

## TABLE OF CONTENT

TITLE	PAGE
FORWARD .....	i
EXECUTIVE SUMMARY .....	ii
TABLE OF CONTENT .....	vi
LIST OF FIGURE .....	viii
LIST OF TABLE .....	ix
LIST OF ABBREVIATION .....	x
1. BACKGROUND .....	1
1.1. THE RELATIONSHIP BETWEEN FRAGMENT AND PRODUCTIVITY .....	1
1.2. CONSTRAINT AND SOLUTIONS .....	2
1.3. THE ORIGIN OF THE PROJECT .....	3
1.4. SELECTION SCHEDULE .....	4
1.5. SELECTION RESULT .....	4
1.6. AIM OF THE PROJECT .....	4
1.7. SCOPE OF THE PROJECT .....	5
2. TEST LOCATION .....	5
3. TEST PARTICIPANTS .....	7
3.1. CAMBODIAN MINE ACTION CENTRE (CMAC) .....	7
3.2. JAPAN INTERNATIONAL COOPERATION SYSTEM (JICS) .....	8
3.3. MANUFACTURER .....	8
3.3.1. PROJECT MEMBER .....	8
3.3.2. PRE-LIMINARY SURVEY BY MANUFACTURER .....	8
3.3.3. SCOPE OF THE PRE-LIMINARY SURVEY .....	8
3.3.4. TERMS OF THE PERMISSION FOR THE PRELIMINARY SURVEY .....	8
3.4. PARTICIPANTS OF PRE-LIMINARY SURVEY .....	9
3.5. FEATURES OF MINE DETECTORS –ALIS .....	9
4. PREPARATION PRIO TO THE TEST .....	10
4.1. TRAINING .....	10
4.2. TEST LANE PREPARATION .....	10
4.2.1. GENERAL LAYOUT OF THE TEST AREA .....	10
4.2.2. TEST LANE .....	11
4.2.3. SOIL TYPE .....	14
4.2.4. SOIL CONDITION (WET & DRY) .....	15
4.2.5. THE USE OF LANDMINE/UXO IN THE CALIBRATION BOX .....	15
4.2.6. THE USE OF LANDMINE/UXO IN THE TEST LANE .....	19
4.2.7. DEFINITION OF DEPTH .....	21
5. TEST PROCEDURE .....	22
5.1. TEST SCHEDULE .....	22
5.2. TEST ACTIVITY .....	23
5.2.1. TEST 1: IN-AIR TEST .....	24
5.2.2. TEST 2: SENSITIVITY TEST .....	24
5.2.3. TEST 3 & 4: TARGET LOCATION ACCURACY TEST .....	24
5.2.4. TEST 5: PROXIMITY TEST (RESOLUTION OF ADJACENT TARGETS) .....	24
5.2.5. TEST 6: EFFECT OF RADIO FREQUENCY INTERFERENCE TEST .....	24

5.2.6. TEST 7: POWER/FUEL CONSUMPTION .....	25
5.2.7. TEST 8: DETECTION SPEED (PRODUCTIVITY).....	25
6. EVALUATION PROCEDURE.....	25
6.1. PASS OR FAIL DECISION BY DISTANCE.....	25
6.2. PASS OR FAIL DECISION BY DETECTED OBJECT .....	31
7. TEST RESULT .....	31
7.1. PASS AND FAIL TEST .....	32
7.1.1. TEST 3 & TEST 4: TARGET LOCATION ACCURACY TEST .....	32
7.1.1.1. PROBABILITY OF DETECTION .....	32
7.1.1.2. POSITIVE FALSE ALARM RATE .....	32
7.1.1.3. NEGATIVE FALSE ALARM RATE .....	32
7.1.1.4. DISTINCTION RATIO BETWEEN METAL AND MINE .....	32
7.1.1.5. CONSIDERATION OF NO. 3 AND NO. 4 TEST RESULTS .....	33
7.1.2. TEST 5: PROXIMITY TEST (RESOLUTION OF ADJACENT TARGETS).....	33
7.1.2.1. PROBABILITY OF DETECTION FOR CLOSE-SET BURIED TWO TARGETS .	33
7.1.2.2. CONSIDERATION OF NO. 5 TEST RESULTS .....	33
7.1.3. TEST 6: EFFECT OF RADIO FREQUENCY INTERFERENCE TEST.....	34
7.1.3.1. PROBABILITY OF EFFECT OF RADIO FREQUENCY INTEFERENCE TEST .	34
7.1.3.2. CONSIDERATION OF NO. 6 TEST RESULTS .....	34
7.2. TEST FOR INFORMATION PURPOSE.....	34
7.2.1. TEST NUMBER 1: AIR-TEST .....	34
7.2.2. TEST NUMBER 2: CALIBRATION BOX .....	35
7.2.3. TEST NUMBER 7: FUEL/POWER CONSUMPTION .....	35
7.2.4. TEST NUMBER 8: DETECTION SPEED .....	35
8. CONCLUSION OF "PASS OR FAIL" TESTS.....	36
9. RECOMMENDATIONS.....	36
10. ADDITIONAL TEST BY DEVELOPERS .....	37
10.1. PROBABILITY OF DETECTION.....	38
10.2. POSITIVE FALSE ALARM RATE.....	38
10.3. NEGATIVE FALSE ALARM RATE .....	38
10.4. DISTINCTION RATIO BETWEEN METAL AND MINE .....	38
10.5. PROBABILITY OF DETECTION FOR CLOSE-SET BURIED TWO TARGETS.....	38
11. GENERAL COMMENTS FOR DEVELOPER / RESEARCHER.....	38
12. ALL RIGHTS RESERVED .....	39
ANNEX 1:ALIS DURING TEST IN PICTURES .....	40
ANNEX 2:PROCEDURE TO BE APPLIED DURING TEST OF MINE DETECTOR.....	42
ANNEX 3:CMAC PROJECT MEMBERS IN PICTURES .....	48
OTHERS.	

