Advanced Explosives and Ordnance Training Seminar - Cambodia 2018

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An overview of the Advanced Explosives and Ordnance Training Seminar held in Cambodia, 2018.

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Summary:

The Oklahoma State University (OSU), School of Forensic Sciences, CENFEX Program teamed with Golden West Humanitarian Foundation to provide another one-of-a-kind training opportunity in Cambodia, January 15 through 19, 2018. Those in attendance included people from corporate security, 3rd Marine Division, military EOD technicians, Public Safety Bomb technicians, the legal profession, as well as the OSU School of Forensic Sciences and School of Medicine. The details of the five training seminar are outlined below.

The Seminar:

Day 1, Monday, January 15, 2018:

The first day provided an overview of the issues to be addressed throughout the week, including advanced technical concepts covered in a crawl, walk, run perspective. In the morning, everyone met in the hotel lobby, boarded the bus and traveled to the Cambodian Mine Action Center (CMAC), Ordnance and Weapons Museum. Upon arrival, we were met by Len Austin from Golden West HF. Len provided a brief on the history of warfare within Cambodia over the last 90 years, which resulted in unimaginable amounts of landmines, UXO and ERW still contaminating large portions of the country. With the depth and scope of the problem laid out, the guided tour of the museum began.

The majority of the ordnance displayed in the museum was inerted by Golden West personnel working under Len's supervision. As such, the details provided by Len throughout the tour offered tremendous technical and tactical insight. The group then traveled to Golden West's headquarters in Phnom Penh to tour the Advanced Ordnance Training Materials (AOTM) shop. Guided by Golden West's chief design engineer, John Wright, attendees were treated to hands-on demonstrations of the 3D printed,100%, 200%, and 400% sized fuzes, landmines, submunitions and other ordnance items. The group then moved to the Virtual Reality (VR) room and afforded an opportunity to experiment with ordnance-based VR training equipment. The images shows Len working with an attendee wearing a VR headset.

After watching the VR presentation of a munition, Len then handed a cutaway version of the same munition to the attendee and explained how the item functions. The level of understanding achieved though this multifaceted approach to training cannot be replicated through other conventional

methods. Following the tours, the group traveled to a very nice restaurant for a traditional Khmer lunch before the final stop of the day.

After lunch, the group traveled to the S-21, Killing Fields Museum, known as "The Schoolhouse" located in Phnom Penh (http://www.killingfieldsmuseum.com/s21-victims.html). Though horrifically reminiscent of Dachau and Auschwitz, a visit to Phnom Penh would not be complete with visiting this site. The group returned to the hotel after the tour, thus concluding the training for Day-1.

Day 2, Tuesday, January 16, 2018:

The day started with everyone checking out of the hotel, meeting in hotel lobby and boarding the bus for our 2-hour trip to KCTC. After arriving at KCTC, Len Austin provided a detailed safety brief and oriented everyone on the layout of the facility. After which, the technical training continued with a brief on the operation of a small arms burn-tank, which was filled with 20kg of small arms up to 20mm in diameter. After moving to the Explosives Harvesting System (EHS), the burn tank was ignited and could be heard crackling and popping for the next hour.

The EHS tour began with Len explaining how the facility supports demining operation across Cambodia through the Cambodian Mine Action Center. Followed by a briefing and demonstration on each stage of the EHS. In the preparation area, the apparatus used to test explosives sensitivity to friction, impact/drop, and heat were explained. Though similar in design and function to the explosive's characterization equipment in an explosives research laboratory, these apparatuses are used with larger amounts of explosives in field setting. The group then moved to a display table where Len explained the techniques used to cut six projectiles of different designs, displayed on the table. All six were cut using different methods, all of which were covered in detail.

