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# Explosive Harvesting Program

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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.

by Roger Hess [ Golden West Humanitarian Foundation ]

For many mine-action agencies, the three most expensive components of a clearance program can be referred to as the "Three E's": expatriates, equipment and explosives. Procurement and importation of explosives can consume up to one-third of an operational budget and this often becomes one of the most difficult issues to resolve.

## 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 aircraft bombs.
- Develop the methodology to convert the recovered explosives into neutralization and/or disposal tools for demining and explosive-ordnance-disposal teams.

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

Instead of building the system in a Western country and then shipping it abroad, Golden West elected to construct and develop the system in Cambodia, importing 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 the field, Golden West identified the logistical/spare part problems during the development process and overcame those; so when it is deployed anywhere else, enough spares are on hand to support the operations and a functional resupply 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 specialized tools that were fabricated 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 had 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.

Figure 1: An early prototype of the 100-gram (3.5-oz) "caseless" charges produced by the EHP. The detonating cord initiation system is cast into the charge, so the demining operator only has to attach a blasting cap to the free end. The red arrow indicates which end to place facing the target to optimize the effect of the blast.
PHOTO COURTESY OF R. HESS, GWHF

## EHP Cutting Equipment

Based on recognized technologies used in the remote cutting of unexploded ordnance, we used available data and selected two systems: the BHR/DiaJet 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 had 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/DiaJet Osprey.** Cost is obviously a key issue as there is no sense in building a system that most end-users cannot afford. Of all equipment purchased for this program, the hydro-abrasive cutting system was the most expensive.[1]

Hydro-abrasive methods are recognized as the safest means to cut explosive ordnance. Worldwide, over 500,000 pieces of ordnance have been cut using this method, including highly sensitive 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/DiaJet Osprey was the best price available. Following extensive testing, the British Ministry of Defence selected this machine as a standard, which aided 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-authorized trainer. It also requires a large supply of imported 100-micron olivine 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 centers 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 hacksaw ran out of cutting fluid and was not shut down.

Figure 3: Measuring the temperature of the projectile casing and explosive main charge immediately after it was cut with the modified band saw; the case and main charge did not exceed ambient temperature. Note the smooth surface of the main charge, with no noticeable loss of explosives occurred during the cut.
PHOTO COURTESY OF R. HESS, GWHF

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 remote operation and conducted more tests, after which the team felt confident in testing the saw against explosive ordnance in our secure testing site. The barricading 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.

Figure 2: Two views of a USSR 122-mm OF-462 TNT-filled projectile as cut in half with the Diajet Osprey hydro-abrasive cutter.
PHOTO COURTESY OF R. HESS, GWHF

**Results.** The test results exceeded our expectations. Neither the casing nor explosives exceeded ambient temperature, nor 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 the tasks that can be done with the hydro-abrasive systems. The Osprey was designed for field deployment to cut fired, fuzed 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 charges, the initial results show a 75-percent decrease in capital equipment costs with a 150-percent increase in production capability.[2]

The sustainability in remote locations is greatly improved and training requirements for local staff are minimal. This approach also eliminates the over-spray 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 adapter used to extract the explosives from the ordnance casing. Compared with our previous system, these improvements reduced the time for extracting the explosives by over 25 percent.[3] The exact time varies with the projectile sizes 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 sensitive to standard blasting caps, the team has analyzed mixtures of TNT and other commonly available main-charge explosives to cast small, individual charges and to make the recovered explosives go as far as possible.

For larger charges, boosters with detonating-cord knots are first cast; then TNT is cast over the booster, which ensures full contribution of the TNT. Maximum use is being made of locally available, low-cost containers that allow the permanent marking system to be employed for accountability and reliability tracing. Once marked, the individual charge can be traced back to the date it was made, who made it and from what type of projectile the explosive was recovered.

Figure 4: GWHF staff members operating an early version of the steam adapter developed to remove the explosives from the projectile case. The latest model is far more efficient and less manpower-intensive.
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

Figure 5: Explosive mixing to obtain "cap sensitivity." Cast TNT (left), RDX (center) and Cap-sensitive EHP Blend (right).
PHOTO COURTESY OF L. AUSTIN, GWHF

Figure 6: Russian-made TNT as removed by the EHP process from a 122-mm OF-462 projectile.
PHOTO COURTESY OF L. AUSTIN, GWHF

extremely well-suited for explosive ordnance disposal and demining operations. As of October 12, 2006, the Cambodian Mine Action Centre and The HALO Trust have destroyed over 5,000 landmines with these charges, reporting 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 cooperating 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 lessens 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 explosive" 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.

Figure 7: "Alstom Steam Genny Ig," the previous steam generation unit used by the EHP; weight: 480 kilograms (1,058 lbs), height: 1.8 meters (6 feet), power requirement: 110 kVa.
PHOTO COURTESY OF R. HESS, GWHF

Figure 8: A 10-kVa generator carried in the back of a Toyota Hilux pickup—all that is required to run the "fly away" kit.
PHOTO COURTESY OF R. HESS, GWHF

## 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 8x10-foot (2.4x3-meter) ISO shipping container for sea/air transport, or sent by individual component boxes that can load into a single three- to five-metric-ton (3.3–5.5-U.S.-ton) cargo truck.

The modified band saw already reduced our size, weight and cost requirements; however, the steam generator was the other major item that required attention. The current unit is 1.8 metres (6 feet) tall, weighs 480 kg (1,058 lbs), and requires a 110-kVa generator (see Figure 7 on previous page). Other commercial units were not suitable, so our Cutting, Melting and Casting Manager built a system specific to the EHP needs that runs from a 10-kVa 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 10-kVa, which is suitable for the basic fly-away kit.

**Overall cost reductions.** With the recent 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 nongovernmental organizations to procure the required equipment and train their personnel in its use.

**Long-term goals.** Working with the U.S. Department of Defense NVESD, 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 NVESD and WRA, the Golden West EHP team can continue training its CMAC counterparts in proper explosive identification, ordnance cutting, 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*

**Roger Hess** has been involved with explosives, landmines and explosive ordnance disposal for over 28 years. He retired from the U.S. Army EOD field in 1998 as a First Sergeant and went directly into civilian landmine and UXO clearance operations. He has worked extensively in Africa, the Middle East, the Balkans and Southeast Asia, supporting both commercial and nonprofit demining and EOD organizations.

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## News Brief

### Australia Increases Aid to Middle East

The Australian government recently announced it will increase humanitarian aid for relief and recovery efforts in the Middle East by AU$3 million (US$2.35 million). This will bring the total funding by Australia to the region to AU$10.5 million (US$8.2 million).

Four U.N. organizations will receive AU$2 million (US$1.57 million) directly because they are actively involved in immediate recovery efforts in Lebanon.

- The United Nations Development Programme will receive AU$500,000 (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 AU$500,000 in funding for medical and health programs.
- Finally, the U.N. Mine Action Service will receive AU$500,000 for the removal of unexploded ordnance.

UNICEF will also receive AU$1 million (US$780,000) for emergency health services in the Palestinian territories.

Further reconstruction assistance will be forthcoming as the governments of Australia and Lebanon coordinate efforts.