## LIST OF FIGURE

TITLE	PAGE
Figure 1: Major constraints/solution in Mine Clearance Operation .....	2
Figure 2: test location in Siem Reap province, Cambodia .....	5
Figure 3: Project team structure .....	7
Figure 4: ALIS during test at CMAC regional Centre (Siem Reap Province).....	9
Figure 5: CMAC deminer is being trained by manufacturer in temporary field office of the manufacturer.....	10
Figure 6: Test zone in detail .....	11
Figure 7: Test lane is dug up to 1.5m. In case of present of water, water pump is used to dry the test lane before refilled with designated soil type. ....	12
Figure 8: soil is brought from original location by truck.....	13
Figure 9: Test land and calibration box are ready for testing .....	13
Figure 10: Location layout of buried targets in Calibration Box No.1 to No.6 for hand held type detector .....	17
Figure 11: Location layout of buried targets in Calibration Box No.1 to No.6 for vehicle-mounted type detector.....	18
Figure 12: Location layout of buried targets in Calibration Boxes No.7 (hand-held & vehicle mounted). 18	
Figure 13: Definition of Depth for Level burial.....	21
Figure 14: Definition of Depth for vertical burial.....	21
Figure 15: Evaluation criteria for APM.....	26
Figure 16: Evaluation criteria for ATM & UXO .....	27
Figure 17: Flow chart of decisive method for Pass or Fail .....	30

## LIST OF TABLE

TITLE	PAGE
Table 1: CMAC clearance result since 1993 .....	1
Table 2: Selection Committee Schedule .....	4
Table 3: Successful candidates .....	4
Table 4: Summary soil type and calibration box property .....	14
Table 5: Summary soil type and test lane property .....	14
Table 6: Summary soil type and test lane property of lane number 7 .....	15
Table 7: Summary soil type and test lane property of lane number 8 .....	15
Table 8: Date of targets/mines buried for hand-held type .....	16
Table 9: Buried targets in Calibration Box No.1-No.6 (for hand-held type & vehicle mounted type).....	16,17
Table 10: Buried targets in Calibration Box No.7 (for hand-held type & vehicle mounted type detectors) .....	18
Table 11: Date of targets/mines buried for hand-held type.....	19
Table 12: Buried targets in Test Lane No.1-No.6 for hand-held type detectors .....	20
Table 13: Buried targets in Test Lane No.1-No.6 for vehicle mounted type detectors .....	20
Table 14: Buried targets in Test Lane No.7 (hand-held type & vehicle mounted type detectors) .....	20
Table 15: Buried targets in Test Lane No.8 .....	20
Table 16: Total quantity of buried targets prepared by CMAC.....	21
Table 17: Test schedule of ALIS .....	22
Table 18: List of Tests .....	23
Table 19: Pass or Fail criteria (Pattern A for APM) .....	28
Table 20: Pass or Fail criteria (Pattern B for APM).....	28/29
Table 21: Pass or Fail criteria (Pattern A for ATM and UXO).....	29
Table 22: Pass or Fail criteria (Pattern B for ATM and UXO) .....	29,30
Table 23: Evaluation criteria for APM .....	30
Table 24: Evaluation criteria for ATM & UXO .....	30
Table 25: Decisive method of Pass or Fail by detected object through GPR images.....	31
Table 26: Alarm function .....	31
Table 27: Radio frequency interference test result of ALIS .....	34
Table 28: Maximum depth of detection (cm) – bottom of detector to the top of target.....	34
Table 29: Test result of Calibration box number 1 – 7 by Minelab A1F4 .....	35
Table 30: Test result of Calibration box number 1 – 7 by ALIS .....	35
Table 31: Detection speed by ALIS .....	35,36
Table 32: Summary test result of ALIS .....	36

**ABBREVIATIONS**

Ad	Additional valid detection
AP mine	Anti Personnel mine
AT mine	Anti Tank mine
CEN	The European Committee for Standardization
CMAC	Cambodian Mine Action Centre
CWA	CEN Workshop Agreement
EOD	Explosive Ordnance Disposal
FAR	False Alarm Rate
GICHD	Geneva International Centre for Humanitarian Demining
GPR	Ground Penetrating Rader
GPS	Global Positioning System
HF	High Frequency
IMAS	International Mine Action Standards
ITEP	International Test and Evaluation Programme
ITOP	International Test Operation Procedures
JST	Japan Science Technology Agency
MAC	Mine Action Centre
Pd	Probability of Detection
PMCS	Preventive Maintenance Checks and Services
SOP	Standard Operating Procedure
SOR	Standard Operating Requirement
TNT	Ttrinitrotoluene
UXO	Unexploded Ordnance
UNMAS	The United Nations Mine Action Service