

Test and Evaluation Protocol

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Machines

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Foreword

CEN Workshop Agreement for Demining Machines

This CEN Workshop Agreement has been drafted and approved by a Workshop of representatives of interested parties on 20.04.2004, the constitution of which was supported by CEN following the public call for participation made on 03.06.2003.

After three years, CEN requires a review of the Workshop Agreement. Revisions to the original agreement have been made by consensus of the original workshop participants on 30.06.2009.

A list of the individuals and organizations which supported the technical consensus represented by this CEN Workshop Agreement is available to purchasers from the CEN Management Centre. These organizations were drawn from the following economic sectors (non governmental organizations, national authorities and producers and users of demining equipment).

This document supersedes CWA 15044:2004.

The formal process followed by the Workshop in the development of this CEN Workshop Agreement has been endorsed by the National Members of CEN but neither the National Members of CEN nor the CEN Management Centre can be held accountable for the technical content of this CEN Workshop Agreement or possible conflict with standards or legislation. This CEN Workshop Agreement can in no way be held as being an official standard developed by CEN and its members.

This CEN Workshop Agreement is publicly available as a reference document from the National Members of CEN: AENOR, AFNOR, BSI, COSMT, DIN, DS, ELOT, IBN/BIN, IPQ, IST, NEN, NSAI, NSF, ON, SEE, SIS, SFS, SNV, and UNI.

Comments or suggestions from the users of this CEN Workshop Agreement are welcome and should be addressed to the CEN Management Centre.

1 Introduction

Test standardisation for demining machines will support the development of new demining tools and methods and make it easier to compare different existing tools and products. Standardisation will also significantly improve the efficiency of demining programs. The benefits of agreed-upon specifications are world-wide and urgently needed.

The CEN Workshop Agreement (CWA) which follows is the result of a Swedish EOD and Demining Center (SWEDEC) initiative, with participation from the Croatian Mine Action Center (CROMAC), Croatian Mine Action Center- Center For Testing, Development and Training (CROMAC-CTDT Ltd) and the Geneva International Center For Humanitarian Demining (GICHD). This result culminated in European Commission funding of a workshop to develop a CWA for testing of mechanical demining machines. The CWA was developed under SWEDEC leadership and secretariat at SIS over four (4) workshop meetings in Sweden and Croatia. The development was supported by the following who provided knowledgeable experts in demining equipment testing: International Test and Evaluation Programme (ITEP), countries: (Canada, Germany, Sweden, United Kingdom, United States of America) and the ITEP Secretariat; two (2) governmental organisations (CROMAC, GICHD); two (2) government agencies (Swedish Rescue Services Agency (SRSA) , Swedish Defence Research Agency, (FOI); two (2) non-governmental organisations (Norwegian Peoples Aid, International Trust Fund For Demining and Mine Victims Assistance), three (3) equipment manufacturers (Scandinavian Demining Group, DD Special Vehicles Ltd, Dok Ing d.o.o.) and one (1) government laboratory (Bundesanstalt Für Materialprüfung). It was developed within a framework contract between CEN and EU DG AIDCO.

This CWA specifies a systematic and stepwise approach. The reason is from a technical point of view but most important are concerns about the security for personnel. The first task is to provide the terms of reference for comparing present testing techniques and instrumentation and for improving and optimising existing technologies (development or improvement of new mechanical methods, standardisation of test mines, etc.). This CWA is a critical step in the development of new technologies. Having a CWA in place that manufacturers follow would contribute to the credibility of a new product when it is introduced into the market.

This CWA will help users find the key technique or the key combination of techniques best suited to a given mine-clearance operation. The importance of the CWA has therefore been stressed in terms of a collaborative effort conducted between developers and end users. It is for this reason that both machine manufacturers and in-field operators were invited to participate in the discussions. The CWA covers the following:

- Performance testing.
- Survivability testing.
- Acceptance testing.
- Test targets.

2 Background

Test and evaluation specifications and test methodology for demining machines need to be developed for the following reasons:

— Although a lot of test and evaluation work is performed in the demining world today, in many instances, it is not what most of the demining community or developers need. To improve this situation it is necessary to provide a CWA whereby each piece of equipment would be tested under the same conditions, using criteria that can withstand technical scrutiny.

— The test and evaluation shall provide users and donors with useful and reliable data. This will permit users, donors, and others to assess the effectiveness and efficiency of particular equipment to improve operational effectiveness and safety in demining operations.

— Important spin-offs are expected from well-executed, standardised test and evaluation. Manufacturers will be aware that the requirement of the CWA must be met and will design and develop the equipment to meet those criteria. At a very early stage, poor candidates can be eliminated. Persons tasked with test and evaluation would be able to plan and execute the work much more efficiently if the protocols and CWA are clearly defined. Their results will gain greater acceptance and credibility when the protocols and CWA are carefully followed.

— Much of the test and evaluation being performed today is done on the basis of local experience and conditions. Some characteristics being tested have little bearing on the requirements of demining. In other cases, whole aspects of demining are left out because of a number of constraints for example testing is too expensive, takes too much time, lack a proper procedure, etc.

Many trials of the capabilities of mechanical demining equipment have been conducted in recent years, stimulated by the growing international effort to combat the threat posed by mines and unexploded ordnance to civilian populations. However, there is no standardised methodology for the conduct of such tests. The ability of one organisation to assess the findings of another's test for their own purposes has been limited. This CWA will be a benchmark for testing.

3 Aim and objectives

The aim of this CWA is to create industry-accepted criteria for the testing, evaluation, and acceptance of mechanical demining equipment. This CWA is also intended for use as a tool for type testing of Demining Machines in serial production.

4 Scope

The scope of the CWA is to provide standardized methodology for testing and evaluation of Demining Machines. It gives technical criteria for the following.

— Performance test

A test to establish whether the machine and its tool is capable of performing the role for which it is intended under comparable and repeatable conditions and to evaluate the manufacturer's specifications. See Annex A.

— Survivability test

A test of the effects of explosive forces on the machine and operators. The explosive force used will be based on the level of threat against which the machine is designed. See Annex B.

— Acceptance test

A test to ensure that the machine is able to work in the environment where it is intended to be used. The criteria shall provide guidelines for local authorities when accrediting machines. See Annex C.

— Test targets

Requirements for targets used in the above tests. See Annex D.

The CWA also recommends a pre-test (pre-trial) assessment (PTA) in which a candidate machine can be examined to determine whether there is merit in committing the necessary resources to full performance and survivability tests. This may be viewed as an opportunity to 'weed-out' machines whose designs have not matured enough to make the full suite of tests cost-effective. It also provides the trial team an opportunity to view the machine and its basic operating procedures, which may suggest modifications to the trial program. Finally, it will give the trial team an opportunity to investigate aspects of the machine which are not explicitly included in the formalized performance or acceptance tests.

