Report of the World Health Organization Depleted Uranium Mission to Kosovo

22 to 31 January 2001

Undertaken at the request of the Special Representative of the Secretary-General and Head of the United Nations Interim Administration Mission in Kosovo (UNMIK)

12 March 2001

Contents

1. Background to the Mission

The Director-General of the World Health Organization (WHO) received a request for assistance from the Special Representative of the Secretary-General and Head of the United Nations Interim Administration Mission in Kosovo (UNMIK). The request appealed to WHO ‘to send public health experts to assist in monitoring any possible health consequences of the use of depleted uranium among the civilian population.’

Accordingly, WHO responded positively to this request, and assembled a mission to travel to Kosovo comprising a team of four specialists. The team members arrived in Prishtinë/Pristina on 22 January 2001 and began their work immediately. In addition to the specialists that comprised the WHO Depleted Uranium Mission, additional assistance was provided by WHO staff based in Kosovo as part of the long-running WHO Humanitarian Assistance Programme.

The composition of the mission and the terms of reference are presented in Appendix 1.

The purpose of the mission from the outset was to assimilate the information and opinions presented to it from all interested parties within Kosovo. The mission team has been conscious of the recent intense international interest in depleted uranium and the desire of UNMIK to institute prompt action, if and where needed. Therefore, in the limited time available, strenuous efforts have been made to consider all of the quantitative and qualitative information within Kosovo presented to the mission team members. Information from Kosovo sources has been supplemented with authoritative knowledge gathered from the international medical, scientific and environmental literature and organizations and WHO personnel outside of Kosovo.

In the time available, the mission endeavoured to be as comprehensive as possible in its assessment of health issues relevant to Kosovo. In this respect the mission is confident that the assessments made and the advice given to UNMIK are practical and relevant.

The main thrust of the WHO assistance to UNMIK has been a fact-finding and assessment mission. This was determined to be the most expeditious way to assist UNMIK. No new environmental sampling was conducted. Instead, those who have undertaken environmental sampling in the recent past, such as the United Nations Environment Programme’s (UNEP's) Balkans Task Force, have co-operated and supported the work of WHO.

The mission focused solely on the Kosovo geographical area and endeavoured to use the UN adopted names for all villages and towns.

A list of the organizations that have assisted the WHO mission is given in Appendix 2.

2. Situation Found in Kosovo

On 10 June 1999, the Security Council authorized the Secretary-General of the United Nations to establish civilian administration in Kosovo. Soon after, an operational concept was presented for UNMIK. The main tasks of UNMIK, paraphrased, are:

- To promote the establishment of substantial autonomy and self-government in Kosovo
- To perform civil administrative functions
- To facilitate a political process to determine the future status
- To support the reconstruction of infrastructure and humanitarian and disaster relief
- To maintain civil law and order
- To promote human rights
- To assure the safe and unimpeded return of all refugees and displaced persons.

In parallel to the interim civilian administration, the security of Kosovo is underpinned by the North Atlantic Treaty Organization (NATO) and other military forces (Kosovo Force-KFOR). They are divided into five 'areas of responsibility' (known as AORs): MNB (Multinational Brigade) North, led by the French contingent; MNB West, Italian contingent; MNB South, German contingent; MNB East, American contingent; and MNB Centre, British contingent.

Use of Depleted Uranium in Kosovo

In Kosovo, only one type of ammunition containing depleted uranium was used: PGU-14 API 30 mm rounds fired from Gatling guns mounted on A-10 Warthog 'Tankbuster' aircraft. The rounds are composed of a propellant charge and a solid depleted uranium tip (known as the 'penetrator') weighing 300 g, which is coated on the outside with aluminium, 0.8mm thick (Lockheed Martin 1995). The penetrator does not contain an explosive charge. Instead the penetrator relies on the pyrophoric properties of uranium. The impact of the penetrator at high velocity on a target results in its fragmentation and between 10 and 35% becomes aerosolized (Harley et al. 1999). Sufficient heat is generated to ignite the aerosolized uranium metal. The penetrator fragments then burn vigorously at a high temperature and, in effect, melt their way through steel plating into the interior of an armoured vehicle. Once inside the confined space of a tank, the heat from the burning penetrator fragments ignites flammable vapours and munitions within the vehicle. The ignition of flammable components within a tank is reinforced by the use of high explosive rounds in conjunction with depleted uranium ones. Information provided by KFOR has stated that depleted uranium rounds are mixed with high explosive rounds in ratios of around 4:1.

An environmental study conducted at the Nellis Air Force Range in the United States of America (US) on the use of depleted uranium from A-10 aircraft mentions that the uranium is alloyed with 0.75% titanium. It is understood that titanium is used to make the uranium metal less brittle and more corrosion resistant (Ebinger 1990, US Army Corps of Engineers 1997).

KFOR has informed the mission that 112 attacks were made in the period from 6 April to 11 June 1999. The number of rounds (both depleted uranium and high explosive) per location varied from 50 to 1300. The total number of rounds fired in the Kosovo conflict was about 31 000. This amount is substantially lower than the estimated 783 500 depleted uranium rounds alone fired by A-10 aircraft in the 1990-1991 Gulf War (US Department of Defense 2000). Some locations were attacked several times and as a consequence there are 84 geographically different sites in Kosovo where depleted uranium rounds were used. Most of the attack sites and numbers of depleted uranium rounds were fired in the German (MNB South) and Italian (MNB West) AORs, predominantly in the border areas with Albania. Fewer attack sites are located in the American (MNB East) and British (MNB Centre) AORs and only three locations (all about four to eight km south of Mitrovicë/Mitrovica city) were attacked in the French (MNB North) sector.

KFOR informed the mission that, with regard to depleted uranium, no systematic cleaning-up of sites was carried out, although one KFOR brigade collected 36 penetrators at one location. KFOR reported that 80% of the rounds that were fired or the fragments remaining after hitting the target are likely to be deposited within 100 metres of the target (as defined from NATO grid co-ordinates). Penetrators that hit armoured vehicles or hard rocks would be crushed on impact and residual fragments and dust would be deposited on the ground. Penetrators that miss the target may penetrate two to three metres into the soil (depending on the type of soil).

3. Depleted Uranium and Titanium Characteristics

3.1 Uranium

Uranium is a naturally occurring metal that consists of three radioactive isotopes: U238, U235 and U234. The concentration by weight is approximately 98.3% U238, 0.72% U235 and 0.006% U234. Uranium is ubiquitous in the environment. It occurs in all rocks and soil. A typical concentration of U238, the main isotope, in the earth's crust is between 0.5 to 10 gram/t. The resulting activity is of the order of 5 to 125 Bq/kg. For U235 the activity concentration is 0.2 to 5 Bq/kg (UNEP/United Nations Centre for Human Settlements [UNCHS] Balkans Task Force 1999).

The Agency for Toxic Substances and Disease Registry estimates that there are typically four US tons of uranium in one square mile of soil, one foot deep (comparable to 1.4 t/km^2). It has also been estimated that each year 180 US tons of uranium decay products are added to US agricultural lands due to the presence of trace amounts of uranium in fertilisers (ATSDR 1997).

Depleted uranium (also referred to as DU) is a waste product of the process of enriching natural uranium. During this process the content of U235 is depleted to about 0.2 to 0.3% and nearly all U234 is removed.

Depleted uranium is about 60% as radioactive as natural uranium. It has a low specific radiation activity (39.4 kBq/g) and is considered as only weakly radioactive (Snihs & Åkerblom 2000, UNEP/UNCHS Balkans Task Force 1999).

Depleted uranium has peaceful applications, such as counterweights in aircraft, missiles and racing sailboat keels and as a material used in hospitals for shielding X-rays or gamma radiation from equipment used for radiation therapy. Depleted uranium is used in armour-piercing ammunition because it has a high density (1.7 times that of lead), and is also used for military armour to reduce the effect of other conventional munitions.

Due to the pyrophoric nature of uranium metal and the extreme temperatures generated on impact of depleted uranium ammunition on a hard target, it ignites and produces an aerosol of fine particles of uranium oxides. The main oxidation product is triuranium octaoxide (U_3O_8), but also uranium dioxide (UO_2) and uranium trioxide (UO_3) will be formed. It is assumed that a large fraction (50 to 96%) of the aerosol consists of respirable particles that could enter the lower respiratory tract and cannot be expelled (UNEP/UNCHS Balkans Task Force 1999).

In addition to U235, U234 and U238, the mission was confronted with questions on the presence of plutonium or other radioactive chemicals in the munitions. KFOR informed the mission that it did not exclude the possibility that traces of plutonium could be present in depleted uranium. This is because the enrichment of some natural uranium, from which depleted uranium is a waste by-product, occurred at a production facility that had been used previously for the processing of spent fuel rods from nuclear reactors. The production facility had not been completely cleaned and cross-contamination could have been possible.

According to NATO (referring to a statement placed on the Internet on 18 January 2001) it "has long been established that there may be trace elements of U236 and plutonium in depleted uranium." The presence of plutonium was addressed in a report of the US Department of Defense (2000), which also contains comments on the possible presence of trace elements of other materials in depleted uranium. The report concludes that depleted uranium "may contain trace levels (a few parts per billion) of transuranics (neptunium, plutonium and americium). Tests on samples of DU showed that transuranic contamination added 0.8% to the radiation dose from DU."

