Golden West Humanitarian Foundation

In partnership with

Cambodian Mine Action Centre

Information Briefing

Explosive Harvesting System (EHS)

From Initial Concept to Operational Reality

Regional Approach to Stockpile Reduction (RASR) Workshop

May 2011

Golden West?

- A US-based Non Profit Charity established in 1998.
- Operationally focused to help overcome challenges in the Demining & EOD Efforts.
- The Golden West core team consists of highly trained specialists with extensive field experience in:
  - EOD
  - Field Engineering
  - Geophysics
  - Chemists
  - Past Projects/Clients:
    - Angola
    - Azerbaijan
    - Bosnia
    - Cambodia
    - Columbia
    - Guatemala
    - Iraq
    - Mozambique
    - Moldova
    - Nicaragua
    - Solomon Islands
    - Vietnam
  - CMAC, DoD-HD R&D, DoS-WRA, HALO, MAG, NPA, OAS, Renew, UNMAS,(Etc)

Golden West Assistance?

- Establish the specific type of assistance needed.
- Request an assessment mission from Golden West to identify the relevant issues.
- Establish the potential donor sources (if externally funded)
- Sign an MoU with Golden West regarding:
  - Security/Non-proliferation
    - Golden West ***will not be involved*** with questionable or illegal activities
  - End User Agreements
  - Financial responsibilities of each organization
  - Protection of Proprietary Designs and Equipment

Original Objectives

The EHS program was initially sponsored by the US DoD Humanitarian Demining R&D program in March 2005.

The task was to establish a cost-effective, *field deployable* system which can:

- ✔ *Safely recover the explosives from bombs, anti-tank mines, large caliber artillery projectiles, and other ordnance.*
- ✔ *Recycle the explosives into disposal charges for the demining and EOD teams.*
- ✔ *Create high quality training aids to improve Demining and EOD Knowledge in Cambodia*

These objectives have been successful accomplished above expectations. The program is now supported by the US DoD/HD for R&D and the US DoS/WRA for sustainment

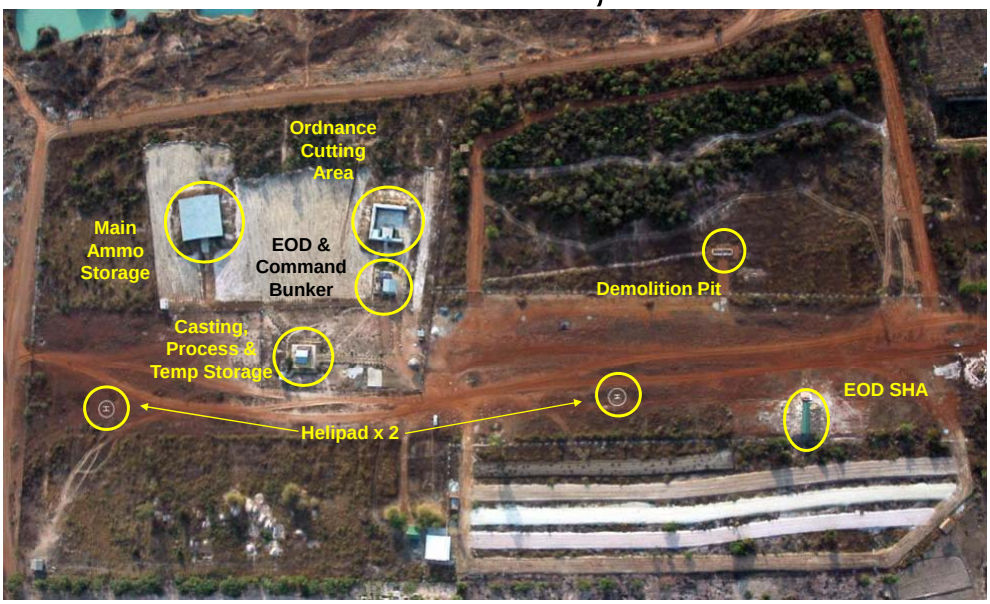
Basic Objective Concept

EHS Advantages

- Provides a cost-effective alternative for disposing of abandoned/excess ammunition.
- Less damaging to the environment than OB/OD.
- Reduces hazardous waste stream from manufacturing new explosives for disposal operations.
- Recovery of metal for recycling helps off-sets cost.
- Substantial savings when compared to conventional disposal methods.
- Full accountability is gained on explosive materials which are only loosely controlled (*Cambodia specific*).