We then moved to the cutting house where a Russian 122mm high explosive (HE) projectile was prepared to be cut. After explaining the cutting process, custom-made mounts, and equipment used, Len had the group move to the command center bunker in the safe area to remotely watch the cut via camera. After returning to see and be briefed on the results of the cut, the group moved to the mixing house. Len spent a considerable amount of time explaining the design and construction of the multi-layered housings used to apply radiant heat to break the adhesion between the body of a munition and the explosive filler. As well as the techniques used to break up, melt, mix and reuse the explosives as SEA-91, a pliable C-4 or PE-4-like explosive and the 100-gram boosters CMAC provides to demining companies to destroy mines and UXO. All four sides of a 100-gram booster and a 100-gram piece of SEA-91 are show in the figures below.

The reminder of the day was spent covering internal and external configurations common to different ordnance categories and groups. With hundreds of bisected munitions readily available, the depth of this training was extensive. The day ended with a detailed range brief for the following day.

Day 3, January 17, 2018:

The group met in the hotel lobby, boarded the bus for the short trip to KCTC. The day began with a range safety brief delivered by Len Austin, followed by a short drive to Elephant Range. There, eight explosive shots were set up, briefed, fired, and debriefed throughout the morning. Each shot was preceded by an on-site presentation covering the ordnance to be destroyed, countercharges used and specific techniques being applied. After which, everyone walked back to the bunker in the safe area where every shot was initiated from. Below are short briefs on each shot, which were filmed from a drone and all attendees were provided with these videos on Thursday evening.

Morning shot list & learning points:

1. 1,000,U.S. manufactured,20mm HE projectiles were simultaneously destroyed with NMD liquid explosives. Shot #1,small explosive filled ordnance such as bulk 20mm and fuzes are prone to kicking-out some un-consumed munitions when destroyed in bulk with conventional C-4 or TNT blocks. However, the application of a liquid high explosive in the form of NMD, the exceptionally positive explosive continuity provided by liquid versus hard blocks consistently results in clean shot crater with no kick-outs, as demonstrated with this shot.
2. Five, Chinese, 60mm HE mortars with DNN main charges were simultaneously destroyed with NMD liquid explosives. Shot #2, demonstrated an efficient means of destroying Chinese munitions filled with dinitronaphthalene (DNN) explosive. DNN is extremely insensitive resulting in significant problems when destroying single or multiple munitions. Additionally, the trinitrotoluene (TNT) booster used in many Chinese projectiles has the texture of sawdust. The low-quality explosive configuration further complicates the destruction of these munitions, yet the only recoverable fragment, seen in Figure 5 below, was approximately 45mm in diameter, thus reinforcing the versatility of NMD explosive.
3. One, 100-gram booster made in the EHS was secured to a 12mm round steel plate for a quality-control shot. After filling the molds to make the 100-gram boosters, three boosters were randomly selected, set on a 12mm steel plate (Figure 6), and detonated (Figure 7). Each lot from the EHS is tested in this manner before the lot is distributed to deminers.
4. One, Russian, TM-46 anti-tank landmine, containing 5.7kg of TNT was destroyed with the use of a 100-gram charge made in the EHS. Shot #3, demonstrated the efficient application of a 100-gram charge against a thin-skinned anti-tank landmine.
5. One, Russian, 122mm HE projectile was destroyed with the use of a 100-gram charge made in the EHS. Shot #4, demonstrated the successful application of a 100-gram charge against the thick steel body of robust HE projectile.
6. One, Chinese, 100mm HE mortar was hit with a shaped charge containing 35ml of liquid NMD high explosives (Figure 8). Followed by a second shot to destroy the munition. The first shot resulted in a shaped charge hole straight through the body and booster charge of the mortar, approximately 0.5 inch in diameter. It is important to note that other conventional main charges would have [most likely] detonated, yet less than 20% of the dinitronaphthalene (DNN) main charge had burned. As mentioned with Shot #2, DNN is used in some Chinese mortars; however, DNN is also mixed with other explosives and commonly used by many other countries. Shot #6, reinforced the inconsistent and thus dangerous performance characteristics associated with DNN filled munitions. In accordance with military EOD procedures, as well as safety and reporting purposes, ordnance must be identified prior to being destroyed. Additionally, to ensure the probability of success, consideration must be given to identifying the explosive filler in a munition, usually through external markings. For example, common markings identifying Russian ordnance with an explosive charge containing DNN include; TD-42, TD-50, TN-42 and TN-50 to name a few.
7. Using 40mm thick steel plate, two shots were connected with det-cord and initiated to demonstrate different explosive effects including: 1) 100-grams of "SEA-91" pliable explosive made in the EHS was placed in contact with the plate and detonated (Figure 9). The "spalling" effect on the reverse side is unmistakable (Figure 10). 2) A shaped charge container with a 2-inch standoff from the target plate, with 35ml of liquid NMD high explosive (Figure 11). The same configuration used for the 100mm mortar in Shot #6. The entry hole (Figure 12) demonstrates the viability of this liquid high explosives, which easily penetrated the 40mm steel plate.
8. One, US manufactured; 105mm White Phosphorous (WP) projectile was destroyed. Prior to the shot, the explosive burster running the length of the munition was removed. The projectile was set standing on its base and the fuze-well was packed with approximately 150-grams of A-91 pliable explosive and initiated. Shot #8, demonstrated the successful application of a

