

## **APPENDIX R- Aerial Use of DU During the Gulf War**

### **R.1 U.S. Air Force**

In the early 1970s, the U.S. Air Force developed the GAU-8/A air-to-surface gun system for the A-10 Thunderbolt (“Warthog” or “Tank Buster”) close-air support aircraft. This seven-barreled 30mm cannon was designed to have the 30mm round penetrate the heaviest of the Union of Soviet Socialist Republics tanks, OSAGWI, (1998).

At the onset of the air campaign during the Gulf War, the A-10 Thunderbolts aircraft operated about 8,000 feet above ground level to remain out of the range of the anti-aircraft fire. However, during the ground war the A-10 Thunderbolt aircraft operated in close support of the ground troops, OSAGWI, (1998).

The Air Force fired the 30mm, armor-piercing incendiary (API) PGU-14 munitions, each having a 300-gram DU penetrator slug from the GAU-8 Gatling gun mounted on the A-10 Thunderbolt. The gun can fire at a rate of 3,900 rounds per minute. A typical burst is 120 to 195 rounds or a 2 to 3 second burst.

During a typical strafing run, approximately 50 to 100 DU rounds are fired. These rounds will be spread within an area of about 500 m<sup>2</sup> (10 meters wide and 50 meters long). About 10 to 20 DU rounds will hit within this 500-m<sup>2</sup> area, and the total mass of DU in the area would be 3 kg to 6 kg of DU.

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If three A-10 Thunderbolts work together against a target(s), the amount of DU expended within the area might be about 9 to 18 kg. There may be more than one target in the same general area. In tests at Nellis Air Force Range, the DU dust from a hard-target impact was deposited within a distance of 100 meters from the target. In tests with larger caliber (120mm) DU munitions, about 90 percent of the DU residue was within about 50 meters of the target.

The A-10 Thunderbolts deployed to the Gulf flew 8,077 combat sorties. A typical combat load would include 1,100 rounds of 30mm high explosive or armor-piercing ammunition from the GAU-8. The combat load typically was API mixed with 30mm high-explosive incendiary (HEI). The combat mix was a ratio of API to HEI of 4:1 (80 percent API and 20 percent HEI). The Air Force fired a total of 783,514 (PGU-14) 30mm rounds in the Gulf War. This relates to about 97 DU rounds per sortie. It is estimated that the U.S. Air Force expended about 259 tons of DU during the Gulf War, OSAGWI, (1998).

The PGU-14 round has about 6 percent of the mass of a M829A1 round. The M829A1 round is fired from the Abrams tank. Therefore, it would take about 16 PGU-14 rounds to equal the mass of DU in an M829A1 round.

The primary kill mechanism of an API penetrator is fragmentation. The fragments are a mixture of the heavy metal penetrator and armor, OSAGWI, (1998).

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There are at least two other incidents that occurred during the Gulf War for which there is inadequate information to estimate the exposure and intake of DU by exposed personnel.

- The first incident involved an A-10 Thunderbolt that reportedly crashed and burned at King Khalid Military City, Saudi Arabia. It is presumed to have had a combat load of ammunition. Eyewitness accounts of First Responders indicate that very few rounds "cooked-off" during the fire. In addition, testimony from eyewitnesses, indicate that the fire was extinguished shortly after the crash by firefighters and that the runway cleared for operation within approximately 30 minutes after the crash, OSAGWI, (1998). Based on these eyewitness accounts, it is estimated that very little DU was released into the atmosphere. Therefore, personnel exposures and intakes of DU are estimated to be in the range as those identified in the OSAGWI Levels II and III scenarios. As more information becomes available, a more detailed assessment can be made.

- The second incident is what was reported as a "hot-gun" response for an A-10 Thunderbolt that involved a "hang-fire". During the ammunition unloading procedure personnel may have been exposed to airborne DU residue and direct external exposure from handling the intact 30mm DU rounds. Because "hang-fire" problems typically do not result in starting fires, very little oxidation of the DU rounds would have occurred. This would limit the amount of oxidized DU residue available for an internal intake. Therefore, it is estimated that their exposure and intake of DU would be in the lower range as those exposed in the OSAGWI Levels II and III scenarios. As more information becomes available a more detailed assessment can be made.