With regard to the presence of U236 in Kosovo, UNEP has mentioned (UNEP press release,16 January 2001) that "along with the more commonly expected isotopes, one of the laboratories has reported finding 0.0028% of U236." The UNEP press release says the "content of U236 in depleted uranium is so small that the radio-toxicity is not changed compared to DU without U236." Consequently, it has been concluded that detection of U236 indicates part of the depleted uranium originates from reprocessed uranium.

It would appear that the presence of the U236 isotope led to the scientific deduction that plutonium may also be present. At a meeting immediately prior to the commencement of the WHO mission in Kosovo, UNEP informed the team that the laboratory had not reported detecting any plutonium in their samples. After the mission returned from Kosovo, UNEP announced (press release, 16 February 2001) that traces of Pu239 and Pu240 were found in four penetrators. UNEP advised that the content of the plutonium found is very low and does not have any significant impact on overall radioactivity.

Environmental behaviour

Upon weathering, non-oxidized small particles become adsorbed to clay minerals and humus. The surfaces of remaining depleted uranium fragments will slowly oxidize to uranium oxides. These oxides are only sparingly soluble but will gradually form hydrated uranium oxides in moist conditions. The hydrated uranium oxides will then slowly dissolve and be transported into the surrounding soil, pore water and eventually groundwater, although adsorption of uranium to organic compounds in the soil will inhibit the rate of migration. In contrast to these oxidizing conditions, uranium is practically insoluble under reducing conditions, such as those found in anoxic soil conditions. Generally, the migration of depleted uranium depends on the type of uranium compounds formed, the sorption properties of the soil, the presence of complexing agents and the acidity of the soil. Microbial activity might speed up the corrosion of depleted uranium, but it should be noted that the titanium present in depleted uranium would tend to counteract and slow down the process (UNEP/UNCHS Balkans Task Force, 1999).

The preliminary report by the UNEP/UNCHS Balkans Task Force (1999) noted that the lifetime of 1kg of uranium metal ground down into 1g pieces is about 400 years in a humid environment. A solid depleted uranium penetrator from a tank shell (not used in

Kosovo), having a mass of 1.345kg, has an estimated corrosion lifetime of 2100 years (Erikson 1990).

Accordingly, for a depleted uranium penetrator of 300g, as fired by an A-10 aeroplane in Kosovo, a corrosion lifetime may be reasonably estimated to be around 500 years. This is a very slow rate of corrosion and hence the leaching of uranium into the soil will be equally slow.

Possibilities for population exposure to depleted uranium

Everyone is exposed to external radiation from naturally occurring and man-made radionuclides in the environment. These radionuclides emit, in varying proportions, depending on the radionuclide, three forms of radiation: alpha, beta and gamma. Uranium isotopes emit mainly alpha particles, a type of radiation which can only travel about 30 µm in soft tissue and cannot penetrate dead superficial skin layers, paper or glass. Alpha particle exposure to internal organs only occurs therefore when the depleted uranium is taken up in the human body, for example through inhalation, ingestion or the contamination of open wounds. Uranium also emits beta radiation. Beta particles have a greater ability to penetrate skin, but exposure is also superficial and beta radiation also only presents a hazard if internalized (Harley et al. 1999).

The mission postulated possible pathways for exposure of the general population to depleted uranium from an attack site and the following were considered:

- Inhalation of uranium oxides in smoke and dust
- Depleted uranium fragments entering the body in wounds
- External contact with depleted uranium penetrators
- Uptake of uranium by crops for human consumption
- Uptake of uranium in grass or soil by cattle grazing
- Uranium accumulation in drinking water

Aerosols route

Depleted uranium particles or aerosols formed following impact and ignition on a hard target will be dispersed and deposited on the ground. It is reported that most of the depleted uranium dust will be deposited within a distance of 100m from the target (US Army Corps of Engineers 1997). People, most likely soldiers, close to an impact could therefore be exposed to dust by inhalation. UNEP (2000) has estimated that the inhalation and ingestion of depleted uranium contaminated dust, even under extreme conditions, and shortly after the impact of projectiles, as determined by the amount of dust that can be inhaled, would be less than about 10 millisieverts (mSv). This represents about half the annual dose limit for radiation workers. The exposure of civilians to dust and smoke at the time of an attack is less likely. Deposited uranium dust might slowly be transformed through environmental weathering processes into more mobile and soluble forms (discussed elsewhere in this section) and dispersed in the environment by air currents.

Fragments

During the Gulf War, soldiers were exposed to depleted uranium by ‘friendly fire’. Fragments from penetrating depleted uranium rounds are embedded in the bodies of several soldiers and others inhaled depleted uranium aerosols generated by the impact of the depleted uranium munitions penetrating the target. Thirty-three US veterans seriously injured in friendly fire incidents have been monitored by the Baltimore Veteran Administration Medical Center since 1993. About half of them have depleted uranium fragments in their bodies. A subsequent study considered 29 veterans from the original 33. Though these veterans have higher concentrations of uranium in their urine, indicating that depleted uranium is being oxidized by body fluids, no adverse kidney effects have been observed (McDiarmid 1998 and 2000; US Department of Defense 2000).

External contact route

Picking up a penetrator and keeping it in a pocket is the only realistic way of a long period of exposure to external (beta) radiation from depleted uranium. Snihs & Åkerblom (2000) stated that by keeping it in the same position for several weeks, it might be possible that the dose administered to the skin would exceed the skin dose limit for the general population, though not that of radiation workers. The effect of such exposure would be localized and the delivered dose would not be sufficient to cause any deterministic effect.

Agricultural route

The possibility was mentioned to the mission that uranium dust might become incorporated in vegetables and crops. The mission was advised by the Food and Agricultural Organization of the United Nations (FAO) that in the published literature there are no known plants that preferentially accumulate uranium and the normal amounts of uranium taken up in plants would not be expected to be dangerous to humans, birds or other animals (communications between the mission team and FAO in January and February 2001).

Drinking water route

The final plausible route of exposure of the population is through drinking water contaminated by migration of soluble depleted uranium compounds in ground or surface water. In particular, possible contamination of wells or spring protection tanks close to an attack site from pieces of depleted uranium might be an isolated occurrence and its relevance should be considered further.

Absorption of depleted uranium

If or when a person comes into contact with depleted uranium from a penetrator, there is no known immediate or acute risk to life. Furthermore, the radio-medicine literature provides no evidence to assume that a person having contact (either externally or internally) with depleted uranium will develop an illness. The onset of any illness argued to be due to depleted uranium has to be related to the amount of radiation dose or amount of toxic chemical to which a person has been exposed (US Department of Defense 2000).

Absorption of depleted uranium in the body following inhalation or ingestion is very limited. Mean absorption following inhalation exposure is about 0.8 to 0.9%, with less soluble compounds as uranium oxides remaining in the lungs. Absorption following ingestion also depends on the solubility of the uranium compounds, but is also limited at between 1 to 2% of the ingested amount with the remainder passed out in faeces (UNEP/UNCHS Balkans Task Force 1999).

Most of the small amount of uranium that is absorbed in the body (about 70%) will be filtered out by the kidneys and excreted in urine within 24 hours. The remaining part will be distributed to the skeleton, liver and kidneys. The time to excrete half of this remaining uranium is in the range of six months to one year.

Health effects

The radiological toxicity of depleted uranium is primarily confined to body cells that are susceptible to the effects of alpha and beta radiation. It is therefore thought that inhaled depleted uranium particles may lead to damage of lung cells and might increase the possibility of lung cancer.

Epidemiological studies provide consistent and convincing evidence of excess lung cancer, but not of leukaemia, related to alpha particle exposure among uranium miners (IARC1988; US NAS 1999). However, this effect is attributed to be related to exposure to gaseous decay products (radon). The risk of lung cancer appears to be proportional to the radiation dose received. Indeed, among nuclear workers involved in uranium processing (whose exposures to alpha particles from uranium are less than those of miners), no consistent excess of lung cancer has been found (NCRP 1978; NRC 1988; NIH 1994; Cardis & Richardson 2000; IARC 2001).

Kidney dysfunction is considered the main chemically induced toxic effect of depleted uranium in humans, though this is thought to be reversible (Priest 2001). Until now, a study of 29 Gulf War veterans with embedded fragments of depleted uranium in their bodies has not shown adverse kidney effects (McDiarmid et al. 1998 & 2000).

The risk of kidney effects following ingestion of depleted uranium depends on the amount of soluble uranium compounds present (effects increase with higher solubility). Information on the presence of soluble uranium compounds following the use or degradation of depleted uranium penetrators is therefore essential to evaluate the potential risk of developing kidney dysfunction.

Exposure assessment

For the assessment of both the potential radiological and chemical effects related to the use of depleted uranium munitions, actual information on exposure (dose) is necessary.

The mission is aware that the UNEP field mission (November 2000) visited 11 of the sites that were targeted by A-10 aircraft. The UNEP team collected soil, water, vegetation and milk samples. The results of the UNEP field mission are expected to be available in early March 2001. In advance of these results becoming available, albeit less precise, an expert opinion can be made on the likely level of radiological or chemical exposure a person or community may be subject to.

