

The HALO Trust and HSTAMIDS

A technology that employs multiple mine-detection techniques could improve demining around the world. Twenty-six months of using this product on-site have shown exciting results. Benefits of this demining tool include increased effectiveness, speed and safety. This device was initially manufactured and used for military purposes only. The process of making it available to non-military organizations was difficult but successful.

by Chris Boshoff [The HALO Trust] and Roger Cresci [U.S. Humanitarian Demining Research and Development Program]

The Handheld Standoff Mine Detection System (HSTAMIDS) is a dual-sensor mine detector developed specifically for the U.S. military by L-3 Communications CyTerra Corporation. HSTAMIDS combines an advanced metal detector and ground-penetrating radar, allowing the user to discriminate between metal debris (clutter) and metal that has associated mass (probable mines). What makes the HSTAMIDS unique from other dual sensors is that it discriminates in real-time, without the need to switch between MD and GPR when investigating a signal. This feat is achieved by both MD and GPR technologies functioning concurrently through a series of sophisticated data algorithms.

Although HSTAMIDS has been operationally deployed since 2003, its use has been limited to military operations only. It was not until the start of the HSTAMIDS Operational Field Evaluation conducted by the U.S. Humanitarian Demining Research and Development Program and The HALO Trust during 2006 in Cambodia that HSTAMIDS was actively marketed to a non-military organization.

The HSTAMIDS OFE began with fundamental expectations of productivity increases due to the system's discrimination capability. The direction and significant strides in demining that have transpired since the initial HSTAMIDS deployment could never have been predicted. New capabilities and massive increases in efficiency have materialized from the efforts put forth by those involved in the OFE. The following account describes a small portion of the Operational Field Evaluation and some of the reasons HALO was inspired to purchase its own HSTAMIDS systems for deployment throughout its global operations.

Progress Through Design

If HSTAMIDS was going to make a successful transition from military hardware to humanitarian demining tool, it needed to be understood and operated well by local deminers; thus, during 2004, the HD R&D Program set out to conduct tests in Afghanistan, Namibia and Thailand in order to determine whether HSTAMIDS could be used as effectively by humanitarian deminers as by their seasoned military counterparts. The test results were positive, proving that deminers, who because of civil strife generally have limited education, could indeed be taught to operate HSTAMIDS correctly. The tests also demonstrated and brought to light the potential benefit of the dual sensor's discriminating capability.

The first organization to participate was The HALO Trust, which after realizing the potential of the system, expressed a desire to obtain and incorporate the Handheld Standoff Mine Detection System into its day-to-day operations. The next step, which became the aim of HALO and the HD R&D Program HSTAMIDS Operational Field Evaluation, was to place HSTAMIDS in the hands of conventional deminers during live operations. The HD R&D Program and HALO decided to conduct the HSTAMIDS OFE in Cambodia because of its high levels of mine contamination and various types of soils.

The Operational Field Evaluation was designed to allow the local operators to systematically improve their ability while periodically increasing the difficulty of the operational conditions. The OFE started in an area with dense rows of high-metal anti-personnel mines in mundane soils. It then progressed into areas containing minimal-metal mines in non-cooperative soils and later advanced into areas of mixed mines in soils with heavy metal contamination.

HSTAMIDS SOPs

The HSTAMIDS OFE commenced in March 2006, when HD R&D Program staff trained 10 HALO deminers at the training facility specifically built for HSTAMIDS, located within the HALO-Cambodia compound in Siem Reap. While the training was taking place, HALO set out to develop standard operating procedures that would incorporate HSTAMIDS as the primary sensor, as well as achieve the highest possible productivity gain. The result was a fusion of the HD R&D Program's technical knowledge and The HALO Trust's longstanding experience in demining.

The HSTAMIDS SOPs involve clearing multiple pre-prepared search lanes, which are set up along the edge of a minefield, creating a lateral flow of movement. This setup is markedly different from the conventional "one-man, one-lane" drill, whereby deminers move forward creating "breach" lanes into the suspect area. Conventional methods also entail a sole deminer being responsible for marking, cutting and clearing the vegetation before conducting his detector search. With the HSTAMIDS SOPs, support deminers each perform one function, which allows the efficient preparation of multiple lanes ahead of the HSTAMIDS search. This process consists of five distinct actions:

1. Cutting of vegetation
2. Lane preparation
3. HSTAMIDS search
4. Excavation of probable mine calls
5. Investigation of clutter calls

Similar to directing water through a network of channels, the SOPs' aim is to keep HSTAMIDS moving. If there is a stop, the process and the water will dam up and spill and, in the case of HSTAMIDS, valuable productivity will be lost. Once the process is set in motion, all the functions are conducted concurrently.