technique used to "banana peel" and thus successfully destroy a WP projectile by exposing all of the filler as quickly as possible.

Figure 5: Largest fragment recovered from five 60mm Chinese HE mortars.

Figure 6: 100-gram booster set up on a 12mm steel plate for a quality control test.

Figure 7: Successful result of 100-gram booster functioned on 12mm steel plate.

Figure 8: Chinese 100mm HE mortar with shaped charge hole through the DNN filled body, as well as the TNT booster.

Figure 9: 100-grams of SEA-91 on a 40mm steel plate.

Figure 10: Spalling effect from 100-grams of SEA-91 on 40mm steel plate.


Figure 11: 35ml of NMD being injected into a shaped charge container.

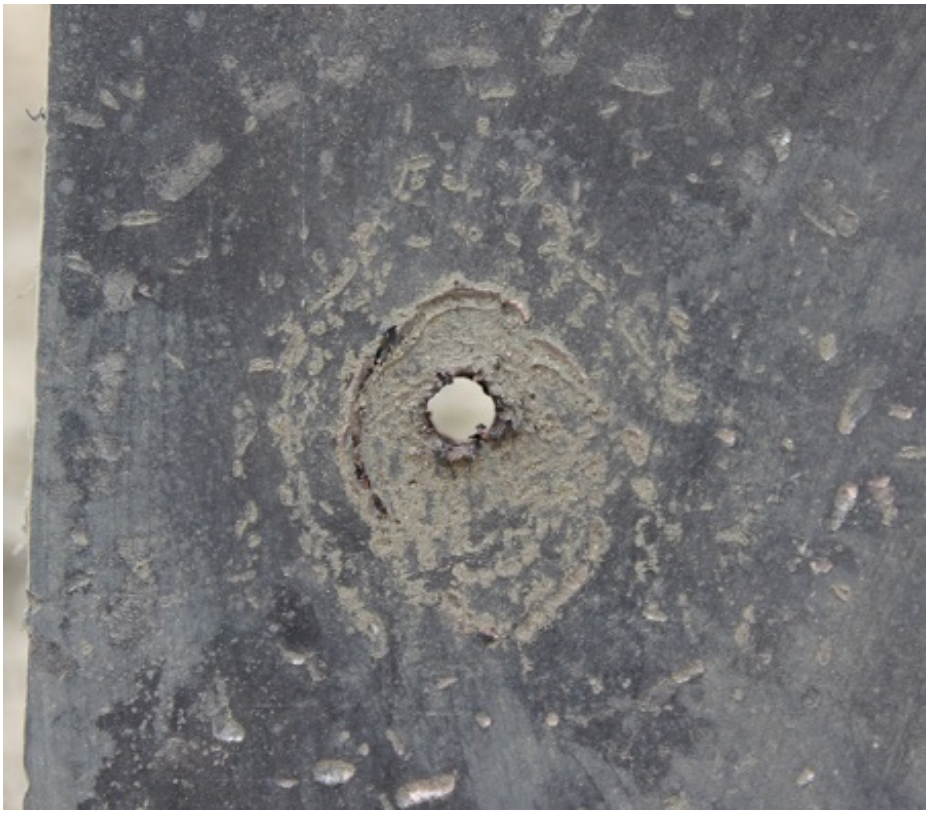
Figure 12: Figure 12: Results of 35ml NMD shaped charge on a 40mm steel plate.

