ZDRAVOTNÍ A ENVIRONMENTÁLNÍ PROBLÉMY POUŽITÍ MUNICE S JÁDREM Z OCHUZENÉHO URANU

HEALTH AND ENVIRONMENTAL PROBLEMS OF USING ANTI-ARMOUR MUNITIONS CONTAINING DEPLETED URANIUM CORE

Jiří Matoušek

Masaryk University, Faculty of Science,
EU Research Centre of Excellence for Environmental Chemistry and Ecotoxicology,
Kamenice 126/ 3, CZ- 625 00 Brno, Czech Republic
matousek@recetox.muni.cz

ABSTRACT

In the 1970s**, c**ore of depleted uranium commenced to be introduced into the breakthrough antitank munitions of various calibres and types in order to considerably enhance their effectiveness due to extremely high density in comparison with steel. The health and environmental threats of using this munitions and other weaponry where depleted uranium has been utilised as counterbalance stem from the pyrophoric character of uranium, burnt due to material deformation and friction when penetrating armour targets creating thus highly respirable aerosol of uranium oxides that are deposited in alveoli after being inhaled or in other tissues after being ingested. Composition and main properties of depleted uranium are presented. Chronic effects of deposited particles of uranium oxides are due to internal irradiation of sensitive organs at proceeding radioactive decay accompanied with alpha-irradiation. Long-term internal irradiation by radionuclides producing alpha-rays leads to proved risk of increased incidence of carcinoma and leukaemia not to speak on chronic chemical toxicity of uranium, independent of its isotopic composition. Environmental impact of extensive use of munitions with depleted uranium in the recent armed conflicts is assessed.
Keywords: depleted uranium, antitank munitions, uranium oxides, toxicity, radiotoxicity

INTRODUCTION

Since the 1970s, a new trend in constructing anti-armour ammunition has been started. This was principally based on changing shape to introduce „arrow munitions“ with such a diminished mass, allowing significant increase of the mouth velocity and thus of the kinetic energy of penetrator in target. In order to enhance the effect in the target of previously known sub-calibre (or core) munitions, containing a stick made from hard steel with high density that itself carries kinetic energy for breakthrough, new materials for such penetrator with much higher density have been looked for. Beside tungstene, in some countries with nuclear programme, depleted uranium (DU), the by-product in the nuclear fuel cycle was found as suitable for the new anti-armour weapon technology mainly due to its high density and other mechanical properties.

Depleted uranium (DU) with the density of 19 x 10^3 $kg.m^{-3}$ contains about 0.2 - 0.4, in extreme cases up to 0.7 per cent of active isotope ^{235}U and a negligible amount of ^{234}U [1]. Radiological properties of a typical composition of DU are shown in the table 1.

PROBLEMS OF PROLIFERATION AND USE OF DEPLETED URANIUM

With the exception of manufacturing respective parts from DU and assembling munitions, there are actually no too serious health threats in handling and storing this weaponry but moderate risk exists even there as witnessed by the manual edited by Pentagon devoted to this matter [2]. On the other hand, main problems commence after munitions have been fired, mainly when striking target. Due to friction and material deformation, the DU munitions core (penetrator) burns when piercing and penetrating armour to the tiny highly respirable aerosol particles of uranium oxides (UO_2, UO_4, U_3O_8) dangerous for the risk connected with inhalation and ingestion of the particles that can be deposited in tissues and cause expected consequences due to chemical toxicity (mainly renal) and radiotoxicity, i.e. internal irradiation of internal organs by the daughter products of the radioactive decay [3,4]. In some cases, the “depleted uranium” contains traces of plutonium, witnessing that it does not originate from primary enrichment of natural uranium, but from reprocessing of used reactor fuel. In this case, consequently both chemical toxicity and radiotoxicity of inhaled or ingested aerosol particles increase. The threat by deposited aerosol particles might be compatible with other risks of war events in case of destroyed tanks and armoured combat vehicles, where the crews would be more seriously injured or killed due to other effects of that munitions, i.e. kinetic energy or/and fires, leading to the explosions of own munitions with such energy of blast totally destroying the combat vehicle even throwing out the tank turret. The aerosol plume of uranium oxides with particle size of 10^{-6} mm proceeds downwind and contaminates the close area to the distance of about hundred meters or more. On the other hand, projectiles missing armoured targets do not burn and they are buried in soil. These types of anti-armour munitions were used for the first time in the Arab – Israeli War (1974) and since this time, both vertical and horizontal proliferation of DU munitions has been proceeding very quickly. At present, beside NATO armies, there are about 40 possessors of DU munitions of about thirty various (original and modified) types and calibres, mainly for tank cannons containing DU in the kg order per grenade (100, 105, 120, 122 mm), for automatic cannons of combat aircraft and attack helicopters with about 300 g of DU per projectile (20, 25, 30 mm) and also in aerial bombs with terminal guidance [5]. DU is used also in missiles as counterbalance (e.g. in GLCM Tomahawk reportedly more than 400 kg [1]). The public will be perhaps surprised that DU is used even in bullets for small arms (7.62 and 5.56 mm).

