# LibMAS 03.40/1

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# DETECTORS

**Responsible National entity:**
Libyan Mine Action Centre (LibMAC )
mandated by the Ministry of Defence (MOD)

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**NOTE:**
This document is current at the date shown on this page. The Libyan Mine Action Standards (LibMAS ) are subject to regular revision, so users should ensure that they are using the latest version of each document in the standards. The most recent versions of LibMAS are the versions that are posted on the LibMAS pages of the LibMAC website www.lmac.gov.ly

**Contents**

**Foreword**

Critical safety, control and quality elements of the International Mine Action Standards (IMAS) have been retained in the Libyan Mine Action Standards (LibMAS), so ensuring that they maintain the principles agreed in IMAS guidelines.

The work of preparing, reviewing and revising LibMAS is conducted by a technical committee with the support of invited international, governmental and non-governmental organisations in Libya. The latest version of each standard can be found LibMAC website.

In all LibMAS the words “must”, “shall”, “should” and “may” are used in the following way. “Must” or “shall” is used to indicate a requirement, something that must be done in order to conform to the LibMAS. “Should” is used to indicate the preferred requirements, methods or specifications, but these may be varied when reasons for doing so are given. “May” is used to indicate a possible method or course of action that should be considered but need not be applied.

## 1. Introduction

a. LibMAS 03.40/1 provides an example of detectors which may be use in mine action. The categories detailed are in accordance with the Geneva International Centre for Humanitarian Demining (GICHD) Detector and Personnel Equipment catalogue 2009.
b. The detectors illustrated in this standard are some common detectors used in Mine Action, and only included to enhance comprehension of the standard.
c. It is expected that Mine Action Organisations will select appropriate detectors to achieve the necessary standards.

## 2. General Principle

a. Detectors are an essential part of demining operations, in particular manual mine clearance and battle area clearance. As such, prior to use in mine action operations they shall undergo pertinent test and evaluation (T&E) to confirm their suitability to operate in the environment where it is intended they are to be used.

b. The purpose of Testing and Evaluation (T&E) is to provide an independent assessment of the suitability and effectiveness of mine action equipment. The results of such assessments may be used by planning staff in UN headquarters and National Mine Action Authorities (NMAA), and by designers and donors to establish programme options, inform procurement decisions and establish Quality Assurance (QA) requirements.

c. T&E can assess the potential of new technologies or confirm the performance and characteristics of 'Commercial Off The Shelf' (COTS) equipment.

d. The need for T&E standards is evident. The results of T&E are most useful if the testing conforms to accepted protocols and the results are presented in a uniform manner

## 3. Objective

a. To promote uniformity and understanding with regards to reporting detector testing, evaluation, and use in mine action operations.

## 4. Detector Categories

a. There are various detectors which may be used in Humanitarian Mine Action operations and they may be separated into different categories according to function *(Reference: GICHD Detectors and Personal Equipment Catalogue 2009)*:

