GICHD Advisory Note

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Depleted Uranium (DU) hazards in post conflict environments

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1. Introduction and Scope

In the past, there has been major media speculation and interest in the potential hazards presented by DU contamination in post-conflict environments. This has resulted in the publication of speculative material about the possible risks to health from DU. Much of this published material is not supported by existing scientific knowledge of the real health hazards posed by DU.

This GICHD Advisory Note [1] has been written to advise the international humanitarian community of all the potential hazards of DU and to provide guidance on the establishment of a safe operating environments and procedures. Any DU clearance tasks should only be undertaken by appropriately qualified EOD personnel or other qualified staff; they are not a task for other field staff.

2. Background

Recent conflict has seen the limited use of DU munitions by both air and ground forces to destroy ground targets, mainly AFVs. The legacy of the use of these munitions currently remains in Bosnia and Herzegovina, Kuwait and Kosovo; it could be a threat following other future conflicts.

DU ammunition is known to be currently in service with the armed forces of Israel, Russia, UK and USA, and is reportedly under development by India. It is thought that DU ammunition is restricted to the following generic types of ammunition;

a) Armour Piercing Fin Stabilised Discarding Sabot (APFSDS) tank and AFV ammunition in calibres including 25mm, 105mm and 120mm;

b) 20mm cannon rounds for the U.S. Navy's Close-In Weapons System (CIWS), commonly referred to as "Phalanx"; and

c) Cannon rounds, both 25mm and 30mm, for U.S. ground attack aircraft, including the A-10 "Warthog," and the AV-8B "Harrier."

3. The DU threat

3.1. Uranium

Natural uranium is a material of low radioactivity, which can be handled, worked and stored with simple safety precautions. When enriched uranium is manufactured from natural uranium, a residue of depleted uranium is left, which is markedly less radioactive than the initial uranium; it is no more chemically toxic than lead.[2]

Natural uranium exists as three isotopes of different half-life and different radioactivity in the following proportions:

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[1] Further details on the Clearance of DU hazards can be found in Technical Notes for Mine Action (TNMA) (http://www.mineactionstandards.org/).

[2] UK Ministry of Defence website, (http://www.mod.uk/index.php3?page=2442).

ISOTOPE	ABUNDANCE (ATOM %)	DISCHARGES / MINUTE	HALF-LIFE (YEARS)	REMARKS
^{238}U	99.200%	10^5	10^9	The parent of the natural uranium series.
^{235}U	0.720%	10^6	10^8	the parent of the natural actinium series.
^{234}U	0.006%	10^{10}	10^5	A daughter product of ^{238}U decay.

The ^{235}U and ^{234}U are more active and are therefore more commercially useful isotopes. In order to provide the commercial uranium industry with a standard for the activity of uranium, a level of 0.711 weight% (wt%) of ^{235}U is considered to be natural uranium. ^{235}U was chosen for this standard because it is the most relevant isotope for use as fuel in nuclear reactors. To exceed this 0.711wt% requires processing, to produce what is known as "enriched uranium". The remaining uranium substrate from which the ^{235}U has been removed to enrich other uranium is known as "depleted uranium" (DU). This DU usually has less than 0.2wt% ^{235}U content.

To display sufficient radioactivity to be commercially useful, uranium requires enrichment to more than 8.0wt%. At this level, the radiation hazard exceeds the metal's toxicity. DU, with a ^{235}U component of less than 0.2wt% emits too little radiation to cause serious harm, and therefore the hazard is metal toxicity.

DU is a by-product of the uranium enrichment process and is also widely used as ballast or counterbalances in ships and aircraft. It is also used as radiation shielding and in non-nuclear civil applications requiring high-density material.

DU is comprised almost entirely of ^{238}U isotopes; it is approximately 60% as radioactive as natural uranium and behaves, chemically and physically in the same way as natural uranium.

The uranium industry has been operating for over 50 years and the experience gained from handling uranium in its raw, enriched and depleted state over this period has provided the basis for the handling and use of DU. As a result of this experience, care and safety standards have been developed to reduce the potential hazards of handling and using DU to a minimum.

3.2. DU ammunition

DU is used in kinetic energy attack munitions because of its metallurgical properties; it is metallurgically similar to steel, thereby allowing similar production and processing techniques to be used. The very high density allows for much higher kinetic energy levels to be delivered to the target than an equivalent round made of, for example, steel. A secondary effect is that the DU oxidises readily, thereby proving a pyrophoric effect within the target.

The combination of design, high mass and high velocity allows the DU round to penetrate the target using the principle of hydrodynamic penetration. The pressures involved are so high that the armour of the target flows away from the DU penetrator

3.3. Identification of DU fragments

DU fragments have the following physical characteristics:

a) non-magnetic;

b) extremely heavy. (In relation to size DU is 60% more dense than lead);

c) jet-black coloured lumps or dust, possibly with a greenish tinge. After three to four weeks they will turn green;

d) honeycombed or aerated texture;

e) they retain heat. (DU fragments will retain heat to the point where they will cause serious burns for three to four hours after firing. A red hot core may be coated with black dust and therefore appear cool); and

f) sparking. (When cold, if struck with a metallic object such as a pick or shovel, they it spark in a similar fashion to a lighter).

