

**Humanitarian Mine Action
Test and Evaluation
Metal Detectors
Business Plan for the CEN Workshop**
Version 1 - 12 November 2001

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Humanitarian Mine Action – Test and Evaluation - Metal Detectors

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1 The Background to Humanitarian Mine Action Standards

1.1 Context

The presence of landmines represents a serious safety hazard and a major obstacle to reconstruction and development in former conflict zones across the world. With the incentive of entry into force of the Ottawa Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and their Destruction [1], the challenge for the international community is to overcome the landmine problem in the next 10-15 years. Based on its contribution to date, the European Union is expected to be one of the largest players in this activity [3]. Success will only be achieved if the international political and resource commitment is sustained, if international co-ordination is improved, if effective national capabilities are established in all of the most seriously mine-afflicted countries and safer and faster demining techniques are introduced.

The Commission Communication [2] for the proposed European Parliament and Council Regulation concerning action against anti-personnel landmines [3], calls for the establishment of international standards and their implementation, in close co-operation with CEN, ISO, and the UN. The European Commission has granted a mandate to the European Standardization Bodies to proceed with this standardization [4]. Such standardization would include mine field survey, close-in detection and identification of anti-personnel land mines (APL), information fusion and information management, quality assurance in the whole process of mine clearance and especially for *test and evaluation of any tool* in support to humanitarian demining.

CEN has formally agreed to the mandate issued by the European Commission [5] and has created a Working Group of the CEN Technical Board (BT/WG 126) to ensure co-ordination and to generate specific standardization initiatives. While no decision has been taken yet on the final status of the documents, the participants in BT/WG 126 have expressed their strong interest in CEN Workshops and their deliverables, the CEN Workshop Agreements.

1.2 The Role of Standards

Standardization will support the development of new demining tools and methods, will facilitate the comparison of different tools and products and will significantly improve the safety of the “deminers” in the field. The benefit of agreed standards is acknowledged world-wide and urgently required.

A systematic and stepwise approach has been recommended [4]. The first task is to provide the terms of reference for comparing present techniques and instrumentation and also for improving and optimizing existing technologies (in terms of sensor efficiency and effectiveness, reduction of false alarm rate, time required for operations, etc). However, standards are seen as a crucial aspect also for the development of new technologies and it is recognized that they would contribute to increasing the credibility when a new prototype is introduced on the market.

The European Community and originators of the Workshop proposal will use Standards to ensure that they get value for money, supporting only validated methods and experienced teams. This will permit such “purchasers” to verify and certify that services provided are

performed well and according to requirements. So they will support better EC decision making/quality control capacity and allow better quantification of the benefits of EC aid programs.

Reference standards would provide objective input for the creation and the validation of simulation models in support to the measurement campaigns.

Lastly, standards will help users to find the key technique or the key combination of techniques best adapted to given mine detection and identification operations.

The importance of standards has thus been stressed in terms of a collaborative effort to be conducted between developers and end users. It is for this reason that both sensor manufacturers and in-field operators must be invited to participate actively in the discussions. Concerning the actions anticipated, participating experts in the process will have to be asked to consider the following important aspects in order to obtain a workable basis for an Agreement:

- provide a suggested selection of standard test targets and soil backgrounds for each class of sensors;
- provide a preliminary set of definitions, parameters to be controlled and standard test conditions for characterization and assessment tasks;
- investigate the possibility of developing a performance effectiveness measure for mine detectors;
- specify a measurement system to ensure standard test conditions; and
- provide an uncertainty estimate for the measurement process.

1.3 ITEP

On 17 July 2000, Belgium, Canada, The Netherlands, Sweden, Great Britain, the United States and the European Commission signed a Memorandum of Understanding for the International Test and Evaluation Program for Humanitarian Demining (ITEP).

The purpose is to develop standards, coordinate and perform tests of materials and methods, and disseminate information about test results. Co-utilization of resources and expertise from participating ITEP countries will allow allocated resources to be used more efficiently, thus contributing to improvement of global humanitarian demining programs.