EHS Note: For demining operations, shipping high explosives into the country usually constitutes the single largest overhead item for the contract. To date, the EHS located on KCTC has provided over 500,000 charges to deminers working in Cambodia, thus allowing each dollar to result in more

landmines, UXO and ERW destroyed and no longer posing a threat to innocent Cambodians.

After breaking for lunch, Len provided an important presentation on landmine warfare, minefield designs and configurations, as well as booby-traps and anti-disturbance fuzing commonly encountered in demining operations. Then geophysicist, Dr. Marcel Durocher from Golden West, lectured on geology applied to demining, as well as the equipment used for surface and subsurface search, and mapping techniques used to document mines, UXO and ERW. The initial class was delivered around a table containing eight types of equipment representing three different technological approaches used in demining.

Dr. Durocher then moved the class out to training lanes. The training areas were seeded with inert training aids of various sizes, positioned at different depths and angles. All attendees were then offered an opportunity to "suit up" which was voluntary. Surprisingly, everyone in attendance not only suited up, but enjoyed being walked through demining processes.

Attendees began by selecting the technology and equipment they wished to use. Most attendees spent this time testing-out all of the technologies available to locate suspect items. Once located, demining techniques were used to excavate, identify and determine an appropriate course of action to ensure the item would no longer pose a threat. Mentored by Dr Durocher (Figure 13), his assistant Heang Sambo, and Len Austin, attendees really enjoyed the chance to get their hands dirty during this portion of the training.

The day ended with a detailed range brief for the following day. The group then boarded the bus for the hotel.

Day 4, January 18th, 2018:

The group met in the lobby, boarded the bus for the short trip to KCTC, received a range safety brief from Len Austin, and moved to Elephant Range.

There were two shots scheduled involving 80-pound pigs that had been killed by a butcher prior to purchase, but otherwise unaltered. Each pig was used to mimic an 80-pound child initiating an anti-personnel (APERS) landmine. After each shot, the pig was laid flat on the ground and opened to

expose internal organs. Then a 4th year medical student "Karley" started at the hind legs and worked to the head conducting a detailed medical assessment for the group, while also being assessed by a doctor from the OSU medical school. As fragments were removed from the pig, they were handed to Len who was holding an inert mine of the exact same model. The origin of each fragment from on the mine was pointed out to attendees. Karley did an outstanding job of locating and pointing out each injury before providing details on fragmentation track, organ damage, field treatment options, emergency room treatment options, as well as overall severity, survivability, and long-term care associated with each injury.

Shot#1: The first pig was secured in a "standing position" with its hind-legs touching the ground. To provide protective footwear, the hind legs were put inside military jungle boots. Under one of the boots, a Russian,PMN-1, APERS "blast" landmine, containing a main charge of 249-grams of TNT was placed just below ground level.

The group then moved to the bunker in the safe area and a drone was launched to document the shot. After the shot, the group returned to the site, the pig was cut down from the mounts and laid on the ground for Karley to conduct the previously explained assessment. After the first shot, while following the track of a large fragment that had ruptured the bowels many times, lacerated the stomach laying it completely open, and causing severe damage to a lung, Karley removed a 3mm thick, flat but slightly twisted 30mm x 10mm fragment from the inside of a rib. Immediately realizing the fragment had not originated from the PMN-1 landmine, we began a search for the source. After cutting open the other boot, we realized the fragment was part of the metal plate placed in the sole of many jungle boots to protect against punji stick boobytraps. In this case, the fragment was by far the most lethal aspect of this shot and serves as a reminder of how lethal secondary fragmentation can be.