3.4. Depleted Uranium (DU)

3.4.1. Health hazards

The health hazards depend on:

a) the route of exposure, (inhalation, ingestion or contact in wounds);

b) the magnitude of exposure; and

c) the particle size and solubility of DU.

Effects due to external exposure would be limited to radiological effects, whilst the effects due to internal exposure include both radiological and chemical toxicity effects.

Information on the health and environmental effects of DU is limited. However, since uranium and DU are essentially the same, except for the composition of their radioactive components, scientific studies on natural uranium are applicable to DU.

Notwithstanding these hazards, the real risks have been assessed as minimal, provided appropriate safety precautions are taken and followed.

3.4.2. Radiation dose rate

DU emits alpha, beta and gamma radiation. Alpha radiation will not penetrate clothing or even skin. The radiation dose rate at the surface of unshielded DU is approximately 2.3 milli sieverts per hour (mSv/hr). A large proportion (98%) of this dose rate is attributable to beta radiation.

The density of DU means that only radiation emitting from the surface is a factor, as the DU itself shields the internal emissions.

Despite this decay rate, it is emphasized that DU is not a nuclear, radiological or chemical weapon; the DU is used because of its high atomic mass/density and metallurgical properties.

3.4.3. Hazard reduction

The bare DU material (either as a complete round or as pieces of a fired penetrator) would have to be handled in excess of 200 hours before the UK Safe Exposure Limit (SEL) of 500mSv (for the hands) is exceeded. This SEL is extremely conservative. The external radiation hazard to the hands can be significantly reduced by the wearing of gloves that attenuate the beta dose further, giving safe times of up to 5000 hours per year.

The risk can therefore be considered to be low and it becomes negligible once gloves are worn.

3.4.4. DU dust

A slightly increased hazard to those undertaking EOD clearance arises from the presence of DU dust produced as a result of fire or explosion. Ingestion, inhalation or the passage through an open wound or abrasion of DU particles could, but is very unlikely to, affect the kidneys and lungs.

Insoluble DU particles could accumulate in the lung parenchyma; this presents a low toxic risk because of the insolubility, but could lead to localised low-level radiation damage.

Soluble DU particles at a low concentration level can be rapidly excreted by the kidneys without damage. At very high concentrations, there is a possibility of renal necrosis followed by regeneration. However, to reach these high levels, an individual would have to be exposed to DU dust particles, without any form of personal protection, for a very long time. Normal EOD operations require the use of PPE, and are completed long before there is any real risk of surpassing even the low concentration levels.

The UK Defence Radiological Protection Service (DRPS) consider the precautions recommended in this Technical Note are more than adequate to provide protection. Good personal hygiene, such as the covering of cuts and grazes before work commences and the washing of hands after work will further reduce the already small hazard.

The respiratory protection requirement is related more to the chemical toxicity of DU than to its radioactivity. The danger from heavy metal poisoning may exceed the radiation hazard.

3.4.5. DU contamination from stored or unbroken fired rounds

In all DU ammunition, the DU component of the projectile or round is contained within a steel or aluminium jacket. Should it be obvious that the projectile or round is intact, being either unfired or having impacted on a soft surface, and the jacket appears to be unbroken, the rounds have virtually nil hazard.

3.4.6. DU fragments and contamination from fired rounds

As the sub-projectile, (penetrator), of DU ammunition hydro-dynamically penetrates through a target it breaks up into fragments, some of which can be quite large. At the same time, very high temperatures are generated within the DU and DU oxide is dispersed into the atmosphere, albeit in very small quantities.

DU fragments will be in all shapes and sizes. Some may still be oxidizing and, as such, their cores will remain red hot up to some hours after firing.

4. Safety brief

Humanitarian organisations should ensure that all of their managerial, administrative and support staff are briefed as to the hazards of DU if they have to move in a potential DU environment. Although such personnel should not be actively involved in the clearance of DU hazards, they may inadvertently place themselves in a potentially hazardous situation by examining targets hit by DU munitions.

The following safety brief [3] should be made available to such personnel:

[3] Developed from the DU Safety Brief given to NATO troops prior to deployment to the Balkans.

DU is a heavy metal, which is used primarily in anti-armour ammunition in the main armament of battle tanks, and in the cannon of some ground attack aircraft. It is only slightly radioactive and it has a chemical toxicity similar to lead.

There is no appreciable hazard when the DU round is intact, even after firing, but there is a minor hazard when the DU round strikes a hard target. This can result in DU dust and fragments around the target to a radius of 50m. There is only a risk if particles are eaten, breathed in or enter the body through an open wound. Even then, there is only a very slightly increased risk of cancer, or liver failure, over the next 50 years.

You should be aware that it will not be possible, except with special instruments, to detect whether a damaged target has been struck by DU. The following precautions should be taken.

a) *Do not enter or climb onto a damaged hard target, or loiter within 50 metres, unless you are working in co-operation with an EOD technician.*

b) *If your work requires you to work within 50 metres, wear a facemask and gloves, and roll your sleeves down. Cover any cuts and abrasions with waterproof dressings. Spend as little time as practicable on the task.*

c) *Do not eat, drink or smoke near the damaged target. After completing your task, wash and shower as soon as practicable. Remove your outer clothing and, if feasible, replace it. Otherwise, have it laundered. Do not eat, drink or smoke until you have done so.*

d) *If you suspect you have been exposed to DU, inform your medical support team.*