EHS Site @ 1 March 2005

EHS Site KCTC, Current

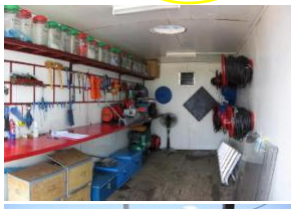


Cutting & Testing Area

- **Walls** :1.4 meters thick filled with sand + reinforced with 3.0 meters of sand buttressing.
- **Cutting zone**: 1.0 meter sand filled barriers & 40 cm steel reinforced concrete roof.
- **Cutting position**: 40 cm wall for containment of contaminated water run off.

Command & Control

- Cutting is controlled from a 30cm thick steel reinforced bunker 35 meters away.
- The Blue ISO container stores the tools/additional equipment for the cutting area.
- 25kW generator provides primary power to the site.
- 125kW generator remains from initial setup for additional power requirements if needed.



Recasting Container

- The Red ISO container is outfitted with all equipment and ventilation to melt and recast explosives.
- With the tropical climate of Cambodia; explosive melting and recasting is done under the shelter year round.
  - More space
  - More comfortable
  - No explosive fume or dust buildup

Temporary Storage Container

- Outfitted with formica shelving suspended by stainless steel rods from the roof.
- Freshly cast charges are stored to cool in a secure, controlled environment.
- Shelves can disassembled for transport when the container is used for shipping bulky items.

Munition Quality Control

- The QC Inspector verifies that *each munition* is safe to process.
- A white strip is painted on the body and signed “QC” by the inspector.
- The munition is then placed as “accepted inventory” list and transferred to the Ammo Storage Point.

Starting Point: Gaining Access

- The EHS started with industry recognized standards and equipment.
- The most expensive and complex was the hydro-abrasive cutting (HAC) system.
- $85k base price + specialized training and support materials are required

HAC Realities

- Requires a factory trained and certified operator.
  - Failure to do so presents high risks and voids warranty.
- Relies on imported olivine sand.
  - All local options were tested and are unsuitable.
- Excess water runoff created must be contained, collected and processed as *explosive waste.*
  - Between 100-200 grams of HE were lost on <u>each</u> US 105 mm projectile.
  - *Larger munitions would create equally larger runoff issues*

Alternative Method

- For main charge compounds; the following has proven to be faster, less expensive and far more environmentally friendly than HAC systems.

Advantages

- All working parts and supplies are readily available.
- Minimum operator training required.
- Minimum explosive loss.
- Minimum over-spray and run-off.
- Smaller in size & weight.
- Cuts ordnance over 50% faster
- No measurable temperature increase in the case or explosive.
- **Multiple** RBS systems can be purchased and modified for the cost of ***a single*** HAC system

Evolution: Remote Band Saw (RBS)

- The following RBS types have been employed at the EHS
  - 7x12 (17 x 30cm: initial model): Low cost but limited capacity
  - 8x12 (20 x 30 cm): Better capacity with low cost
  - 8x14 (20 x 35 cm): More expensive but cutting capacity doubled over 7x12
  - 10x18 (25 x 45 cm): Heavier but still uses 220v/1ph power*; best balance of power consumption and cutting capacity*





RBS Results

- 70+ different munition/fuzes have been processed without accident or incident
- 8,500+* metal-metal & 200,000+ bare HE cuts have been done to date

  *This ***Does Not*** *include assessments of foreign fuzes and unique ordnance*



Remote Bomb Cutting

- "Safe to Move" US bombs are commonly transported to central storage areas in SE Asia.
  - The main charge explosive is very insensitive; but quite powerful when boosted
- With a very large amount of explosive available; the Bomb Cutting Area was established by the support of US DoS/WRA.
- Only the electricity is hard-wired; all other controls are done via wireless systems

