

# Collaborative Demining Training in Cambodia

by Jorge Rivero [ U.S. Marines ] and Tom Gersbeck [ Oklahoma State University ]

**S**ince 2016, the Center for Fire and Explosives, Forensic Investigations, Training and Research at Oklahoma State University (OSU) has teamed up with Golden West Humanitarian Foundation to offer a training opportunity to military and civilian bomb experts, as well as OSU medical personnel and students. During the second half of January 2018, a group of civilian law enforcement bomb technicians, military explosive ordnance disposal (EOD) technicians, medical personnel, a lawyer, and educators visited Cambodia to participate in the OSU Explosives Ordnance seminar conducted by Golden West.

Throughout the seminar, numerous topics like exploitation, ordnance, explosives effects, medical treatment, and general demolition procedures were discussed and observed. Moreover, future technologies in the field of EOD training aids and field identification were presented to the group. The training consisted of an intense week of explosives seminars, life-saving techniques in a jungle environment, and an in-depth approach to large-scale inerting and explosive manipulation. While the days were long and jam-packed with information, the experience was incredibly valuable from an EOD technician perspective. This article will summarize the days' events and lessons learned.

## History and Additive Manufacturing

On **Day one** participants met Len Austin from Golden West Humanitarian Foundation who provided the group with a private tour of the Cambodian Mine Action Center (CMAC) Ordnance Museum. As a former United States Marine Corps Master Sergeant EOD technician with over ten years of mine-action experience working with Golden West in Cambodia, the South Pacific, Caribbean, and throughout Asia, Len was a valuable guide to explain the vast amounts of ordnance that the museum holds, where it came from, and how it was rendered safe. With so much experience and knowledge of the area and the types of ordnance used by the United States and

other countries throughout Cambodia, Len both enriched the tour and engaged everyone in attendance.

Following the CMAC museum tour, Golden West took the group to its headquarters in Phnom Penh. Led by one of Golden West's engineers, the group toured Golden West's 3D Advanced Ordnance Teaching Materials (AOTM) manufacturing lab, where they create 100-percent, 200-percent, and 400-percent sized fuzes, landmines, submunitions, and other ordnance items. These accurate or oversize munitions function as training aids for anyone working in the fields of bomb disposal, demining, or public safety.

Toward the end of the day, participants traveled to one of the only remaining and most infamous Khmer Rouge prisons in Phnom Penh: the Tuol Sleng Genocide Museum, commonly known as the "S-21 Schoolhouse," which was an eye-opening and somber experience. Participants were fortunate since one of the few survivors of the prison was there selling his book. Gunnery Sergeant Rivero was lucky enough to speak with him and to see how vital telling the history of S-21 was to him.

## Technical Overview and Manipulating Energetics

**Day two** began with a two-hour trip down a single-lane highway across southern Cambodia to the Kampong Chhnang Training Center (KCTC). There the group met Len who familiarized all attendees with the area and gave a safety brief. After a short lunch, Len gave participants a tour of the Golden West compound and the Explosives Harvesting System (EHS).

Len explained how the facility supports demining operations across Cambodia as well as CMAC. Following the briefing and demonstration of the facility, Len demonstrated each step in the EHS via stages. First, in the preparation area, which is located outside of the cutting house, Len described the numerous testing tools that the organization uses for testing friction, drop, and heat. On the display table, Len began to explain how all six projectiles present were cut and displayed. All six of the items were cut using different methods, so the purpose of the display was well founded.

Following this stage of the process, Len took the group to the cutting house in which a Russian-made 122 mm high-explosive (HE) projectile was being prepared for cutting. Len spoke about the different modules used in this process, the custom-made mounts, and where the machines are made and purchased. Throughout the tour, Len's primary concern was safety, and he went into detail on the safety features for the whole operation.

Lastly, the group left the cutting area for the command center bunker in which the 122 mm projectile was cut remotely. After a short brief on the cut, the group made their way to the mixing house. In the mixing house, Len provided a short period of instruction on how heat is moved through a multi-layered housing, which results in a radiant heat melting and breaking the adhesion between the body of the ammunition and the explosive filler. Upon the explosives reaching their melting point, the explosives fall into the catch bin and are broken into golf-size balls before moving to the heating container. At this point, Len and his staff gave the group a detailed briefing on different explosives used, quality control, and what he and his team look for when melting the explosives. Upon completion of this step, the melted explosives are poured into a high-heat silicone form, which makes their 100 gr boosters that the team uses to destroy mines and other unexploded ordnance (UXO).

## Technical Approaches to Success

**Day three** began with a short briefing by Len, who then led the group to Golden West's "Elephant Range." Eight separate shots—or detonations—were scheduled, with each shot having an ordnance item to be destroyed. Each shot was briefed by Golden West staff and primed by its team while the students were all accounted for at the bunker.

**Shot one.** 1,000 U.S.-made 20 mm HE projectiles were destroyed with the use of Golden West's NMD liquid explosive. This shot was one of the most educational. Experienced EOD technicians conduct shots with thousands of pounds of net explosive weight (NEW). Using bulk explosives like C4 on these vast shots causes kick-outs of munition debris more often than not. For EOD techs doing large-scale demolition operations, kickouts are becoming an even bigger issue due to the U.S. moving toward insensitive high explosives. However, Golden West uses liquid explosive, and the results of these shots are astonishing. The liquid explosive allows for much greater HE-to-HE contact throughout the process, which significantly reduces the probability of kick-outs and therefore reduces the



Students gather around Dr. Marcel Durocher as he explains different types of demining equipment, how they function, and the science behind demining.