1.4 UNMAS

The United Nations Mine Action Service (UNMAS) initiated a review and revision of the International Mine Action Standards for humanitarian mine clearance operations (IMAS) in October 1999. The Geneva International Centre for Humanitarian Demining (GICHD) is implementing the project on behalf of UNMAS, with financial assistance from the Government of the United Kingdom.

The review and revision acknowledges the important changes that have taken place in the management of mine action. International interest and funding has increased and there is an expectation of improved co-operation, co-ordination and unity of effort. The UN has recommended that a framework be established to provide structure and coherence to the growing number of standards and guidelines.

The IMAS standards also provide a suitable medium for informing the mine action community of existing international regulations, conventions, treaties and standards which impact on mine action, particularly those referring to basic human rights, clearance requirements, hazard marking and general safety issues.

1.5 CEN Workshop Approach in Mine Action Standardization

Different actors will progressively identify the needs. CEN will deal with them in CEN Workshops (CEN WS) to be set up as and when needs are identified, in a transparent way, based on a CEN Workshop Business Plan, which will be approved during a kick-off meeting, announced in advance. The general concept and rules for a CEN WS can be found at its website [6].

Each such CEN WS will identify its own purpose, have its own objectives, fix its own programme and planning, provide its own resources (in terms of expertise, technical secretariat and CEN National Standardization Bodies as professional standardization support, participation fees or financial contribution).

Given that the experts involved already attend relevant meetings together (sometimes in the context of existing projects in development), it seems more efficient to declare the status of CEN Workshop over a part of such meetings. During these sections of meetings, the rules of the CEN WS and the WS BP will be followed. These meetings need to be announced well in advance; especially regarding the agenda, on which must appear the documents to be approved as CWA.

During the CEN WS parts of such meetings, the identified and announced documents will be considered, consensus will be verified, and checks made as to whether the documents can be given the status of CWA, or whether changes need to be made.

As stated above, in the area of "Humanitarian Mine Action" there could be various specific focussed CEN Workshops, organized according to the needs and priorities.

This could cover such specifications as follows:

- Test and Evaluation of all equipment,
- Technical training assessment/certification,
- Existing standards terminology/definitions,
- Risk and quality management and performance indicators,
- Other; to be decided.

The first such "focussed" CEN Workshop (CEN WS) will deal with Testing and Evaluation (T&E) of the performance of metal detectors used for humanitarian mine clearance. The main aim of standardization for metal detectors is to give the responsible organization(s) for mine action (in the field) information so that they can use the best possible metal detectors in their specific situation.

2 Origin of the Proposal for a CEN WS on T&E of Metal Detectors

The ITEP Executive Committee [7] and CEN BT/WG 126 have mandated the JRC, in view of its expertise and interest, to organize a CEN Workshop on Testing and Evaluation of the performance of metal detectors. JRC proposes to take the responsibility for the technical secretariat of this Workshop. UNI (Ente Nazionale di Unificazione), the Italian National

Standardization Body affiliated to CEN, will provide the professional standardization expertise and a formal link to the CEN system.

The proposers of this Workshop are as follows:

- United Nations Mine Action Service (UNMAS)
- Geneva International Centre for Humanitarian Demining (GICHD)
- The European Commission Joint Research Centre (JRC)
- International Test and Evaluation Program for Humanitarian Demining (ITEP)
- CEN BT Working Group 126

3 Market Overview - Metal Detectors in Humanitarian Demining

The markets that will be affected by the outcome of this CEN workshop are metal detector manufacture and commercial humanitarian demining. The metal detector market is a mature one, its products having been used in a similar form for many years. Humanitarian mine clearance organizations often use the same detectors that are used by the military. The customers of these manufacturers are chiefly governments (often the military), non-governmental organizations (NGOs) performing humanitarian mine clearance and independent commercial mine-clearance contractors. The market is a world-wide one involving a high amount of international trade. For example the US military have bought many metal detectors from a European manufacturer.

The Workshop is needed to establish standardized ways of testing the performance of metal detectors. The results of such tests will then enable customers to select the product best suited to their requirements. The quality of mine clearance operations will thus be improved; saving time, money and lives. It is in the interest of reputable manufacturers to have a standard that will guarantee the quality of their product. Many of the manufacturers are European. Having widely-applied specifications would help them in exporting their products. The aim is that any CWA would be accepted and applied internationally and that an international standard will eventually result.

