

# Davy Crockett M101 Spotting Round

## INFORMATION GUIDE



## INTRODUCTION



The Department of the Army developed this booklet about the 20mm Spotting Round (M101), which was used with the Davy Crockett Weapon System, as a means of meeting its commitment to transparency. This booklet informs the public about the Army's research concerning the deployment of the Davy Crockett Weapon System and the use of the M101 that contained depleted uranium (DU).

Since our Nation's founding, our military has conducted extensive training to prepare for combat and to protect the United States from outside attacks. This role continues today.

Davy Crockett M28 light weapon - note size of barrel that fired the M101

Key to meeting this national defense role has been the military's conduct of live-fire training and testing with military munitions. Between 1961 and 1968, the military used the M101 spotting round in training. The M101 was a small (about 8 inches in length and 1-inch diameter) low-velocity projectile weighing about one pound and containing 6.7 ounces of DU. The use of the M101 during live-fire training throughout this time period may have resulted in DU being deposited in large fragments on some ranges. The Army developed a report on each installation where there is evidence of the use of the M101. The reports are based on extensive archive research and site surveys at installations and sub installations.

We believe that providing information to the public about the M101 and DU will help address your questions and concerns. We hope you find this material informative and helpful. Should you have any questions or concerns, please contact your local Army Public Affairs Office (contact information provided on the back of this brochure).

## BACKGROUND

The Davy Crockett Weapon System was in the Department of Defense's (DoD) inventory of weapons between 1961 and 1971. The Davy Crockett was a battalion-level nuclear-capable recoilless weapon used by infantry, armored, airborne and mechanized divisions. This system consisted of the M28 (Light Weapon), which was deployed between 1961 and 1968, and the M29 (Heavy Weapon), which was used until 1971. This nuclear capable weapon system fired practice projectiles that contained high explosives during training. The M101 20mm spotting round, which was only used with the M28 Light Weapon, was used to verify the aiming point of the weapon system. The M101 was a small (about 8 inches in length and 1-inch diameter) low speed projectile weighing about one pound and containing 6.7 ounces of DU. Unlike modern munitions that use DU as penetrators to defeat enemy armor, the DU in the M101 was used to provide weight sufficient for the spotting round to simulate the flight of the supercaliber Davy Crockett projectile.



M101 spotting round and cartridge case—key shown for scale

Approximately 75,000 M101 rounds were manufactured. The Army demilitarized approximately 44,000 of these M101 spotting rounds at the original manufacturing facility. For the others, the US Army Corps of Engineers (USACE) researched the identity of Army ranges in the United States where the M101 may have been used. Once this records review identified a potential range, USACE conducted site surveys or worked with the local Army office to determine whether there is evidence that live-fire training with the M101 occurred at a range.

The Army would have conducted training with the Davy Crockett Weapon System at Department of the Army (DA) major and subordinate installations. During such training, only M101 spotting rounds and practice supercaliber projectiles would have been used.

The Army will address DU under the statutes, treaties or regulations that apply to the property where the range is located in an open, transparent manner.

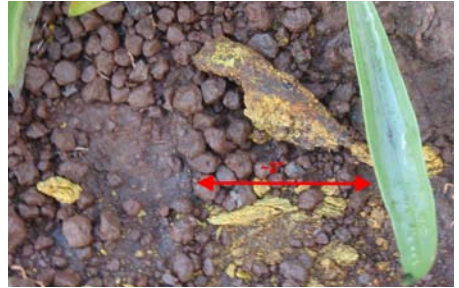
## WHAT IS DEPLETED URANIUM (DU)?

DU is a processed form of uranium. Uranium is a heavy metal, naturally occurring in the environment, and is radioactive with a relatively lower level of radioactivity than some other radioactive elements. Rocks, soil, water, air, plants and animals all contain varying amounts of uranium. Because it is found everywhere on earth, we eat, drink and breathe a small amount every day. People have been mining uranium and using it in various applications for over 60 years, so there is a great deal of information available on uranium.

DU is the uranium left over from the process that enriches uranium for commercial and military uses. Enrichment is a process where a portion of the most radioactive isotopes of uranium are removed from naturally occurring uranium. DU is nearly twice as dense as lead, with 40 percent less radioactivity than an equal amount of natural uranium.

Under certain circumstances and at very high temperatures, DU can aerosolize into small particles. During a prescribed burn of brush on ranges at Schofield Barracks where DU from the M101 was known to be present, air sampling did not detect DU. Additionally, DU has not been detected in air samples collected outside of the impact areas, and it is highly unlikely that DU will migrate off the impact area.