Shot #2: The second pig was secured at a 45-degree angle to the ground. A sheet of plywoodwas lashed to a tree2-meters to one side of the pig as a witness board. One Russian, POM-Z, APERS "Fragmentation" landmine, containing 75-grams of TNT was placed 1.5-meterson the opposite side of the pig (Figure 14).

The group then moved to the bunker in the safe area and a drone was launched to document the shot. After the shot, the group returned to the site, the pig was cut down from the mounts and laid on the ground for Karley to conduct the previously explained assessment. In this case, evidence of a

ruptured bowel was clearly evident with bowel contents coming though many of the nearly 100 fragment impacts on the pig. Once again, Karley did an outstanding job of walking the group through the injuries and potential treatment methodologies. Additionally, the witness board provided evidence of the lethality of a POM-Z type landmine at over 3.5 meters. Other than a void pattern where fragments had impacted the pig, there was not a 75mm area of the sheet without a fragment hole.

After returning to KCTC, attendees and instructors alike were treated to an outstanding BBQ provided by CMAC personnel. The rest of the day was spent eating, going over any of the equipment and techniques covered, asking questions, or just relaxing before the group returned to the hotel.

Day 5, January 19, 2018:

Everyone met in hotel lobby at 9:00am, checked out, and boarded the bus for the return trip to Phnom Penh, where most attendees checked in to the hotel. Anyone with a flight that afternoon or evening was provide an opportunity to shower before heading to the airport.

Conclusion:

The execution of this training event, from travel logistics and technical classroom presentation, to down range tests and demonstrations, was a tremendous learning experience. For the OSU personnel working directly with Golden West staff, the experience was a professional dream-come-true, and something we look forward to doing again.

The AEFTI graduate and doctoral programs are "hybrid" designs with the majority of course work performed online, but there are courses requiring 1-week onsite, hands-on workshops. The application for this seminar, followed by a 20-page paper to be a "study abroad" course is being evaluated by the OSU Gradate College. We should have an answer by September 2019. If approved, the Advanced Explosives and Ordnance Training Seminar in Cambodia is an outstanding opportunity for AEFTI students and working professionals to attend a unique education and training program, while also working on a graduate course.

The next seminar is scheduled for February 24 - 28, 2020. Contact Tom.gersbeck@okstate.edu for information.

For more information on Golden West Humanitarian Foundation: http://goldenwesthf.org/
For more information on the forensic programs offered at OSU and the Center for Fire & Explosives, Forensic Investigations, Training & Research
https://health.okstate.edu/forensics/cenfex/index.html

Authors' Bios:

Tom Gersbeck, MFS: After retiring from the Marine Corps as an EOD Officer in 2001, Tom joined the Federal Air Marshal Service and served as an Explosives Security Specialist for 7-years. He then spent 4 years working in Afghanistan, Iraq, Cambodia, Tanzania and India in a number of positions before joining OSU as a Graduate Faculty Member in 2014.

Tom's book, Practical Military Ordnance Identification, 2nd Edition; part of the "Practical Aspects of Criminal and Forensic Investigation" series, was released in May 2019. While in the Marine Corps, Tom earned his BS, MFS and in 2015, was promoted to "Fellow" in the American Academy

of Forensic Sciences. For more information, contact Tom at Tom.gersbeck@okstate.edu.

Background:

Golden West HF is a 501(c) non-profit with a mission and vision:

"Our mission is to safeguard the lives and livelihoods of men, women and children residing in areas contaminated with landmines and unexploded ordnance through the development of innovative and practical materials and technologies designed to combat these life threatening munitions." http://goldenwesthf.org/.

Oklahoma State University (OSU) is a land-grant, non-profit, public research university. The Arson-Explosives,Firearms & Toolmarks Investigation (AEFTI) option is a [restricted access] Master of Science in Forensic Science (MSFS) program. In addition to conventional biology, psychology, chemistry, and other baseline forensic disciplines, AEFTI dedicates much of its curriculum to the physics, chemistry, engineering,and legal issues associated with the investigation and processing of fire, explosives, firearms and toolmark related evidence.