depleted uranium weapons.

With little discussion or fanfare, depleted uranium weapons have found their way into the arsenals of nations powerful and poor in some of the world's most volatile regions. The U.S. Department of Defense anticipates the use of depleted uranium weapons in future conflicts, and increasing numbers of depleted uranium exposures among friend and foe alike. Long after the guns fall silent and the survivors march home, the casualties and costs of using depleted uranium weapons will continue to mount.

LESSON 5

Depleted uranium contamination is unlikely to be cleaned up by victor or vanquished because of the extreme cost and the prospect of further environmental damage.

As noted by the U.S. Army, "[DU] contaminated soil . . . should be scraped up and containerized for removal as radioactive waste."[57] This is the procedure used in the United States during cleanup of depleted uranium contamination at the Starmet plant in Concord, Massachusetts (where DU penetrators are manufactured), and at Sandia National Laboratory and Kirkland Air Force Base in New Mexico (where DU penetrators were test fired).[58]

The U.S. Army states cleanup involves removing "the top layer of soil,"[59] which could be potentially devastating to an environment, especially if depleted uranium contaminates arable land or wetlands. Further, the cost involved in removing the topsoil from contaminated areas could be astronomical. As an example, the cost of cleaning up and disposing of the estimated 69,000 kg (152,000 lbs) of depleted uranium dust and debris on 200 hectares (500 acres) of the U.S. Army's Jefferson Proving Ground in

Indiana has been placed at $4 to 5 billion (U.S.$).[60] The cost of cleaning up 290,000 kg (640,000 lbs) of depleted uranium on thousands of hectares in Saudi Arabia, Kuwait, and Iraq could therefore easily be tens of billions of dollars (U.S.$).

A July, 1990 U.S. Army report warned: "Assuming U.S. regulatory standards and health physics practices are followed, it is likely that some form of remedial action will be required in a DU post-combat environment."[61] However, once the scale and cost of cleaning up depleted uranium in the Persian Gulf region became clear, the U.S. Army Environmental Policy Institute informed American policymakers that "no international law, treaty, regulation, or custom requires the United States to remediate the Persian Gulf War battlefields."[62] As the most powerful nation in the world today, the United States established a standard of behavior in the Gulf War which allows nations and armed forces to use depleted uranium weapons without taking any responsibility for cleanup, environmental restoration, or provision of health care to exposed combatants or civilians.

In the last hundred years since the first The Hague conference, the devastating results of war have been multiplied in proportion to the increased mobility of armed forces, and the unparalleled destructiveness of the weapons used. In the conflicts of the next century and beyond, huge expanses of land and countless numbers of soldiers and civilians may be poisoned by radioactive and toxic waste shot from armored vehicles, aircraft, small arms, and ships. Depleted uranium weapons are the offspring of nuclear weapons, and the newest weapon capable of causing mass destruction. If the international community accepts the use of depleted uranium weapons in warfare, it must also accept the moral obligation to fully address the health and environmental consequences, regardless of the cost.

References

1. "Environmental Exposure Report: Depleted Uranium in the Gulf;" Office of the Special Assistant for Gulf War Illnesses, U.S. Department of Defense; July 31, 1998; Tab F - DU use in the Gulf War.

2. Health and Environmental Consequences (ref. 2)

3. Health and Environmental Consequences of Depleted Uranium use in the U.S. Army; U.S. Army Environmental Policy Institute; June, 1995; p. 154.

4. Development of Depleted Uranium Training Support Packages: Tier I -General Audience; U.S. Army Chemical School; October, 1995; p. 21. See also Kinetic Energy Penetrator Long Term Strategy Study (Abridged); U.S. Army Armament, Munitions, and Chemical Command Task Force; July 24, 1990; Chapter III.

5. Kinetic Energy Penetrator Environmental and Health Considerations (Abridged); Science Applications International Corporation (SAIC); July, 1990; Vol. 2, 2-4.

6. U.S. Army tanks fired 504 105mm and 9,048 120mm rounds; UK armed forces fired less than 100 120mm rounds; the number of DU rounds fired by U.S. Marine Corps tanks is not known. "Response to Questions from Mr. Dan Fahey;" letter from Bernard Rostker, Special Assistant to the Secretary of Defense for Gulf War Illness; Nov. 4, 1997; p. 1 - 2. "Technical Response to FOIA Case Number 97-F-1524, Question Eleven;" Office of the Assistant Secretary of Defense; February 11, 1998.

7. U.S. Air Force A-10 aircraft fired 783,514 30mm DU rounds; U.S. Marine Corps AV-8B Harrier jets fired 67,436 25mm rounds. Ibid.

