November 2006

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Explosive Harvesting Program

The Explosive Harvesting Program is a research and development program funded by the U.S. Department of Defense Night Vision and Electronic Sensors Directorate Humanitarian Demining Research and Development Program. The concept was designed by Golden West Humanitarian Foundation and is being jointly developed with the Cambodian Mine Action Centre.

Program Background

The Explosive Harvesting Program was designed to alleviate this problem. The effort mobilized as a joint project between Golden West Humanitarian Foundation and the Cambodian Mine Action Centre in March 2005 with the following goals:

- Develop a deployable, cost-effective means to remove explosives from munitions such as artillery, anti-tank mines and anti-personnel.
- Develop the methodology to convert the recovered explosives into neutralisation and/or disposal tools for demining and explosive ordnance-disposal teams.

The initial concept involved using three 20-foot (6-meter) containers for Standardisation shipping containers incorporating all the equipment required to conduct operations. The local support would be fuel, water and an unpopulated location from which to work.

Instead of building the system in a Western country and shipping it abroad, Golden West elected to construct and develop the system in Cambodia, imposing only those critical items that could not be found locally. The reason behind this approach is simple: research and development efforts designed in developed countries sometimes fail once they are sent to the field. The most common reasons are logistics and spare parts. By assembling the system in Cambodia, it is expected that 90 percent of problems will be identified during the development process and overcome; those, when it is deployed elsewhere, enough spares are on hand to support the operations and a functional recovery system is in place for consumables. Since January 2006, the on-site team has moved the EHP from development into refinement.

The initial program design was based on using industry-standard equipment for cutting explosive-loaded munitions with some specialization to the specific mission required to complete the process. The team had previously established that recovering explosives from excess ordnance and constructing disposal charges can be accomplished safely in a field environment. It is now focusing its efforts on assessing if this equipment is the most cost-effective and supportable means to safely accomplish this task.

We are looking for ways to evaluate whether explosive recovery is a cost-effective approach, as opposed to importing explosives. As we have already built the facilities to test various methods safely, we are going down the line starting with the key elements. The major issues we are focusing on are cost, safety, supportability, size and weight.

EHP Cutting Equipment

Based on recognized technologies used in the remote cutting of unexploded ordnance, we used available data and selected two systems: the BH/DoD Osprey hydro-abrasive cutter and the metal-cutting saw. We first selected the Osprey cutter, but after using it in a production role, as opposed to an explosive-ordnance-disposal role, it was determined that hydro-abrasive methods were actually not well-suited. We then discovered that some organizations have adapted commercial metal-cutting band saws for remote operation and successfully cut open stockpiled explosive ordnance. This approach was tested at our site and proved to be a much more suitable system.

BHR/DoD Osprey

Cost is obviously a key issue as there is no sense in building a system that most end-users cannot afford. Off all equipment purchased for this program, the hydro-abrasive cutting system was the most expensive.

Hydro-abrasive methods are recognized as the safest means to cut explosive ordnance. Worldwide, over 100,000 pieces of ordnance have been safely and humanely destroyed by non-primitive primary explosives such as lead azide and mercury fulminate.

Before purchasing the cutting system, we completed an extensive market survey, and we found the BHR/DoD Osprey was the best price available. Following extensive testing, the British Ministry of Defence selected this machine as a standard, which aid ed us in our decision to purchase the Osprey.

While developing this new system for harvesting explosives, we found it important to ensure the hydro-abrasive cutting system can be supported in field conditions. This objective includes the ability to work in remote locations where resupply is difficult; local manpower has minimal skills and only the bare essentials, such as fuel and water, are available. While the Osprey is a fine machine, it is moderately complex and the operator must be certified by a factory-authorised trainer. It also requires a large supply of imported 100-micron silicon sand to work effectively; the sand found in Cambodia was not suitable even after screening to the correct micron size.

With the Osprey, on projectiles up to 122 mm, between 150 and 200 grams (5–7 ounces) of explosive is lost in the water run-off. If only one or two projectiles were to be cut, this would not be a major concern. However, for a production line processing many projectiles, the water must be trapped and evaporated and residue destroyed to avoid an environmental contamination problem.