For the purposes of this document, demining machines are defined as those machines whose stated purpose is the detonation, destruction or removal of landmines (mine clearance machines¹). This does not necessarily imply a fully demined area following passage of the machine. Ground preparation machines are those which are primarily intended to improve the efficiency of subsequent demining activities such as manual demining. This may include breaking of hard ground, vegetation cutting, fragment removal, or rubble removal. It may or may not involve the detonation, destruction or removal of landmines. It is recognised that this CWA concentrates on the testing of machines employed to clear mines, and there is a need to expand future work to address a number of issues, including:

Appropriate testing for ground preparation devices, including test of:

- a) vegetation clearance;
- b) breaking of hard ground;
- c) fragment removal;
- d) rubble removal;
- e) enhancement of testing of operator/crew safety, through development of the current survivability tests;
- f) possible degradation of performance due to the presence of blast resistant mines;
- g) possible degradation of performance due to the presence of environmental factors such as ditches, rocks, wires, rough ground, etc;
- h) enhancement of mobility testing beyond that currently in the pre-test (pre-trial) assessment.

It is intended that future work should be able to expand the scope of this CWA to cover these points. It is also acknowledged that the current version of this document is written with an apparent bias toward intrusive machines, and flail and tiller working tools. It should be noted that other machines including rollers could be tested equally well using these same procedures. In addition, machines intended to remove mines (versus triggering or breaking them) such as sifters, could be tested simply by modifying the test sheets to delete the reference to mines being triggered or neutralized and changing it to mines being successfully removed. Finally, the test and evaluation procedures specified herein should be viewed as minimum requirements. Additional or more stringent requirements can be imposed if appropriate. Some care should be taken, however, that such changes do not compromise the intent of the tests or the ability to compare test results.

¹ IMAS 9.50 (2)

5 Classification of machine

5.1 Classification according to weight, mode of operation and tool

Machines are classified as follows:

5.1.1 Classification according to machine weight

Historically mine clearance machines have been classified according to machine weight as light, medium or heavy machines according to the following limits.

- Light, lighter or equal to 5 tonnes
- Medium, heavier than 5 tonnes and lighter or equal to 20 tonnes
- Heavy, heavier than 20 tonnes

The main difference between these classes is that it was assumed that light machines would generally be remotely controlled and would only be used against antipersonnel mines, heavy machines would generally have an on-board operator and would have to have the ability to deal with antitank mines, and that medium machines would fall in the middle with a mix of requirements. This has implications primarily for the survivability tests (see Annex B), and for transportation requirements.

Since this CWA first came into effect, machines appear to have grown in size and weight, with machines that used to be categorized as “light” now being well over the 5 tonne limit. In addition, more and more machines are equipped with remote control, or even dual (remote control or on-board control) capability, and even some of the lightweight machines are showing capability against antitank mines. It has been suggested that transportation limits may now be more relevant and that the adopted weight classes should refer to the total weight of the machine in operating order, including the working tool(s). The adoption of the following new demining machine weight classes, proposed by the Geneva International Centre for Humanitarian Demining, are therefore recommended.

- Light, lighter or equal to 10 tonnes
- Medium, heavier than 10 and lighter or equal to 20 tonnes
- Heavy, heavier than 20 tonnes

5.1.2 Classification according to mode of operation

- Direct operation from the cabin of the machine
- Operation with remote controls
- Operation with remote controls and video monitoring

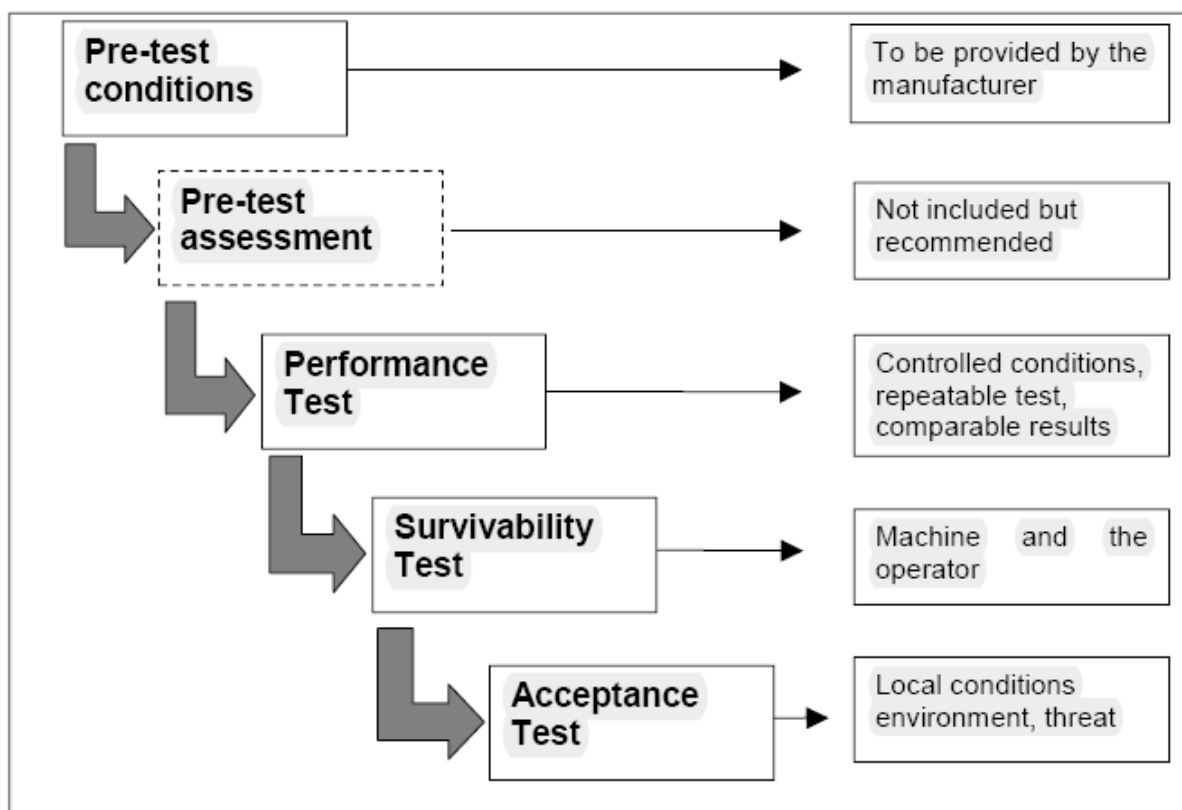
Dual classification for direct and remote operation is possible. In this case the machine shall only be accredited for the classification in which it was tested

5.1.3 Classification based on tool

- Machine with flails
- Machine with a tiller (sometimes referred to as soil mill)

- Machine with a vegetation cutter
- Others, including machines with dual or multiple tools (e.g. Flail and tiller)

6 Flowchart of Steps in the CWA



7 Modifications or changes to the demining machines or Standard Operating Procedure

If during the mine action program changes are made to the machine or the SOP that could have influence on the capability of the machine, the testing organisation or the national mine action authority may ask for a revision of certification. For this reason the owner/user organisation shall inform the certifying organisation about all modifications planned for the machine or the SOP and other changes. The testing organisation will determine if the expected changes require a repetition of the evaluation, in whole or in part and whether such testing can be met by an engineering review of field tests.