8. Several American snipers had reported they used depleted uranium rounds during the Gulf War. During a September 28, 1998 meeting of the U.S. Presidential Special Oversight Board, Jeff Prather from the Office of the Special Assistant on Gulf War Illnesses confirmed the use of 7.62mm depleted uranium rounds during the war, but stated he had seen no information confirming the use of .50 caliber depleted uranium rounds. In July, 1998, the U.S. Department of Defense confirmed: "[U.S.] Army Special Forces also use small caliber DU ammunition on a limited basis;" Office of the Special Assistant for Gulf War Illnesses; "Environmental Exposure Report";(ref. 1)

9. Of the 2,054 American tanks used in combat, 654 had depleted uranium added to their armor. Conduct of the Persian Gulf War: Final Report to Congress; U.S. Department of Defense; April, 1992; p. 750.

10. Health and Environmental Consequences (ref. 2), p.76

11. "Environmental Exposure Report" (ref. 1) p. 69. Operation Desert Storm: Army Not Adequately Prepared to Deal With Depleted Uranium Contamination; U.S. General Accounting Office; GAO/NSIAD-93-90; January, 1993; p. 14.

12. Kinetic Energy Penetrator Environmental and Health Considerations (Abridged); Science Applications International Corporation (SAIC); July, 1990; Vol. 1, 2-5.

13. "Summation of ARDEC Test Data Pertaining to the Oxidation of Depleted Uranium During Battlefield Conditions;" U.S. Army Armament Research, Development, and Engineering Center (ARDEC); 8 March 1991; p. 2. Health and Environmental Consequences (ref. 3),p. 78.

14. "Summation of ARDEC Test Data Pertaining to the Oxidation of Depleted Uranium During Battlefield Conditions;" U.S. Army Armament Research, Development, and Engineering Center (ARDEC); 8 March 1991; p. 2.

15. "Environmental Exposure Report" (ref. 1), p. 13.

16. "Environmental Exposure Report" (ref. 1), p. 157.

17. "Colonie Uranium Plant Closes as Radiation Continues Unchecked;" The Schenectady Gazette; February 6, 1980.

18. Development of Depleted Uranium Training Support Packages (ref. 4),p. 28. "Environmental Exposure Report (ref. 1), p. 157.

19. Development of Depleted Uranium Training Support Packages(ref. 2) p. 28.

20. Rostker, Bernard; Special Assistant on Gulf War Illnesses; testimony to the U.S. Presidential Special Oversight Board; Washington, DC; November 19, 1998.

21. "Riding the Storm", ITN TV, United Kingdom, aired January 3, 1996 in the UK. "Desert Storm's Deadly Bullet", Gabriel Films (New York) and BBC (UK), aired November 8, 1997 in the USA.

22. "Depleted Uranium (DU) Ammunition;" Lt. Col. Gregory Lyle, U.S. Defense Nuclear Agency; March, 1991.

23. "Radiation Protection;" Memorandum for Commander, 22nd Support Command, Department of the Army; 20 April 1991.

24. Health and Environmental Consequences (ref 3), p. 141.

25. U.S. Code of Federal Regulations, Standards for Protection Against Radiation., 1997. 10 CFR 20.1502(b), Subpart F - Surveys and Monitoring, and 10CFR 20.1206(c)(1)(2)(3), Subpart C - Occupational Dose Limits. Also UK Ministry of Defense, The Lord Gilbert's Answer to the Coutness of Mar, March 2, 1998. Also "Kuwait - Depleted Uranium Contamination." UK Atomic Energy Authority, April 30, 1991.

26. Federally Sponsored Research on Persian Gulf Veterans' Illnesses; Annual Report to Congress of the Research Working Group of the Persian Gulf Veterans Coordinating Board; April, 1997; p. A-64.

27. "Summation of ARDEC Test Data Pertaining to the Oxidation of Depleted Uranium During Battlefield Conditions;" U.S. Army Armament Research, Development, and Engineering Center (ARDEC); 8 March 1991; p. 1.

28. McDiarmid, Dr. Melissa; Transcript of March 25, 1998 VA/DoD teleconference on the DU Program.

29. Encyclopaedia of Occupational Health and Safety; 3rd Edition, Vol. 2; 1991; p. 2238. Development of Depleted Uranium Training Support Packages (ref 4),p. B-5. Assessment of the Risks from Imbedded Depleted Uranium Fragments; Armed Forces Radiobiology Research Institute; Lt. Col. Eric Daxon and Capt. Jeffrey Musk; March 25, 1992; p. 3 - 4. "Minutes of Meeting, November 17 and 18, 1997;" Department of Veterans Affairs Gulf War Expert Scientific Advisory Committee. Public Health Statement: Uranium; US Agency for Toxic Substances and Disease Registry; December 1990. "HHIN Responds to Questions on Radioactive Materials and Health"; Hazardous Substances and Public Health; US Agency for Toxic Substances and Disease Registry; Spring 1998; Part I

30. Kinetic Energy Penetrator Environmental and Health Considerations (Abridged); Science Applications International Corporation (SAIC); July, 1990; Vol. 1, 2-2.

31. "Depleted Uranium Safety Training;" Memorandum for Headquarters, U.S. Army Chemical School from Col. Robert G. Claypool, Director, Professional Services, Army Surgeon General's Office; August 16, 1993.