1. **Metal Detectors**

2. **UXO Detectors**
   - Electromagnetic Detectors
   - Magnetometer Detectors

3. **Dual Sensor and Ground Penetrating Radar (GPR) Systems**

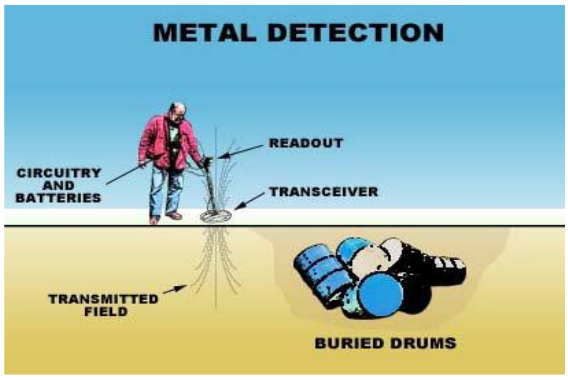
4. **Vehicle Mounted Detectors**

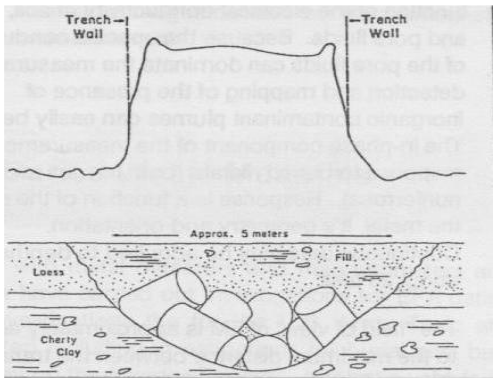
b. The type of detector used should depend on their capability and clearance requirements, i.e. large-loop detectors are effective in barren, open ground although

maybe limited in areas with high vegetation or obstacles, where as a detector with a small search head or probe type design may be more effective.

### 4.1 Metal Detectors

a. Metal detectors respond to the high electrical conductivity of metal targets contained within the normally low conductivity of soil. Targets with greater surface areas will cause greater responses (Figures 1 and 2). Targets may consist of any metallic materials which cause a local conductivity anomaly, such as iron, steel, copper, brass, bronze, tin, aluminium, silver, gold, and lead.




Figures 1 and 2: Detection of buried metal objects with a metal detector and metal detector profile over buried drums *(Reference: GEOPHYSICAL METHODS, "Magnetometry and Metal Detection", Nalan Tepe, CEE 8104, November 11, 2003)*

Figure 3: Example of a metal detector

Minelab F3 *(Reference: Minelab training manual and google website)*

## 4.2 UXO Detectors

### 4.2.1 Electromagnetic Detectors

a. According to electromagnetic theory, metal objects will generate eddy currents in an electromagnetic field and these eddy currents generate a secondary field.
b. When a metal object is within range of the search head coil, the secondary field generated by the eddy currents will distort the original electromagnetic field and cause changes to the equivalent impedance in the circuit.
c. The alarm sent through the speaker / earphone after demodulation (*conversion of wave into a current equivalent to the original signal*) and signal processing indicates the existence of a metal object (*detection*).

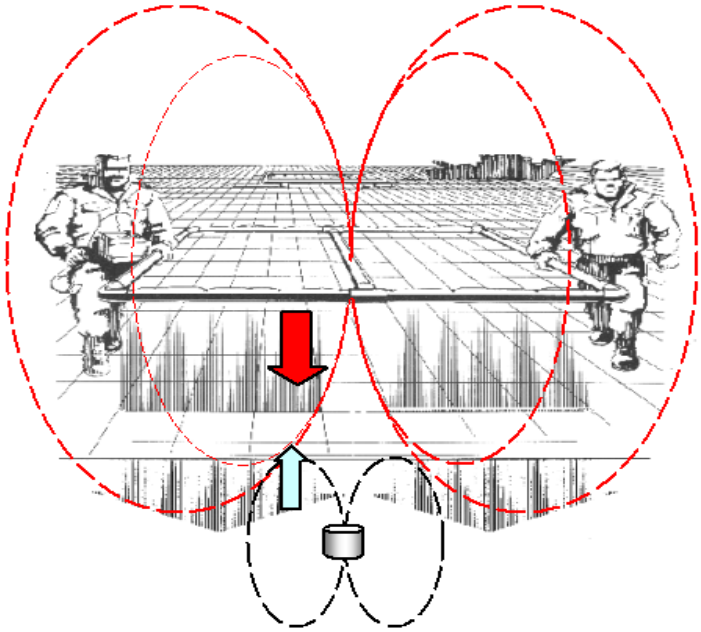


Figure 4: Example of electromagnetic principle with large loop type detector

Figure 5: Example of UXO electromagnetic detector

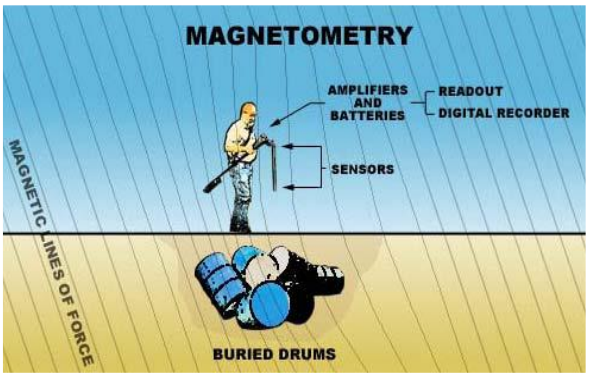
Ebinger UPEX 740 M large loop detector *(Photo provided by Doug Ware, UNMAS)*