3.2 Titanium

About 0.75% of the weight of a depleted uranium penetrator is composed of titanium. Titanium, a grey metal, is widely distributed in the environment. It is extremely resistant to corrosion and, in the form of a powder or dust, highly flammable and explosive. Metallic titanium is mainly used in the aircraft industry and in the production of high-strength, corrosion-resistant alloys.

Titanium in the molten state has a great affinity for oxygen, resulting in the formation of titanium dioxide at high temperatures. Titanium dioxide is extensively used as a white pigment in paints, enamels, plastics and cosmetics as well as a colouring agent in food (WHO 1982).

Absorption of titanium

Titanium compounds are poorly absorbed from the gastro-intestinal tract, which is the main route of exposure for the general population. WHO (1982) estimated that the absorption is about 3%. Intake by inhalation is less than 1% of the total intake and considered of little significance in relation to the intake from food. Titanium and titanium compounds are poorly absorbed and retained by both animals and plants.

Health effects

The lung is considered to be the primary target organ in humans and the residence time of titanium dioxide in the lung has been regarded as long. However, no fibrogenic changes have been detected in lungs of workers exposed to titanium dust (Schmitz-Moorman et al. 1964, as cited in WHO 1982).

Human clinical studies have shown that titanium in implants and prostheses is extremely well tolerated by tissues, and titanium dioxide is a frequently used compound in lung clearance studies, where a biologically inert substance is required (WHO 1982).

Based on the data available in the literature on the toxicity of titanium and titanium compounds and the minor amount of titanium in depleted uranium, it is unlikely that in the current situation exposure to titanium would constitute any health risks for the general population.

4. Mission Approach

The mission team followed a step-wise procedure to deduce the likelihood of speculated health-related issues arising from the presence of depleted uranium leading to a perceivable health risk. It was appreciated during the preparatory work by the mission team members, before arriving in Kosovo, that the quantity of environmental and health data on the prevailing situation in Kosovo would be limited. In addition, results of recent sampling programmes by other agencies were not expected until March.

Therefore, the mission team followed a rational and reasoned approach to determine whether plausible health concerns to citizens could arise from the presence of depleted uranium. This involved supplementing the useful, but modest, data available from sources in Kosovo with information from the international literature. More specifically, the mission would:

1. Gather, in the time available, medical, environmental and munitions information and opinions from as many sources as possible in Kosovo;

2. Supplement Kosovo-specific information with medical and environmental data available internationally in the public domain;

3. Assess collectively whether credible environmental transmission pathways occurred and radiation or toxic chemical-induced health concerns were present and likely to be associated to DU exposure; and

4. Present to UNMIK a set of short and longer-term measures in those instances where the mission believes there are issues to be addressed. If, during the course of the work of the mission, other non-depleted uranium health concerns were identified, these would also be reported to UNMIK.

Members of the mission held numerous meetings with medical and public health authorities in Kosovo to review the available health statistics on non-communicable disease incidence, in particular cancers and congenital birth defects. One aspect of this work was to verify available recent and pre-conflict medical data and information to assess if any changes in the rates of relevant illnesses were discernible. The mission reviewed the information collected, mechanisms for collection of data, referral patterns for cancers and other diseases and mechanisms for confirming diagnoses. Meetings took place with agencies in Prishtinë/Pristina and several similar bodies at regional and local level.

Opinions and other information were collected from various parts of UNMIK at central and local level, as well as from informal discussions with citizens. Various Albanian and Serbian organizations had an opportunity to express their comments and concerns.

Several international agencies present in Kosovo were approached and the mission received a wide range of opinions and advice. Consideration was taken of all of the views.

KFOR provided extensive information on the locations and quantities of depleted uranium munitions used in the Kosovo conflict. Subsequently, members of the mission team conducted visits to some depleted uranium sites in the most heavily attacked regions, namely Gjakovë/Djakova, Gjilan/Gnjilane, Pejë/Pec and Prizren regions. The purpose of the site visits was to determine the presence or absence of populations living in proximity of these attack sites and their likelihood to be exposed to any depleted uranium directly or through environmental contamination.

Further information-gathering visits were made to the mainly Albanian and Serb-inhabited areas in Mitrovicë/Mitrovica region, as well as Gjilan/Gnjilane region.

5. Assessment of health information system and health of the population

A large number of health institutions were visited where medical and public health personnel were interviewed in Prishtinë/Pristina and in several medium and small towns. These included institutes of public health, hospitals, military hospitals, health houses, pathology laboratories and maternity wards. The mission received reports about changes in disease patterns in the recent past, and specifically in cancer or congenital malformations. The mission also investigated the reporting mechanisms for these diseases, and assessed the ability of the present diagnostic and information facilities to identify an increase in those diseases, should one occur.

Population and migration data were needed to estimate disease frequencies. Several institutions, including the International Organization for Migration (IOM), the Office of the United Nations High Commissioner for Refugees (UNHCR), the UNMIK civil registration unit and the Organisation for Security and Cooperation in Europe (OSCE), were contacted to identify population and migration information in Kosovo. The mission reviewed the available data on population and migration patterns, as well as available data on mortality by cause, the incidence of cancers and congenital malformations.

Population and migration data

The population and migration information is very incomplete and uncertain, both at local level and on a Kosovo-wide scale. This is an important limitation, which made it, in effect, impossible to carry out adequate calculations of disease frequency in the population.

The population of Kosovo was recorded in a 1981 census. In the 1991 census the majority of ethnic Albanian Kosovars refused to participate and estimates extrapolated from the 1981 data were made. Since then, no complete population data are available. UNHCR made estimates covering only displaced populations in 1998. People over 16 years were registered between March and July 2000 by the Civil Registration Department of UNMIK. Only the total counts in the 30 municipalities are available, but breakdown by age and gender might be made available in the future. Around 920 000 people over 16 were registered. Current estimates for the total population over 16 years are between 1.2 and 1.5 million. If these are correct, at least a few hundred thousand ethnic Albanians can be assumed not to have registered in 2000.

Minority populations in Kosovo, notably Serbs and Roma, live in enclaves in various locations in Kosovo and particularly in northern Kosovo. They did not take part in the civil registration in 2000, and are not participating in current civil registration efforts. It is not known how many people live in the enclaves, but they are approximated to be around 100 000 to 150 000. The inhabitants of the enclaves normally seek hospital care far from where they live.

Large-scale migration and population movements have occurred in Kosovo during and after the armed conflict. They continue to occur now, as houses are rebuilt and people can return to their homes. In addition, migration to different European countries and return occur, making assumptions about how many people have been in or close to a potentially contaminated area at a given time extremely difficult.

Causes of death and of consultation

Information systems for deaths and diseases are beginning to be established following a complete standstill during the conflict. Morbidity and mortality data will be collected at every stage of the healthcare system and forwarded to the regional and central Institute of Public Health (IPH) for analyses and dissemination of results. Still there are difficulties with the regular transfer of information from hospitals to the IPH and the feedback of results to health institutions providing the original data.

The municipalities have the responsibility to collect death and birth registrations and the IPHs should prepare statistics on causes of death. At the moment, cause of death statistics are not yet available, but a first analysis for the period July-September 2000 is being prepared.

There were no statistics on illnesses identified at the time of a medical consultation (i.e. 'causes of consultation'), except for communicable diseases.

Data on cancer

In general, cancer information is incomplete and there are no mechanisms in place to ensure there is complete ascertainment and no double counting. Patients with a suspected cancer are referred by their local doctor to one of the five regional hospitals or the tertiary level hospital, Prishtinë/Pristina University Hospital (PUH) for diagnosis. Analyses of blood samples and biopsies are sent to the pathology laboratory at PUH and a few are sent to one of the three private pathologists. However, on diagnosis, ethnic Albanian Kosovars have had to go abroad (mainly to the former Yugoslav Republic of Macedonia or Albania) for treatment, as chemotherapy has only recently begun, and there is still no radiotherapy in PUH. It is possible that patients with sufficient funds may go directly abroad even for diagnosis.

Those living in Serb-inhabited enclaves and in northern Kosovo use a different health care system. Most tend to go for diagnosis and treatment of cancer at the Mitrovica/Mitrovicë hospital, but they may also go elsewhere in Yugoslavia. The mission visited Mitrovica/Mitrovicë hospital, but cannot comment on the proportion of cases seen elsewhere in Yugoslavia. These cases are not part of the cancer incidence figures gathered through the hospital.

Clinical observations on cancer

The health professionals interviewed in Gjakovë/Djakova, Gjilan/Gnjilane, Pejë/Pec, Prishtinë/Pristina, Prizren and the southern part of Mitrovicë/Mitrovica had not observed any changes in causes of consultation in their services. In some places, the director of the hospital has instructed the staff to pay particular attention to diseases suspected to be related to the armed conflict.

New cases of haematological malignancies (Kosovo-wide) referred to the PUH have been counted over the last four years. They observed that a similar number of cases of leukaemia have been referred every year.

