EXECUTIVE SUMMARY

1. INTRODUCTION

The Cambodian problem of landmines and Un-Exploded Ordnance (hereinafter refer to as “UXO”) has been the direct result of decades of wars and conflicts which have devastated the country in every sense. Today, the people of Cambodia have to deal with one of the worst impacts of mines and UXO contamination on the surface of the globe. In the course of these conflicts, each warring faction has polluted indiscriminately and scattered without record or regard to later consequence their killing tools of mines and UXO. It has been estimated that between 4 to 6 million landmines have been laid - the frightening statistics of one landmine for every two rural Cambodians. In addition, there are the UXOs - the remains of the massive air bombing campaign, and the ordinance that litters the many battlefronts, which are part of the two to three million tons of ammunition expended from 1970 to 1997.

Dealing with these landmines and UXO requires patience, expertise, vast financial resources and advanced technology. As a leading national demining organization in Cambodia, and one of the leading demining organizations worldwide, the Cambodian Mine Action Centre (hereinafter refer to as “CMAC”) has taken every effort to increase its productivity and improve its efficiency. As mine action evolves and technology advances, CMAC continues to make enormous efforts to carry out research and development of demining related equipment.

As part of the continuous effort by CMAC to improve its demining technology, and as a manifestation by the Japanese Government to continue to support mine action in Cambodia and promote research and development of demining related Equipment (hereinafter refer to as “the project”), on 17 March 2006 the Government of Japan and the Government of Cambodia signed an Exchange of Notes concerning the Japanese economic cooperation for the execution of the Project for Research and Development of Mine Clearance Related Equipment to be executed by CMAC.

The aim of the project is to test and evaluate the performance and suitability of demining machines and mine detectors manufactured by Japanese companies and research institutions. The Japan International Cooperation Systems (hereinafter refer to as “JICS”) was selected as a consultant firm to supervise this important project. The total budget plan for the project is 416,000,000 yens.

Following the signature of the Exchange of Notes, a separate Memorandum of Understanding was signed between CMAC and JICS to lay out detailed project execution. A Selection Committee comprising of CMAC team, two officials from the Ministry of Foreign Affairs of Japan, two representatives from relevant institutes of Japan and a representative from UNMAS was formed to carry out the selection of test participants. The tasks of the Selection Committee included the review of the selection criteria and process, the assessment of the applicants' qualifications based on CMAC's Standard Operation Requirements (hereinafter refer to as “SOR”), and the final selection of the participants.

The purpose of the Project is to carry out the test and evaluation of the mine detectors produced by Japanese developers in Cambodia in order to determine their performance and suitability in the context of demining in Cambodia.

2. PURPOSE OF TEST AND EVALUATION

CMAC operators related to mine detector received the proper training for by developers. Operators were trained for about two weeks before the test and evaluation to operate the machine/detector and to analyze the sensor and the monitors performances, etc. The test and evaluation was conducted at CMAC Regional Centre and had five (5) purposes:

- To train CMAC demininers for the operation mine detector in accordance with CMAC’s SOR “Simplicity”
- To confirm detecting capability with various soil conditions and various targets in accordance with CMAC’s SOR “Recognition & Identification System of Safety Measures”

- To compare the performance against current use of metal detector Mine Lab F1A4 in accordance with “Recognition & Identification System and Safety, Cost Efficiency and Productivity”
- To confirm “Durability of Natural Condition”, and
- To study “Technological Advantage”.

2. TEST PARTICIPANTS

Five applicants submitted applications to test their mine detector (with ground penetration capability) in the solicitation process. Some of them had also participated in similar projects in Afghanistan under the Japanese Research Project 2005. However, upon the arrival of the systems in Cambodia, Kawasaki requested to withdraw from the Project due to the technical difficulties they faced. With the withdrawal of Kawasaki, there were only four applicants left: a) Tokyo University of Technology, b) Tohoku University, c) Mitsui Engineering & Shipbuilding Co. Ltd. And d) TAU GIKEN Co. Ltd. The equipment used by the applicants fall into two categories: Vehicle Mounted Metal Detector (hereinafter refer to as “VD”) and Hand Held Metal Detector (hereinafter refer to as “HD”)

A. VEHICLE-MOUNTED TYPE DETECTOR / NAME OF DEVELOPER

VD - 1. GRYPHON with metal detector and LAMDAR-3
University of Electro Communications,
Tokyo Institute of Technology,
TAU GIKEN Co., Ltd.

VD - 2. GRYPHON with Dual-Sensor
Tokyo Institute of Technology

B. HAND-HELD TYPE DETECTOR / NAME OF DEVELOPER

HD - 1. Advanced landmine imaging system (ALIS)
Tohoku University

HD - 2. Mitsui Fusion Sensing A.P.Mine Detector
Mitsui Engineering & Shipbuilding Co. Ltd.

In order to conduct this test successfully, CMAC assigned 1 project manager, 1 project assistant, 1 driver, 5 teams of deminer (each team consists of 1 team leader, 3 deminers), and other support staff such as financial staff, medical staff, drivers and security guards. In the execution of the project CMAC management team closely coordinated with JICS in both general management and technical aspects.

3. TEST PREPARATION

Management and supervision of personnel concerned in all aspects of the mine detector must be undertaken using the SOR, SOPs and field experience of CMAC. However, the final version of SOPs for such mine detector for the Project is still under consideration in Cambodia. JICS made a proposal of test plan referring to the international trial report from ITEP and Research Project in Afghanistan 2005.

