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## **In-Country Trials Cambodia: Minehound**

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# **In-Country Trials Cambodia Minehound August 2005**

## **Report on two additional tests**



*Figure 1 MAG deminers, ITEP test team and interpreter*

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## Introduction

In the framework of the in-country trials of the hand-held dual-sensor system Minehound [ref 1] in Cambodia, tests additional to the main trials are executed. In this document two of these additional tests are reported. Both are blind tests. In the first test the ability of the local deminers to discriminate mine-like targets from indigenous clutter with the help of the Minehound is examined. In the second test the ability of these deminers to discriminate adjacently buried low-metal targets and targets that contain a lot of metal, is investigated.

These tests were executed mid August 2005 at the test site that was established for the Minehound in-country trials in a recently cleared part of the Lveate mine field, Batambang province, Cambodia, i.e. these tests were performed simultaneously with the first use of the Minehound in the MAG demining operations.

Due to the limited availability of suitable targets for both tests, no comprehensive tests could be set up. For this reason the results should be regarded with care.

## Test procedures

### (1) Discrimination between mine-like targets and clutter

The aim of this test is to determine if the local deminers can discriminate between buried mine-like targets and indigenous clutter with the help of the Minehound dual-sensor detector.

Since no (inert) mines were available, three different types of ITOP targets were used. Of each target type, two samples were used. These ITOP targets have diameters of 6, 9 and 12 cm. These targets are denoted in this report as SIM6, SIM9 and SIM12, respectively. The SIM6 and SIM12 targets were provided with the Io insert and the SIM9 targets were provided with a Ko insert. Figure 2a shows the used ITOP targets, while figure 2b shows the inserts and their metal parts. Detailed information on the ITOP targets and their inserts can be found in [ref 2]. The ITOP targets were buried at a depth of 5 cm (i.e. distance form the top of the targets to the soil surface).



Figure 2a ITOP targets (left) and inserts Io and Ko (right).



Figure 2b ITOP inserts Io and Ko with their metal parts in front.

For these test, indigenous clutter was collected from the buckets with metal parts that were found by the deminers during their demining operation in the live mine field. The clutter used in the test consisted of a small bullet, two cartridges (4.5 cm long), a washer and two small rusted iron fragments. Figure 3 shows these items. The clutter items were buried at a depth of 1 to 2 cm. One cartridge was vertically oriented buried; the other one horizontally.

Both the ITOP targets and the clutter items were buried on August 15.



Figure 3 Indigenous clutter items used in the test: washer, two cartridges, bullet and two metal fragments

The 6 ITOP targets and the 6 clutter items were buried in a metal-free test lane with a width of 1 meter and a length of 4 meter. This test lane was subdivided in 4 cells of 1 by 1 meter. The sites of the lane were marked with plastic ribbon and wooden poles. Figure 4 shows the test lane. The soil type is laterite. In [ref 3] the relevant electromagnetic properties of the soil, as measured during the Minehound trials, are given. The locations of the targets and clutter items were recorded with the help of a grid ("Quick Grid") of 1 by 1 meter. These locations were not marked and they were not known by the Minehound operators that execute the test.



Figure 4 Test lane.

The local MAG deminers that had been trained to operate the Minehound detector, were asked to scan the test lane with this detector according to the procedures as taught in the training and to mark the locations of mine-like objects and clutter items with two differently colored markers (blue markers for mine-like objects and yellow markers for clutter). For the set-up of the detector, a metal-free area near the test lane was available.

## **(2) Resolution of adjacent targets**

The aim of this test is to determine if the local deminers can discriminate between two adjacently buried metal and low-metal targets with the help of the Minehound dual-sensor detector.

For these test, three steel discs with a diameter of 6 cm and a thickness of 3 mm are used. ERA Minehound test pieces are used as low-metal targets.

