Anthropogenic Influences of Depleted Uranium

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Abstract

Natural uranium has ^{235}U content of 0,7%, whereas the content of ^{235}U in DU is depleted to about one – third of its original content (0,2 –0,3%). DU is unstable, radioactive, heavy metal that emits ionizing radiation of three types: α, β and γ. Microbial action can speed the corrosion of uranium. The corrosion rate is controlled by several variables, including the oxygen content, presence of water, size of metal particles, presence of protective coatings and the salinity of any water present. In the long term, all uranium metal will oxidize to U^{4+} and U^{6+}

Date about the cape Arza (UNEP/UNCHS (Habitat) 'Balkans Task Force: (environmental assessment in the Federal Republic Yugoslavia presents date (2002.): 188 contamination points were located, 102 whole penetrators, 28 penetrates fragments and jacket were collected. The soil very closed to penetrators contended up to $3{,}5\ 10^6$ Bq/kg.

Residual risk: in the undecontaminated areas, after 4 years since military conflict, the condition influencing the environmental consequences has changes and thereby the risk to people: resuspension of DU dust on the ground surface decreases all the time (dispersion into the ground by dissolution in water. The probability of water contamination increases for a time as DU from surface dust and corroded DU penetratora (hexsavalent form) enters the water table.

The significant levels of exposure/risk when number of penetrators increase or potential increase by other reasons is much higher on chemical exposure than radiation, from contaminated water when is source penetrators (30) – heavily corroded. Medical research by exposure persons should be direct to medical exam, blood tests (complete blood tests-monocyts, lymphocytes, eosinophyls, chromosomes analyses (lymphocytes cariotyp). By those persons, who have collected the penetrators, the experts have found the existing chromosomes aberration at 50% by examine persons.

Introduction

Depleted uranium (DU) is a by – product of the process used to enrich natural uranium ore for use in nuclear reactors and in nuclear weapons. This is distinguished from natural uranium by differing concentrations of certain uranium isotopes. Natural uranium has ^{235}U content of 0,7%, whereas the content of ^{235}U in DU is depleted to about one – third of its original content (0,2 –0,3%).

DU is unstable, radioactive, heavy metal that emits ionizing radiation of three type: α, β and γ, with half-life period: 4,5 billion years in the case of isotope uranium ^{238}U. The overwhelming part of the radiation emitted from nuclides in the ^{238}U series is emitted from isotopes that follow after ^{234}U. Compared with the sum of the energy of α radiation emitted per transformation from all isotopes in the ^{238}U series, the isotopes that follow after ^{234}U emittted about 89% of the alpha energy, about 58% of the beta radiation energy, and about 98,6% of the gamma radiation energy (1-5)(Table 1.).

Table 1. Depleted Uranium (^{235}U 0,2%)

Chemical composition (%)		Specific activity (Bq/mg DU)	
^{238}U	99.8000	^{238}U	12.27
^{235}U	0.2000	^{235}U	0.16
^{234}U	0.0010	^{234}U	2.29
^{234}Th	Traces	^{234}Th	12.27
^{234}Pa	Traces	^{234}Pa	12.27
^{231}Th	Traces	^{231}Th	0.16
		Sum	39.42

Refernce: Browne et al1 1996. (2)

Chemical composition

Uranium occurs naturally in the +2, +3, +4, +5 and +6 valence status, but it is most commonly found in the hexavalent form. In the nature, hexavalent U is commonly associated with oxygen as the uranyl ion, UO_2^{2+} . The different isotopes of U are chemically identical and thus exert the same chemical and toxicological effects(2,6,7).

Metallic DU react chemically in the some way as a metallic U, which is considered to be a reactive material. U is a strong reducing agent, particularly in aqueous system. In air at room temperature, solid U metal oxidizes slowly. It first assumes a golden-yellow color. As the oxidation proceeds, the film becomes darker, and at the end of three to four weeks the metal uppers black.

Upon oxidation, uranium metal forms UO_2 . A typical oxidation rate for massive uranium metal would be penetrations of 0,005 mm/day (0,19 mg/cm^2 per day) at 175 ^oC.

