PM STRAUSS & ASSOCIATES

Energy and Environmental Consulting

MEMORANDUM

TO: Cory Harden

FROM: Peter Strauss

DATE: August 1, 2008

SUBJ: **Independent Review of Pohakuloa Training Area (PTA): Depleted Uranium from the Davey Crockett Weapon System**

Introduction

In 2005, spotting rounds associated with the Davy Crockett Light Weapon were discovered during routine activities at Schofield Barracks. These spotting rounds contained depleted uranium (DU). Spotting Rounds were used in practice for targeting the weapon. DU was used because of its heavy weight and density, which was supposed to mimic the trajectory of the projectile. The practice projectile did not contain any DU.

The Davey Crockett Weapon system was a tactical nuclear weapon, designed for use in the field. Target training of the weapon took place in three ranges in Hawaii. The suspected ranges include Makua Military Reservation (MMR) on Oahu, Pohakuloa Training Area (PTA) on Hawaii, and Schofield Barracks Impact Area on Oahu. For MMR and PTA, an archive search was done. A Technical Memorandum summarizing the results of the survey was completed in April 2008. This report focuses on PTA.

PTA is located on the island of Hawaii between Mauna Loa, Mauna Kea, and the Hualalai Volcanic Mountains Its elevation ranges to approximately 6,800 feet to 9,000 feet. Groundwater occurrence on the island of Hawai‘i is not well studied, although groundwater is used as the major drinking water source on the Island. Depth to groundwater is approximately 600 to 2,000 feet below ground surface (bgs). The 29-year average annual precipitation on the northern portion of the installation ranges from 10 to 16 inches.

The Davey Crockett Weapon System

This weapon system was based on recoilless rifle, a launcher similar to the shoulder-fired bazooka used during the Second World War. This weapon system, which was produced from 1960 until 1968, was used in training until 1968. It contained a warhead equivalent to 10 tons of TNT in destructive power. Only 80 warheads were produced during the first generation of the weapon. This was replaced by the W-48 warhead. The W-48 could be used in a more standard 155 mm howitzer. The W-48 increased destructive power of the earlier weapon by 7 fold. Together, almost 1,000 of these warheads were produced. Below is a picture of the earlier weapon, mounted on a truck.

In 1962, this weapon system was tested in Nevada; a picture of that explosion is shown below.

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http://www.youtube.com/watch?v=khyZI3RK2lE

The Davey Crockett used a piston to fire each practice round. It was like a booster: the piston is discharged from the weapon, and falls off the projectile, anywhere from 30 to 60 feet from the weapon. The practice rounds had a range of approximately 1,000 to 1,500 yards. The DU spotting rounds were used to help the weapon system operator to target the weapon accurately. The spotting rounds were equipped with a small explosive charge to provide the operator of the weapon with information on the accuracy of weapon. If the operator did not hit the target with

the spotting round, it would adjust the weapon and fire another spotting round. This would be repeated until the spotting round hit the target; after which the practice round was fired. Below is a photograph of the DU spotting rounds recovered from the Scofield Barracks.

U.S. Army Analysis

Analysis of the extent of DU on PTA was done by Cabrera for the Army. It first did an archival search. Because the weapon system was classified, this may have been more difficult than anticipated. Afterwards, a field scoping survey investigations conducted at PTA areas in August of 2007. The scoping survey was performed to assess the presence of DU fragments that might have originated from past training activities involving Davy Crockett. The survey's objectives were to identify whether the Davey Crockett was used at PTA, and if so, where and to what extent. It used historical data, aerial reconnaissance, radiation detection, and soil samples. If it was found that the Davey Crockett was used, readily visible DU was retrieved, where possible. Soil samples, were collected, if possible. Both of these latter tasks were made difficult because of the unexploded ordinance on the PTA.

The aerial survey revealed the presence of pistons used to fire practice rounds. "A rough estimate showed there to be approximately 30-100 pistons at each of four locations."

The field teams made "rough" calculations based upon the location of the pistons, the operational range of the Davy Crockett system, and the likely firing points. Once these calculations were made, field personnel traveled to the likely impact areas. Field teams made two trips into the impact area. The field team consisted of three personnel, one of which was the UXO escort. Where terrain, vegetation, and safety concerns allowed access, radiological surveys to measure levels of alpha, beta, and gamma radiation were done. It is important to note that DU is a composite of different isotopes of uranium, but on the whole it is chiefly an alpha emitter. Alpha particles will usually not penetrate an ordinary sheet of paper or the outer layer of skin. Alpha radiation is more damaging than the same dose of beta or gamma radiation. Further, alpha particles are very heavy and very energetic compared to other common types of radiation. Uranium is also a weak gamma emitter. As such, in areas that have naturally occurring uranium, it is very difficult to discern the presence of DU through standard radiation detection techniques.