First the three steel discs are buried at a depth of 10 cm in the centre of metal-free test lane cells of 1 by 1 meter. With the help of an experienced ITEP Minehound operator the size of the metal detection halo of these targets is determined. This halo has a radius of 17 (+/- 1) cm. It should be noted that this halo is much smaller than expected when designing this tests. Subsequently one ERA test piece is buried at a distance of 12 cm of each metal disc and a depth of 5 cm. The ERA test pieces are buried with the wide base up (i.e. "GPR D" showing). The locations of the steel discs and the low-metal ERA test pieces are not marked. Figure 5 shows a buried metal disc and the adjacent ERA test piece before filling up the holes. The targets are buried on August 17.

The local MAG deminers that have been trained to operate the Minehound detector, are asked to scan the three test lane cells with this detector according to the procedures as taught in the training and to mark the locations of mine-like objects and clutter with blue and yellow markers, respectively. The deminers are not told that only one low-metal target is buried in the cell. For the set-up of the detector, a metal-free area near the test lane cells is available.



Figure 5 Buried metal disc and ERA test piece for the resolution of adjacent targets test

### Execution of the tests

#### (1) Discrimination between mine-like targets and clutter

The test is executed in the period from August 22 to 24, 2004, by the four MAG deminers that are trained to operate the Minehound detector, and by one ITEP representative; i.e. a week or more after the burial of the targets. Two MAG deminers executed the test twice, in both cases the second time two days after the first test. The lanes are scanned only in one direction. The MAG deminers needed between half an hour and three quarters of an hour to scan the 4 meter lane.

#### (2) Resolution of adjacent targets

The test was executed on August 23, i.e. a week after the burial of the targets. Each of the four deminers performed the test on the three cells in less than half an hour. After the test was finished by the four MAG deminers, the digging up of the targets was done in the presence of the deminers.

### Results of the tests

#### (1) Discrimination between mine-like targets and clutter

Table 1 shows all results of the test performed by the four MAG deminers and the ITEP representative.

Table 1 Results of the tests

Ground truth	22-Aug	24-Aug	22-Aug	24-Aug	22-Aug	24-Aug	22-Aug	22-Aug	23-Aug
Cell Grid	Mitch (MAG)	Mitch (MAG)	Kim Say (MAG)	Kim Say (MAG)	Roth (MAG)	Savon (MAG)	ITEP representative		
1 F-6	G-5 VV M	H-5 VV M	C-5 VV C f.a.	G-5 VV M	G-5 VV M	G-5 VV M	G-4 VV M		
1 C-3	D-3 VV C f.a.	D-2** VX C		C-2** VX C	C-4 VV C	C-4 VX C	D-2** VV C f.a.		
	A-6 VV f.a.	B-3** VX C		D-4** VX C	D-1 VV f.a.	E-2 VX f.a.	B-4** VX C		
2 G-1/H-1	H-2 VV M	G-2 VV M	1H-10 VV M	G-1 VV M	H-1 VV M	G-1 VV M	1G-10 VV M		
2 G-8	F-8 VV M	G-8 VV M	G-7 VV M	G-9** VV M	F-8 VV M	F-8 VV M	G-8 VV M		
2 D-4	D-4 VX C	C-3 VX C	D-4 VX C	H-7** VV M	D-3 VX C	D-4 VV C f.a.	C-5 VV C		
3 F-8	E-8 VV M	F-8 VV M	E-8 VV M	G-9 VV M	E-8 VV M	E-8 VV M	E-8 VV M		
3 B-4	B-4 VV C f.a.	B-4 VX C	B-3 VV C f.a.	B-3 VV C f.a.	B-4** VV C f.a.	B-3 VV C f.a.	B-3 VV C		
3 H-3	H-2 VV C f.a.	H-4 VV C f.a.	H-2** VV C f.a.	I-4 VX C	I-2 VV C f.a.	H-2 VV C f.a.	H-3 VV C		
4 B-6	B-6 VV M	B-6 VV M	B-6 VV M	C-6 VV M	B-6 VV M	B-6 VV M	B-6 VV C		
4 H-6	I-6 VV M	H-6 VV M	H-6 VV M	I-6 VV M	I-7 VV M	I-6 VV M	I-4 VV C		
4 I-2	I-2 VV C f.a.	I-2 VV C f.a.	I-2 VV C f.a.	I-3 VV C f.a.	I-2 VV C f.a.	I-2 VV C f.a.	H-2 VV C f.a.		
4 D-9	D-9 VX C	D-9 VX C	D-10 VX C	E-10 VX C	D-9 VX C	D-9 VV C f.a.	E-8 VV C		
			missed SIM12 @ cell 1			missed SIM6 @ cell 4 loose earpiece contact?			