8 Pre-test (pre-trial) conditions

The following is indicative of the type of information that should be provided by the manufacturer before any testing.

	Specification	Performance	Remarks
	Over All data		
1	Driving speed	km/h	
2	Capacity for vegetation cutting in light and heavy vegetation	m ² /h	Conditions: terrain and vegetation to be reported in accordance with annex 3 clause 6
3	Operating speed and clearance depth/ in varying terrain	/m/min -cm	Terrain conditions shall be reported in accordance with annex 3 clause 6
4	Contouring system		Description
5	Speed-control system		Description
6	Maximum and minimum operating temperature		
7	Maximum operating range from remote control unit	m	Mode of operation when out of range or in case of communication failure
8	Maximum climb slope while operating	degrees	
9	Maximum descending slope while operating	degrees	
10	Maximum traversing slope while operating	degrees	
11	Height	m	
12	Weight	tonnes	
13	Daily servicing schedule	hours	Machine working hours
14	Transportability		Shorter distances. By its own. Km Longer distances. Need of transport equipment?

	Specification	Performance	Remarks
15	Documentation requirements		Users manual Service and repair documents Wiring diagram Spare part catalogue Failure Mode Effects and Criticality Analysis (FMECA), (if available) Consumption records Service maintenance schedules
16	Protection Machine survivability Crew survivability (where applicable)		Description of armour with supporting documents Description of crew escape routes and fire suppression
17	Reliability The machine shall operated under load for minimum of 48 hours over a 6 consecutive days	time/depth /m ²	Records of: fuel consumption oils and coolant temperatures taken hourly spare parts used consumables failures maintenance soil and vegetation conditions reported in accordance with annex 3 clause 6
	Vehicle data		
18	Turning circle	m	Minimum turning radius
19	Length	m	
20	Width	m	
21	Maximum fording depth	m	
22	Gap crossing capability	m	Width of a ditch which a machine can traverse
23	Axle weights	tonnes	
24	Wheel spacing	m	
25	Wheel/track footprint	mm × mm	
26	Ground bearing pressure	kPa	
27	Power requirement to drive the vehicle (if available)	kW	On flat ground without the tool in operation
28	Engine power at the flywheel	kW	
29	Fuel consumption under normal operation	litres/hour	
30	Fuel tank capacity	litres	

	Specification	Performance	Remarks
	Tool Data		
31	Clearance width	m	
32	Maximum angle of depression		
33	Maximum angle of elevation		
34	Tool width	m	
35	Beat pattern	hits per m ²	At operating speeds defined in line 2
36	Power at the working tool	kW	
37	Tool operating speed	Rpm	Where applicable

Machine testing experience has demonstrated that it is useful to include a test, or at least a demonstration of how a disabled machine can be recovered. Some machines will include a self-recovery capability, while others may rely on the organization supporting the machine; either approach will have advantages and disadvantages. As the method for evaluating machine recovery will vary depending on the machine and the specific situation, it is not possible to give a complete procedure for this process but it is recommended that the following scenarios be tested or assessed at some point within the pre-test (pre-trial) assessment:

- machine stuck, but still operational;
- machine stuck, no engine or electrical power available at the vehicle;
- machine not stuck, but no engine or electrical power available;
- other scenarios as appropriate to the machine in question.

Annex A

Performance Test of Demining Machines

A.1 General

The purpose is to test, in an objective and repeatable manner, the performance of mechanical mine-clearance devices and ground-preparation systems used in the context of mine action, to identify equipment that is safe, reliable, and fit for its purpose.

Machines not designed to have a clearance capability, for example vegetation cutters and ground preparation machines, will be tested in accordance with clauses 4-7 in this annex.

Results are based on test conditions and may not necessarily be repeated in field conditions. Field conditions are dealt with in the Acceptance Test (Annex C).

A.2 Clearance test

The purpose of the clearance test is to test, under controlled conditions, the capability of the machine to clear (i.e., detonate, destroy or remove) mines at different depths in different types of soil. The test is performed in three different ground configurations at various depths from flush with the surface to the maximum penetration depth (according to the manufacturer) and at the optimal speed for the given clearance depth (according to the manufacturer).

A.2.1 Test environment

Three lanes each with a homogenous soil type. The soil in the lanes shall be separated from the surrounding soil. The lanes shall have such width and depth that the machine and its tool will not interfere with the soil outside the lane. Experience in conducting performance tests to this CWA has shown that adhering to these requirements, in particular the soil types and conditions, is critical to ensuring that the data is clear, repeatable, and comparable to other machine tests.

A.2.2 Soil characteristics

A.2.2.1 Soil types

Gravel with particle size from 0,075 mm to 45 mm, of which 10 % is less than 0,4 mm, and then a size distribution up to 45 mm normally specified as 0-32 mm.

Sand (e.g. with particle size from 0,075 mm to 20 mm, with 85 % less than 0,6 mm).

Topsoil may have different contents of organic material. Locally available topsoil is accepted but the particle size shall be from 0,001 mm up to 31 mm.

A.2.2.1 Soil density

Each soil type should be subjected to a standard Proctor soil compaction test to determine the density-moisture relationship for that soil.

Before every run the soil shall be cultivated, or otherwise loosened up, and then compacted to its original state again. The level of compactness is to be measured and recorded using no less than three points randomly distributed along the lane. The measurement shall be done at the expected clearance depth. The document *Measuring the soil compactness and soil moisture content in areas for testing of mechanical demining equipment* (http://www.itep.ws/pdf/LL_CWA15044PartThree.pdf) provides a summary of methods which can be used to measure the soil compactness in mechanical demining test areas.

Each test lane shall be compacted as follows:

- Gravel: 94 % \pm 2 % of the maximum theoretical dry density
- Sand: 90 % \pm 2 % of the maximum theoretical dry density
- Topsoil: 85 % \pm 2 % of the maximum theoretical dry density

A.2.3 Execution

The machine shall be driven at a constant and optimal clearance speed through the whole length of the test lanes. This speed should be constant throughout each complete run through a test lane. The speed may be changed between test lanes and between depths of burial. The operating speed shall be recorded for each clearance test.