During the first trip into the impact area, no locations were identified. During the second trip into the impact area, the team located one spotting round. The round was recovered intact. No soil

samples were collected because the round was resting on basaltic rock.

Soil samples were collected at areas where sediment had accumulated from past runoff/erosion events. Ten soil samples were collected around the perimeter of the suspect impact areas at the PTA during the scoping survey. All of the samples were analyzed for isotopic uranium by alpha spectrometry. All of the results are consistent with naturally occurring concentrations of uranium. None of the results indicate the presence of depleted uranium. Soil samples collected around the perimeter of the site did not indicate the presence of DU, although the consultant (Cabrera) noted that the data "do not represent a statistically significant data set".

The results of the PTA scoping survey confirmed four areas were used to test fire the weapon, as described above. There was only one siting and recovery of a spotting round. The report noted that sampling of the impact areas would yield a more significant result. Furthermore, "Cabrera recommends that the Army conduct a characterization survey of the impact range, with an emphasis on defining the impact areas, eliminating areas where possible from further evaluation, and developing data appropriate to support a human health risk assessment."

Analysis of Cabrera Report

Number of Practice Rounds

Based on aerial reconnaissance, there is definitive evidence that the Davey Crockett weapon was used at PTA. Anywhere from 120 to 400 pistons were identified by air at PTA (30 to 100 in four locations). Because of the sparse vegetation on PTA, the Army is confident that this is probably the extent of practice firing at PTA, although it cannot be ruled out that other locations were missed. If this estimate is correct, up to 400 firings of the weapon took place. However, the number of times the weapon was fired based on aerial reconnaissance can only be roughly estimated by this method. If vegetation or terrain blocked visual recognition, one may have not been able to identify a firing location, or the presence of discharged pistons. To be conservative, I would use the upper end of this range. Note that the Davey Crockett practice rounds were made of plastic with an explosive charge. They would not leave a signature on the firing range after more than 50 years. (As noted above, I have confirmed that the practice rounds did not contain DU.)

Number of Spotting Rounds

I have estimated that up to 120 to 2,000 spotting rounds were fired on the PTA. The Army has stated anywhere from one to five spotting rounds were used for each practice round. Again, I would use the upper end of this range, because of the roughness of the estimates. The spotting round was made of a DU/molybdenum alloy, containing 92% DU, weighing 6.7 ounces each. Thus, if the maximum number were fired, 770 pounds of DU would be present on PTA. (If only one spotting round was fired for each practice round, there would be 46 pounds on PTA.)

Further evidence of the amount of spotting rounds was revealed in the archival survey. It was confirmed that 714 spotting rounds were shipped, containing 275 pounds of DU. In my opinion, this is not definitive – merely it is indicative that at least one shipping document was located. Record searches of shipping papers dating back 50 years cannot be relied on as a definitive source – but may be used as a first step in understanding if there is a problem. It should be noted that the ITRC UXO Team stated that "It is critically important to recognize the potential limitations of many initial historical reviews. The historical research may not be exhaustive and may not have identified all potential munitions sites or hazards". Furthermore it states that

"Some initial historical reviews may be cursory reviews that are not intended to be an all-inclusive, exhaustive review of available historical records. Such reviews are usually intended to provide enough information to identify areas that require an immediate response or to prioritize the site for the next step in the munitions response."

It should be noted that I personally have not performed an archival search, and have not reviewed the Archival Search by the US Army Corps of Engineers (2007), except for the summation in the Technical Memorandum. There is no information about the use of the Davey Crockett in the summation with regards to PTA, only that there were 12 firing ranges on PTA. However, the Army's Radiation Health Specialist feels confident that only 714 spotting rounds were shipped.

Location of the DU

The Army attempted to get a better picture of the extent and location of DU on PTA by using radiation detectors in the field. Because DU is primarily an alpha emitter – it does not travel far and can be easily shielded, detection is very difficult. Ground surveys using radiation detectors suffer if one is not immediately above an item, so long as it is not shielded. As noted in the Army's analysis, upon identifying the firing locations, estimates of four impact areas were made. Personnel traveled to the likely impact areas - however in the scoping survey, "the rough terrain limited accessibility to the suspected impact areas". During one trip, no spotting rounds were identified; during a second trip one spotting round was identified. This highlights the limitations of scoping survey, but says little about the presence or extent of DU on the range.