Phase One: Dense Rows of Mines and Mundane Soils

All 10 HALO deminers passed the intensive two-week Handheld Standoff Mine Detection System training course; however, since initially only three HSTAMIDS units were available to HALO, only the six best HSTAMIDS-trained deminers were chosen for the first actual field deployment.

The Handheld Standoff Mine Detection Systems were deployed in support of humanitarian demining for the first time on 27 April 2006 at the Buong Tra Koun West 4 minefield in Banteay Meanchey province in

northwest Cambodia. This minefield forms part of the K5 Mine Belt, which came to be after a Vietnamese military offensive during 1984 and 1985 aimed to push the Khmer Rouge from Cambodia into bordering Thailand. In this area of HSTAMIDS deployment, the K5 consists mainly of Russian PMN¹ anti-personnel mines, with a density of roughly 3,000 mines per linear kilometer.

At the start of the Operational Field Evaluation, both the U.S. Humanitarian Demining Research and Development Program and The HALO Trust were wary of mistakes, and therefore decided to re-clear all HSTAMIDS-searched ground conventionally, to ensure the results were accurate. Each metal signal the HSTAMIDS detected was marked with a numbered chip placed at the seat of the metal signal, and the operator's "call"—i.e., his assessment of whether the metal signal was a probable mine or clutter—was recorded. This method documented both the HSTAMIDS operator's call and the result of the subsequent investigation (excavation) of the metal signal. This process not only gave credence to the blind data results, but also prevented the follow-up deminers from being influenced by the HSTAMIDS operator's call.

The question, "Is it possible for an ordinary deminer to discriminate between mines and metal clutter while using the HSTAMIDS?" took only weeks to answer. The six HSTAMIDS deminers, once adapted to the different procedures, were confidently rejecting clutter and discriminating between probable mines and clutter. Within the first week, some operators rejected close to 100 percent of the clutter. This action made the HD R&D Program and HALO senior staff slightly wary, however, as they were concerned that the operators were rejecting clutter on the basis of the strong audible return of a PMN, rather than sticking to the prescribed rule of marking all metal signals that had both a metal and GPR return as a probable mine. To address this concern, HALO decided to introduce an additional method of quality assurance, involving randomly inserting Type 72 Alfa (T72A) test pieces, which were made free from explosives by replacing the explosive content with epoxy resin, into the HSTAMIDS search lanes. This procedure allowed HALO to monitor if the operators were isolating and calling the clutter correctly. While the presence of T72A test pieces made the deminers a bit more cautious and influenced the clutter-rejection figures, the HSTAMIDS operators were still clearing approximately 263 square meters per man per day, while rejecting an average of 93 percent of metal signals as clutter.

Phase Two: Minimal-metal Mines and Non-cooperative Soils

The use of the T72A test pieces proved that T72A mines were not going to be much of a challenge for HSTAMIDS; however, HALO still felt that searching for T72As, Cambodia's most minimal-metal mine, in non-cooperative soils should make a difference in the pace of the now-confident operators. The place to achieve this was Anlong Veng, a district town of Odar Meanchey province, which was a Khmer Rouge stronghold as late as 1996. Here, dense T72A minefields surrounded much of the town's infrastructure, preventing farmers from tending to their fields. The first area chosen was a minefield called Chong Serai Kang Keut, a defensive Khmer Rouge perimeter minefield, located only 5km west of Anlong Veng and laden with T72A and T69s.¹



HALO deminer operating the HSTAMIDS.
PHOTO COURTESY OF ROGER CRESCI

As expected, HSTAMIDS had little difficulty locating the T72As, and even in non-cooperative soils it never became much of a challenge for the HSTAMIDS operators. This outcome increased HALO's faith in the ability of the operators and resulted in the decision to stop the full follow-up clearance behind the HSTAMIDS. It also led to using red and blue chips to mark the operators' calls (red chips marking probable mines and blue chips clutter calls), instead of using white, numbered chips. The change to colored chips did away with the convoluted accounting process, which, although necessary during the start of the OFE, was now a hindrance to the teams' increased pace and efficiency. These changes also reduced the staff supporting an HSTAMIDS from 10 to three persons, with two deminers to clear vegetation and set up lanes and a third deminer to conduct excavation of the blue and red chips.