32. Health and Environmental Consequences, p. 108.

33. Medical and Environmental Evaluation of Depleted Uranium; Ad Hoc Working Group on Depleted Uranium of the Joint Technical Coordinating Group for Munitions Effectiveness; April, 1974; p. ix.

34. Kinetic Energy Penetrator Environmental and Health Considerations (Abridged); Science Applications International Corporation (SAIC); July, 1990; Vol. 1, 4-5; Vol. 2, 3-4.

35. Development of Depleted Uranium Training Support Packages(ref 4), p. B-10. Nuclear, Biological, and Chemical (NBC) Vulnerability Analysis; U.S. Army Field Manual 3-14; U.S. Army Chemical School; July 1, 1996.

36. Operation Desert Storm: Army Not Adequately Prepared to Deal With Depleted Uranium

Contamination; U.S. General Accounting Office; GAO/NSIAD-93-90; January, 1993; p. 4.

37. Health and Environmental Consequences , (ref 2),p. 4.

38. Annual Report of the Office of the Special Assistant to the Deputy Secretary of Defense for Gulf War Illnesses; January 8, 1998; p. 29.

39. "Primary Areas of DU Expenditure;" map released by U.S. Department of Defense; November 19, 1998.

40. Rostker, Bernard, Special Assistant to the Deputy Secretary of Defense for Gulf War Illnesses (U.S.); remarks at the American Legion Washington Conference, Washington, DC, March 23, 1998. "Environmental Exposure Report" (ref 1),p. 44.

41. "11 ACR Fire in Doha: Updates from CENTCOM Forward;" U.S. Central Command Log. July 12, 1991, entry 10.

42. See Fahey, Dan, Case Narrative: Depleted Uranium Exposures. September 20, 1998 (3rd Edition), "Personnel present at the July, 1991 fire at Doha, Kuwait," pp. 137-142.

43. "Environmental Exposure Report" (ref. 1), p. 99.

44. Kinetic Energy Penetrator Environmental and Health Considerations (Abridged); Science Applications International Corporation (SAIC); July, 1990; Vol. 2, 3-4.

45. "The Effectiveness of Depleted Uranium Penetrators;" Los Alamos National Laboratory memorandum; Lt. Col. M.V. Ziehmn; March 1, 1991.

46. "Depleted Uranium (DU) Ammunition;" Lt. Col. Gregory Lyle; Defense Nuclear Agency; March, 1991.

47. "Kuwait - Depleted Uranium Contamination," United Kingdom Atomic Energy Authority. April 30, 1991.

48. Ibid.

49. Development of Depleted Uranium Training Support Packages(ref 4), p. 9.

50. Ibid.; p. 37.

51. Health and Environmental Consequences (ref 3), p. 119-120.

52. "Environmental Exposure Report" (ref 1), pp. 5-6.

53. "NATO warplanes blast Serb targets;" Press-Republican; August 6, 1994. Ammunition Produced from Depleted Uranium; D. Ristic et. al.; December 8, 1997. "Uranium bullets fired on Okinawa;" San Francisco Examiner; February 11, 1997.

54. Telephone conversation with Margaret Gidding, US Air Force public affairs, April 8, 1999.

55. Telephone conversation with Lt. Col. Bill Whellehan, US Army public affairs, Weapons and Environment division, April 7, 1999.

56. Health and Environmental Consequences, (ref 2), p. A-11. "Desert Storm's Deadly Bullet;" Gabriel Films (usA) and BBC (UK); aired November 8, 1997 in USA.

57. Guidelines for Safe Response to Handling, Storage, and Transportation Accidents Involving Army Tank Munitions and Armor Which Contain Depleted Uranium; TB 9-1300-278; Headquarters, Department of the U.S. Army. September, 1990, p. 7-3.

58. "Starmet cleanup proceeds on target," The Concord (MA) Journal; Richard Fahlander; October 2, 1997. "Sandia says nearly all uranium-tainted sites cleaned;" The Albuquerque (NM) Tribune; Brent Hunsberger; June 10, 1995.

59. Guidelines for Safe Response to Handling, Storage, and Transportation Accidents Involving Army Tank Munitions and Armor Which Contain Depleted Uranium; TB 9-1300-278; Headquarters, Department of the U.S. Army. September, 1990, p. 4-4.

60. Kinetic Energy Penetrator Environmental and Health Considerations , (ref 5), 9-1. Health and Environmental Consequences (ref 2), p. 47. Shelton, Dr. Stephen, University of New Mexico; Testimony to the (U.S.) Presidential Advisory Committee on Gulf War Veterans' Illnesses; Denver, CO; August 6, 1996.

61. Kinetic Energy Penetrator Environmental and Health Considerations (ref 2 for 4), 4-6.

Contact: Dan Fahey, c/o Swords to Plowshares, 1063 Market Street, San Francisco, CA 94130, USA; tel +1-415-252-4788, fax +1-415-252-4790, email: duweapons@hotmail.com