

[Project Nr. 2.1.1.8 Reliability Model for Test and Evaluation of Metal Detectors](#)
(follow-up of [Project Nr. 2.1.1.2](#))

The mine detection reliability tests will be performed in accordance with the CEN workshop agreement describing specifications for test and evaluation ([CWA 14747:2003](#)) on the one hand and compared and calibrated with fully automated scanning which is part of the research program HuMin/MD ([Project Nr. 2.1.1.7](#)). The results of the new tests will serve to validate the previous results and help to improve and optimise the proposed procedures for reliability testing of metal detectors on the basis of the test experience in 2003 ([Project Nr. 2.1.1.2](#)ⁱ) and field and test experiences acquired by the research team in the context of the [GICHD Study of Manual Mine Clearance](#).

The CEN Workshop Agreement CWA 14747:2003 standardises methods for test and evaluation of metal detectors for humanitarian demining. It covers in-air and in-soil laboratory sensitivity measurements, immunity to operational conditions and electromagnetic interference as well as ergonomics, shock and bump tests etc. Reliability trials are covered by Section 8.5 of the CWA.

In the above document detection reliability is defined as “the degree to which the metal detector is capable of achieving its purpose, which is to have maximum capability for giving true alarm indications without producing false alarm indications.” An overall reliability of a mine detection system (R) can be understood as a result of three factors: an intrinsic capability (IC) describing the physics and basic technical capability of the devices and representing an upper limit of R, factors of application such as special environmental conditions in the field (AP) generally diminishing R and finally the human factor (HF), which lowers R. All three factors are described in a concept called the Reliability Model (Ref. ⁱⁱ, ⁱⁱⁱ, ^{iv}):

$$R = \mathcal{F}(f(\text{IC}), g(\text{AP}), h(\text{HF})) \quad (1)$$

It is important to bear in mind that there may be interactions between the factors. In humanitarian demining the influence of the last two factors has already been recognised as very important, since the conditions in the field and the behaviour of the operators have proven significant impact on the overall performance. Only the Intrinsic Capability and a part of the Application Factors are determined in laboratory measurements. The overall reliability, including the Human Factor, can be evaluated only in blind trials (reliability trials).

In a reliability test, targets are placed in metal free lanes at positions not known to detector operators. While scanning, the operators mark the places of indications and, later, supervisors measure and record the spatial co-ordinates of the markers. A target is considered to have been detected when a marker is dropped within a prescribed radius (“halo”) around the true target location. The innovation of the trials in 2005 will be the implementation of many elements of the local Standard Operating Procedures (SOP) and of the working system applied in practise.

CWA 14747:2003 makes recommendations about lane widths and soil depths, soil types, target types, numbers, depths, orientation, separation and halo size and gives

some practical instructions about lane preparation. The planned reliability tests are aimed to determine the optimum choice of all parameters for a reproducible and repeatable trial, which would provide knowledge about true performance of metal detectors used under real field conditions and will give a guide to distinguish between the physical (IC+AP) and human factor influences.

After the accomplishment of all trials and evaluation of results, a workshop is planned to give all affected parties the chance to interact.

ⁱ C. Mueller, M. Gaal, M. Scharmach, U. Ewert, A. Lewis, T. Bloodworth, P-Th. Wilrich, D. Guelle, "Reliability Model for Test and Evaluation of Metal Detectors", Final Report, Berlin, September 2004, <http://www.itep.ws/>

ⁱⁱ C. Nockemann et al., "Performance Demonstration in NDT by Statistical Methods: ROC and POD for Ultrasonic and Radiographic Testing", Proceedings, 6th European Conference on Non Destructive Testing, pp. 37-44 (1994)

ⁱⁱⁱ C. Mueller, M. Scharmach, M. Gaal, D. Guelle, A. M. Lewis, A. Sieber, "Performance Demonstration for Humanitarian Demining", Materialpruefung Jahrg. 45, Vol. 11-12 pp. 504-512, 2003

^{iv} C. Mueller, M. Scharmach, M. Gaal, D. Guelle, A. M. Lewis, A. J. Sieber "Proposals for Performance Demonstration and Modular Reliability Assessment for Humanitarian Demining", International Conference on Requirements and Technologies for the Detection, Removal and Neutralization of Landmine and UXO, EUDEM2-SCOT, Brussels, 15-18 September 2003
<http://www.humin-md.de/index.php?page=overview&show=&lang=en>