The hospital personnel in Mitrovica/Mitrovicë, located in the mainly Serb-inhabited area, reported they received more referrals for cancers amongst Serbs in the year 2000 than in years 1997 and 1998, and a smaller number of referrals in 1999 than in 1997/1998. The Mitrovica/Mitrovicë (north) IPH has identified cases of cancer in the population in northern Kosovo that are additional to those reported by the hospital: four cases in 1999, 39 in 2000 and six up to the end of January 2001. These cancers were of different types and diagnoses and none were reported to be leukaemia.

No conclusion could be drawn from the available data regarding any change in cancer frequency in the population. The changing numbers of cases seen by the hospital in 1999 and 2000 could be due to a number of factors, such as changes in the size and age distribution of the population (for instance, more people of older age) served by the hospital as a result of the large migration of people following the armed conflict.

Data on congenital malformations

Data on congenital malformations are not being systematically collected. Information on births are routinely recorded wherever the birth takes place (hospital or health house) in books kept at maternity wards. There is no standard way of recording information; however, there is a space for “diagnosis” in the maternity book, where any obstetric event or congenital malformation is recorded. These data are not being collected, reported or used in a standardized fashion.

Some hospitals carry out ultrasound examinations at 16 weeks of pregnancy to identify malformations. This information is not being systematically collected either. Consequently, any data on congenital malformations or miscarriages must be viewed with caution because of: a) geographical differences in uses of ultrasound; and b) the fact that Prishtinë/Pristina is a tertiary level hospital and so would be expected to receive the more complicated pregnancies.

No information on miscarriages is being collected. Most births are now believed to take place in health institutions, following the re-opening of health services with maternity care available in both hospitals and most health houses. At the time of the armed conflict, around 22% of births took place at home.

Clinical observations on congenital malformations

Health institutions visited have not observed any changes in congenital malformations, with the exception of Mitrovica/Mitrovicë hospital. There the mission was informed about three recent congenital malformations observed in the hospital, but compiled data on the number of births and congenital malformations observed over the last few years were not available. No conclusion could be drawn regarding any changes in malformations with the limited information available at the visit.

Assessment of data and future developments

The mission team proposed that Mitrovica/Mitrovicë hospital and Mitrovica/Mitrovicë (north) IPH combine their available data on cancer cases and classify them by age group, sex, type of cancer diagnosis, as well as collect data over the last few years on births and congenital malformations from maternity ward books. This will provide information about whether any apparent increase in cancer diagnosis is due to a different age/sex distribution of patients attending the hospital, and whether there have been changes in consultations for specific types of cancer. The mission team agreed to review these data as soon as they are available.

There are initiatives that could facilitate the establishment of a cancer registry for Kosovo. Hospital doctors involved in cancer diagnosis and treatment in their specialities and pathologists are forming an oncology society. They are setting up a working group to look at the whole issue of oncology in Kosovo. Particularly important is the fact that pathology is practically centralized in one large laboratory at the PUH, which has started to analyse data on recent pathological examinations made. The chief pathologist has, in addition, access to the data from the limited number (3) of private pathologists in Kosovo. These data would be an important element of a cancer registry. Better facilities for diagnosis (no immuno-histochemistry is available yet in the pathology laboratories), and for treatment of cancer (i.e. no need to seek treatment abroad) would facilitate the establishment of an effective registry and more reliable, subsequent epidemiological analyses.

A few recent developments could facilitate the implementation of registration for congenital malformations in Kosovo. A standard monthly activity report of maternity wards will soon be implemented across Kosovo by the WHO/Mother and Child Health Unit (MCH); this will improve data collection from maternity books and computerize the record keeping. It is suggested that an extra field could be added to the data entry form to be used as a means for the congenital malformation registration system. In addition, a registry would require facilitation of standard diagnoses through training of practitioners, as well as a capacity for analyses of results and provision of feedback to practitioners to make it meaningful. The recently formed Association of Gynaecologists is analysing data from PUH and is interested in developing standard methods for birth registration across Kosovo. The Association could support the implementation of a new system for standardized registration of congenital malformations.

In addition, a new information system for the management of hospitals and outpatient clinics is about to be implemented (one experiment with the latter is under-way in Gjakovë/Djakova hospital). This could permit the collection of data on discharge from hospital and causes of death in hospital. However, training of hospital staff will be necessary to harmonize diagnostic criteria and practices.

Improving health information systems in Kosovo

There is a clear need to establish and improve the health information systems in Kosovo in order to be able to identify any changes in disease frequency amongst the population. As discussed above, there are budding initiatives amongst interested health practitioners to develop cancer and congenital malformation registries. The health services are beginning to implement systematic data collection in maternity wards (MCH) and the IPH would like to improve information on other diseases.

There is a further need for better data on population and migration. Collaboration between institutions gathering this type of data to produce updated and consolidated estimates, would be of immense value for assessing the frequency of diseases of interest in the population, and also for other health policy and public health uses.

The improvement of the data collection on diseases of interest should start immediately, by providing support to the local institutions to assess adequately the quality of the information they have in hand. The mission team made suggestions during visits to the hospitals and the IPH on collection and analysis of new cases of cancer, as well as on births and congenital malformations from maternity ward books for the last few years. These should be followed up in the immediate future, building on the present interest to establish the capacity for adequate data collection and its critical analysis.

Perceptions of the potential risks associated with depleted uranium in Kosovo

Addressing the health concerns, anxiety and reactions of the civilian population, as a result of their perception of the potential health risks associated with depleted uranium, were part of the work of the mission. The mission reported what was observed through interactions and interviews with many groups and individuals (as no formal assessment of perceptions could be made during the mission), and also considered results of the news media content analysis, conducted weekly by OSCE.

It was observed that international staff working for humanitarian assistance agencies seemed to be the group most concerned with any potential health risks from depleted uranium. At least one agency had issued a memo to its staff, stating that their posting in Kosovo was 'noted' in their staff records, in view of potential health claims in the future. This introduced doubts amongst female personnel regarding reproductive matters. The intended purpose of the policy decision was explained to the mission as being a 'precaution'. There were also questions directed to the mission about whether or not there should be some sort of medical screening.

Almost all ethnic Albanian health personnel interviewed held the view that reports on the potential risks of depleted uranium were politically motivated and fuelled by those who were against the NATO intervention. Much of the Albanian media voiced a similar opinion and this was indicated from the media content analysis undertaken by OSCE. Ethnic Serbs seemed to be of the opposite opinion; health staff in the north of Mitrovica/Mitrovicë region were of the opinion that they are seeing increasing numbers of cases of cancer and congenital malformations. A non-governmental organization (NGO) working with the Serb population voiced a similar concern. They believe that such increases are due to depleted uranium munitions used by NATO. Several military contingents are offering staff a general medical examination and the protocol used by one of those visited by the mission was to look for symptoms of leukaemia and renal diseases. Some of the contingents have also monitored for uranium in urine amongst their personnel and uranium contamination in the environment near their bases. On request, one of these military contingents tested the urine of children living in a nearby village for uranium. The results of these were apparently negative.

Decisions concerning the necessity (or not) of health and environmental screening, the type of data to be collected and analyses to be conducted, the choice of results to be distributed (and to whom) and the strategy for communicating this information are being taken separately by different agencies and military groups. There is, so far, no communication strategy in place that involves all the above players. The mission believes this is fuelling unnecessary speculation and anxiety about potential risks, which, from what can be judged so far, are not present or are minimal.

There is an urgent need for developing a concerted effort to:

1. Bring together all the objective information on the subject obtained by different groups including: health and environmental data being gathered by bilateral agencies and military contingents involved in Kosovo, results from the UNEP's sampling for environmental contamination, health data from the local health services (including the ones which suspect an increase in disease) and the results of this WHO mission.

2. Develop an information strategy based on the gathered information and involving all the above groups in its implementation. This effort should be facilitated by a neutral broker with credibility among the different actors, and should be conducted in a way that ensures transparency and open participation.

Health of military personnel deployed in the Balkans

Claims of health impacts from depleted uranium (presented in the media) amongst some military personnel were the primary source of the contemplated collateral effects to the civilian population living in Kosovo. In particular, claims and viewpoints publicized in the media suggesting increased incidences of leukaemia amongst military personnel involved in deployments across the Balkans led directly to concerns being expressed amongst civilians in Kosovo. This was most notable within the international community and Serb inhabited areas.

KFOR informed the mission about the outcome of the NATO consultation on the possible health effects of depleted uranium in Balkan veterans. It was noted that no distinction was made between soldiers deployed elsewhere in the Balkans such as Bosnia and those in Kosovo. An (unofficial) summary table was reviewed by the mission. It contained the "preliminary input" of 17 nations, comprising about 600 000 troops in total, with information on the number of military personnel deployed by each NATO country in the Balkans and the number of haematological malignancies, non-haematological cancers and deaths among them. Two of those countries indicated in the table that they have compared the age-adjusted frequency of non-haematological malignancies in their soldiers and in the general population and found no increase.

The mission was informed that each nation is currently expected to compare the age-specific mortality rates of military personnel deployed in the Balkans with the rates of those not deployed in the Balkans and the general population. It is understood that this work will also consider separate Balkans deployments and also comparisons of leukaemia incidence between the same study groups. The senior medical advisory committee of NATO (COMEDS) envisages the possibility of a peer-reviewed analysis of these independent studies. It is expected that these results will be made available soon. The mission has urged that the results of these studies are made available as quickly as possible and disseminated widely in order to bring greater transparency to this issue.