Soil samples and laboratory analysis are the most reliable technique for identifying the presence and migration of DU. However, soil samples depend on locating the sites where the rounds have fallen. The samples that were taken were taken from the perimeter of the impact area, and are not reliable indicator of what is on the site. No other biological, air or groundwater analysis was done to more accurately identify the location of the DU.

All that being said, there is little reliable information about the location of DU on the four impact areas.

Health Threat of DU

The health effects of DU are controversial. The science surrounding DU's effects on the body is rapidly expanding due in large part to the concerns that have arisen from its use in weapon systems deployed in the Gulf War and the 1999 NATO action in the former Yugoslavia and the health effects that are known as Gulf War Syndrome. DU is primarily dangerous to people when it gets inside the body: through ingestion or inhalation. Inside the body, DU creates risks both as a toxic heavy metal and as a radioactive material. Exposure to DU in water is regulated largely because uranium is known to be nephrotoxic (toxic to the kidneys).

But health effects can only present themselves if there are exposure pathways. Below I have briefly described the issues involved with the two major potential pathways at PTA. One is through inhalation, the other through ingestion of drinking water.

Inhalation

Inhalation is of concern both in the short term and the long term. In the short term, it is probably more critical to workers in the field than residents of the island. It is unlikely, in my opinion, that small particles of DU would be inhaled unless the person was in the immediate

vicinity. Wind-carried particles would not likely carry very far because of the weight of the DU. Because the spotting rounds were not vaporized, but broke into fragments, off-site inhalation would be unlikely. Homeowners nearby took air samples and had them analyzed, and there did not appear to be the presence of uranium above background. Although the samples were collected by the Homeowners Association and the chain of custody and quality control probably did not follow general procedures, I would have expected the same result.

However, should changes to the land-use take place, recreational or other users could be exposed to DU through this pathway.

Ingestion

Infiltration and percolation of surface water could potentially dissolve and transport chemicals deposited in surface soils to the subsurface, including DU. However, it is posited by the Army that most of the mass of chemical residues are expected to dissolve relatively slowly in water and would remain in shallow soils. A Professor at the University of Hawaii has stated that "the high binding affinity that U (Uranium) has for Fe (iron)-rich particulates found in Hawaii soils should help immobilize the U (i.e., DU particles) near the point of impact." I agree that geochemistry of the site makes it unlikely that DU is leaching from the surface to the groundwater. However, because of the sparseness of information about groundwater, and the fact that it supplies the majority of drinking water for the Island, long-term monitoring of groundwater, as recommended below, is important.

Recommendations

I have several recommendations for further action.

1. Ensure follow through on Cabrera's recommendations

   The Army is just beginning to follow up on the Cabrera recommendations (i.e., "the Army conduct a characterization survey of the impact range, with an emphasis on defining the impact areas, eliminating areas where possible from further evaluation, and developing data appropriate to support a human health risk assessment"). Greg Komb indicated that the Army is flying over the impact areas with radiation detection devices, using low-flying helicopters to detect radiation anomalies. In my opinion, it's unlikely that a helicopter would be able to distinguish readings from natural background. However, Greg Komb has stated that in flat terrain over the Scofield Barracks, he was able to discern the presence of DU. Regardless, aerial radiation detection would be gross, and in my opinion, I would not rely on it for evidence. Instead statistically significant soil samples analyzed by mass spectrometry and field radiation detection should be carried out, except where there are concerns about safety due to the unexploded ordinance in the impact areas.

2. Establish Long-Term Monitoring

   Long-term monitoring of soil and groundwater is essential to ensure that DU is not migrating through the environment. In particular, potable supplies of groundwater should be monitored. After any DU is found and cleared, then perimeter sampling of soil should be sufficient. I would recommend that the sampling be done annually, and after five years with no indication of DU, it may be adjusted to once every two years. Potable water supplies should be monitored annually. In addition, and as the Army intends, if there is any construction activity on PTA, soil samples and radiation

detection should take place. If any DU is found, then a wider area should be surveyed.

3. Defining a Hazard

   During my conversation with Greg Komb he stated that unless there were a hazard it would be unlikely that the Army would take active steps to remediate the area. I asked him what this meant, using the example that if he discovered 2,000 spotting rounds, would he consider this a hazard? The question was left unanswered. The Army needs to inform the public about how they would define a hazard that would lead to further action. From my review of munitions response documents, hazard assessment is based on a site-by-site analysis, and does not have strong regulatory guidance. Keep in mind, however, that probably the greatest hazard on PTA is from UXO.

Sources of Information

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