Bomb Cutting Results

- If fuzed; the nose and/or tail section is removed and destroyed.
- The body is then cut into 30 cm sections for processing.
- If bulk disposal charges are needed, the bomb is cut into 6 cm slices and issued “as is”.
  - Lower NEW than an antitank mine but just as effective

RBS Field Employment Uses

- Over 1,700 cuts have been done through booster/secondary explosive compounds.
- Questions were raised on possible use against fired/fuzed munitions in the field.
- Tests were conducted cutting **directly** into *Primary/Detonator* explosives allowing for operator error.
- Quite surprising,..

Overall Results

- Over 30 cuts directly ***through*** the detonator assemblies on various munitions and fuzes have been done to date:
- Only two detonators have exploded:
  - This occurred when the fuze moved while the blade was passing through the detonating compound
  - Three others also moved **but** did not detonate
- This had only been accomplish by HAC systems in the past,....

Mobile Cutting System (MCS)

- Based on all the tests; a trailer mounted RBS system for cutting away bomb fuzes in the field was developed.
- Fully self contained including fold-up hoist, power system and wireless video monitor.
- From arrival on site to set up ***and finish*** is approximately 45 minutes.

Original Prototype

Finished Version

Cost Reductions: Steam Generation

- The EHS started with a commercial "Small" steam generator.
  - Reliable low pressure steam at 105 c
  - 1.8 meters tall & 480 kg in weight.
  - ***Requires125Kv/3 phase generator***
    - The single most expensive item of the EHS to operate
- All alternatives were unsuitable, so the GW staff designed our own:
  - One man portable and can run on a 5 Kv generator
  - The entire site can now run on a 25 Kv generator (circled in green)
- Fuel/running costs were ***reduced by 70%***



Cost Reduction: HE Steam Extraction

- Cutting the case to expose the main charge allows melt-cast explosives to be quickly removed with low-pressure steam.
- The oven design focuses steam onto the case before venting out through the base chute.
- The charge drops free in 3-5 minutes; all explosive residue is contained in the PVC pipe.
- The design is simple, fast, requires minimal steam and power.



Recasting Selection

- Extensive testing was done to establish the best mixing ratios for NATO and WARSAW pact explosives.
- The explosives properties must be fully considered to produce a powerful, cap-sensitive charge that is safe to use and handle.

- Unacceptable Explosives

ТД-42 (TD-42) or ТД-50 (TD-50): TNT & Dinitronaphthalene
  - ***May become shock sensitive***

ДБТ (DBT)**:** TNT & Dinitrobenzene
  - ***Highly toxic***

Amotol or Minol: TNT & Ammonium Nitrate + Aluminum (Minol)
  - ***Hydroscopic and low power***

Tetrolite or Pyronite: Pure Tetryl
  - ***Highly toxic,100o C maximum safe working temperature.***

Many more can be listed,..

Charge Design Options

- Direct processing of cap sensitive explosives (USSR 100-152mm TNT):
  - Simple & multi-purpose; requires multiple RBS cuts
- Bulk casting of cap sensitive mixes & cut into individual blocks on RBS:
  - Good quality and output, but variance in size and some QC issues
- Commercial “High-Heat” silicon baking moulds:
  - Casting was simplified with good uniformity but commonly available moulds were not practical for EOD teams

Custom Silicon Molds: 100 gram

- Minimal waste & excellent uniformity
- <u>Decreased</u> HE runoff from RBS use by 75% while increasing production by 50%
- When use correctly; charge design imparts maximum force on target

10mm steel witness plate OC test

100 Gram Charge
QC Test

Accountability

- All charges are given a final QC check for substantial air pockets or gaps.
- Random charges are selected for practical testing against live targets.
- Upon passing QC; each block is serial numbered.
  - The serial number can be traced back to the exact munition which the explosive came from (***Cradle-Grave Monitoring***).