The mission also received information from the NGO Médicins du Monde-Greece on the conference on the "Environmental Consequences of the Balkan Crisis", which they organized in Greece on 26 January 2001. At this conference, no substantiated evidence was reported of any health problems in the Balkans that may be linked to depleted uranium.

Other environmental health risks in Kosovo

Several health professionals informed the mission about their concerns regarding other environmental health issues in Kosovo. Very high blood lead levels have been demonstrated in the past and continue to be observed in the population of Mitrovicë/Mitrovica, even after the nearby lead smelter was closed last year. Various studies are available and published. The most recent report from mid-2000 (not yet published) by a French public health institute found persistently high blood lead levels in the resident civilian population many times over the accepted norms. There is a clear need to take action to protect the population, implementing interventions, for example, to prevent exposure of the population to lead dust from large mining waste sites.

There were many reports of a large increase in the number of traffic accidents. Detailed statistics are not available, but a meeting of Institutes of Public Health co-ordinators counted 29 deaths due to road traffic accidents in the two weeks prior to the visit of the mission. A large and sudden increase in the number of vehicles in use, imports of older vehicles, increased road speeds on repaired roads and absence of a driving licence requirement or training are leading to a high level of accidents and many deaths, particularly among young people. The use of seat belts is being enforced, as are speed limits in urban areas. Additional preventive measures are required, and should follow a further analysis of accidents, their risk factors and the identification of blind spots. Solutions will depend on collaboration between health, police, insurance and traffic departments.

There is an obvious high level of smoking in the population. In addition, Kosovo still has problems with fatalities from communicable diseases such as bacterial meningitis, haemorrhagic fever, viral meningo-encephalitis and diarrhoeal diseases. The high incidence of tuberculosis, estimated at between 60 and 70 cases per 100 000 people, should also be a cause for concern and attention by the health authorities.

6. Site Assessments

The members of the mission visited a variety of locations that were identified by KFOR as target sites where depleted uranium from A-10 aircraft had been fired. The team discussed with KFOR the possibilities and necessity for a KFOR mine clearance escort to sites of interest. Due to the short time available it was difficult to arrange this. KFOR subsequently informed the mission that most of the sites of interest were cleared of mines, at least in the vicinity of roadways. Only two of the sites of interest were not visited because it was advised that they may be dangerous due to the presence of mines or other explosives.

Eight sites were visited in the Decan/Decani, Gjakovë/Djakova and Prizren areas. They were selected after consideration of three sources of information:

1. A NATO/KFOR map entitled ‘Mines & Depleted Uranium, as of 15 August 2000’
2. A NATO target list (dated 19 January 2001) indicating the grid co-ordinates of all locations where depleted uranium rounds had been fired
3. The list of sites visited by the UNEP Balkans Task Force mission in November 2000

The WHO mission was not equipped or intended to take field samples for laboratory analysis. Consequently, the purpose of the site visits was to examine typical locations near villages or towns to observe the likelihood of realistic pathways for the transmission of depleted uranium back to a local population.

More specifically, the sites chosen were based, as far as possible, on the following criteria:

- Apparent potential for direct or indirect human exposure:
    1) Site close to a populated area (town or village)
    2) Site in or close to an agricultural area
    3) Site close to a drinking water source
- A large total number of rounds fired at the site
- Locations also visited and sampled by the UNEP team in November 2000
- Prevailing logistic possibilities in the short time period
- Permissible access

Decan/Decani area

Llukë e Epërme/Gornja Luka, DN430100

Small village east of Decan/Decani. Site close to the road about 200 to 300 metres south of the village. Fired rounds: 560. The precise location is difficult to identify. Only a few isolated houses nearby. Agricultural area (grassland and crops).

Irzniq/Rznic, DN464082 and DN474090

Small village. The first site (former barracks of the Yugoslav army) is located by the road passing through the village. Fired rounds: 440. Shells and bombs had hit a few houses.

The second site is about one kilometre north-east of the village, at or close to the road. Fired rounds: 745. Agricultural area (grassland, crops).

Batushë/Batusa, DN393005
A small mountain village situated close to the border with Albania. The targeted site was just south-west of the village and 280 rounds were fired. The surrounding environment was hilly with grassland and woods. Another site (not visited by the mission team) is further up in the mountains, about 1 km from the village. Fired rounds: 560.

Gjakovë/Djakova area
Lagjja e Hadumit
Hill west of Gjakovë/Djakova overlooking the town. On this hill artillery of the Yugoslav army was located. The site was heavily bombed but there is no indication that depleted uranium ammunition was used at this site.

Zhub/Zub
A former police station at the side of the mountain road to the Albanian border was bombed and one isolated house next to the police station was completely destroyed. Area on both sides of the road marked for mines. According to the grid coordinates (DM503893) provided by NATO/KFOR, the depleted uranium rounds were fired a few hundred metres west of the road. It was difficult to gain access to this site and therefore not directly visited by the mission team.

Gjakovë/Djakova, DM525911
The site was a large, former Yugoslav army base in the south-west part of the town, a few hundred metres from the regional hospital and close to the last houses at the end of town. The area was totally destroyed and heavily bombed. Fired rounds: 300. There were (and are) people living close to this site. Of all the sites visited this is the one closest to a large populated area. On the other side of the river, a few hundred metres south, there is a grassland area.

Radoniq/Radonjic Lake, DN534026
The targeted site is located very close to the lake. Fired rounds:655. The lake is used as a reservoir for the drinking water of Gjakovë/Djakova town.

Prizren area
Zhur/Zur, DM680690, DM672693
A village located south-west of Prizren on the main road to the Albanian border. Unknown number of rounds fired at the first site close to the village. At the second target site 286 rounds were fired. This was in the wide valley, close to the river, about two kilometres west of the village. The precise location of the targeted site was difficult to pinpoint since access was restricted due to the presence of unexploded cluster bombs.

Observations at the sites revealed that at several places there could have been a transient exposure of the population during the actual attack if a fire resulted, because the targeted sites were in the proximity (within a few hundred metres) of a populated area. This is particularly the case for Llukë e Epërme/Gornja Luka, Irzniq/Rznic and Gjakovë/Djakova. However, quantitative information on the amount and precise location of depleted uranium dust or uranium oxide products of combustion at the Irzniq/Rznic and Gjakovë/Djakova sites is awaited from UNEP.

If, on the basis of the results of the UNEP analysis, measurable concentrations of depleted uranium are found leading to the expectation that population exposure may have occurred, it should then be considered whether an assessment of health impact is warranted. Also, further information on possible contamination of local wells on or close to attack sites could be needed for such as assessment.

At remote or isolated locations there might be the potential for indirect environmental exposure through, for instance agricultural or animal products or drinking water, but this is regarded as unlikely. This is also the situation for the location close to Radoniq/Radonjic Lake, the water reservoir for Gjakovë/Djakova. Here, considerable dilution would occur to any depleted uranium dust or oxides that may enter the water body. Also, for these locations quantitative information is awaited from UNEP to draw firm conclusions as to any apparent environmental contamination.

Based on its observations, the WHO mission concluded that, in general, elevated human health risks are unlikely. However, quantitative information on the level of environmental contamination (to be provided in the forthcoming UNEP report) and subsequent human exposure is needed to confirm this conclusion.

7. Concluding Discussion

At the outset of the WHO mission it was decided by the team to address four parallel lines of investigation, in order to provide UNMIK with reasoned opinions and practical recommendations, i.e.:

- To consider relevant information from the published literature;
- To review the existing health information system and statistics available in Kosovo;
- To consider if believable pathways for the exposure of the general public to depleted uranium may exist; and
- To gather views and opinions expressed by organizations in Kosovo and to formulate a series of recommendations.

Published literature

Several studies have investigated the environmental consequences of depleted uranium at testing sites and firing ranges, most notably in the US, for example at the Aberdeen Proving Ground, Yuma and Nellis bases, as well as in the Gulf states following the Gulf War. Similarly, various medical studies have been initiated and a growing body of literature is now publicly available. State of knowledge literature reviews were examined by the mission as part of the preparations for the activities undertaken in Kosovo. Two particularly relevant observations were drawn from the literature:

- First, the low radioactive content of depleted uranium compared to natural uranium;
- Second, the lack of authoritative epidemiological and radio-biological evidence that demonstrates the initiation of cancer or serious dysfunction of organs through exposure to depleted uranium.

The scientific literature is unambiguous with regard to the relative radioactivity of depleted uranium. An object composed of depleted uranium contains lower radioactivity than one with the same concentration of natural uranium (as discussed in section 2).

WHO issued a fact sheet on depleted uranium in January 2001 (WHO 2001); it provides an interpretation of the consequences of depleted uranium. The fact sheet points out that no radiation-related increases in leukaemia have been found in uranium workers and that in war zones, even under extreme conditions, the inhalation of dust and smoke will only result in a small increase in radiation exposure. It also points out that the accepted latency period before the clinical identification of leukaemia from any ionizing radiation or other relevant exposures is at least two to five years. This is a period longer than has elapsed since the end of the Kosovo conflict in mid-1999.