key  
M declared as mine-like object  
C declared as (metal) clutter  
\*\* probably 2 alarms from same object  
mis-class mine declared false alarm: mis-classification  
f.a. ghost: no target present  
C f.a. clutter declared mine

The following comments can be made to Table 1.

- In two cases an ITOP target was missed by a MAG deminer. A SIM12 in the first cell was missed on the first day of these tests. The other occurrence of a missed ITOP target, a SIM6 in cell 4, is probably due to a loose earpiece of the Minehound detector.
- The MAG deminers never declared a mine-like target (i.e. an ITOP target) falsely as clutter. However, the ITEP representative misclassified both SIM6 targets.
- Approximately 50% of the clutter items are declared as clutter, while the other 50% are declared as a mine.
- The vertically buried cartridge (in the first cell of the lane) yielded in three cases two alarms. Also in cell 3 the washer and the bullet yielded two alarms in two cases.
- The horizontally buried cartridge is in all test runs falsely declared as a mine-like object. The washer, the bullet and the vertically buried cartridge are in more than half of the test runs falsely declared as mine-like objects.
- In cell 1 three false alarms are found, by different deminers and at different location.

## (2) Resolution of adjacent targets

The MAG deminers were able to get clear metal detection signals from the Minehound to discriminate between the two targets. In general the Minehound GPR signal was consistent above the ERA test target, but the steel discs gave inconsistent GPR signals. The figures 6a to 6c give an impression of the markers as placed by the deminers for this test.

All four deminers placed blue markers at the locations of the steel discs and the ERA test piece, apart from one or more additional markers denoting mine-like objects (see figure 6c) and/or metal clutter (see figures 6a and 6b).





*Figure 6 a- c Markers placed by the MAG deminers for the resolution of adjacent targets test (blue marker denotes a mine-like object; yellow marker denotes metal clutter)*

### **Conclusions**

In considering the results of the two tests performed, the following two remarks should be kept in mind.

- (1) Only a very limited number of targets were available, so the statistical reliability of the tests may be questionable.
- (2) The four local MAG deminers that performed the tests were trained to operate the Minehound. However, at the moment of the tests they could not be regarded as experienced Minehound operators.

The following conclusions can be drawn.

- The trained MAG Minehound operators are able to locate the mine-like ITOP targets, buried at 5 cm deep in the Cambodian soil, and declare them correctly, in nearly all cases.
- Missing of one of the two mine-like targets that was not detected by the MAG Minehound operators may be explained by the loose contact of the earpiece. No plausible explanation for not detecting the other mine-like target is present.
- Although the metal clutter items are localized correctly, it appears difficult to discriminate the clutter items from mine-like targets for the trained MAG Minehound operators. Especially the horizontally buried cartridge, and to a lesser extent, the washer, the bullet and the vertically buried cartridge are often declared as mine-like targets.
- Only a very limited number of alarms (both metal detection and GPR) occurred at locations where no targets (mine-like nor clutter) were present.
- The inexperienced ITEP representative mis-classified the two smallest mine-like targets, although overall he matched up with the MAG operators.
- The results of the 'resolution of adjacent targets test' showed that, firstly, the metal detection halo of large metal targets for the Minehound detector is relatively small, secondly, that the trained MAG deminers were able to localize the low-metal targets with the help of the GPR signal in all cases and, thirdly, that in each test configuration with one metal target and one low-metal target one or more false alarms were found.

### **References**

- 1 Report on the in country trials of the Minehound mine detector, t.b.d.
- 2 'Simulant test targets', information from VSE Corporation, Alexandria, VA, U.S.A.
- 3 Report with EM-soil properties of Cambodian test site, t.b.d.