Future re-suspension of small particles of DU from the M101 due to range activities is remotely possible, but to date has not been seen. Studies have determined the re-suspension of DU is primarily due to particle size rather than particle density or chemical form. DU may oxidize (e.g., rust) and form smaller particles but these will typically bind to soils and remain near the point the original fragment was deposited. It appears the DU is relatively immobile in the environment because of the large particle size of the DU metal fragments from the M101 and DU's tendency to bind to soils once oxidized. Although it is highly unlikely that DU will move off an impact area due to wind or military live-fire training, the Army will address DU under the statutes, treaties or regulations that apply to the property where the range is located in an open, transparent manner.



DU fragment. Often DU is found in the form of flecks and grains. Because of the physical and chemical properties of DU associated with the M101, it does not migrate far from where it was deposited. Note the distinctive yellow color of the uranium oxide.

## WHAT IS DU USED FOR?

DU is currently used by the armed forces as armor to protect Army and Marine Corps tanks and their crews. DU armor, which is designed to cause rounds to function prematurely or bounce off the exterior of a tank, provides unsurpassed protection against enemy anti-tank munitions. When used in armor-piercing projectiles, DU provides unmatched capability to engage and penetrate enemy armor at distances out of the range of the enemy's weapons systems.

DU is also used in commercial applications that require very dense material. These include: ballast and counterweights in airplanes and ships, radiation shielding and collimation in medicine, radiation therapy and industry.



## SHOULD I BE CONCERNED?

No. The Army takes very seriously all issues and public concerns arising from DU. The community's health and safety, on post and off, is our top priority. As such, the Army is taking appropriate, proactive measures to assess the overall situation and to coordinate with the appropriate governmental authorities regarding further actions. This principled approach relies on federal and international scientific methods and protocols in consultation with state, federal and other government officials to ensure public health and safety. The Army is researching historical archives and local installations to determine the locations of M101 rounds and their fragments.

Based on careful analysis of the data gathered, there is no immediate or imminent health risk to people who work at Army posts or live in communities adjacent to these military facilities from DU residues from the M101 present in the impact areas. The Army believes that health effects are unlikely for several reasons:

- Any DU residues from the M101 present are limited to impact areas well within the perimeter of operational ranges. Because explosive hazards (i.e., unexploded ordnance) are normally present on operational range impact areas, public access is generally prohibited and authorized access is strictly controlled. Authorized access is strictly limited to personnel fully trained to recognize the potential hazards associated with military munitions.
- Numerous studies conducted by non-military agencies, including the World Health Organization and the US Department of Health and Human Services, have not found credible evidence linking DU in the environment to radiation-induced illnesses.
- The migration of DU off a military installation by natural processes is highly unlikely. Studies have shown that DU transport is limited and that it is unlikely to move from a range under most conditions. Studies also have shown that the DU fragment size and the environmental conditions on Army ranges serve to prevent migration, including by air. Nevertheless, the Army will monitor ranges where there are DU residues from M101 use present, when required to ensure the protection of human health and the environment.
- The Army conducted an extensive survey at Schofield Barracks covering over 425 acres, which resulted in over 1,400 air, vegetation and soil samples sent to independent labs for testing and analysis. These data were used to perform a risk assessment released in 2008 that concluded that "no adverse human health impacts are likely to occur as a result of exposure to the uranium present in soil." The Army is using this comprehensive analysis along with information concerning the presence of DU at each range and other installation- and range-related factors (e.g., land access, adjacent communities) to assess potential health risks posed.

The bottom line is that there are no imminent, immediate or long-term adverse health effects to the public expected from DU residues from the M101 present on Army ranges, and the Army will address DU under the statutes, treaties or regulations that apply to the property where the range is located in an open, transparent manner.

## **CURRENT RESPONSE INITIATIVES**

The Army conducted research and site surveys to identify installations where the M101 was used. These include installations in the United States and in several countries where the Army had training bases in the 1960s.

The Army followed a deliberate process in identifying all locations where the M101 was used. This process included historical research at the National Archives, regional headquarters and local installations. A report of the research was prepared for each installation visited.

Using information in the report, the Army, along with local officials, will assess the potential health and environmental risks associated with the M101 fragments. The Army, in consultation with the appropriate federal and state agencies, will determine based on applicable statutes, treaties and regulations whether a response is required. The Army's actions will be open and transparent.