The EU provided €103 million for anti-mine operations in 1999 alone. The proposed figure for the period 2000-2006 is around €200 million. Metal detectors are basic tools and would be used in most of this work. A standard for metal detector testing and evaluation that improves quality of demining operations means that this money will be much better spent.

Several manufacturers produce commercial-off-the-shelf (COTS) metal detectors. A list of some major manufacturers is given below.

Company	Location
Adams	UK
Ebinger	Germany
Fisher	USA
Foerster	Germany
Giat	France
Guartel	UK
LG Precision	South Korea
Minelab	Australia
Pro-Scan	Australia
Reutech	South Africa
Schiebel	Austria

Vallon	Germany
White's	UK / USA

Considering the market described above, the following groups of people are invited to contribute to this CEN workshop:

- Users of metal detectors in humanitarian demining.
- Manufacturers of the metal detectors used in humanitarian demining.
- Institutions who have performed tests on metal detectors or those who are planning to do so.
- Mine Action Centres.
- Experts in standardization of measurement equipment.
- Humanitarian-demining funding organizations that purchase metal detectors and/or contract demining services.

4 Objectives of the CEN WS on Testing and Evaluation of Metal Detectors

Metal detectors are an essential part of the toolkit of a humanitarian deminer. Apart from visual inspection, metal detection is one of the only “non-contact” methods available to search for mines in most of the areas of the world where humanitarian mine clearance operations are carried out. Despite the fact that metal detectors have been used for finding mines since the Second World War, there is no universal specification for any performance standards.

Many trials of the capabilities of metal detectors have been performed in recent years, stimulated by the growing international effort to combat the threat posed by mines and unexploded ordnance to civilian populations. However, the lack of an agreed standard for comparing the performance of these instruments has limited the value of this work to the end-users. As no standard exists, it is difficult to make cross-comparison between instruments to determine which is best suited to any particular needs.

The main objective is therefore to develop widely-accepted and applied specifications for the testing and evaluation of metal detectors used in humanitarian mine clearance. The goal is to have operations and equipment that are safe, reliable, fit for purpose and low-cost. These specifications shall be based on experience gained, in part, through projects testing such metal detectors that have been performed recently [11].

The procedure for developing a “full” EN standard is lengthy and has practical difficulties. In addition, the faster CEN Workshop process is open to participation from non-CEN member states – clearly an advantage in this case where the aim is to produce a document that can be accepted internationally. It has been decided therefore, to start with a CEN Workshop Agreement (CWA) and eventually upgrade to TNMA, IMAS, EN standards and possibly ISO standards. The objective is to have a CEN Workshop Agreement by mid-2002.

5 Workshop Programme for Testing and Evaluation of Metal Detectors

5.1 Scope

The deliverable is a CEN Workshop Agreement dealing with specifications for the testing and evaluation of metal detectors used for humanitarian mine clearance. It is intended that any CWA resulting from this workshop conform to the IMAS on equipment test and evaluation [12].

A standard for testing and evaluating metal detector operation could have different roles. One role is as a “manufacturing” standard that defines the minimum performance and characteristics of the instrument on delivery to a customer and how to measure these things. This type of standard can be used to define specifications for procurement and how to make acceptance tests.

In order to ensure Quality performance of demining operations, a demining technician must test the performance of his metal detector before starting work and periodically during a working shift. Although in-field calibration is not explicitly included within the scope of this Workshop, there is no reason why the same simple, standardized sensitivity tests cannot be used both for in-field use and for setting sensitivity reference levels as part of extensive trials. If such tests were defined within a CWA on Test and Evaluation therefore, these tests could be adopted by users in the field.