The most significant discovery of the Handheld Standoff Mine Detection System deployment in the T72A minefields, and perhaps of the whole Operational Field Evaluation, did not happen at Chong Serai Kang Keut, but at another T72A minefield called Ou Tameng village, located 15km south of Anlong Veng. During an HSTAMIDS operator's sweep of a lane, he noticed a GPR signal that on closer inspection gave a well-defined and regular GPR reply. What made the signal peculiar was the fact that there was only a GPR signal and no accompanying metal tone, as was generally the case. As instructed by the HSTAMIDS SOPs, after first isolating the signal, the operator marked the signal with a red chip, which led to the discovery of a severely



Ou Tameng minefield. Note the ground saturation and white stakes. Each white stake is where a mine was found and blown *in situ*.
PHOTO COURTESY OF CHRIS BOSHOF

degraded T72A. The Ou Tameng minefield is situated in an area of low-lying ground, which means during the Cambodian wet season, periods of prolonged flooding occur there. Over the years, the mines and their metal content have degraded considerably due to repeated water ingress, which ultimately has made detection of these mines with conventional detectors even less likely.

The T72A, found solely by the HSTAMIDS GPR signal, piqued the interest of the HSTAMIDS senior operations staff. They decided to test this particular T72A against various metal detectors and discovered that none was able to detect it. The only detector capable of finding this mine was HSTAMIDS. Since this initial discovery, several more degraded and deeply buried mines, for example a PMN buried at 29cm, have been found in various conditions by HSTAMIDS GPR signals only. This facet of HSTAMIDS is one that no sensor can equal and, in HALO's opinion, constitutes the first genuine mine detector. Given the correct application, it potentially allows the location of minimal-metal anti-tank mines such as the South African #8,¹ which for years has been the Achilles' heel of conventional detection systems.

Phase Three: High Metal Contamination

The greatest benefit of HSTAMIDS in Cambodia remains its discrimination capability. This asset, however, was not fully realized until the introduction of rapid-clutter investigation techniques. The use of a rapid-clutter investigation technique was first introduced after HALO senior staff saw the follow-up deminers, those responsible for excavating the blue and red marked detections, beginning to apply more vigor

when dealing with blue clutter chips. When the changeover to colored chips occurred, it was clearly explained that the OFE was still a trial, and deminers should continue to treat all marked detections as dangerous, regardless of chip color. After excavating thousands of blue chips without finding any mines, however, it was natural for deminers to accelerate blue chip excavations. The senior staff addressed this challenge by developing alternative methods to rapidly excavate the clutter calls.

The first tool HALO tried in excavating clutter calls was a hoe on a 2-meter extended handle. Although heavy and unyielding, the long handle hoe immediately revealed the true potential of the Handheld Standoff Mine Detection System. The quick excavation technique now allowed HALO to efficiently deploy HSTAMIDS into the heaviest of metal-contaminated minefields. Combined with rapid-clutter excavation techniques, HSTAMIDS became the primary tool for tackling heavily metal-contaminated minefields.

One such minefield was Prey Chan, located near a small border village populated with Khmer day laborers on the K5 in Banteay Meanchey province. Due to the high metal contamination, deminers equipped with metal detectors were forced to revert to manual excavation methods. This process was arduous, given the very hard, compacted soil; clearance rates averaged only 5 square meters per day. In order to continue this task, HALO had to introduce heavy mechanical equipment to assist in the clearance of the area, which posed a different set of difficulties. These challenges included increased operating costs, limited resources and logistic difficulties due to seasonal constraints, which could delay operations significantly.