VJ (Yugoslav) soldiers are the population group most likely to have been at a site of an attack by A-10 aircraft when the attack occurred. The mission did not receive any information that the civilian population was subjected to air strikes involving depleted uranium munitions.

In an overview of the peer-reviewed medical literature no cases of cancers have been identified as being induced by the presence of depleted uranium in the human body. Possibly the most explicit view has been expressed by Harley et al. (1999) following an extensive scientific literature survey. They state:

> "Although any increase in radiation to the human body can be calculated to be harmful from extrapolation from higher levels, there are no peer-reviewed published reports of detectable increases in cancer or other negative health effects from radiation exposure to inhaled or ingested natural uranium at levels far exceeding those likely in the Gulf [War]. This is mainly because the body is very effective at eliminating ingested and inhaled natural uranium and because the low radioactivity per unit mass of natural and depleted uranium means that the mass of uranium needed for significant internal exposure is virtually impossible to obtain."

The information found in the literature based on studies of populations elsewhere is equally relevant for the people of Kosovo.

Conclusions drawn by the mission from the currently available scientific data:

1. *Depleted uranium is only weakly radioactive and emits about 40% less radioactivity than a similar mass of natural uranium.*

2. *Scientific and medical studies have not established a link between exposure to depleted uranium and the onset of cancers, congenital abnormalities or serious toxic chemical effects on organs. Caution has been expressed by some scientists who would like to see a larger body of independently (i.e. non-military) funded studies to confirm the current viewpoint.*

3. *Soldiers, particularly those at the site of an attack, are the most likely to have inhaled uranium metal and oxides in dusts and smoke. It is likely that the general population would not have encountered this form of transmission pathway or, at the very worst, only in very isolated instances.*

4. *The presence of minute quantities of plutonium in the depleted uranium used in Kosovo was reported by UNEP on 16 February 2001 (press release). UNEP has stated that 'these newest findings on the composition of the depleted uranium only lead to a minor change in the overall radiological situation and therefore should not cause any immediate alarm'.*

Health information and statistics available in Kosovo

A review of the health and population statistics for Kosovo before the conflict and the fragmented data collected after the conflict suggests that a thorough investigation of cancer trends in Kosovo will not be a simple task. Given the time-scale and scope of the mission, it was not possible to analyse the existing data for trends. The health information system in Kosovo at the present time is not functioning in any meaningful way. A few medical departments and institutes are collecting limited amounts of data on a few types of illnesses. Others are collecting no statistical data. Different data collection arrangements are being used and the data is either not being shared or is not comparable. Elsewhere in Kosovo, various individual medical departments are making efforts to collect data, but they are not using a common basis and the lack of reliable population data makes the statistical interpretation of trends impossible.

The current evidence from the scientific literature is that no increasing trend in cancer or congenital anomalies from exposure to depleted uranium in the general population is likely. However, as a measure to confirm this point, it would be beneficial to continue to enhance and improve the collection and monitoring of all forms of ill-health throughout Kosovo.

Conclusions drawn by the mission:

5. *No convincing evidence is available to indicate any health impacts to the Kosovo population associated with the use of depleted uranium.*

6. *The health and population information systems presently available in Kosovo do not permit the reliable identification of any changes in disease frequency in the population.*

7. *The present health information system, in spite of the best efforts of many people, is fragmented and inadequate. In particular, for non-communicable diseases the health information system does not exist. The comprehensive collection and continuing statistical analysis of all forms of recorded illnesses must be re-established swiftly and implemented in all health institutions in the same way. Without a functioning health information system it will not be possible to discern with certainty any health trends in the future, mediated by whatever cause.*

8. *There are a variety of responses to the claims of health impacts from depleted uranium in Kosovo, and no communication strategy that involves all relevant players is in place. Decisions on health screening, environmental monitoring, the type of analyses and treatment to be given to the data collected, which results to distribute and to whom, and how to issue that information, are being taken separately by different agencies and military groups. These different initiatives and pieces of information provided separately by each of these groups add confusion to the present situation.*

9. *Unnecessary speculation and anxiety about the potential for risks from depleted uranium, which, from what the mission can judge so far, are not present or minimal, are being fuelled by the different opinions expressed as a consequence of the normal process of scientific debate, as well as by the lack of a common communication strategy.*

10. *The presence of high levels of lead in people in the Mitrovicë/Mitrovica region and the absence of efficient measures to reduce the long-term exposure to lead, together with the alarmingly high rate of traffic-related deaths, both observed by the mission, require urgent attention by UNMIK and other organizations. The unlikely health effects of depleted uranium exposure, if any, are much smaller in comparison to these causes of death or incapacity.*

Believable pathways for transmission of depleted uranium

In conflict zones, the inhalation and ingestion of depleted uranium contaminated dust, even under extreme conditions and shortly after the impact of projectiles, as determined by the amount of dust that can be inhaled, have been calculated to result in a radiation exposure of less than 10 millisieverts. This extreme situation represents half the annual dose limit for radiation workers. Such an exposure theoretically could result in a small increase in the risk of leukaemia (of the order of 2% over the natural incidence of the disease) which cannot in practice be detected in epidemiological studies. The current epidemiological literature provides no evidence of an increased risk of leukaemia related to uranium exposure among occupational groups likely to be in closer contact with uranium materials than the general population, for example uranium miners or workers milling uranium from nuclear reactor fuel elements.

Several years are needed between exposure to ionizing radiation and development of cancers. As barely two years have elapsed since the conflict in Kosovo, it is not biologically plausible to expect any increase in cancers at this stage, even if there were high doses of radiation.

There have been claims of congenital malformations following the Gulf War, which have been thought to be associated to depleted uranium. These claims have not been substantiated and there are presently no peer-reviewed studies of that association.

The mission team assessed whether realistic pathways existing from an attack site could credibly lead to measurable concentrations of depleted uranium reaching nearby communities. It should be remembered that even if a credible pathway can be identified the possibility of medical effects occurring from the measurable radiation, based on the findings in the published literature, appears to be remote.

Based on the information made available by KFOR, the amount and fate of depleted uranium at an 'average' attack site has been hypothesized by the mission. This was used as a means to understand and visualize more clearly if or how the potential exists for depleted uranium to become mobilized. A 'typical' site situation, developed using data available to the mission on the type of attacks by A-10 aircraft undertaken in Kosovo in 1999, is presented in Appendix 3. A summary of the results is given here.

Summary of depleted uranium at a target site

Spatial distribution of penetrators around an attack site:

Depleted uranium penetrators hitting the target	24	10%

Depleted uranium penetrators landing within 100 m radius	172	72%
Depleted uranium penetrators landing within 1.85 km radius	44	18%
Total at the 'typical' site	240	

Likely form of uranium after an attack:

Depleted uranium as uranium oxides following combustion	3.6 kg	5%
Depleted uranium metal	68.4 kg	95%
Total at the 'typical' site	72 kg	

Likely location of penetrators on the surface and below ground:

Depleted uranium buried (172 x 300 g)	51.6 kg	72%
Depleted uranium on surface as oxides	3.6 kg	5%
Depleted uranium on surface as unburnt fragments	3.6 kg	5%
Depleted uranium on surface as metal (44 x 300 g)	13.2 kg	18%
Total at the 'typical' site	72 kg	

The percentages above are useful when attempting to visualize the fate of depleted uranium in and around an attack site.

The measurable surface radiation extends only a tiny distance from a piece of depleted uranium (about 30 µm in soft tissue). Therefore, the weak radiation from the estimated 72% of the penetrators at a typical site buried within soft soil could be isolated from people walking over the ground.

The rate of corrosion of uranium metal in the environment is slow. The presence of a small proportion of titanium should act to further slow the rate of environmental degradation. A figure of 500 years to decompose a 300g object was discussed in section 3. Consequently, it is regarded as unlikely that the penetrators will degrade quickly once in the environment and hence only contribute a very slow leaching of uranium into the environment. Once leached, the uranium may well become sorbed in an immobile form to the soil or diluted substantially in soil and ground waters.

One literature reference refers to a typical natural uranium composition in soil as 4 US tons per square mile to a depth of 12 inches. The metric equivalent is 1.4 tonne per square kilometre to a depth of 30 cm.

Even if all of the depleted uranium at the illustrative typical site (72kg) eventually degraded and was all within one square kilometre of the target with none removed, the additional amount of uranium compared to the natural occurrence of uranium in the soil would be 5%.

Conclusions drawn by the mission:

11. *For a typical type of attack site on soft soil, only a very small fraction of the depleted uranium from the penetrators is likely to exist in the form of uranium oxides or*

metallic dust on the surface. These are the forms likely to be more mobile in smoke and by wind dispersal. However, even if dispersed, they are likely to become diluted to background concentrations and even then, if some reached nearby settlements, they are not very soluble. Subsequently, even if inhaled or ingested, only a tiny percentage is likely to be absorbed in the body and even then most of what is absorbed would be quickly eliminated from the body through the kidneys.