An example of the test protocol can be seen in Example 1. Manufacturers are responsible for supplying operators for the operation of the machine during the testing period.

The tests will be conducted as follows:

- Sand, 50 APM test targets at three different depths, total 150
- Gravel, 50 APM test targets at three different depths, total 150
- Topsoil, 50 APM test targets at three different depths, total 150

A.2.4 Target selection

The standard target defined in Annex D shall be used for performance clearance.

ATM test targets will be used if the manufacturer considers the machine to be a mine clearance vehicle (MCV) for ATM.

A.2.5 Target deployment

The mines are laid at three depths: flush with surface, 10 cm and the maximum depth claimed by the manufacturer. The target mines shall be laid without pattern along the lane within the following constraints: mines shall not be within 0,5 m of each other and shall be distributed to cover the middle 50 % of the width of the working tool. The targets shall be placed creating the minimum disturbance to the surrounding ground (e.g., using an earth auger).

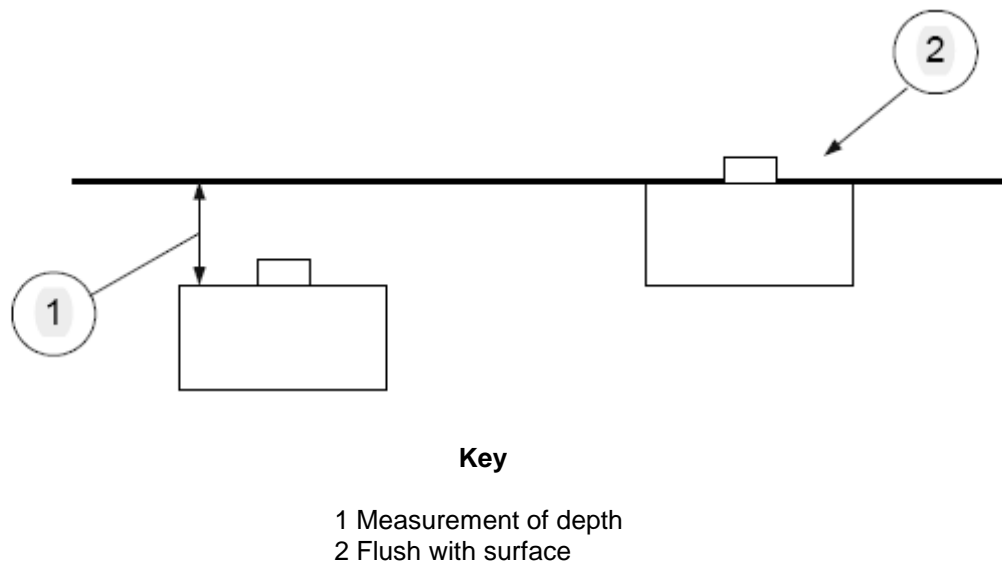
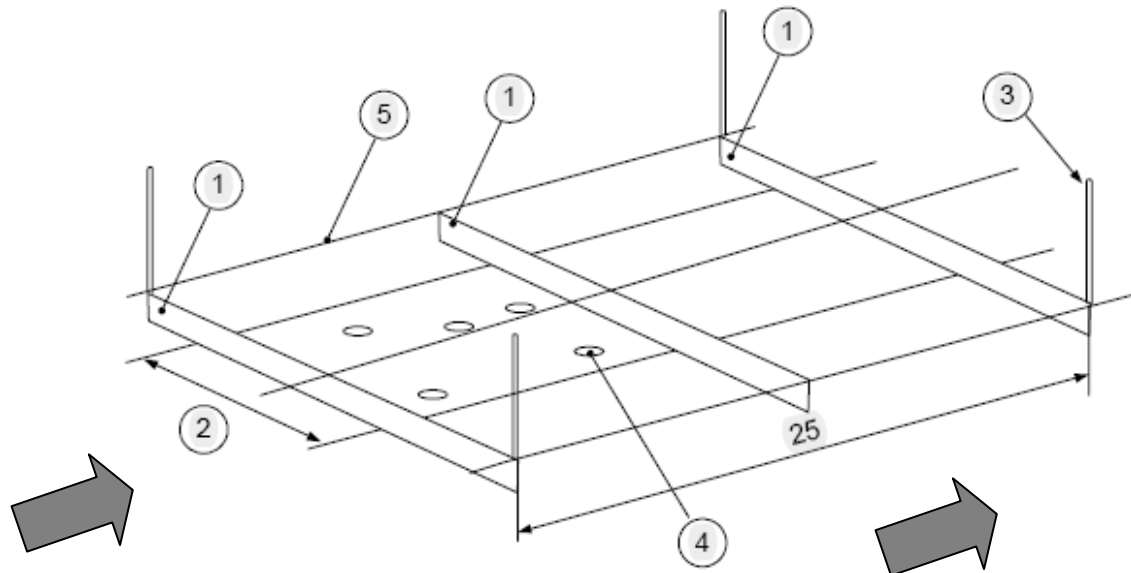


Figure A.1 — Charge placement for performance test



Key

- 1 Fibreboard
- 2 50 % of the tool width
- 3 Marking sticks
- 4 Test targets
- 5 Surface of ground

Figure A.2 — Distances in meters

A.2.6 Ground penetration depth of the working tool

To evaluate the ground penetration depth during the clearance probability test, sections of 3 mm thick fibreboard will be put into the ground, across the clearance path of the machine, buried up to 15 cm below the maximum depth with the top of the fibreboard flush with the surface. The width of the fibreboard shall be at least 10 % greater than the width of the digging tool. Joining of several sections to achieve the required width is acceptable. A minimum of three fibreboards is to be used, one before the targets, one within the targets, and one after the targets. See Figure A.2. Where possible the location of the fibreboards should remain unknown to the operator of the machine.

The machine shall be allowed to stabilize itself and drive 5 meters with the working tool running and engaged before the measurement starts.

Certain aspects of measuring the tool ground penetration depth have been found to be of critical importance. The document *The effect of soil condition on measurements of ground penetration depth and machine performance* (3) gives an overview of the lessons learned and includes details and illustrations of ground penetration depth measurement techniques, including the measurement using fibreboards. If fibreboards are used it is critical to avoid creating soft zones near the fibreboards. Figure A.3 shows an acceptable method of installing fibreboards in which the fibreboard are inserted into a vary narrow slit, created by a special cutter.



Figure A.3 – Proper fibreboard installation

A.2.7 Defining the clearance result

After each test run, targets and target debris are collected. This can be done by visually inspecting the area. Frequently a metal detector is used to more easily find targets which are not immediately visible on the processed surface. Alternatively the processed area can be sifted.