The Nuclear Regulatory Commission (NRC) has been advised of the situation and has been provided updates on actions being taken to address the presence of DU on Army installations in the United States. (The NRC does not license activities outside the United States.) The Army filed an application for an NRC license to possess the DU on its operational ranges in the United States, and the NRC will license these ranges for long-term environmental monitoring or clean up.

Additionally, the Army is in constant communication and coordination with a wide array of DoD and non-DoD federal agencies.

## **QUESTIONS AND ANSWERS**

### **What forms of uranium make up the DU we have encountered?**

DU used in the M101 is comprised of the same three uranium isotopes of natural uranium found in the earth: U-238, U-235, and U-234. DU is formed as a by-product of the enrichment of natural uranium. The enrichment process removes the lighter isotopes from natural uranium, so that the remaining material is "depleted" in U-235 content and is called DU. The lighter isotopes, U-235 and U-234, are more radioactive than U-238. Because the remaining material contains more U-238 and less of the more radioactive isotopes, DU is 40 percent less radioactive than an equal amount of the naturally occurring uranium that is found in the food, water and air that you consume daily.

### **What is the radioactive half-life of uranium and why does it matter?**

Half-life is the time it takes for one-half of the atoms of a radioactive element to change (transform) into another element. Uranium 238, the primary component of DU, has a half-life of over 4.5 billion years. Half-life is important because it tells us how long an element will be around and it is also an indicator of how radioactive it is. DU has a relatively long half-life which means

it will exist for a relatively long period of time, but it also means it does not produce as many radioactive emissions over the length of time that a person might be exposed to it.

### **How does the Army find the DU from the M101 spotting round?**

The first step is to thoroughly research the historical records. National Archives and local records are searched to find evidence of historical use of the M28 Davy Crockett Weapon System. Sometimes, live-fire training with the M101 can be confirmed by a records search.

Once a potential range was identified, Army experts conducted a site survey or coordinated with the local Army office to determine whether evidence was present that live-fire training with the M101 occurred on the range. During these surveys, the experts searched for highly visible supercaliber projectile launch pistons that indicate that live-fire training with the M28 Davy Crockett occurred and that the practice round—the M101—would have been used.



Launch pistons are several feet long and provide evidence of Davy Crockett training.

If launch pistons are found, it is easy to locate the area where M101 fragments may be found. It is possible to find DU fragments from the M101 when the tell-tale pistons are not found; however, doing so takes much longer and may require the use of radiation detection instruments.

### **The Army has said that no DU weapons are used on Army installations during training. Isn't this an example of training use?**

Current Army and DoD regulations prohibit the use of munitions that contain DU in training. An Army representative had indicated in early 2000 that munitions containing DU were never used during live-fire training in Hawaii. This was believed accurate until the discovery of fragments from the 1960's era M101 in 2005 and determination that this munition contained a DU alloy.

About 40 years ago, a weapon system named the Davy Crockett was used by the Army under a classified DoD project. Information about where the Davy Crockett was tested or deployed to include what military units received training on the weapon was only known to a small number of individuals. This restriction combined with the standard practice of the Army, at that time, to routinely remove local files and send them to the National Archives for storage, unfortunately resulted in the lack of knowledge by current Army officials pertaining to the use of DU in certain training events that occurred on Army installations.



Tail assemblies belonging to the M101 spotting round. The yellow uranium oxide can be seen on the right side of the assembly. Note the small size of these items.

Immediately after the discovery of the M101 fragments at Schofield Barracks, Hawaii, the Army determined that the round contained DU and launched an investigation into the history of use of the Davy Crockett weapon system to learn the extent of its use on DoD ranges. It was discovered that a number of other military installations may have been used for training with the Davy Crockett. These have been included in a systematic review of historical records and site surveys that the Army recently completed.

### **Are DU munitions being used in current operations by the military?**

This is an operational question that should be addressed to the appropriate Service public affairs personnel. However, several modern weapons systems, (e.g., the Abrams tank, the Bradley Fighting Vehicle, the Air Force's A-10 aircraft) fire military munitions that contain DU. It should be noted that the DU used in the M101 had a different composition and was used for a different purpose than the DU used in the penetrators of modern military munitions. DU is used in stabilizers and ballast in aircraft, boats, and even cruise missiles. DU is also used in tank armor. Given these non-munitions uses, DU may be present on the battlefield, even when munitions that contain DU are not being fired.

Current Army and DoD regulations prohibit the use of munitions that contain DU in training.