*All images courtesy of the authors.*



Dr. Durocher lectured on geology—surface and subsurface—and mapping techniques to the class. Throughout the seminar, Dr. Durocher provided instructions for eight different types of equipment used throughout the demining community.



Two of Austin's assistants pour liquid explosives into a bag containing 1,000 U.S.-made 20 mm HE projectiles. This method, which Austin explained, significantly reduces the chances of "kick-outs" during demolition operations. After completing the shot, all participants searched for kick-outs, and none were found.



The 1,000 20 mm HE Projectiles that Austin used on his liquid explosives shot.



Austin from Golden West fills a shaped charge container with 35 ml of NMD liquid explosive



Exit hole in 40-mm thick steel plate from the 35-ml NMD shaped charge.

chances of having ordnance scattered through a demolition area. With plastic explosives like C4, HE-to-HE contact can be achieved on some or most parts of the ordnance item but not all.

**Shot two.** Five Chinese 60 mm HE mortars were filled with dinitronaphthalene (DNN) explosives using liquid explosives for the detonation. This shot was significant in showing once again the power of liquid explosives to dispose of DNN, which is known to be an incredibly insensitive munition that offers substantial problems during the disposal phase of EOD operations.

**Shot three.** One Russian-made TM-46 anti-tank landmine containing 5.7 kg of TNT. For this shot, the 100 gr EHS booster was used to demonstrate the effectiveness of the explosives.

**Shot four.** One Russian-made 122 mm artillery projectile containing HE was detonated. During this shot, another 100 gr EHS booster was used to demonstrate its ability to penetrate a ½-inch thick plate of steel.

**Shot five.** One Chinese-made 120 mm mortar containing HE was used. For this, a 35 gr SEA-91 was used. SEA-91 is a homemade pliable explosive made via the EHS. This shot was once again done to demonstrate the ability of these EHS products.

**Shot six.** One U.S.-made 105 mm white phosphorous (WP) projectile was used. Another SEA-91 tool was placed in the fuze well to demonstrate destroying WP-filled munitions, which are extremely dangerous for EOD technicians.

**Shots seven and eight.** These shots consisted of 40 mm thick steel plates placed on the ground, hit with two shots. The shots demonstrated the effectiveness of the explosives made at the EHS. For the first shot, a 100 gr EHS booster was placed touching the plate and detonated creating the spalling

effect on the plate. The second shot used 35 gr of liquid NMD in a container positioned with a standoff of 75 mm and detonated. The precision and penetration of these two charges impressed everyone in attendance.

After lunch, Golden West's Dr. Marcel Durocher provided classes on geology, surface and subsurface search, and mapping techniques. Dr. Durocher also provided instruction on eight different types of equipment used throughout the demining community.

## Interconnections Between Victims, Bomb Disposal, and Medical Personnel

**Day four** began with a safety briefing from Len and movement to the Elephant Range. The demonstrations involved two 80-lb pigs due to the close resemblance with the human body and ease of acquisition; both pigs were euthanized roughly one hour before shots occurred. Having a medical doctor and 4th-year medical student within the group, the training capitalized on the opportunity to analyze the effects of these ordnance items, as the medical personnel expertly detailed the external and internal injuries suffered. Three shots were planned in which two would involve the pigs, and the third was a quality control shot of the new batch of EHS boosters. All students remained in the down-range safety bunkers while the shots were prepared.

**Shot one.** The first pig was in a standing position with its rear legs touching the ground and wearing military-style boots. A Russian-made PMN-1 anti-personnel blast mine was positioned underground beneath the pig's rear right foot.

After detonation, Len sent Golden West's drone down-range to ensure it was safe for personnel. Upon arriving on site, we saw the pig on the ground with wounds consistent with mortal injuries. Once all students were present, Karley Koch, a 4th-year medical student at OSU, dissected and provided details on the pig's injuries, severity, and survivability of those injuries.

**Shot two.** The second pig was secured between two small trees at a 45-degree angle with a sheet of plywood to its left. A Russian-made POMZ fragmentation mine was positioned one meter from the pig and 1 ft (0.3 m) off the ground. After detonation, the pig was laid on the ground and split open. Koch again examined and dissected the pig. While narrating the results, Koch provided first-hand knowledge of the injuries and probability of survival of a human being, concentrating on a child weighing approximately 75 lbs.

**Shot three.** The EHS charges were all chosen randomly from the lot, transferred to the range and detonated on steel plates. For the lot to pass certification, all three of the shots must penetrate the plates, which all three did.

## Conclusion

For those in attendance of OSU and Golden West's collaborative training opportunity, the experience taught valuable lessons that participants took back to their respective fields. For those in attendance, the experience was one-of-a-kind. It is the authors' hope that Golden West can host additional courses so that other military members, civilian bomb squads, and medical personnel also can benefit. The world we live in, which is full of unpredictable regimes, volatile situations, and terrorist groups, only leads one to understanding the need for well-educated and trained people who are willing to help those trying to survive in formerly- and currently-contested areas contaminated with mines and UXO. In 2020, OSU and Golden West will be hosting another training course February 24–28. For more information, please contact Tom Gersbeck at [tom.gersbeck@okstate.edu](mailto:tom.gersbeck@okstate.edu). ©

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Jorge Rivero is an active duty Marine EOD technician. Rivero joined the EOD field in 2011 after multiple infantry deployments to Iraq, Haiti, and the Middle East. After graduating from Naval School Explosive Ordnance Disposal (NAVSCOD), he deployed to Afghanistan in 2013 and to Europe and Africa in 2015 where he served at Second EOD Company as a Team Member and EOD Team Leader. Rivero holds a Bachelor of Arts in Political Science from Arizona State University and is currently enrolled in George Washington University's master's program.

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