12. *Most of the depleted uranium is expected to be in the metallic form. Of this, over 70% of the depleted uranium at a typical attack site on soft soil is likely to be buried at depths of up to 3m. Therefore, this depleted uranium will be more isolated from the population.*

13. *The corrosion and degradation of depleted uranium in metallic form will only occur slowly over hundreds of years. For example, soil composition of natural uranium of 1.4 t per square kilometre plus the entire, gradual degradation of depleted uranium at the illustrative attack site would only add about 5% uranium to the natural abundance.*

14. *The quantity of depleted uranium physically available to come into contact with civilians at sites with soft soils is considered to be very small. The only sites where higher percentages of depleted uranium may be at the surface are those with hard ground surfaces. These should be regarded as the priority locations if or when any remedial measures are considered.*

15. *The most believable pathway by which civilians could come into contact with depleted uranium is through picking up objects from the ground surface. Consequently, routine measures to remove depleted uranium objects from the ground surface would be beneficial.*

16. *The likelihood of depleted uranium entering agricultural products is not known but can reasonably be expected to be small given that most of the depleted uranium is in a solid, very slow degrading metallic form.*

17. *The likelihood of depleted uranium contaminating drinking water supplies is equally unlikely, although it is considered prudent to consider the effect of a penetrator landing in the bottom of a family well or village spring water collector tank. The mission found no evidence that this situation has occurred in Kosovo, but the leaching characteristics of depleted uranium in stationary or slow flowing water was not found in the literature.*

Views and opinions expressed in Kosovo

The mission received many views and opinions expressed by individuals, as well as the organizations listed in Appendix 2. They were considered by the mission and addressed below in the context of the information and details presented elsewhere in this mission report.

- *Fence or not to fence the attack sites* – The overwhelming view received from international organizations and local bodies is that the fencing and signing of sites is impractical to maintain over the long term. Experience has shown that at mine and cluster bomb sites with border marking fences and signs, when erected, were quickly removed by local people for their building and personal purposes. It would probably be preferable to institute public education instructing people to report to the authorities if a penetrator is found for subsequent removal, in much the same way they do if a mine or cluster bomblet is seen.

- *Public education* – The mission regards the commencement of public information and education an important activity to organize and sustain. Several medical specialists and administrators have asked for straightforward, relevant and sensibly worded leaflets to give to the general public. The mission regards the supply of public information as being of high importance and emphasizes that this should be integrated into general mine awareness training and not be separated as some type of special problem.

- *Depleted uranium in Mitrovicë/Mitrovica region* – The mission checked this matter specifically with KFOR has and they confirmed that no attacks using depleted uranium rounds took place in the mainly Serb-inhabited municipalities in the northern part of Mitrovica/Mitrovicë. In addition, KFOR confirmed that no depleted uranium rounds were used in attacks in the Morka Gora area near Zubin Potok.

- *Depleted uranium in the VJ forces* – The mission was informed from military sources that there is absolutely no evidence that the VJ used any depleted uranium munitions or armour plating in Kosovo. This clarification was sought by the mission following press articles (e.g. Time magazine, 22 January 2001) in which VJ officers in Serbia mentioned that depleted uranium materials were available within their armoury of weapons. Apparently, these weapons were not deployed in Kosovo at the time of the conflict in 1999.

- *Decline in milk production and birth defects in lambs* – The mission was made aware of various reports by farmers in villages claiming that animals had encountered problems in giving milk or breeding healthy lambs. The mission sought advice from agricultural specialists at FAO and no information was found by them in the literature to link these issues with depleted uranium.

- *Uranium testing in drinking water* – The Administrative Instruction (AI) 2/1999 (Health) in force in Kosovo defines the drinking water quality requirements expected from all drinking water sources. The AI is based on previous water testing regulations that were used in the past by the Federal Socialist Republic of Yugoslavia. The standard testing protocols do not monitor for the presence of uranium in the drinking water. Whilst the mission believes the likelihood of depleted uranium affecting drinking water supplies is low, the introduction of the routine testing of this parameter may help to reassure public confidence regarding the presence of all sources of uranium. The possibility of testing for this parameter by the IPH laboratories should be considered.

- *Soil testing equipment* – The Institute of Radiological Protection in Obiliq/Obilic has asked for equipment to undertake soils testing for the presence of uranium. In the view of the mission this does not seem to be necessary since it is understood that others (public bodies and military agencies) have found little or no radiation. Since actual numerical values were not made available to the mission, it is suggested that this recommendation should be reviewed following the publication in March 2001 of the UNEP Balkans Task Force report.

- *Uranium testing of the general public* – UNMIK announced in January that it is considering making available a testing service for members of the public. The mission has not considered the types of equipment that could be used. Others are addressing this issue. Instead the mission has observed what is being done by KFOR contingents in some places and it is noted that very few soldiers have made the voluntary decision to seek testing. If the reasoning expressed in this report is accepted, then it is not justified to establish a Kosovo-wide mass-testing programme. If to reassure the public some form of testing is still sought by UNMIK, then a limited programme should be considered perhaps for communities near to attack sites. The necessity (or not) of this course of action should be addressed as part of the work of the UNMIK Department of Health and Social Welfare (DHSW) Commission of Experts.

- *Commission of Experts* – The mission attended the first meeting of the Commission of Experts who are responsible to advise the DHSW on practical aspects relating to depleted uranium in Kosovo. It is suggested that the following are added to the terms of reference of the Commission, so that their work is oriented to provide support to local institutions to:

    - Collect routine medical statistics on cancers, congenital malformations and renal dysfunction and assess the data (and its quality) to discern if trends are apparent
    - Act as the repository and knowledge bank on international medical and technical information
    - Assess and justify the need or otherwise for establishing an environmental soil testing capability in Kosovo
    - Assimilate the advice in this report and from other authoritative bodies, then advise DHSW on the relevance of any general or smaller testing programme for the public.

8. Recommendations

The mission proposes the following recommendations for consideration by UNMIK.

Short-term measures for immediate attention:

1. A concerted communication strategy should be developed to inform the local population about depleted uranium and reasons for or the absence of cause for concern, involving the different actors and agencies concerned through:

   - Bringing together all the objective information on the subject obtained so far by different groups including: health and environmental data being gathered by the international military based in Kosovo, results from UNEP's measurements of environmental contamination, analysed health data from the local health services and the results of this WHO mission.

   - Developing an information strategy based on this gathered information and involving all the above groups in its implementation.

   - Preparing useful and realistic information on the topic of depleted uranium for distribution to the general public through the usual community channels, such as clinics, education establishments, community groups, administration offices and the media.

This effort should be facilitated by a neutral broker with credibility among the different actors, and should be done in a way that ensures transparency and participation of the various actors.

2. The public should be encouraged to understand that penetrators should be treated with caution in the same way as other types of munitions found in the environment. If a penetrator is found, then clear advice should be widely available so that it can be reported to the authorities in the same manner as the discovery of mines or unexploded ordnance.

3. The terms of reference of the DHSW Commission of Experts should be reinforced to ensure that they are a focus of an emerging technical capacity within Kosovo to advise UNMIK in the future.

4. The Commission of Experts should be utilized to bring together the local, regional and international bodies to agree a common approach for an improved medical data recording system for Kosovo. Renewed emphasis on this matter is urgently required. This should be coupled with the many independent and disjointed activities attempting to assemble population data in Kosovo.

5. A comprehensive health information system should be made operational as soon as possible. If a comprehensive health information system can only be

implemented in the longer-term, then, with respect to depleted uranium, efforts should be concentrated on establishing cancer and congenital malformation registries. Malformations could, perhaps, initially build upon the current WHO Mother and Child Health Monthly Activity Report. A cancer registry could build upon the data held by pathologists and health professionals across Kosovo.

6. Better population estimates and cause of death statistics are necessary. These could be obtained through multi-agency co-operation, including the UNMIK population registry and IOM, and by providing additional support to the IPH.

7. Mass screening of the population is not recommended on the basis of evidence found in the literature, deductions made by the mission team and respected advice that was received. The mission is sensitive to the strong beliefs held by some members of the public. If these beliefs continue to be held, then a more limited testing regime could be considered based on a medical referral by a local doctor. Issues related to testing options are being considered separately by the Sustainable Development and Healthy Environments Cluster (Executive Director: Ms A. Kern) at the WHO Headquarters in Geneva.

8. The creation of an immediate, separate clean-up programme at target sites where depleted uranium rounds were used is not recommended. Site clean-up activities, should, whenever possible, be part of planned, routine demining activities. During such clean-up activities it is pointed out that (with the exception of hard surface and concrete sites) only a small portion of the depleted uranium rounds will be recovered since most will be buried. The buried penetrators are unlikely to decompose quickly and hence, their addition to the natural environmental abundance of total uranium in soil will be small.

9. Facilities to include the measurement of total uranium in routine drinking water quality samples taken by IPH for public health monitoring purposes should be made available. The WHO has a guideline value that could be used as the basis for quality testing if no other value consistent with UN Resolution 1244 is available in Yugoslav legislation.

Longer-term measures for attention:

10. If the results from the environmental samples taken by UNEP indicate any issues not addressed by the WHO mission, their findings should be considered in the first instance by the Commission of Experts.

11. UNMIK should make a firm commitment and be seen to sustain the continued recording and assessing of key non-communicable diseases and report regularly on their incidence.