Metal-cutting saws. Based on all of these issues with the hydro-abrasive method, we determined a different approach should be identified and tested. While looking at alternatives, we found an African ammunition manufacturer had been using modified metal-cutting saws with great success. Further investigation revealed other test centres have also used metal-cutting saws on explosive ordnance. Our research showed that over 3,000 pieces had been cut using this process, and only one accident occurred when a power backjaw ran out of cutting fluid and was not shut down.

After learning of this technique, the team procured an inexpensive metal-cutting band saw through local sources and tested the system on empty shell casings to assess the cutting speed and temperature. The team made some adjustments, modified the controls for re- more operation and conducted more tests, after which the team felt confident in testing the saw against explosive ordnance in our secure testing site. The testing of this site is sufficient to protect the team from blasts of up to a 155 mm high-explosive projectile, so safety is maintained at all times.

Results. The test results exceeded our expectations. Neither the casing nor explosives exceeded ambient temperature, not was there a measurable loss of explosives. We found that using the metal-cutting saw allowed us to cut the ordnance four to five times faster than with the hydro-abrasive system. It must be noted the band saw cannot perform the full range of tasks that can be done with the hydro-abrasive system. The Osprey was designed for field deployment to cut fired, fused ordnance. This task should never be attempted with a band saw.

Some more modifications and testing are planned for the band-saw technique; however, for processing stockpiled ordnance and converting it into disposal charge, the initial results show a 25 percent decrease in capital equipment costs with a 150 percent increase in production capability.

The sustainability in remote locations is greatly improved and training requirements for local staff are minimal. This approach also eliminates the environmental concerns of the hydro-abrasive system, and the hazardous waste stream of the production line is all but eliminated.

EHP Operations

Explosive recovery. Along with reducing the time required to cut open a projectile, our Cutting, Melting and Casting Manager improved the steam shaper used to extract the explosives from the ordnance casing. Compared with our previous techniques, this new steam shaper has reduced the time for removing the explosive by over 25 percent. The exact time varies with the projectile size and fillers; however, a broad average for TNT- and Composition B-loaded projectiles between 122 and 152 mm (5–6 inches) in diameter is now only three minutes. The explosives drop free from the projectile casing as a solid piece. Once the explosives have been allowed to dry and cool, they are weighed and inventoried.

Casting operations. As cast TNT is not standard blasting caps, the team has analyzed mixtures of TNT and other commonly available main charge explosives to create a set of individual charges and to make the recovered explosives go as far as possible.

For larger charges, detonators with detonating cord kits are first cut; then TNT is cast over the booster, which ensures full contribution of the TNT. Maximum explosive use is being made of locally available, low-cost containers that allow large allowances for accountability and reliability tracking. Once mixed, the individual charge is cast to a date pre-determined, made to order and from what type of projectile the explosion was recovered.

Figure 1: An early prototype of the 100-gram (3.5-oz) “caseless” charges produced by the EHP. The explosive formulations systems used in the charge, so the detonating charge is not be compromised.

Figure 2: Measuring the temperature of the projectiles casing and explosive main charge immediately after it was cut with the modified metal-cutting saw. The water used to cool the saw is cooled with ambient temperature. Note the smooth surface of the main charge, with no noticeable loss of either during the cut. Micrograph courtesy of M. Hess, GWHF.

Figure 3: Two views of a USG/120-mm GT-462 TNT-filled projectile as cut in half with the Osprey hydro-abrasive cutter. Photo courtesy of R. Hess, GWHF.
pressed TNT-filled projectiles. Our team noticed a substantial difference between the texture and density of Russian and U.S. TNT. Working on a hunch, our Explosive Ordnance Disposal Supervisor created a detonator well in a small piece of Russian TNT for a standard blasting cap and tested it against a 20-mm (1-inch) steel witness plate. It detonated with full contribution.

Research revealed that the Russian manufacturers used a process called “screw loading” for filling large-caliber projectiles with TNT. This makes what the Western technicians would call “pressed TNT.”