The following definitions are provided to describe the condition of targets as a means of evaluating the resulting effect of the machine on the targets. (See Annex D).

Test target will be recorded as:

— **Triggered (detonated)**

The firing chain or circuit has been completed.

— **Mechanically neutralized (untriggered, damaged, non-functional)**

The target has been engaged by the tool, and the firing chain or circuit cannot be completed.

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— Live damaged (untriggered, damaged, still functional)

The tool has engaged the target, but the possibility of the firing chain being completed exists.

— Live (untriggered, undamaged)

The target has not been engaged by the tool, and the firing chain or circuit remains active.

All test reports shall include photographs indicating examples of the conditions in the test lanes, fibreboards showing the clearance profile and target's functioning mechanism.

A.3 Interpretation of clearance test result

A.3.1 Definitions

Confidence interval

A confidence interval gives an estimated range of values which is likely to include an unknown population parameter, the estimated range being calculated from a given set of sample data.

Confidence level

The confidence level is the probability value associated with a confidence interval, the probability that the unknown parameter is included in the confidence interval.

A.3.2 Test conditions

The result from the performance test, the number of mines cleared, is an estimate of the machines' ability to clear mines. If two identical machines are tested in identical conditions, one using 3 test targets and the other using 50 test targets, it is intuitively obvious that one can be more confident in the results from the 50-target test, but that neither test might represent the *actual* ability of the machine with absolute, or 100% certainty. Before any conclusion can be drawn from the estimate of the machines' real performance, the confidence of the estimate has to be calculated. The document *Statistical methods used to calculate demining machine performance and performance confidence intervals (6)* provides details on how the machine performance and confidence intervals are calculated.

The parameters that are known to affect the performance result shall be controlled and kept the same for each test run. These parameters are:

- a) type of target
- b) depth of the target
- c) type of soil in the test lane

The parameters that we do not know if they affect the performance result shall be randomized. The only parameter of this kind in this type of test is the position of the targets in the test lane. To place the targets randomly a predefined pattern or a tool that can generate random patterns shall be used. A person deploying targets does not give a random pattern.

A.3.3 Interpretation of the performance test results

The uncertainty of the estimate, the confidence interval, is presented in Figure A.4. The horizontal axis, the x-axis, is the number of targets, out of the 50 in the test cleared by the machine. The vertical axis, the y-axis, is the performance in percentage and the two curves in the figure denote the upper and lower edge of the confidence interval, i.e. the performance of the machine is between the lines. The confidence level for the curves in Figure A.4 is 95 %, i.e. the probability that the interval includes the performance of the machine is 95 % or the risk that the machines' performance is outside the interval is 5 %.

Details on the statistics and the calculations to obtain the graph in Figure A.4 can be found in the document *Statistical methods used to calculate demining machine performance and performance confidence intervals* (6)

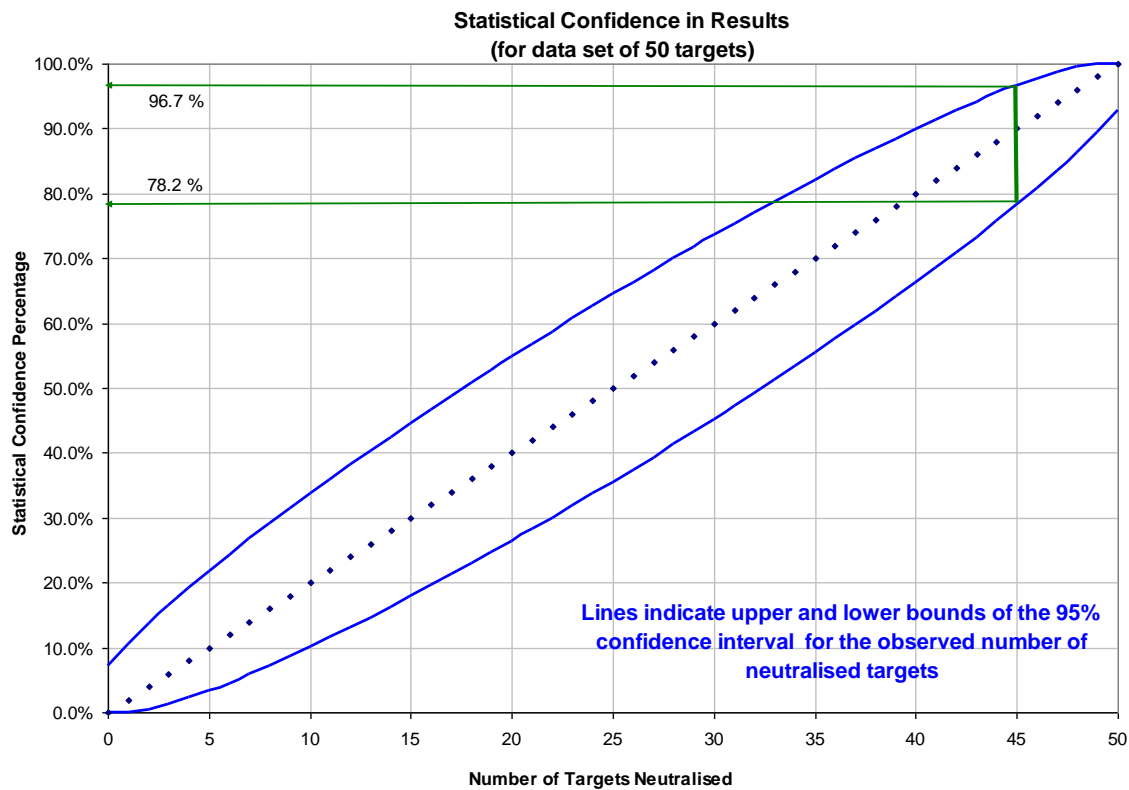


Figure A.4 — Uncertainty of the estimate

EXAMPLE: A machine cleared 45 of the 50 targets in a performance test. The lower curve in Figure A.4 crosses 45 at 78.2 % on the vertical axis, i.e. the lower limit of the confidence interval is 78 %. The upper curve crosses 45 at 96.7 %, i.e. the upper limit of the confidence interval is 97%. The confidence interval is 78 % to 97 %, or the performance of the machine is in the interval 78 % to 97 % at the confidence level 95 %.

In the situation that the performance of two machines shall be compared, Figure A.5 shall be used.

The question now is how big the difference in the estimates of the performance rate has to be before we can say that there is a significant difference in the performance of the machines. In Figure A.5 the horizontal axis is the estimated performance of the machine with the highest estimated performance. The vertical axis is the estimated performance for the second machine. If the estimated performance for the second machine is below the curve then there is a significant difference between the machines.