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These fragments become pyrophoric when the super-heated metal particles begin rapidly oxidizing. It is estimated that the temperature of the fragments will reach about 2,000°F filling the vehicle with hot gas and burning metal fragments. These fragments easily ignite flammable and combustible material upon contact causing flash, heat, shock, and overpressure for the vehicle occupants.

In Air Force tests prior to the Gulf War, the A-10 Thunderbolt flew at an altitude of 200 feet, an angle of 1.8 to 4.4 degrees, and a slant range of 2768 feet to 4402 feet. The weapon effects on the hard target (T-62 tank) were 90 percent miss and 10 percent hit with a 2 percent kill.

## **R.2 U.S. Marine Corps**

The U.S. Marines developed the GAU-12 air-to-surface gun system for the AV-8B Harrier Close Air Support System. This six-barreled 25mm gun pod was designed to be centerline mounted, OSAGWI, (1998).

The AV-8B Harrier aircraft deployed to the Gulf flew 3,342 sorties. A typical combat load would include 300 rounds of 25mm with an equal mix of DU and high explosive rounds. The average turnaround time for flight operations during the ground war was 23 minutes, OSAGWI, (1998).

The U.S. Marines fired 25mm PGU-20 munitions, each having a 150-gram DU penetrator slug from the GAU-12 Gatling gun center mounted on the AV-8B. The Marines fired 67,436 (PGU-20) 25mm DU in the Gulf War. This relates to about 20 DU rounds per sortie. Therefore, it is estimated that the U.S. Marines expended about 11 tons of DU during the Gulf War, OSAGWI, (1998).

The PGU-20 round has about 3 percent of the mass of an M829A1 120mm round. Therefore, it would take about 31 PGU-20 25mm rounds to equal the mass of DU in an M829A1 round.

### **R.3 Discussion**

Due to the pyrophoric nature of DU, many of the DU particles and fragments that are formed during and following impact and perforation will spontaneously ignite, resulting in a shift of the particle size probability distribution function to a smaller mean diameter. As a result of physical differences between DU and its oxides, the oxide particles tend to crumble under relatively weak mechanical forces, further shifting the particle size to an even smaller mean diameter, Parkhurst et al., (1995b).

There are limited data on the precise number of munitions expended and of sorties flown against tanks and other vehicles. Also, because it is impossible to systematically collect and compare battle damage assessment data to assess munitions hit-and-kill rates, the level of effectiveness

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that was achieved during the Gulf War for the various DU munition types used is impossible to know.

Since many of the spent DU munitions would have hit soft targets, such as the sand, DU would be present as intact penetrators or as large fragments on the surface of the ground or very near the surface of the ground. This is very different from having a contaminant mixed homogeneously in the sand.

Each strafing run could result in a different pattern of “hot spots” (spent penetrators) on the surface.

Surveys conducted by various DOD survey teams have not found DU-contaminated sand in the Gulf environment simply because they do not have access to areas where there may be “hot spots” with deposited DU fragments. The DU was expended primarily in the battle areas, which are in southern Iraq and not the rear areas of Kuwait and Saudi Arabia. To date, there has never been a definitive assessment of the deposited DU and its migration potential in the Gulf area. It has been nine years since the end of the Gulf War. Due to the changing environment from sand and rainstorms, it is believed that any comprehensive environmental sampling strategy and plans would produce totally different and perhaps meaningless data with respect to the OSAGWI Levels II and III exposure scenarios.

The amount of intact DU that is embedded in the sand is impossible to estimate. Some of the PGU-14, 30mm and PGU-20, 25mm DU penetrators have been found intact at a depth of 12 inches (30 cm) in soft soil.

Soil (sand) samples have been collected in various areas of Kuwait and the “Highway of Death”. To date, the uranium levels that have been found in the soil samples have been indistinguishable from the naturally occurring uranium in the environment.

The major air strikes and tank battles took place in Iraq. To date, areas are not accessible to DOD survey teams. Since the ground war 24-28 February 1991, multiple sandstorms and rainstorms have reduced the ambient DU concentration via weathering, USAFE TAC, (1992). Any DU fragments that remained have solubilized and released DU to the ground surface soil layer at a rate of about 1 percent per year.

Based on the exposure assessment and risk characterization for Level II individuals, the conclusion is that the exposure of personnel, who entered DU-contaminated Iraqi vehicles and equipment that had been perforated by either the 30mm, PGU-14 or the 25mm PGU-20 rounds, would be less than that reported for Level III Scenarios.