Microbial action can speed the corrosion of uranium. The corrosion rate is controlled by several variables, including the oxygen content, presence of water, size of metal particles, presence of protective coatings and the salinity of any water present. The principal factor controlling corrosion is the size of the particles: large masses of uranium metal corrode rapidly and a large masses corrode very slowly. In the long term, all uranium metal will oxidize to U^{4+} and U^{6+}

DU is pyrophore; when DU burns, the high temperatures oxides the uranium metal to a series of complex oxides: triuranium octaoxide (U_3O_8), but also uranium dioxide (UO_2) and uranium trioxide (UO_3).

DU can expose people to radiation from the outside (external radiation) and from the inside (internal radiation), if DU has passed into the body by inhalation or ingestion.

The harmful effect of such radiation is mainly an increased risk of cancer, with the magnitude of risk depending on the means of exposure (particularly exposure of the lungs through inhalation) and on the radiation dose.

DU also has a chemical toxicity. This depends on the chemical composition of the uranium and is normally the dominant risk factor to consider in the case of ingestion (as a result of biochemical effects in the human body).

Corresponding health consequences may, depending upon the dose or intake, include cancer and malfunction of body organs, particularly the kidneys.

The consequences of radiation may be expressed directly in terms of radiation dose, which is measured in millisieverts (mSv) or microsieverts (μSv).

With regard to chemical toxicity, the consequences are expressed in concentration or total intake and compared with given health standards or guidelines. In this way it should be possible to express the risk (consequence) as a ‘insignificant’ or ‘significant’, bearing in mind the basis for the comparisons drawn.

Radiation: 'insignificant' – for doses less than 1 mSv per year; 'significant' - higher than 1 mSv per year.
Chemical toxicity: 'insignificant' for concentration or total intakes below applicable health standards or guideline, and 'significant' for those above (1-3,6,7).

Environment contamination

UNEP/UNCHS (Habitat) 'Balkans Task Force' was established with the aim of making an overall assessment of the consequences of Kosovo, conflict for the environment and human seelemens, focusing in particular n the Federal Republic Yugoslavia (Kosovo, Serbia and Montenegro) (1,3,5,7) (Picture 1., Map 1.)

Some levels of exposure lead to significant risk, other to insignificant risk. If ground contamination is less than 0,1 – 1 g/m^2, the consequences are normally all insignificant.
Airborne contamination – risk of contamination of food (fruit, vegetables, meat etc.) and drinking water; risk of contamination of hands, ...
If somebody picked up solid pieces of DU lying on the ground surface (handling uranium) a risk of external and internal beta radiation exist.

A large percentage of DU rounds that either hit soft targets, or missed target completely, will have penetrated into the ground and become corroded over the time ⇒ risk of future contamination of groundwater and nearby wells used to supply drinking water. There is also risk that fragments of DU will be brought up to the surface during reconstruction of houses, roads etc. According WHO health standards TDI is 0.6 μg/kg BW.

Table 2. Health standards (WHO) (3)

Drinking water	2 μg U/liter (WHO, 1998.)
Tolerable Daily Intake (TDI)	0.6 μg/kg BW (WHO, 1998.)
Air	0.6 mg/m^3 (ACGIH)
Insoluble uranium in the air	0.05 mg/m^3 / chronic expos. (NIOSH) 0.15 mg/m^3 / short expos. (NIOSH)

Legend:
ACGIH = the American Conference of Governmental Industrial Hygienists;
NIOSH = the US National Institute for Occupational Safety and Health

According Yu Army, war dossymmetric value is present in tables No 3., 4. (6,8).

Table 3. Maximum allowed doses of external ionization human beings
Maksimalno dozvoljene doze spolja{njeg ozra~enja ljudstva:

Up to 4 days ionization (acute doses)	50 cGy
In the case of several time ionization (chronic doses):	
-during 10 days	100 cGy
- during 3 months	200 cGy
- during 1 year	300 cGy

Table 4. Different level of radioactive contamination in different areas

Face, hand, ...	2,80 μGy/h
Clothes	1,08 μGy/h
- Drinkind water, and water for food prepare	min. LLC * 400 Bq/l average LLC 4.000 Bq/1 max. LLC 40.000 Bq/1
Milk and dietary product	min. LLC 500 Bq/l average LLC 5.000 Bq/1 max. LLC 50.000 Bq/l
Other nutrition production	min. LLC 1.250 Bq/1 average LLC 12.000 Bq/1 max. LLC 60.000 Bq/l

* LLC= limited level of contamination

Medical research by exposure persons should be direct to medical exam, blood tests (complete blood tests-monocyts, lymphocytes, eosinophyls, chromosomes analyses (lymphocytes cariotyp).(6,8).