Also in this figure the confidence level is 95 %, i.e. using the table there is a 5 % risk that the conclusion is wrong.

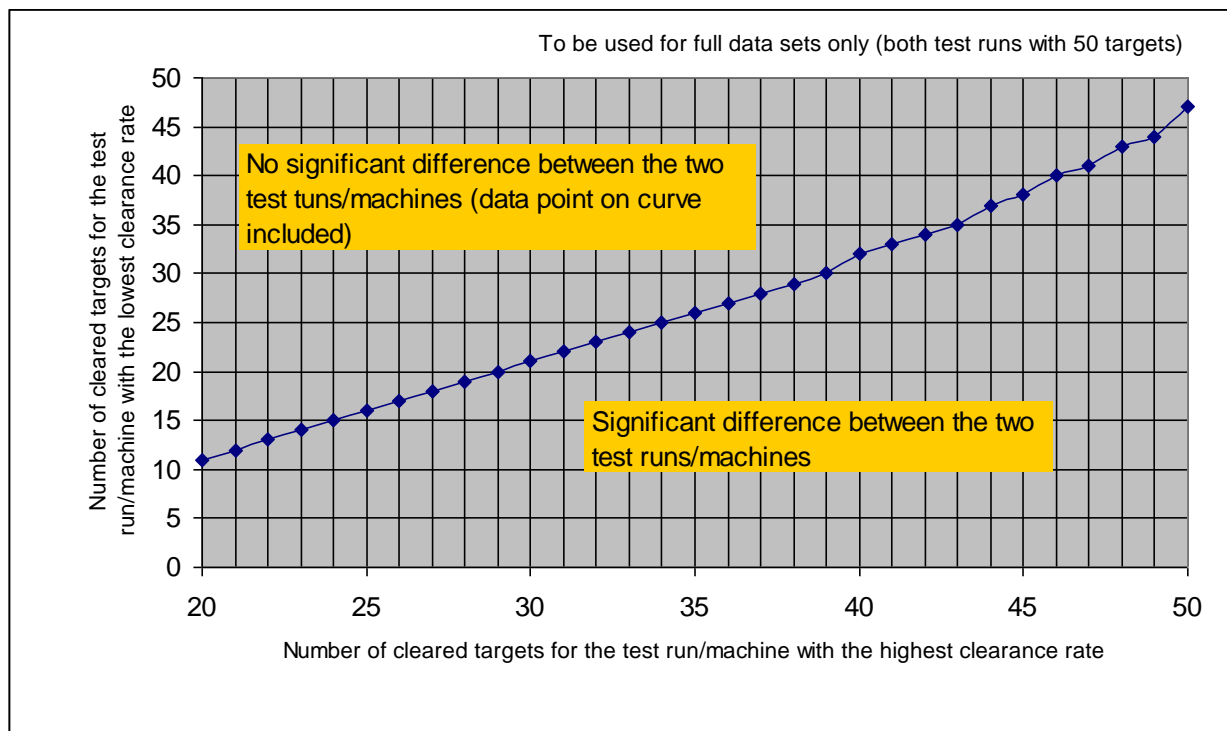


Figure A.5 - Significant difference in the performance

EXAMPLE Machine A cleared 45 of the 50 targets. Machine B cleared 43 in the same type of test. 45 at the horizontal axis cross 43 at the vertical axis above the blue curve in Figure A.5. The conclusion is that there is no significant difference between the clearance rates obtained from Machine A and Machine B.

Details on the statistics and the calculations to obtain the graph in Figure A.5 can also be found in the document *Statistical methods used to calculate demining machine performance and performance confidence intervals* (6)

It is useful to indicate how many targets have been thrown clear of the processed section of the test lane, along with an indication of the status (triggered, mechanically neutralized, etc) of each. A live target throw clear will be of obvious concern, but some report readers will consider pieces of mechanically neutralized mines to represent threats that still need to be cleared. Providing this additional information allows the readers to interpret the information as appropriate to his or her own needs.

Occasionally, it may not be possible to account for every single one of the 50 targets in each test run despite the best efforts to do so. If there are many targets missing it may be best to repeat the test run, but with only one or two missing it may not be practical or even desirable to repeat the test. The exact number of missing targets needed to require a retest will be a judgement call for the trial director to make. In a case where one or more targets are missing and where a retest is not done, the report needs to make clear (i) how many targets were missing, and (ii) how these missing targets will be treated (assumed live or assumed triggered, for example). If the status of these missing targets cannot be determined, some trial directors may choose to define the data set as being comprised of only the 48 or 49 targets that *can* be identified with confidence. Again, this must be made clear in the report.

A.3.4 Interpretation of the ground penetration depth measurements

The information obtained through measurement of the ground penetration depth can provide a subjective evaluation, simply through the use of photographs. The information may show something that is 'good enough' or 'not good enough' without requiring anything more quantitative. On the other hand, it will be

useful in many cases to be able to quantify this information. There is, as yet, no widely accepted method for quantifying the ground penetration depth measurement information. The lessons learned document *The interpretation of ground penetration depth measurements* (4) provides background information on the interpretation of ground penetration measurements, and the parameters that could be used to quantify the ground penetration depth measurements.

A.4 Ground preparation and vegetation clearance

Because no standard methodologies have as yet been developed for the establishment of repeatable conditions for testing vegetation clearance, the aim of the test is to demonstrate that the machine has a capability for vegetation clearance in three different environments. However, it may be possible to include a more comprehensive test in the future.

CLASS	VEGETATION DESCRIPTION
LOW VEGETATION	<ul style="list-style-type: none"> Green or dry grass, thin or thick, weeds, few low bushes up to 1 m high
MEDIUM VEGETATION	<ul style="list-style-type: none"> Grass, weeds, individual bushes, medium to high density, 1 m to 2 m high Few individual trees up to 10 cm in diameter
HIGH VEGETATION	<ul style="list-style-type: none"> Bushes, weeds, grass High density Greater than 2 m high Individual trees with diameter greater than 10 cm
SPECIFIC CONDITIONS	<ul style="list-style-type: none"> Specific conditions where the other classes are not applicable Conditions to be described in the report



Drawings © GICHHD (1)



Low vegetation

Medium vegetation

High vegetation

Figure A.6

The machine shall work through 10 m of vegetation as based on the worst case scenario available. After 2,5 m a 3 mm fibreboard shall be put in the soil 15 cm deeper than the estimated working depth to give

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the penetration profile. Machines constructed not to engage the ground shall not be subject to the fibreboard test.

Ground preparation machines, not intended for vegetation cutting, shall prepare 10 m of ground based on the worst case scenario available. After 2,5 m a 3 mm fibreboard shall be put in the soil 15 cm deeper than the estimated working depth to give the penetration profile.