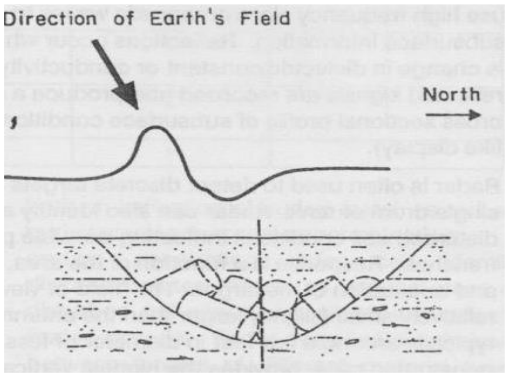
### 4.2.2 Magnetometers

a. Magnetometers measure intensity of the earth's magnetic field whether on the surface or below iron objects or minerals cause local distortions or anomalies in this field.

b. A magnetometer's response is proportional to the mass of iron in the target, i.e. at a defined depth, the greater the mass greater the indication.

c. The magnetometer can only sense ferrous materials such as iron and steel; other metals like copper, tin, aluminium, and brass are not ferromagnetic and cannot be located with a magnetometer.




Figures 6 and 7: Detection of buried metal objects with a magnetometer and magnetometer profile over buried drums (*Reference: GEOPHYSICAL METHODS, "Magnetometry and Metal Detection", Nalan Tepe, CEE 8104, November 11, 2003)*

Figures 8 and 9: Examples of UXO (magnetometer) detectors

Schonstedt GA-52 CX and GA-72 CD/ML (*Reference: GICHD detectors and personal equipment catalogue 2009*)

### 4.2.3 Comparison between Metal Detectors and Magnetometers

- A metal detector finds all types of metal - aluminium, tin, iron, etc.
- A magnetic locator finds only those types of metal that cause a disruption in the earth's magnetic field - ferrous metals, mainly iron and steel.
- A metal detector will find both ferrous and non-ferrous (i.e. no iron content – aluminium, copper, etc.) metals at limited depths.
- A magnetic locator will find only ferrous metals, generally at greater depths.

- The magnetic locator will not 'see' other types of metals and so will not be subject to signal interference from them, i.e. items such as aluminium cans, pull tabs and other common "trash" materials found in many environments.

### 4.3 Dual Sensor and Ground Penetrating Radar (GPR) Systems

a. These detectors comprise a combined metal detector and ground penetrating radar (GPR) system which may be designed specifically for use in humanitarian demining operations and military operations using advanced technology. The detector may be able to operate with metal detection and GPR simultaneously, or alone.

Figures 10 and 11: Examples of Dual Sensor and GPR detector

CEIA MIL-D1/DS (*Reference: CEIA MIL-D1/DS Brochure*)

VALLON VMR2 'Minehound' (*Reference: GICHD detectors and personal equipment catalogue 2009*)

### 4.4 Vehicle Mounted Detectors

a. Detectors mounted on vehicles are particularly useful for route technical survey and clearance operations, which may enhance operational effectiveness due to the ability of vehicles to traverse greater distances in a shorter timeframe than manual detection.