12. Future environmental assessment and development planning measures initiated by UNMIK should ensure that potential developers near or at former attack sites are

made aware of the possibility of buried munitions. They should be given clear instructions on who should be notified if ordnance is unearthed.

13. The mission noted the absence of the means to achieve both a reduction of lead exposures in the Mitrovicë/Mitrovica area and a reduction in traffic accidents. Whilst not part of the central focus of the depleted uranium mission they are brought to the attention of UNMIK for action.

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Appendix 1

Mission Terms of Reference, Mission Team and Acknowledgements

1. Collect information on population exposure to depleted uranium and other toxic substances as a consequence of the military operation in the Balkans.

2. Verify the available data on cancer and leukaemia incidence, and other conditions, in the Kosovo population, which might be related to environmental exposure to DU and other toxic agents.

3. Identify potential health risks to people who may have been exposed to these agents, which may require medical monitoring and follow-up.

   In particular, to be able to advise UNMIK on the following:

4. Recommended short-term measures to prevent further exposure, if any, to toxic agents.

5. Recommended possible medium or longer-term actions and a draft work programme.

6. Useful information to be provided to the general public.

7. Other matters that would benefit from taking immediate action.

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Appendix 2

Organizations Assisting the Mission

The following organizations and bodies are acknowledged as having assisted the WHO Depleted Uranium Mission to Kosovo. The list is presented alphabetically.

AC- Laboratorium Spiez, Spiez, Switzerland

Balkans Unit, United Nations Environment Programme (UNEP), Geneva, Switzerland

European Agency for Reconstruction (EAR), Prishtinë/Pristina

Food and Agriculture Organization of the United Nations (FAO), Prishtinë/Pristina

Health Houses
Decan/Decani
Gjakovë/Djakova
    Mitrovicë/Mitrovica

Institute of Public Health (IPH)
Central Laboratory, Prishtinë/Pristina
Gjakovë/Djakova
    Gjilan/Gnjilane
    Mitrovicë/Mitrovica (south)
    Mitrovica/Mitrovicë (north)
    Pejë/Pec
    Prizren

International Organization for Migration (IOM), Prishtinë/Pristina

KFOR
Medical Co-ordination Center, HQ KFOR Main, Prishtinë/Pristina
    French KFOR contingent, Mitrovicë/Mitrovica
    Italian KFOR contingent, Pejë/Pec
    German KFOR contingent, Prizren

Kosovo Protection Corps (KPC), Prishtinë/Pristina

Médicins du Monde – Greece, Prishtinë/Pristina

Mine Action Coordination Centre, Prishtinë/Pristina

Office of the United Nations High Commissioner for Refugees (UNHCR), Prishtinë/Pristina

Organisation for Security and Cooperation in Europe (OSCE), Prishtinë/Pristina

Prishtinë/Pristina University Hospital (PUH)

Regional Hospitals
Gjakovë/Djakova
Gjilan/Gnjilane
Mitrovicë/Mitrovica
Pejë/Pec
Prizren

United Nations Children's Fund (UNICEF), Prishtinë/Pristina United Nations Development Programme (UNDP), Prishtinë/Pristina

UNMIK
Office of the Deputy Special Representative, Civil Administration
Department of Health and Social Welfare, Prishtinë/Pristina
Regional Administrations, Gjakovë/Djakova, Mitrovicë/Mitrovica, Prizren
Regional Health Advisors, Gjakovë/Djakova, Mitrovicë/Mitrovica, Pejë/Pec, Prizren
Municipal Administration, Decan/Decani

United Nations Population Fund (UNFPA), Prishtinë/Pristina

World Health Organization (WHO)
Headquarters, Geneva, Switzerland
Regional Office for Europe, Copenhagen, Denmark
Humanitarian Assistance Office, Prishtinë/Pristina
Regional Health Advisors, Gjakovë/Djakova, Gjilan/Gnjilane, Mitrovicë/Mitrovica, Pejë/Pec, Prizren

Appendix 3

Illustrative Proportions of Depleted Uranium Around a Site

The amount and fate of depleted uranium at an ‘average’ attack site has been hypothecated as a way of exploring if or how the potential for depleted uranium to become mobilized can be visualized. The ‘typical’ site situation developed using data available to the mission on the type of attacks by A-10 aircraft undertaken in Kosovo in 1999 is presented in Appendix 3. A summary of the results is given here:

1. Rounds fired

31000 rounds were fired from A-10 aircraft (rounded up to next one thousand)

divided by

112 separate attacks by A-10 aircraft in Kosovo

Hence, the average number of rounds fired during each attack = 300 (rounded up from 277)

Geographical sites that were attacked more than once were not considered in this hypothetical illustration.

2. Depleted uranium : high explosive rounds

Four depleted uranium (DU) rounds are fired for every high explosive (HE) round

Therefore, for an average of 300 rounds at a ratio of 4:1 (DU:HE) this would involve the use of 240 depleted uranium rounds at each site

3. Weight of depleted uranium

Each of the 240 rounds has a penetrator containing depleted uranium weighing 300 g

Therefore, the weight of depleted uranium that could be reasonably expected at a typical site is 72 kg

4. Fate of the depleted uranium rounds

Combat simulations in America found that less than 10% of the rounds fired by an A-10 aeroplane hit the target (Stolfi et al. 1979)

From the 240 rounds of depleted uranium at a typical site, 24 could be expected to hit the target and 216 would miss the target. Of the 216 rounds that missed the target, 80% (172 rounds) would land within a 100 m radius of the target and 20% (44 rounds) could land up to one nautical mile (1.85 km) radius from the target. This is based on details provide by KFOR.

4a. Rounds hitting the target and igniting
A round hitting the target should catch fire and less than 50% of the mass of the depleted uranium penetrator will burn, with the remainder as un-burnt fragments and dust.

Correspondingly, using a worst case of 50% of the mass igniting, the estimated amount of depleted uranium converted into uranium oxides as combustion products would be 3.6 kg:

24 rounds hitting the target X 50% of 300 g = 3600 g (3.6 kg)

4b. Rounds missing target and un-burnt
The rounds missing the target are regarded as less likely to ignite and will remain as depleted uranium metal.

216 rounds missed the target X 300 g together with the remaining un-burnt portion of the 24 rounds hitting the target X 50% of 300 g = 68400 g (68.4 kg)

The total quantity of depleted uranium metal at the typical site would be 68.4 kg

5. Surface or buried
For the 216 rounds that missed the target on a hard surface such as concrete, almost all of the penetrators would probably remain on the surface as intact objects or broken fragments.

On soft ground such as moist soil, it is assumed that the 80% of missed rounds expected to land within 100 m of the target (172 penetrators) would enter the soil and become buried at depths up to three m. This is because of the normal, reasonably steep angle of attack of the A-10 aircraft. The remaining 20% (44 penetrators) expected to land further away do so, in part, because of the shallowing angle of attack at the end of an air strike. The penetrators are therefore assumed to represent the likely number that may land on the surface.

6. Summary of depleted uranium at a target site

Spatial distribution of penetrators around an attack site:		
Depleted uranium penetrators hitting the target	24	10%
Depleted uranium penetrators landing within 100 m radius	172	72%
Depleted uranium penetrators landing within 1.85 km radius	44	18%
Total at the typical site	240	
Likely form of uranium after an attack:		
Depleted uranium as uranium oxides following combustion:	3.6 kg	5%
Depleted uranium metal	68.4 kg	95%

Total at the typical site	72 kg	

Likely location of penetrators on the surface and below ground:

Depleted uranium buried (172 x 300 g)	51.6 kg	72%
Depleted uranium on surface as oxides	3.6 kg	5%
Depleted uranium on surface as un-burnt fragments	3.6 kg	5%
Depleted uranium on surface as metal (44 x 300 g)	13.2 kg	18%
Total at the typical site	72 kg	

7. Penetrators likely to contribute to measurable surface radiation

The measurable surface radiation extends only a tiny distance from a piece of depleted uranium. Therefore, the weak radiation from all of the estimated 72% of the penetrators at a typical site with soft soil would be isolated from people walking over the ground.

Consequently, for the scenario an equivalent of about 68 penetrators (intact, fragments or dust) could be on the surface. This represents around 20.4 kg including the quantity becoming uranium oxide combustion products after ignition when the target was hit.

8. Degradation rate for buried penetrators

The rate of corrosion of uranium metal in the environment is slow. The presence of a small proportion of titanium will act to further slow the rate of environmental degradation. A figure of 500 years to decompose a 300 g object was discussed in section 3. Consequently, it is regarded as unlikely that the penetrators will degrade quickly once in the environment and hence they will only contribute a very slow leaching of uranium into the environment. Once leached, the uranium may well become sorbed in an immobile form to the soil or diluted substantially in soil and ground waters.

One literature reference refers to a typical natural uranium composition in soil as four US tons per square mile to a depth of 12 inches. The metric equivalent is 1.4 tonne per square kilometre to a depth of 30 cm.

Even if all of the depleted uranium at the typical site (72 kg) eventually degraded, all within one square kilometre of the target and none was removed, then the additional amount of uranium compared to the natural occurrence of uranium in the soil would be 5%.