The report shall include a narrative description of the results supported by photographs before and after the clearance.

A.5 Reliability and maintainability of machine

Assess manufacturer's documentation and data on reliability and maintainability, including the effect of the environment (e.g., dust, water, and heat) on the machine. The organisation performing the test shall manage at least 8 hours of continuous operation of the machine under maximum load (depth). Stops for refuelling and scheduled maintenance are allowed within this time period. The operation does not need be performed in the test lane with target mines. A daily log shall be kept, accurately recording all performance data and assessing manufacturer's claims.

A.6 Logistic issues

Evaluate and report based on manufacturer's data as far as reasonably practical within the test aims and conditions.

A.7 Human Factors

Evaluate and report on human factors such as visibility, comfort, and ergonomics to the extent reasonably practical within the test aims and conditions.

A.8 Test protocol for Mechanised Mine-Clearing Vehicles: Example 1 and Example 2

Test Protocol Mechanised Mine-Clearing Vehicles		
Date:	Weather:	Temperature:
Ground conditions: Rate of compaction:	Status:	Place:
Scope: Performance in topsoil, mine flush with surface, 10 cm below surface, and at maximum clearance depth or 20 cm, whichever is less.		Photo/video documentation:
Equipment: 3 fibreboards used at beginning, middle and at the end of run.		
<p>Sketch/description</p> <div style="text-align: center;"> </div> <ul style="list-style-type: none"> ▪ Penetrating profile will be evaluated ▪ Transmission/speed control will be evaluated ▪ Clearing speed will be recorded 		
Comments and results:		
Test leader:		Signature

Example 1

Test Protocol - Example 2

Manufacturer		Machine type	
Date	Weather	Temperature	
Test number		Deployment depth cm	
Soil type		Rate of compaction	
Clearing depth	Time/25 m	⇒	Clearing speed m/min

	Number of targets			
Deployed:				
Triggered (detonated)				
Mechanically neutralised				
Live Damaged:				
Live:				
Total:				

Comments:

Accounted for: (example): 48/50 (48 accounted for out of 50 deployed)

NOTE: all reasonable steps shall be taken to find the missing targets

Annex B

Survivability Test of Demining Machines

B.1 General

Survivability is based on the materials used, design features, and threat for which the machine has been designed. The tests focus on two distinct areas (detailed below):

1. Machine survivability - the blast effect from mines on the machine.
2. Operator survivability - the level of protection afforded to operators of non remote-controlled machines subjected to the effects of blast.

Before testing, the test agency shall evaluate at a minimum the protection specifications, which shall include (but not be limited to) the following:

- Materials used (types, thickness, certificate, etc.);
- Design principles (blast deflection, distances, etc.);
- Construction quality (access of fittings and controls, welds, etc.);
- Safety principles (such as exits, fire suppression, etc.)

B.2 Machine survivability

Machine survivability may be interpreted to mean the ability of the machine to survive routine blasts from the intended targets (antipersonnel mines, for example), under the working tool, without requiring repairs. It may be interpreted to mean the ability of the machine to withstand blasts of the intended targets under other parts of the machine such as a wheel or a depth control skid. This may or may not accept a requirement for repairs. Machine survivability may also be taken to mean the ability of the machine to accept the blast from a large antitank mine under the tool, without catastrophic damage to the machine, or the same blast under a wheel or other part of the machine. Any of these is an acceptable condition providing that all participants agree and that the nature of the test is made clear in the final test report. A report stating only that a machine survived a 10kg TNT blast is of no value unless it makes it clear where the blast occurred, and also gives some description of the level of damage.

For the purposes of illustration, this section assumes that mine charges will be detonated as if they were successfully engaged by the tool. If charges under wheels, tracks, skids or other locations are desired, the report shall explicitly define what those condition are.

B.2.1 Test conditions

Blast effects on the tool will be measured under controlled conditions using charges as specified in this CWA and with the tool in normal operation. The size and characteristics of the charges are defined in Annex D. The target selection will be based on the manufacturers declaration of capacity unless otherwise agreed to in the test documentation. As a minimum the machine shall be subjected to testing of APM.

B.2.2 Execution

The smallest charge shall be placed first to avoid unnecessary damage. The first charge will be placed in the centre of the tool. Depending on the result, a second charge of equal effect will be detonated at the end of the tool. Charges may be command detonated or engaged by the tool until detonated..

The placement and condition of the charges in respect to the tool are shown in Figure B.1.

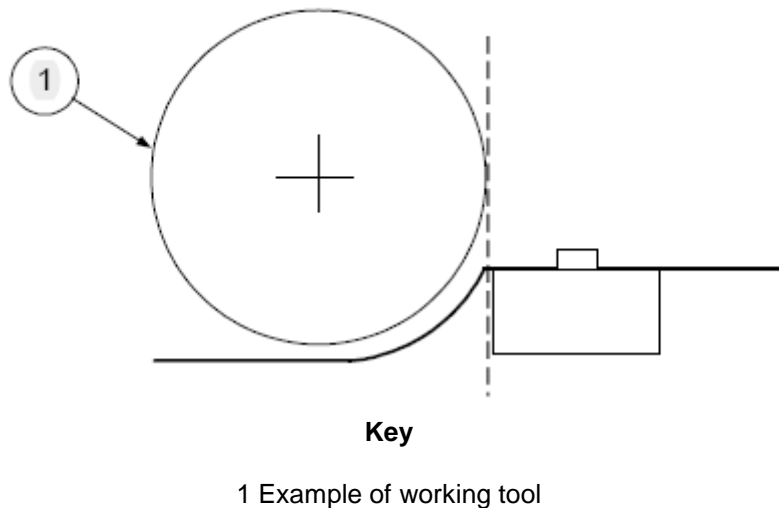


Figure B.1 - Charge placement for machine survivability tests

B.3 Operator survivability

In the case where there is an operator in the machine, it is important to evaluate the safety of the operator. The optimal situation is to test for the worst case condition (a mine under a wheel or under the belly of the machine, for example). This kind of test is likely to do serious damage to the machine, and may not be practical in all situations. Even more than for the machine survivability tests, it is critical that the report describe exactly what was tested to ensure that the reader understands the limitations of the test data. A test that shows no injury to the operator from an antitank mine under the tool is very different from a test that shows no injury to the operator from an antitank mine under the cab. In this section, a worst case scenario is assumed.

Some machines may allow for either operation with a person in the machine, or remote control operation where there is no operator in the machine. Clearly, if there is an option for a person to be in the machine it is best to test for that possibility, especially in a worst case scenario. If no agreement can be reached to do that type of test, the report needs to make clear the limitations (e.g. “tested for remote control only,” etc.)