Minelab STMR
(Single Transmit Multiple Received

Schiebel VAMIDS
(Vehicle Array Mine Detection System)


Figures 12 to 15: Example – vehicle mounted detectors

(*Reference: GICHD detectors and personal equipment catalogue 2009*)

## 5. Test and Evaluation (T&E)

### 5.1 Purpose of T&E of mine action equipment

- To develop and/or prove and/or confirm system performance;
- To obtain data on new operational concepts under field conditions;
- To provide reliable data as an aid to decision making and as a basis for future work;
- To develop and/or prove component or sub-system performance before incorporation in a new or modified equipment;
- To enable comparison between equipment or methods as part of a procurement or selection process; and/or
- To measure reliability to enable in-service reliability and maintainability to be determined.

| Category | Details |
|---|---|
| **Performance** | A test to establish whether the equipment is capable of performing the role for which it is intended under comparable and repeatable conditions and to evaluate the manufacturer's specifications. |
| **Survivability** | A test to verify that the equipment survives the explosive forces used as design criteria. |
| **Acceptance** | A test to ensure that the equipment is able to work in the environment where it is intended to be used. |

### 5.2 Detector Performance Test

a. A performance test **shall** be conducted for each detector prior to the commencement of operations at the demining site to confirm that it is functioning correctly (i.e. in accordance with the manufacturer's manual) and capable of locating the pertinent target at the required clearance depth. If the detector fails to meet the required standard it shall not be used.

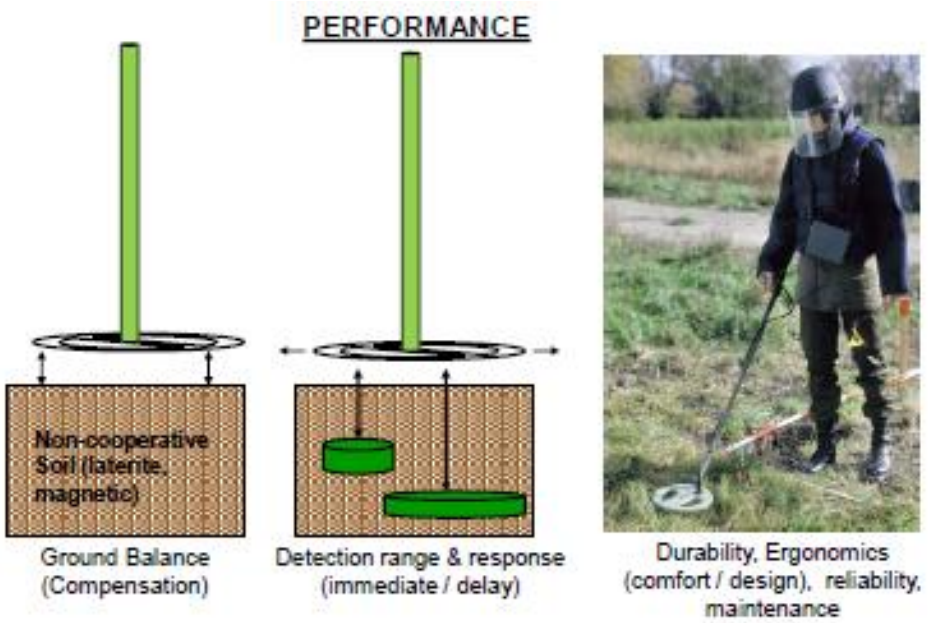



Figure 16 to 18: Example - Detector test and evaluation *(Photo reference: GICHD detectors and personal equipment catalogue 2009)*

#### 5.2.1 Requirements for Detector Performance Test

a. The test item "target" (i.e. FFE – Free From Explosive ordnance); similar to that located at the operational site is buried at a the **minimum** required clearance depth (measured from surface of the ground to the top of the item).
b. The item is buried to ensure the detector is able to locate sub-surface mines / ERW during clearance.
c. The test item maybe placed within a plastic container full of soil with the top of the container removed (to ease removal and inspection).
d. When conducting the test, the detector search head (or similar) shall be moved over the test item at least twice in opposite directions (i.e. north-south and east-west), in accordance with the Mine Action Organisations SOP specific detector operational manual (i.e. alignment and sweep speed).
e. When conducting the performance test, against the test item, the detector search head (or similar) shall be moved over the target at least twice, in two opposite directions (i.e. north-south and east-west), to account for the orientation of the test item.
f. This shall be conducted in accordance with the Mine Action Organisations SOP specific detector operational manual (i.e. search head alignment, and sweep speed).
g. The distance between the search head and the top of the test item shall be equal to the maximum permitted height of the search head during the specific demining operations where the detector shall be used.
h. The detector must be capable of locating the test item when moved over the target in both directions at the required depth.
i. The performance test shall be as accurate as possible, and to ensure that the detector search head is at the correct distance from the ground / test item, it may be necessary to position markers, deploy cord across the test area, or attach material to the search head (i.e. length plastic, wood).