### **Health**

#### **How radioactive is uranium and how hazardous is it to humans and the environment?**

Uranium is a heavy metal, naturally occurring in the environment, and is radioactive with a relatively lower level of radioactivity than some other radioactive elements. DU remains after the majority of the most radioactive isotopes are removed from natural uranium. As part of nature, humans and animals ingest small amounts of this naturally occurring substance from the air, water and soil. Studies on uranium conducted up through 2005 consistently indicated that the health risks associated with DU exposures are considered to be low.

Epidemiological studies (16 studies) of some 30,000 workers in the United States radiation industries were performed. A few of these workers, particularly in the early days of the industry, had recorded significant exposures to uranium particles. According to leading scientists in radiation health effects, there have been no recorded cases of illness among these highly-exposed workers as a result of their exposure to uranium. Natural uranium and DU have not been linked to any health effects at low exposures.

#### **Can exposure to DU cause cancer?**

The risk of contracting cancer from exposure to DU is considered negligible. Cancer rates observed in a population of 19,000 highly exposed uranium industry workers at Oak Ridge National Laboratory from 1943 to 1947, showed no excess cancer rates through the year 1974. Other epidemiological



studies of lung cancer in uranium mill and metal processing plant workers have demonstrated no excess cancer rates from exposure to uranium and were primarily attributed to other materials known to cause cancer (called carcinogens), such as radon.

### **Can DU cause kidney damage?**

It is possible. Recent studies have examined possible health effects from DU exposure related to its chemical -- heavy-metal -- effects, and not related to radiation. The best understood of these potential health risks is damage to the kidney, as was determined in high-dose animal experiments. More importantly, these studies indicated that acute kidney damage would only occur if the amount of uranium in the human body was at a much higher level than what would occur with any exposure to DU contained in the M101.

### **How can the past use of the M101 spotting round on operational ranges affect human health?**

There would be little to no risk to the public, including employees who work on an installation, even if DU residual material from the M101 is present on a range. Any DU present on a range as a result of the live-fire of M101 would be expected to be contained within the range's impact area. These areas are normally located well within the installation boundary. Health hazards related to DU are generally limited to persons who ingest or inhale DU.

Because explosive hazards (i.e., unexploded ordnance) are normally present on operational range impact areas, public access is generally prohibited and authorized access is strictly controlled. Authorized access is strictly limited to personnel fully trained to recognize the potential hazards associated with military munitions.

### **What is being done to address local community concerns about DU contamination on Army ranges?**

The Army takes very seriously all issues and public concerns relating to DU. The health of the community, both on and off an installation, is a genuine concern to the Army and regarded as top priority. The Army, in consultation with local, state and federal officials, is taking appropriate, proactive measures to assess the overall situation and determine the need for further actions.

### **Will the Army test employees exposed to DU on our ranges?**

Yes, if Army employees have the reasonable potential to have ingested or inhaled DU. The potential for exposure is very small since DU is confined to impact areas and access to the impact areas is generally prohibited due to the hazard from unexploded ordnance. Even range maintenance workers who periodically enter these areas are unlikely to have received a measurable exposure to DU.

## **Migration in the Environment**

### **What is the potential for DU from the M101 spotting round to migrate off range?**

Such migration is highly unlikely. DU is similar to certain other heavy metals in its low potential to dissolve and leach or migrate in surface or groundwater. DU may oxidize (e.g., rust) and form smaller particles, but these will typically bind to soils and remain near the point the original fragment was deposited. Under most conditions, DU does not move significant distances from where it is deposited. The impact of an M101 would be expected to deposit DU in fairly large fragments that would be unlikely to move off range due to their weight. This and the tendency for DU to bind to soils once oxidized makes migration unlikely.

The potential for leaching and migration of DU in the environment by natural processes is also dependent upon a variety of factors (e.g., ground cover such as trees and grass, soil pH, proximity to surface water bodies, depth to groundwater, and steepness of terrain). Studies have shown that DU does not tend to move from the location where it is deposited.

### **Is DU from the M101 contaminating our rivers and streams?**

It is highly unlikely given that the amount of DU that was used at any one range is small. Studies also suggest that DU is unlikely to move from a range under most conditions. The Army believes it is important to protect the environment within and around our installations and has therefore established conditions for conducting a site specific hazard assessment and establishing an environmental monitoring program when required on installations in the United States. For overseas installations, the need for further action will be coordinated with all appropriate government agencies.