In order to expedite this task and observe the performance of HSTAMIDS and operators under more difficult conditions, HALO moved HSTAMIDS to Prey Chan. HSTAMIDS made an immediate impact as the operators were able to significantly reduce the large areas of heavily metal-contaminated ground, previously left for mechanical excavation. The HSTAMIDS operators were able to clear ground that had up to 25 metal indications per square meter and, combined with the quick excavation, the productivity increase achieved was higher than any other area in which HSTAMIDS had previously worked. The significant savings in time and cost at Prey Chan clearly demonstrated the benefit of HSTAMIDS in areas with heavy metal contamination.

As with all great advances, there came greater challenges. HALO learned that pushing the boundaries of HSTAMIDS and operators led to a set of circumstances yet to be encountered. The constant "alarming" of signals in this heavily contaminated soil led to hearing fatigue in the operators. Although a seemingly simple problem, the consequences were more complex. An operator mis-called an AP mine located amid dense clutter. At first thought to be a setback, in reality it enhanced future operations.

The mine was subsequently found by the follow-on quality-assurance rapid-clutter excavation method. First and foremost, the effectiveness of HALO's internal QA system had been proven. Maximum clutter densities have been established for the operators, whereby mechanical-clearance methods may prove more efficient.

Total Area Cleared	604,375 sq m
Total Detections	1,423,902
Total Mines Found	5,610
Total Clutter Rejection	95.2 percent

Table 1: Results of using HSTAMIDS in Cambodia.
COURTESY OF THE AUTHORS / MAIC

2006 Clutter Rejection	86.3 percent
2007 Clutter Rejection	95.3 percent
2008 Clutter Rejection	96.5 percent

Table 2: Clutter rejection rates per year.
COURTESY OF THE AUTHORS / MAIC



Heavily metal-contaminated area in Prey Chan. Notice "pock marked" ground in safe area cleared by rapid-excavation method.
PHOTO COURTESY OF CHRIS BOSHOFF

Improved quick-excavation methods have been developed that not only improve safety, but are also less intrusive and more efficient. Lastly, when in heavily contaminated areas, HSTAMIDS operators are rotated on a daily basis to prevent hearing fatigue.

OFE Evolution

In August 2006, the U.S. Humanitarian Demining Research and Development Program increased the number of HSTAMIDS units for HALO's use to 12. The HD R&D Program's involvement evolved from conducting training and monitoring operations into a "train-the-trainer" role for HSTAMIDS operators. This change was necessary to satisfy HALO's growing training requirements. In addition, more focus was placed on the organization and developing strong individuals to supervise daily HSTAMIDS operations.

By December 2006, the HD R&D Program's involvement in HALO's Handheld Standoff Mine Detection System operations was minimal, indicating the success with which the HSTAMIDS OFE progressed. The Handheld Standoff Mine Detection Systems were completely in the hands of local staff, who were running the operations with very little input from senior staff, further demonstrating that HSTAMIDS, with the right supervision and SOPs, can be successfully integrated into humanitarian-demining operations.

Results

From March 2006 through June 2008, The HALO Trust progressively increased

the efficiency and productivity with which HSTAMIDS has been employed in its Cambodia operations. The figures in Tables 1 and 2 (see previous page) are entirely associated with HSTAMIDS, and these accomplishments are only a small portion of HALO's overall contribution to resolving the Cambodia problem.

The Cambodia HSTAMIDS Operational Field Evaluation, although impressive, is just the beginning of what has become a new direction in manual demining. HSTAMIDS has proven to have a multitude of applications, ranging from dealing with degrading mines to dealing with heavily metal-contaminated areas in the Cambodian context. Deployed in a sensible and methodical manner, it not only provides the same level of safety as the conventional system, but also the added bonus of exceptional productivity.

Faced with the challenge of dwindling donor funding, organizations incorporating HSTAMIDS in certain applications will help increase their impact in mine-affected countries. HALO continues to work closely with the HD R&D Program on the further development of HSTAMIDS training, improved rapid-clutter excavation and personal protective equipment. In addition, the HD R&D Program has extended its own program to include OFEs with the Mines Advisory Group and the Cambodian Mine Action Centre. ♦

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Chris Boshoff has worked for The HALO Trust for last eight years. As the HALO HSTAMIDS Manager he has operational oversight of HALO HSTAMIDS setup and roll out into all the countries in which HALO operates.

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