Munitions containing DU was used in huge quantities in the armed conflicts of the 1990s. E.g. in the Persian Gulf War (1990-1991), according to the Pentagon data, only US troops used 315 t of DU. Due to use by other belligerents the estimates of the total amount reach up to 800 t. Similarly, as a result of the conflict on the Balkans (i.e. in Bosnia-Herzegovina in the mid-1990s and more recently in Kosovo crisis in 1999 and later), it has been reported on the *Balcan syndrome,* which is given into connection with the use of DU, because of enhanced occurrence of leukaemia among some NATO servicemen engaged in the ground operations. Since March 24 till June 8, 1999 altogether 35,000 NATO air raids against the whole Serbian territory were carried out using 1000 combat aircraft and 206 attack helicopters. Altogether 10,000 missiles were launched and 79,000 t of explosives employed including 152 cluster bombs. Frequent assaults were carried out against targets on the whole territory of Yugoslavia with aerial bombs GBU-28 and cruise missiles Tomahawk carrying huge amounts of DU. Considerable amount was used against armoured targets in the Serbian province Kosovo. The projectiles PGU-14B 30 mm to the automatic cannon GAU-8/A Avenger in combat aircraft A/OA-10 Thunderbolt II *(Warthog)* and to the automatic cannon M 230 Chain Gun in the attack helicopters AH-64 *(Apache)* and UH-60K *(Blackhawk)* were used. Warthog is equipped with 1,100 projectiles (bearing 300-330 g DU each) [5] . The data on the use of 30 mm projectiles with DU varied from 30,000 (as reported by Pentagon) to 500,000 [1]. It is without any doubt that the amount of the munitions containing DU was superfluous as assessed according to the achieved military results. It only aggravated the health conditions of civilian population in the neighbourhood of targets, not to speak on the adverse effects in NATO servicemen themselves.

The munitions of various types (including heavy bunker-booster ammunition) continues to be used by NATO and mainly US forces in the conflicts occurring in the new century, i.e. in Iraq and Afghanistan.

The public has not been informed yet that at present, the DU counterbalance is routinely used even in civilian aircrafts as the known crash of El Al Boeing 747 in Amsterdam´s Bijlmeer showed in 1992 (with altogether 282 kg of DU used as counterweight in airframes) [6].

CHEMICAL TOXICITY AND RADIOTOXICITY OF DEPLETED URANIUM

Chemical toxicity of uranium does not depend on its isotopic character. Chemical toxicity is due to chemical damage of kidney tubular cells, causing thus *nephritis.* Toxicity is influenced by the aggregate state of uranium. While water-soluble uranium salts are renal and systemic toxicants, water insoluble compounds are in the first line lung toxicants. This relates mainly to the products of burning (depleted) uranium, i.e. UO_2, UO_3 and U_3O_8. Studies of effects of uranium oxides on organ level in humans have shown:

- Respiratory effects (degeneration of lung epithelium, haemorrhagic lungs). It was found that uranium oxides dust has a biological half/life in lungs of about one year;
- Gastrointestinal effects (anorexia, abdominal pain, diarrhoea, tenesmus or ineffective straining, and pus and blood in stool);
- Renal effects (proteinuria, elevated levels of NPN, amino acid nitrogen/creatinine, abnormal phenolsulphophtaien excretion, increased urinary catalase, diuresis).

Radiotoxicity seems to be more important. Because of slow absorption of uranium oxide aerosol particles through the lungs and long retention in body tissues, its primary effect will be due to its radiological damage to internal organs rather than chemical damage of renal system (even if this is still matter of discussions. If we take in consideration that DU is represented by more than 99 % of U-238, where specific activity 12.4 kBq means 12 400 transformations per second – each releases 1 energetic alpha particle and each atomic transformation produces another radionuclide: Th-234 (half-life 24.1 days) >> Pr (half-life 6.75 hrs) >> U-234 (half-life 2.25 x 10^5 years). Delayed effects of deposited particles of uranium oxides are caused by the internal irradiation of sensitive organs by daughter products on cellular level leading to the risk of enhanced incidence of carcinoma and leukaemia.