This fact was not referenced in any of our manuals, however when this specific type of ordnance is available, the harvesting process becomes far simpler. The recovered explosive can be quickly converted into half-moon or wedge charges without complete recasting, producing disposal charges that are extremely well-suited for explosive ordnance disposal and detonating operations.

As of October 12, 2006, the Cambodian Mine Action Centre and The HALO Trust have destroyed over 5,000 landmines with these charges, repurposing a nearly 100-percent success rate.

EHP Achievements

Stockpile reduction. EHP’s working relationship with the Royal Cambodian Armed Forces is excellent, and they are fully cooperative with the program, turning over large stocks of their excess ammunition for processing. This not only identifies a good internal source of disposal explosives to support the long-term clearance effort in Cambodia, but it also lowers the ammunition-storage risks for the general public and reduces environmental damage caused by bulk demolition of ordnance.

FFE Metal. As of October 2006, nearly 6,000 kilograms (6.6 tons) of “free from explosives” metal has been returned to the RCAF. The empty shells are heat-treated for four hours, exposing the metal to temperatures exceeding 1,000°C (1,832°F). This procedure ensures all explosive residues are destroyed and that metal is completely safe to reuse.

The Future of EHP

There are still some development issues required prior to the EHP becoming a functional, cost-effective package. Recognizing this, the U.S. Army Night Vision and Electronic Sensors Directorate has provided funds to continue the research and development through 2006 to complete these tasks.

The team has already made exceptional progress on the development of a “fly away” version of the EHP. The intent is to develop a smaller, less expensive package to support and supply small teams. This system is designed to fit into a single 8-foot (2.4-x-meter) ISO shipping container for air/carat transport, or sent by individual component boxes that can lead into a single three-to-four metric-ton (3.5–5.5-U.S.-ton) cargo truck.

The modified hand saw already reduced our size, weight and cost requirements; however, the steam generator was the other major item that required attention. The current units are 1.8 meters (6 foot) tall, weighs 800 kg (1,805 lbs), and requires a 110-kW generator (see Figure 7 on previous page). Other commercial units were not suitable, so our Caring, Melting and Casing Manager built a system specific to the EHP needs that runs from a 20-kW generator.

The smaller steam unit and generator reduce the overall costs, particularly shipping costs and fuel consumption. Figure 8 (see previous page) puts this into perspective: the unit in the truck is 18-kW, which is suitable for the basic fly-away unit.

Overall cost reductions. With the current developments, the capital expense and logistical support required to assemble and support a “fly away” version has substantially decreased. These price reductions have brought this specific version to a level that is cost-effective for non-governmental organizations to procure the required equipment and train their personnel in its use.

Long-term goals. Working with the U.S. Department of Defense NVEJD, the U.S. Department of State Office of Weapons Removal and Abatement has recently committed funds to expand the explosive-ordnance-disposal capacity of the program in 2006 and to support EHP basic operation in the Cambodian province of Kampong Chhnang in 2007.

Between the support of NVEJD and WRA, the Golden West EHP team can continue training its CMAC counterparts in proper explosive identification, ordnance curation, main charge removal and charge production while providing support and assistance to the demining, EOD and stockpile-reduction efforts in Cambodia.

Given the success of the initial Explosive Harvesting Program, there is an opportunity to construct a second EHP site in Kampong Cham specifically designed for processing large-capacity air-dropped bombs and to field mobile “fly away” kits, as well as permanent units, in other locations around the world.

See Endnotes, page 112

Australia Increases Aid to Middle East

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Four U.N. organizations will receive AUD2 million (US$2.57 million) directly because they are actively involved in immediate recovery efforts in Lebanon.

• The United Nations Development Program will receive AUD500,000 (US$390,000) for the Quick Delivery-High Impact Initiative, a high-impact fund that helps repair infrastructure and make other improvements to the restoration of civil functions.

• UNICEF and the World Health Organization will each receive AUD500,000 in funding for medical and health programs.

• Finally, the U.N. Mine Action Service will receive AUD500,000 for the removal of unexploded ordnance.

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