THE ENVIRONMENTAL AND HEALTH EFFECTS OF DEPLOYMENT OF DEPLETED URANIUM (DU) DURING 1991 BY US AND UK ARMIES IN IRAQ

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This report is an account of the environmental and health effects of the deployment of depleted uranium (DU) ammunitions by the US and the UK armies against military and civilian Iraqi targets during 1991.

What is uranium?

There are three isotopes of uranium present in nature. They are uranium-238, uranium-235 and uraniu 234. There abundance in nature are 99.28, 0.71 and 0.0058%, respectively.

What is depleted uranium (DU)?

Depleted uranium is a nuclear waste accumulated as a result of enrichment of uranium to produce nuclea reactor fuels and for manufacturing nuclear weapons. The enrichment process produces uranium that contains between 2-90% uranium-235 as compared to the contents of 0.71% present in nature. The reminder uranium contains between 0.2 to 0.3% uranium-235 and between 99.7 to 99.8% uraníum-238, which is considered as nuclear waste.

Thousands of tons of DU were accumulated in the industrial countries, specially in the United States. Although depleted uranium can be used for certain purposes such as manufacturing of radiation shields, counterweight in airplanes, and some other peaceful uses, it was used extensively for manufacturing army ammunitions specially against armored vehicles due to its high density which makes it penetrate the armo shield easily; - its pyrophoric property which ignites the vapors and ammunitions inside the targets that were hit; and its cheapness, since it's a nuclear waste.

What is the problem?

The problem started even before the start of military activities in the Gulf Ground War during 1991. Th US Army had fired thousands of DU round during maneuvering in Saudi Arabia before the war. Americar solders were not aware of the dangers of exposure to DU. Furthermore, their commanders did not tell the about the deployment of DU ammunitions. Thus, they were careless in dealing with the contamination created after DU ammunitions hit their targets.

What had happened to the soldiers?

There are many weapons systems in the US and UK armies arsenals that uses DU ammunitions (see Table 1). Abrams tanks were equipped with DU rounds (penetrators). A-10 airplanes and M1 Abrams tanks fired thousands of DU rounds. These rounds hit their targets, and on impact very high temperature generated which caused the fragmentation of the rounds to many particles of various sizes. The oxygen tl is present in air oxidized the fragments to uranium oxides mainly U_3O_8, UO_2 and UO_3 of depleted uranium Depleted uranium dust was also generated. The destroyed targets as well as nearby soil was contaminate heavily with depleted uranium. Solders of both sides of the conflict inhaled, ingested depleted uranium. Some solders had open wounds contaminated with DU, or have DU fragments embedded in their bodies. Thus, they were exposed to DU and experienced some health problems later on.

What had happened to the civilian population?

The war battlefields covered thousands of square kilometers both in Iraq and Kuwait. This area was littered with vehicles and equipment destroyed with DU ammunitions. The destroyed objects play an

important rule in spreading radioactive contamination to other populated areas due to environmental facto Furthermore, it was reported that a fire had happened in Al-Doha American army base in Kuwait in the 1 of July 1991 which consumed a lot of DU ammunition and Abrams tanks with a DU shield. This created immense radioactive contamination smoke and aerosols generated by the fire. This contamination was transported in air towards Kuwait City because it was downwind from the site of the fire, which lasted almost one day.

The residence living in the southern part of Iraq, Kuwait and Saudi Arabia were exposed and continued t be exposed to the radioactive contamination created by the deployment of DU ammunitions by UK armie and US. Many of the American and British solders that served in the Gulf Region during 1991 are experiencing health problem related to their service. Furthermore, it's excepted that DU exposure might b involved in these heath problems. The remainder of this report will be concerned with the environment a health effects in Iraq.

Depleted contamination in Iraq

Depleted uranium environmental contamination in Iraq was detected for the first time in 1993. Exposur rate measurements in the southern region of Iraq had indicated a sharp increase in ambient gamma radiatio recorder before 1991. This value was about 6.5 microR.h^{-1} reported for Al-Basra Governorate. The value recorded near a destroyed Iraqi tank in 1993 was 21 microR.h^{-1} Gamma spectrometric analysis of a soil sample obtained from that location had indicated the presence of very high concentration of radio nuclides the uranium-238 series such as Th-234, Pa-234 and Ra-226. Data analysis proved that the source of contamination was depleted uranium. Table 2 represents exposure rates measured before 1991 and in late dates starting in 1993. The elevation of exposure rates was due mainly to the presence of radio nuclides c the uranium-238 series (Figure 1). The concentration of these radio nuclides in ordinary soil samples (not contaminated with DU) and DU contaminated soil samples are presented in table 3. The most important radioactive contaminant present is Ra-226 because of its long half-life (1620 year) and its deposition in bones (a bone seeker).

Environmental pathways

As we mentioned earlier in this text, some of the DU contamination would be present as small particles uranium dust and aerosols. These particles are present as contaminants and can be transported through th environment and exposed people through many exposure pathways such as those presented in Figure 2. V can observe that both external exposure and internal exposures could occur. The external exposure could result from gamma radiation emitted from some radio nuclides in the uranium-238 series and uraniun-235 series. The internal exposure could result from ingestion of radio nuclides that contaminated the environn either that they reach the plants through root uptake or from contaminated meat or other animal products that became contaminated through ingestion of contaminated pasture or forage. The aquatic system might also become contaminated through floods or water runoff. The population could also be exposed internal through drinking of water or ingestion of fish or shellfish that present in AI-Basra surface water. Howeve contamination of ground water would not be a problem at this time.