CMAC has experience of international metal detector trials conducted on August 2004. The management and supervision of personnel concerned in all aspects of test and evaluation activities on mine detector must be undertaken under the CMAC’s instruction.

4. TEST CONTENTS

Test 1: In-Air Test

In-Air Tests are to determine the characteristics and performance of a metal detector, without the influence of soil. The detector (sensor head) shall be swept over the target and the sensor height above the target adjusted until an alarm indication is obtained from its detection. CMAC operator indicates if he could recognize the alarm from detector.

Test 2: Sensitivity Test (Calibration Box No.1～No.6)

Sensitivity test is to determine sensitivity of the detectors in various soil types and soil conditions.
CMAC operators monitor whether the detector can indicate the buried targets during training period.

Test 3: Target location accuracy test (Test Lane No.1～No.6)

The purpose of this test is to determine the capability of the mine detectors to accurately located test targets in various soils. CMAC operator indicates where he recognizes the centre of the test target is located. This location is marked and recorded using the coordinate measurements.

Test 4: Resolution of adjacent targets test (Proximity test, Test Lane No.7)

This test is to determine the capability of the mine detectors to discriminate between targets that are buried close to each other. Both targets of the same size and also one of different sizes are prepared.
CMAC operator indicates where he recognizes the centre of the test target is located. This location is marked and recorded using the coordinate measurements.

Test 5: Effect of radio frequency interference test (Test Lane No.8)

The object of this test is to determine the distance from any such specific source of interference at which the mine detectors can be used. The mine detector (sensor head) is set on the place of buried targets. Radio transceiver is switched on at intervals of 10m distance from the mine detector. CMAC operators determines whether the mine detector can function well using the Radio transceiver.

Test 6: Power consumption test

The purpose of the power consumption test is to ascertain the power requirement of the detector with a view to planning running cost.

Test 7: Monitoring by CMAC operators

The purpose of the monitoring is to provide operators' feedback about the unit and system. Any comments made will be helpful in developing a system that will perform its mission safely and effectively, and without placing undue stress or hardship on the system operator.

5. TEST LANES

Calibration boxes were prepared to tune the sensor of detectors and to train CMAC operators before starting the test and evaluation. The calibration boxes and test lanes were composed of two categories; one category was for Hand-held detectors, and the other category was for Vehicle mounted detectors. From No.1 to No.7 of the calibration boxes and test lanes were prepared separately for Vehicle mounted detector and Hand-held detector. Test lane No.8 was shared the use for Vehicle mounted detector and Hand-held detector. The soil of Lanes was compacted in dry and wet condition with sand, clay and laterite soil.

All of mines and UXOs were buried one (1) month before the start of the test and evaluation in order to avoid the influence of disturbance of soil condition due to the burial of land mines (GPR is very sensitive to the subsurface cavity).
After burying mines, all of the locations were recorded. It was necessary to compare the result of the test

and evaluation with these layouts. Design of test lanes layout is shown as in the Fig.1.

- **Hand-held detector test lanes**

Seven (7) lanes were made in the compacted soil lanes. The size of six (6) lanes (Lane No.1-Lane No.6) was 1.5 m by 25 m (wet sand soil, wet clay soil, wet laterite soil, dry sand soil, dry clay soil and dry laterite soil). One (1) lane (Lane No.7) is 1.5m by 18m with three (3) kinds of soil placed (sand, clay and laterite soil in dry condition).

- **Vehicle-mounted detector test lanes**

Seven (7) lanes were made in compacted soil. The size of six (6) lanes (Lane No.1-Lane No.6) was 1m by 25 m large (wet sand soil, wet clay soil, wet laterite soil, dry sand soil, dry clay soil and dry laterite soil). One (1) lane (Lane No.7) is 1m by 18m with three (3) kinds of soil placed (sand, clay and lateraite soil in dry condition).

Shared lane for Hand-held detector and Vehicle mounted detector : One (1) lane (Lane No.8) is 1m by 40m for radio frequency affect test and evaluation.

6. OBSERVATION FROM OPERATORS

CMAC operators have several opinions as for mine detectors through the test and evaluation. The following comments from CMAC operators are essential point of view regarding Ground Penetration Radar (hereinafter refer to as “GPR”) sensor. Although some images appeared on screen of mine detector, GPR images can not show which is mine, UXO or metal. Almost all operators got the impression that the GPR image is very difficult to analyze whether the object is mine or metal. It seems to operators that GPR system is very complicated. It dose not fit “Simplicity” and it is not suitable in light of CMAC’s SOR “Recognition & Identification System of Safety Measures”.

7. RESULTS

CMAC extends its deepest gratitude to all those who assisted in making the test and evaluation under the Project successful by providing sincere, helpful and timely advice and material. Without such activities, these tests might have been not so effective. Results of the test and evaluation should only be taken as an outcome of the various performances of mine detectors.

Although current mine detectors’ performance under the Project does not fulfill CMAC’s requirement and their system were too complicated for local operation system, CMAC believes that development of mine detector is getting better day by day and will achieve final goal in the future.

8. CONCLUSION

In light of the positive comments from developers, CMAC concludes that it was fair and high level test and evaluation in one of the typical simulated Cambodian conditions. The images from GPR sensor confused mine and metal. CMAC is not satisfied with this results and CMAC assumes that it is yet too early to carry out the test for GPR sensor in the filed test lane or test area. The results show that GPR sensors are still under development, further laboratory tests and improvement of image processing should be done in research institutes with domestic conditions.