### 5.2.2 Example of the Detector Performance Test

a. Test item “target” (i.e. FFE – Free From Explosive mine, fuze, similar to that located at the site) is buried at a the required clearance depth (i.e. **13 cm** between the ground level and top of target).
b. To replicate the operational conditions, the target is buried for the test to ensure that the detector is able to locate sub-surface targets (i.e. mines/ERW) during clearance.
c. The target should be placed within the soil in a plastic container with the top removed which shall enable accurate measurement for testing, and when removing the target for inspection.
d. The detector is swept at a set height above the ground and over the target (i.e. 5 cm), twice in two opposite directions (i.e. to account for the orientation of the mine).
e. The visual display and/or audio signal heard shall be recorded.
f. **Note:** Test distance of 18 cm = **13 cm** (depth of target) + 5 cm (search height).

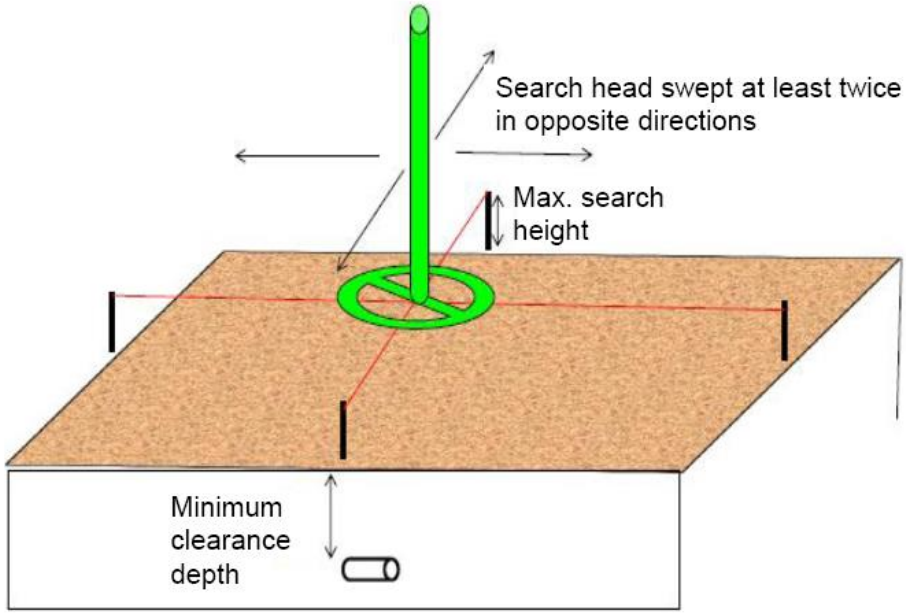



Figure 19: Example - Detector performance test

Figures 20 and 21: Example - Performance test of metal detector and UXO detector
*(Photos provided by Doug Ware, UNMAS)*

### 5.3 Detector Confirmation Test

a. After completing the performance a confirmation test **should** be performed, using the manufacturer's standard "test piece" or same test item, i.e. attached to a ruler, to confirm the detector is functioning in accordance with the performance test.
b. The confirmation test is regularly conducted during operations (at least once during each working shift that it is used) by the Deminer under supervision, and by supervisory / monitoring staff, during demining operations.