Various institutes and Mine Action Centres perform test and evaluation of metal detectors in rather more specific (realistic) conditions than is appropriate for either manufacturing tests and more extensive than appropriate for in-field checks. Such tests could be aimed at evaluating the performance of an instrument in isolation, or of the equipment and test procedure used by a demining contractor. Real mines (made safe) or targets designed to have the same distribution of metal content as real mines are laid in soils that are selected as being representative of an area to be cleared. The capability of a metal detector to detect targets in these specific conditions is then tested. In order that the results of such tests are of use to the world-wide demining community, these tests should be performed according to common procedures. Such test procedures could also be included in the proposed CWA.

A list of suggested topics that may be appropriate for consideration by the Workshop for a CWA fulfilling the above roles follows. Some of these items are clearly more applicable to one role than another.

- Sensitivity calibration:
 - Standard target – sphere, cylinder, tube or other; magnetic or non magnetic, specified as of a named material, in terms of conductivity and permeability or in terms of impedance change in a standardized system?
 - One target or a family? (e.g. sequential sizes)
 - Two or more detector-to-target heights
- Laboratory sensitivity measurements:
 - Sensitivity cone size – how defined
 - Sweep height – how defined, how to be measured
 - Sweep speed and pattern during test
 - Head orientation, head angle and levelling, handle angle during test
 - Detector control settings during test – protocols for continuous and stepped controls
 - Manual versus machine movement during test
 - Require a non-metallic rig?
 - Absolute/differential – e.g. width of null for differential
 - Pinpointing – how to measure?
 - Implications for sweep coverage.
- Measuring the effects of soils:
 - Electromagnetic characterization of soil - permeability/ conductivity measurements and their correlation with the tests with standard targets.

Standard soil mixture – needed or not? How specified (Named substances or conductivity and susceptibility. Moisture? What instruments to measure?)
Soil inhomogeneity? (e.g. bauxite with limestone rocks)
One standard for both detectors with soil compensation circuits and those without, or different standards?
Target burial method

- Detection of realistic targets in soil:
 - Standard “realistic” targets?
 - Tests for particular mines of interest?
 - Soil requirements as above.

- Statistical methods for evaluating performance:
 - Numbers of detectors to be considered
 - Numbers of targets to be used
 - Statistical parameters needed – mean, standard deviation, confidence tests, % missed targets and false calls allowed?
 - Halo method
 - Standardized display of statistics (PoD, ROC?)

- Electronics:
 - Calibration test - reproducibility of set-up
 - Stability test
 - Bipolar/ unipolar – need to specify maximum allowed dc field output?
 - Bandwidth – need to specify?
 - EMC - mains filters, interference between 2 detectors
 - Auto-zero – time for auto zeroing
 - Pulsed/ continuous wave excitation – the standard must be applicable for both
 - Standard to be appropriate for all detectors, but application of the standard to be “blind” as far as possible to details of design?

- Operating environment:
 - Humidity – spray test or environmental chamber?
 - Temperature
 - Standardize ranges or require them to be specified?

- Ergonomics, robustness and suitability for use in remote locations (MTP)
 - Balance, weight,
 - Alarm audibility
 - Ease and comfort of use
 - Manual zero - possibility of accidental operation
 - Sensitivity adjuster/selector control, possibility of accidentally changing
 - Battery type and life – any restrictions?
 - Drop test
 - Carrying case

- Items to be stated in manual:
 - In instructions
 - In Technical Specification

Many of the factors listed are linked. For example, the key requirements for the performance of metal detectors are set by the clearance requirements for the area of ground to be tested. The requirements for the depth to which land is to be cleared of mines are set out in IMAS 09.10 [7]. This standard does not give a definitive depth (as did the former IMAS [9]) because it is recognized that in different environments the requirement may be different, so the clearance requirements may have to be based on local intelligence. This IMAS does however recommend that the clearance depth should not normally be less than 130mm. This figure is based on the capabilities of most metal detectors as measured in the IPPTC report [11]. Other demining organizations use different clearance standards, for example the “normal” detection depth in MGM standard operating procedures [10] is 150mm (from ground level to the top of the mine). There is evidence to suggest that detection of minimum-metal mines at these depths in real soils is not possible with existing metal detector technology [11]. A range of sensitivities may therefore need to be specified for different depths.