### **Does DU from the M101 spotting round aerosolize on Army training ranges?**

The M101 used in the 1960s only served to mimic the flight trajectory of other Davy Crockett projectiles and mark the point of impact. The use of the M101 would have resulted in the small amount of DU in the round being deposited in large fragments in the immediate vicinity of the point of impact. This round would have broken apart instead of burning or aerosolizing. It should, however, be noted that the M101 was removed from the Army's inventory in 1968, and DoD and Army regulations now prohibit the use of munitions that contain DU in training.

### **How much DU gets suspended into the air during live-fire exercises on ranges where the M101 spotting round was used?**

Very little, if any, DU would be put into the air because vehicles and personnel that are the most likely to disturb the DU are restricted from entering impact areas where the DU is present. Live-fire impacts may further fragment M101 remnants and disturb soil, but would be unlikely to cause particles tainted with DU to be transported outside the impact areas. A study is underway which will provide us more information to determine whether DU dust is actually transported outside the impact areas.

## **Could fire aerosolize the DU? Can DU, once vaporized, spread off the range?**

DU aerosolizes at a very high temperature, much higher than temperatures produced by brush fires. During a prescribed burn-off of brush on ranges at Schofield Barracks where the DU from M101 was known to be present, air sampling did not detect DU. Additionally, DU has not been detected in air samples collected outside of the impact areas and it is highly unlikely that DU will migrate off the impact area. Nevertheless, when required to ensure the protection of human health and the environment, the Army will address DU under the statutes, treaties or regulations that apply to the property where the range is located in an open, transparent manner.

### **Measurement**

#### **Can Geiger counters detect DU?**

Yes, Geiger counters, which are non-specific, will detect DU, provided the detector is within a few inches of the DU. A Geiger counter is unable to detect low concentrations of DU in the air. Additionally, because the instrument responds to other radiation sources and not solely to DU, it is not always possible to know what is being measured.

#### **Why does the radiation detector I purchased show a high level of radiation in the air?**

This is not an easy question to answer without knowing the type of instrument being used. Because there are natural fluctuations in natural background levels and the detector used might respond to these levels, the meter indication could result from a variety of sources. Because of the low levels of radioactivity associated with DU, you must be close to the piece of DU before you can detect radiation from it.



Surveying for DU is usually conducted on foot and requires the detector be kept close to the ground. This is a time consuming process, particularly in heavy vegetation or rough terrain.

### **Administration**

#### **When will the information being developed be released to the public?**

When the research is completed, the public will be informed of the results. The results are expected to be made available in 2011.

#### **How is the Army addressing the need for independent analysis and oversight?**

The NRC reviews and evaluates the Army's work at installations in the United States subject to NRC regulatory jurisdiction to ensure public protection and compliance with applicable law. The Agency for Toxic Substances and Disease Registry reviewed the Army work and provided a health consultation on the Schofield Barracks actions. The Army will address DU under the statutes, treaties or regulations that apply to the property where the range is located in an open, transparent manner.

## ***DON'T FORGET***

The M101 was used on ranges where explosive hazards are routinely present.

To avoid injury or death, follow the 3Rs of explosive safety:

**Recognize** that you may have encountered a military munition;

**Retreat** from the area, do not touch or disturb; and

**Report** suspect munitions to local emergency responders, call 911.

## **WEB INFORMATION RESOURCES**

### **DHHS Uranium Toxicological Profile & Public Health Statement**

[www.atsdr.cdc.gov/toxprofiles/tp.asp?id=440&tid=77](http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=440&tid=77)

**DoD Depleted Uranium (DU) Library** - <http://fhpo.osd.mil/du/>

**Deployment Health Clinical Center** - [www.pdhealth.mil/du.asp](http://www.pdhealth.mil/du.asp)

### **Health Physics Society DU Fact Sheet**

<http://hps.org/documents/dufactsheet.pdf>

### **International Atomic Energy Agency, DU Questions and Answers**

[www.iaea.org/NewsCenter/Features/DU/du\\_qaa.shtml](http://www.iaea.org/NewsCenter/Features/DU/du_qaa.shtml)

### **US Army Public Health Command (Provisional)**

<http://phc.amedd.army.mil/topics/workplacehealth/hp/>

### **World Health Organization, DU Exposure Guide**

[www.who.int/ionizing\\_radiation/en/Recommend\\_Med\\_Officers\\_final.pdf](http://www.who.int/ionizing_radiation/en/Recommend_Med_Officers_final.pdf)

Local contact information

For additional information call your local

U.S. Army Public Affairs Office

or see

the US Army's UXO Safety Education website

<https://www.denix.osd.mil/uxosafety>

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