According report from Belgrade Institute "Dr Dragomir Karajovic", by persons, who have collected the penetrators after NATO bombing, the experts have found the existing chromosomes aberration at 50% by examine persons (9).

Four years later Kosovo conflict

Airborne contamination from resuspension of DU dust on the ground surface decreses all the time, because of the expected dispersion into the ground by dissolution in water and because of increasin cover of old grass, leaves etc. Water concentration increases for a time as DU from surface dust and correded DU penetrators, enters the water table.
Risk of touching a penetrator ⇒ must be neutralised by the decreased probability of finding a penetrator that is hidden by old vegetation.

Radiation- preventiv actions

The Law on Ionizing Radiation Protection in Republic of Serbia, based on IAEA recommendations, regulates surveillance of ionizing radiation sources and establishes monitoring system. Actions, taken with the aim to reduce unnecessary exposition of population to widely used ionizing radiation sources in medicine, industry and research, are not sufficient (10).

Objective

Reduction of unnecessary exposures to ionizing radiation is the basis of all strategies and policies for radiation protection.

Compulsory information of the public with their active participation in the decision-making process on healthier environment related to radiation hazards.
(EHAPE, para 211)

Basis for Action:

According to the IAEA recommendations the new RS law was prepared to be ready to regulate adequately this environmental segment and approved in the parliamentary procedure as well as of IAEA international association.

In this report are presented Priorities and Plan for Future Activities, Republic of Srpska, which could be implementation in Republic of Serbia, because the same problem exists (10) (Scheme 1.):

Instead conclusions - Priorities:

- Diminishing of health hazard for population living in the places where the depleted uranium was registered;
- Establishing suitable National body for radiation safety;
- To make the map of the territory where $U^{235, 238}$ was used (GIS);
- Implementing programs for minimizing population exposure to the unnecessary radiation;
- To implement radiological protection and to establish appropriate regular functioning of the nuclear stations for employees, environment and population in the region;
- In investment planning, include monitoring of concentration and effects of radon;
- Development of the national programs on waste safe storage and disposal of radioactive waste;
- Identification of top risk groups with population exposures based on common radiation with different sources and implementation of new methods for appropriate biomonitoring.
- Developing of the automatized monitoring system for gamma radiation;
- Separation of the places which have increased level of uranium compounds and hazard radiation estimation for population and recultivation of affected areas which would include:

1. Dynamics of measuring according to the radiation level in the certain areas with increased antropogenic levels;
2. Inquires which include radionuclides (uranium, radium, thorium and the products of their disintegration) in the environment (ambient air, air in closed spaces, water, soil, plants, food, etc.)
3. Radon measuring including primary sources and basements in the households as well as working space;
4. Determination of embodied natural radionuclides in the organism (in the body or biological samples);
5. Processional activities related to the places with increased values of uranium.

- Implementation of inquiry which would include natural radionuclides monitoring in nitrogenous fertilizers and control system of soil treated with such fertilizers;
- Health professionals' personal dosimeters control;
- Implementation of Program which includes radiation safety in nuclear reactors and possible nuclear wreckage;
- Making project for the place suitable for radioactive waste disposal on the national level;
- Selecting epidemiological studies for estimation of ionizing radiation effects as hazardous factors causing malignant neoplasm and harmful effects on immune system;
- Biomonitoring of population risk groups targeting the areas where it was found increased hazard of malignant neoplasm occurrence and immune system diseases through an early detection. This should be based on necessary preventive activities (building and technical measures, soil recondition, etc.);
- National Carcinoma Register creating and making it operational;
- Making and implementation necessary lawful regulations in the practice, harmonized with WHO recommendations, EU directives and IAEA norms and principles.

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Scheme 2. Extremly envirinment pollution in Republic of Srpska
- ionisation .... -(No 3. on the scheme)