ENVIRONMENTAL CONSEQUENCES OF USING DEPLETED URANIUM

It became clear that the so called “ceramic” black-coloured aerosol of uranium oxides is formed as a result of burning pyrophoric uranium due to dramatic increase of temperature at friction and material deformation during penetration of arrow-shaped projectile through armour. The aerosol of highly respirable particles (70 % of the smoke contains particles in order of micrometers) contaminates close neighbourhood and can be moved downwind hundreds of meters. Projectiles missing hard metallic targets do not burn and are buried under soil surface. Due to high corrosion rate of uranium they can contaminate ground water and cause secondary health and environmental effects in humans and biota.

Open questions on the environmental risk of using DU have led UNEP to launch a theoretical study as part of its assessment of the impact of the Kosovo conflict on the environment and human settlement. A Desk Assessment study by UNO was limited by lack of information on the actual use of DU. In July 2000, the NATO provided UNEP with information including 112 separate strikes by aerial DU ammunition (only 30 mm) and a table showing the number of DU rounds used at targeted areas. During the UNEP field mission to Kosovo (November 2000) soil, water and other environmental samples were collected from 11 sites of DU use. 5 separate labs (Italy, UK, Switzerland, Sweden and IAEA) performed the assessment. Even if traces of uranium were detected in samples, no significant (i.e. exceeding recommended standards) contamination was found. The study however states that due to the corrosion of not yet found penetrators missing targets, buried in the ground, future environmental problems might emerge [7]. Similar findings are contained in a later study, performed at indicated sites on the territory of Serbia, closely adjacent to the Serbian province Kosovo-Metohia and of Montenegro [8]. None of these and other official intergovernmental studies attempted to identify and assess delayed health effects of military personnel, i.e. crews of destroyed tanks and armoured combat vehicles and other people potentially exposed to aerosol of burning DU. On the other hand, the prestigious study by Anti-War Network of Italian Scientists [9] was the first dealing with health effects. It states a significant increase of carcinoma incidence on the sites subject to NATO air strikes even far from Kosovo (e.g. in Pančevo). A high incidence of childhood leukaemia has been noted also in Dumfries in Scotland where DU weapons have been test/fired, according to a CADU report.

It is a reason to doubt that governments of countries the armies of them have been using DU in excessible amounts in missions started in the 1990s presented as peace-keeping or peace-making are willing to actually disclose the adverse health and environmental consequences of their use of uranium weapons in full extent. At present, this belongs mainly to the activities of various organisations of veterans in some NATO countries and of some international NGOs.

CONCLUSIONS

It is to be clearly stated that DU munitions are neither nuclear nor radiological or chemical weapons either but belong to conventional weapons with dangerous side effects when striking hard target. There can be no objections against use for defence of territorial integrity against mobile targets of aggressor. However, their extreme mass-scale use in military missions of the 1990s, declared as peace-making or even as peace-keeping, like the known operations against Iraq, in Bosnia-Herzegovina and Kosovo crisis and still more enhanced scale in the latest military interventions to Iraq and Afghanistan should have been avoided due to highly respirable plume of uranium oxides, formed within and in the neighbourhood of destroyed targets, causing inevitable consequences, i.e. delayed toxicological (mainly renal) and radiotoxicological (mainly carcinogenic) effects of deposited particles and daughter products of uranium decay in tissues. Even peacetime uses such as testing, training, storage and any handling [2] should take in consideration the above mentioned high health and moderate environmental risks, as *inter alia* our own experience with testing DU munitions in the 1980s had shown. The minimum requirement for preventing hazards is full and correct information of personnel involved and necessary preventive measures of workplace safety and environmental protection. Current military-technological and international legal problems of using depleted uranium have been elucidated elsewhere [10].

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Table 1. Typical composition of depleted uranium

Component	Per cent	Half-life [years]	Energy [MeV]	Activity [kBq/kg]
^{238}U	99.7	4.47×10^9	4.17	12.40
^{235}U	ca 0.3	7.04×10^8	4.40	0.16
^{234}U	ca 0.001	2.25×10^5	4.70	2.26

Note: - All three radionuclides emit alpha-radiation.

- In some cases, traces of Pu were found, witnessing that such “DU” was by-product of reactor fuel reprocessing rather than of uranium enrichment