Shaped Charge Tools

- PG-2 Warheads
  - Powerful and quick to make; one charge will destroy **most** thick-cased ordnance.
- PG-7 Warhead/Case Disruption
  - Stand-off distance critical, only 80% effective
- PTAB 2.5 Cluster Munitions
  - Effective disposal charge and can be used as pyrotechnic torch.









Pliable Explosive

- SEA-91 Pliable Explosive developed as replacement for C-4 & “Data-Sheet”
  - Made from USSR A-IX-1 (RPG-7 & BK-881 Main Charge)
  - 65 gram “Diamond” ***95% effective*** for bomb case disruption.
  - Very high velocity; extremely effective for shaped charge packing



Propellant Conversions

- Excess propellant safely converted into rock quarry or brush clearing charges
  - Grains are dissolved in plastic hoses with commercial solvents then cut to length.
  - Reduces heat and flame sensitivity to approximately the same as diesel fuel.
  - Not “Cap-sensitive” but only requires a 30 gram booster for full detonation.
  - Faster to place then ANFO for quarry work and approximately x2 as powerful.




Standard and Converted Propellant: Heat Test

Quarry Test
x3 40mm Boosted PN Charges
NEW Per: 230 grams
Total NEW: 690 grams

Small Arms Disposal: PSAB

- The portable small arms burner (PSAB) for use by the field EOD teams for SAA caches.
  - Two man portable & uses normal propane fuel for heat
  - Holds 50kg of SAA up to 12.7mm.
    - ***Failure tested with 60kg for safety.***
  - Cyclic rate of 30 minutes per load
  - Using two inserts; throughput is 100 kg per hour for a single PSAB

PSAB Burn Stages

- Within 15 minutes a “dynamic” stage is reached:
  - Internal pressure and temperature suddenly boosts dramatically.
  - Bulk of the SAA is consumed within 20-30 seconds afterwards
  - Very little smoke is generated during this stage

Small Arms Disposal: MSAB

- A larger system was design for field ammunition storage points
- The Modular Small Arms Burner (MSAB) was made using four PSAB inserts.
- When used with two sets of inserts (x8 total), the throughput is 400 kg per hour
- The PSAB/MASB system in now in use with MAG, RCAF and OAS
- OAS destroyed 100 Mt of SAA in five months with a single MSAB

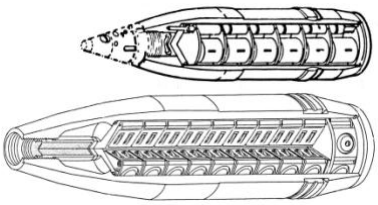
Cluster Munition Projectiles

- US 105mm and 155mm CBU filled projectiles were turned over for destruction assessment.
- Fastest & least expensive method of all means and methods tested:
  - Examine round to determine best location to cut.
  - Use the Remote Band Saw to safely make access point.
  - Transport to demo range, bury up to nose and fill with NMD Liquid Explosive.
  - Prime and detonate

Video Still Shots

Cluster Munitions Disposal

- Tests have been conducted on US 105mm (M35 CBU, 18 each) and US 155mm (M43 CBU, 60 each).
  - All tests were video taped, analyzed and the area fully searched afterwards.
  - Full destruction with no kick-outs have occurred.
- Time and effort is minimal; far less man-hours per projectile.
- Average cost for disposal: between $0.07 to $0.28 per CBU (design and labor cost dependant)



FFE Training Aides and Cutaways

- Free From Explosive (FFE) examples are made from specific munitions to advance the EOD training.
- Over 650 munitions have been processed into high quality training aides, provided at no cost to the demining agencies in Cambodia.

EHS Vital Statistics @ April 2011

- Processed over 81 Mt/Tons of abandoned/excess ammunition.
- Reclaimed more that 28 Mt/Tons of reusable explosives from ordnance and illegal scrap collection operations.
- Returned over 58 Mt/Tons of thermally treated FFE scrap metal back into the economy.
- Provided over 200,000 disposal charges to CMAC, HALO and MAG *at no cost* to their operations.

Questions?

Thank You

Golden West Humanitarian Foundation

Office of Weapons Removal & Abatement