Radiation doses

The exposure to radio nuclides causes radiation doses to the population. The extent of these doses depends on the degree of contamination of different environmental sectors and on the habits of the individuals in the population. Thus, its of vital importance to estimate radiation doses through all exposu pathways. This practice involve the utilization immense site specific information such as land use, water use, food habits of the population and mathematical models used to relate radioactivity to radiation doses

Health effects

It is widely accepted in the scientific community that the effects of low doses of ionizing radiation are linear non-thresholds. This means that any radiation dose, no matter how small it is, could cause health effects. These health effects are either somatic, such as induction of cancer, and heredity effects, that cau health problems to the offspring of the exposed parents. These health effects were very well documented for exposed individuals such as survivors of the atomic bombing of the cities Hiroshima and Nagasaki in Japan during 1945. As for induction of cancers, it is known that some kind of cancers appears after relatively a short time after exposure. For instance, leukemia appears 2-3 years after exposure. However some solid cancers take about 30-40 years to appear after exposure to low doses of ionizing radiation.

Thus, one should estimate radiation doses to the population due to all exposure pathways of the environmental contamination with DU. The resulting doses could be related to health effects that appear the exposed population.

Conclusions

The above discussion is based on what is known scientifically in the literature about the dispersion of radioactive pollutants in the environment and their possible effects in man. The contamination of the southern region of Iraq is also an established fact, which is based on field survey and gamma spectrometri analysis of environmental samples using an internationally accepted methodology. Very high concentrati of some radio nuclides of the uranium-238 series such ad thorium-234, protactinium-234 and radium-226 were detected in environmental samples obtained from the southern part of Iraq.

Dose assessment based on the extent of environmental; contamination with uranium-238 decay product proved that many individuals in the population would receive very high radiation doses especially throug inhalation of resuspended radio nuclides present as contaminants in soil. The presence o high levels of Ra 226 in soil samples creates a dangerous problem because of its long half-life (1620 years), and its metabol in the body which leads to its deposition in bones. Furthermore, radium-226 decays to radon-222 gas. T short-lived decay products of radon-222 causes very high dose especially to the lung.

Since DU was used for the first time in history in an open environment in Iraq, we could not find any report dealing with environmental contamination with DU. The reports that were published by different authors and organizations have did not mentioned the effects of radium-226 contamination when dealing v DU contamination and its effects on the population. Furthermore, we have detected high levels of uraniu 235 and some of its decay products in the environmental samples that we have analyzed. Although the concentration of uranium-235 in depleted uranium is (0.2-0.3%) which is less than its concentration in nat (0.71%). This discrepancy could be explained by the fact that uraniurn-238 was present in very high concentration in some environmental samples is compared to its concentration in normal soil samples.

Thus, it appears that radiation doses were underestimated various groups or individuals due to the fact that they have not taken into account radium-226 and its decay products and uranium-235 and its decay products. The reevaluation of doses could lead to the conclusion that some people; especially solders cou be subjected to high radiation doses, which would be classified as acute exposure.

The number of cancer cases in Iraq has been increasing since 199l. There is a causative relation betweer this increase which is recorded by medical doctors, especially leukemia and radiation doses that the population of Iraq have received and still receiving from DU contamination. The British governments and US should compensate the victims of DU contamination and lift the sanctions against Iraq. Furthermore, they should take the responsibility to clean up the contaminated area not only in Iraq, but also in Kuwait and Saudi Arabia. The international community should also be involved in this effort.

Table I. Selected depleted uranium penetrators in the US arsenal, 1998.

Ammunition type	Weapon system	DU penetrators weight (pounds)
M829A2 Armor Piercing Fin Stabilized Discarding Sabot with Tracer (APFSDS-T) (120 mm)	MIAI, MIA2 Tanks	10.5
M900 (APFSDS-T) (105 mm)	M1, M60A3 Tanks	8.5
PGU-14 Armor-Piercing Incendiary (API) (30 mm)	A-10 Aircraft	0.67
M919 (APDS-T) (25 mm)	M2, M3 Bradley Vehicles	0.2
PGU/20 (API) (25 mm)	AV-8B Harrier Aircraft Light Amphibious Vehicle (LAV)	0.33
MK-149-2 (20 mm)	Phalanx CIWS missile defense gun	0.15

Table 2. Exposure rates microR per hour 1 m above the ground in selected locations

Location	Governorate	Exposure rate	Comment
		microR/h	
Al-Zafarania	Baghdad	7.1 ± 0.6	Normal background radiation
Al-Kifil	Babylon	6.9 ± 0.7	Normal background radiation
Al-Faw	Al-Basra	6.5 ± 0.6	Normal background radiation
Al-Rumiala	Al-Basra	41.3 ± 1.5	DU contamination
Demilitarízed zone	Al-Basra	35.4 ± 1.7	DU contamination
Jabal-Sanam	Al-Basra	32.4 ± 1.6	DU contaminatìon

Table 3. The activity concentration of radionuclides of the uranìwn-238 series

Location	Governerate	Activity concentration (Bq per kg)		Comments
		Th-234	Ra-226	
AI-Zafarania	Baghdad	BDL*	65.2 + 5.3	Normal background radiation
AI-Kifíl	Babylon	BDL	62.5 ± 7.2	Normal background radiation
Al-Faw	AI-Basra	BDL	59.8 ± 6.3	Normal background radiation
AI-Rumaila	AI-Basra	8500	2380 ± 130	DU contamination
Demilitarìzed Zone	AI-Basra	6200	1800±112	DU contamination
Jabal Sanam	AI-Basra	8700	2500±135	DU contamination

BDL = Below delection limits