A useful model for the standardization being considered is that of non-destructive testing and specifically ultrasonic testing. European standards exist for various aspects of the use of ultrasonic “flaw detectors” and probes [13,14,15]. The standards include, for example, the verification of gain and time-base linearity, which is appropriate both in the roles of “manufacturing” standard and for pre-use checks by an operator. Directions for sensitivity setting are appropriate for use in the field or on controlled inspections of test specimens to demonstrate the performance of an inspection procedure.

The analogy of the controlled testing of metal detectors on realistic targets in realistic conditions can be found in the “Inspection Qualification” of non-destructive examinations (also known as Performance Demonstration or Inspection Validation). A common methodology for Inspection Qualification has been achieved by ENIQ (European Network for Inspection Qualification), managed by the EC JRC [16]. It may be useful to copy some aspects of the ENIQ methodology for test and evaluation of metal detectors.

5.2 Action plan

- The formal kick-off meeting of the CEN Workshop will be at the CEN Management Centre in Brussels on 8 November 2001. The meeting will decide on the CEN WS BP and appoint a Chair, a Secretariat and a Programming Committee.
- The Programming Committee will formulate draft proposals for the CWA, invite prospective participants and determine the structure of the Workshop meetings. It is planned that most of the work of the programming committee will be achieved by e-mail correspondence.
- The first technical meeting of the CEN Workshop is planned for 3-5 December 2001 at JRC-Ispra. It will be widely announced. During this and subsequent meetings of the CEN WS, operated according to the WS BP, the Chair will seek consensus in each meeting of this WS (consensus meaning “no major opposition” as opposed to “unanimity”).
- Following the first meeting, the writing and issue of the first draft of the CWA is planned. Comments will be invited by the Secretariat.
- A second, or further meeting(s) of the Workshop will be arranged if necessary in order to make and agree amendments to the draft CWA.

- Once the consensus is reached on the final Agreement, the approved CWA will be circulated to CEN national members, to make it available at national level.
- On completion of the work programme as described in the WS BP, the CEN Management Centre (CMC), in co-operation with Chairman and Secretariat, will consider the Business Plan to be fulfilled and the CEN Workshop will be disbanded.

6 Workshop Structure and Resource Requirements

This CEN WS on Testing and Evaluation of Metal Detectors will be supported by those proposing the WS (given in Section 2 above), with a Programming Committee and a Secretariat with a local organization team.

The Programming Committee will establish a framework of topics for standardization, providing a starting point for the CEN WS, its membership is as follows:

Name	Representing
Tom BLOODWORTH	JRC (Committee Convenor)
Yoga DAS	CCMAT, Canada
Dieter GÜLLE	ADP Mozambique
Carl-Michael ILVING	DS,DK & CEN BT/WG 126
Adam LEWIS	JRC (Secretariat)
Dai LEWIS	QinetiQ, UK / ITEP
Ole NYMANN	NDRF
James PRUDHOMME	UNMAS
Arnold SCHOOLDERMAN	TNO, NL
Adrian WILKINSON	GICHD-IMAS
George ZAHACZEWSKY (or Denis REIDY)	OSD, US

Chairmanship: can be nominated by one of the promoters, but will be formally appointed during the CEN WS kick-off meeting.

Secretariat: EC JRC at Ispra (Italy) has agreed to take responsibility for the technical secretariat and local organization of the CEN WS, with the assistance of UNI.

Professional standardization support to the CEN WS Secretariat: UNI (Ente Nazionale di Unificazione), the Italian National Standardization Body affiliated to CEN.

The CEN Workshop working language and documentation will be English

7 External Liaisons

A CEN Workshop Agreement has the advantage of being very flexible and is therefore the preferred initial option. Later it may be upgraded into an EN or ISO Standard. It is understood between CEN, CENELEC, ETSI and ISO that CEN will take over the development of the Workshop Agreement, but the other Bodies will be informed of every step taken and can join the CEN WS when they so wish.

NGOs will undoubtedly be very much affected by the outcome and some will indeed participate in the writing of the Workshop Agreement.

Close liaisons will naturally be maintained with the promoters: GICHD, ITEP, UNMAS, the EC, and CEN/BT WG 126.

8 Contact Points

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