#### 5.3.1 Example of Detector Confirmation Test

a. The results of the performance test are recorded (i.e. audio signal, visual display).
b. A ruler is positioned perpendicular to the search head and the standard test piece moved along the ruler towards the head.
c. On hearing the initial audio signal, note the number on the ruler (distance of test piece from search head) and if applicable, the visual display (i.e. no. of LEDs).
d. Move the test piece back and then forward along the ruler and reconfirm the results.
e. Alternatively; the test piece may be fixed to the ruler at a set distance and; depending on detector design, the ruler may pass through the area of the search head.
f. Options (criteria for confirmation test, depending on detector type):
    - Initial sound.
    - Initial sound and display (LEDs).
    - Identical display as performance test (LEDs).

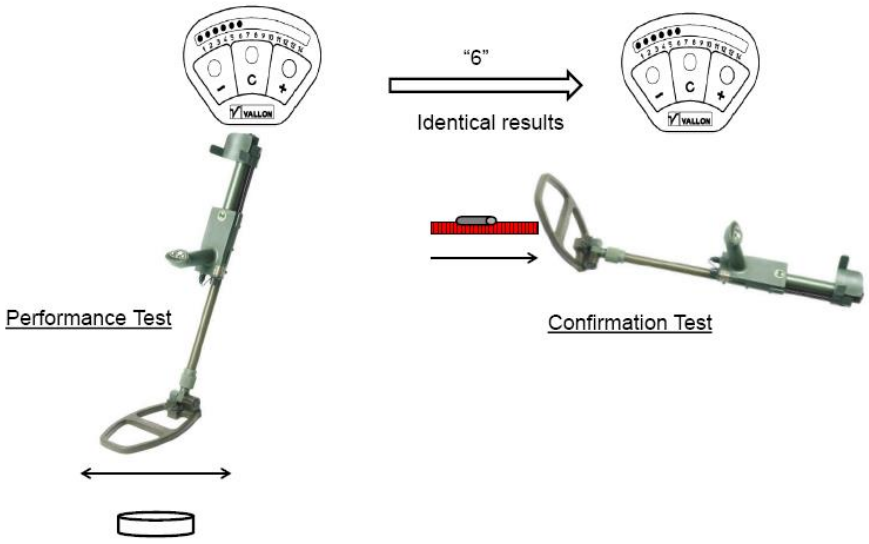
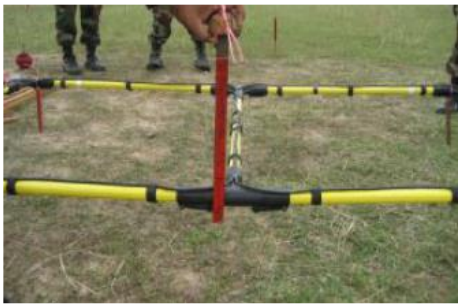



Figure 22: Example - Detector performance and confirmation test using manufacturer's test piece and ruler

Figure 23: Example - Detector confirmation test using manufacturer's test piece and ruler *(Photo of provided by Doug Ware, UNMAS)*



Figures 27 and 28: Example - Detector confirmation test using target (FFE) and detector manufacturer's test piece and ruler (*Photos provided by Doug Ware, UNMAS)*

### 5.4 Recording Test Results

a. As a minimum, the following information should be recorded by supervisory staff (i.e. Team Leader) during the detector testing procedure:

- Location (i.e. task / site number).
- Date / time.
- Detector operator's name.
- Detector type.
- Detector serial number.
- Test item "target".
- Target depth.
- Performance test result, i.e. visual display and / or minimum audio signal.
- Confirmation test, i.e. distance (cm) on ruler, visual display and / or minimum audio signal.

## 6. General References

a. International Mine Action Standards (IMAS), in particular, 03.40, Test and Evaluation of Mine Action Equipment.
b. Geneva International Centre for Humanitarian Demining (GICHD), Detectors and Personal Equipment catalogue 2009.

## 7. Record of Amendments

| Ser. | Date: D/M/Y | Standard | Section / Paragraph | Amended by: Name / Position / Org. | Comments |
|---|---|---|---|---|---|
| 1 | 27/09/15 | 03.40/1 Detectors | All | Doug Ware, Chief of Ops/QA, UNMAS | New Standard |