B.3.1 Aim

The aim is to verify the survivability of the crew of non remote-controlled machines after AT mine detonation in a worst case scenario based on a charge no smaller than the ATM charge agreed to by the CWA.

At a minimum, the following effects will be measured and evaluated:

- Overpressure in internal organs (ear);
- Acceleration (feet and spinal);
- Displacement of operator.

B.3.2 Execution

B.3.2.1 Placement of charges

The charge will be placed in the area deemed most likely to have maximum effect on the operator (worst case scenario) e.g. under the wheel or track bogey closest to the crew compartment. Charge placement will be in direct contact with the target area or otherwise placed to impart the maximum energy to the machine. Charges may be command detonated or engaged by the machine until detonated.

B.3.2.2 Data collection and information management

A methodology for measurement and tolerance levels is given in *VoVC 14 910:1142/03 Mine Clearance Vehicles—Crew Safety Standard* (8)

Injury criteria, tolerance levels and measurement methods to assess the most vulnerable body regions to a blast mine strike under a vehicle can also be found in *Test Methodology for Protection of Vehicle Occupants against Anti-Vehicular Landmine Effects*, (9).

Annex C

Acceptance Tests of Demining Machines

C.1 General

The purpose of an acceptance test is to form part of the accreditation of a demining machine to be used for humanitarian demining. The acceptance test is carried out in a particular, realistic environment. This differs from the performance tests which were done under standardized, laboratory-style conditions. Different countries, national authorities, individual demining organizations, or even different physical locations may require different acceptance tests. Prior to the acceptance test, the acceptance testing organisation shall evaluate the results from performance and survivability test and declare the machine as safe for the acceptance test.

It is important to understand that every different authority may have different requirements, procedures, and limitations in its need for acceptance tests. It is therefore not possible, nor even desirable to specifically define the contents of an acceptance test or how it is to be carried out. This annex uses the experience and examples from machine testing in Croatia as a template for one way of defining and executing acceptance tests. This does not constrain anyone to use the exact methodology contained in this annex. It can, and should, be modified as necessary to suit the needs of other users or authorities.

C.2 Principles

— The first phase involves provisional evaluation on the basis of analysing the documents submitted by the testing applicant. This documentation includes that provided by the manufacturer (such as fact sheets, manuals and more), test results from previous performance and survivability tests, and other relevant documentation.

— The second phase involves a test under real conditions to verify that the personnel, equipment, material, and procedures can be used as intended, and that demining activities can be conducted in a safe, efficient, and effective way.

— Modifications or changes on the demining machines or in its standard operating procedure (SOP)—If during the mine action program significant changes are done on the machine or in the SOP that could have an influence on the capability of the machine, the testing organisation or the national mine action authority may ask for a revision of certification. For this reason the owner/user organisation will inform the certifying organisation of all modifications planned for the machine or the SOP, as well as other changes. The testing organisation will determine if the expected changes require a repetition of the evaluation, in the whole or in part and whether such testing can be met by an engineering review of field test.

— Subject to national authority regulations, this acceptance process should lead to certification of the machine for use in that country.

C.3 Basic preconditions

The minimum conditions for obtaining and keeping a certification for a demining machine are the following:

— That the testing applicant is capable of meeting the provisions of this CEN Workshop Agreement.

— A machine will be awarded the certification only if it meets the standards set down in this CEN Workshop Agreement and in the national regulations.

NOTE If a testing organisation deems that not all the requirements for accreditation and licensing have been met, it shall inform the testing applicant as soon as possible. It shall also identify the problems and propose the corrective measures to be taken. The testing applicant shall show what modifications it has made to fully meet the requirements.

C.4 Provisional evaluation

Upon receiving the application and related documents, the testing organisation will confirm the receipt and, if needed, request for additional information from the applicant.

The evaluation based on the document analysis may end with the issue of a test certificate, based on the following: that the demining machine in question has been tested already in accordance with this CEN Workshop Agreement, or that it has been used in a safe and effective way in similar previous demining operations. The conditions for such post-facto approval shall be decided by the national mine action authority.

If a demining machine does not meet all of the above criteria, it will have to go through the relevant tests as required.

If the testing organisation deems that not all the accreditation and licensing requirements have been met, it shall inform the testing applicant as soon as possible and it shall set out the grounds for denying the application. Whenever possible, the applicant shall be given the opportunity to fill in the gaps in a time frame to be agreed between the applicant and the testing organisation.

If the testing applicant cannot meet the accreditation and licensing requirements and cannot correct the failures within the agreed time frame, the application shall be rejected and the applicant shall be informed.

C.5 Acceptance test – real conditions

The purpose is to verify that a demining machine and operational procedure proposed by the testing applicant in its application are safe, effective, and efficient.

C.5.1 Classifications of test environment

C.5.1.1 Classification of soil

The soil in the area for the test shall be classified and reported with the results from the test.

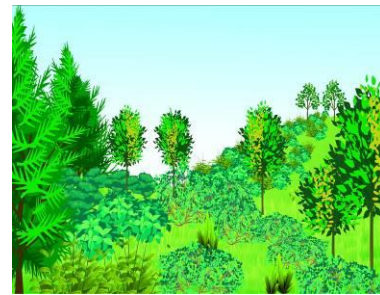
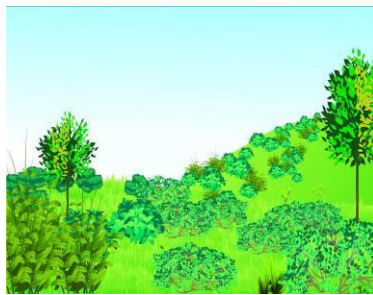
The specifications of the classes are as follows:

CLASS	SOIL DESCRIPTION
CLASS I	<ul style="list-style-type: none"> • Humus, loam, compact sand, hard and semi-hard soil covered in vegetation • Use of manual tools (shovel, pickaxe)
CLASS II	<ul style="list-style-type: none"> • Soil mixed with stone, soil is prevailing, rare vegetation • Limestone, soft, easily crushed by demining tool
CLASS III	<ul style="list-style-type: none"> • Stony terrain, stone plates with soil in between, low vegetation in places • Semi-hard stone • Machine works in reduced depths (10 – 15 cm)
CLASS IV	<ul style="list-style-type: none"> • Specific conditions where the other classes are not applicable • Difficult to work with a machine with acceptable results • Conditions to be described in report
Note that an area might contain different soil classes. This should also be indicated in the report, together with the approximate percentage distribution of each soil class	

C.5.1.2 Classification of vegetation

The specifications of the classes are as follows:

CLASS	VEGETATION DESCRIPTION
LOW VEGETATION	<ul style="list-style-type: none"> Green or dry grass, thin or thick, weeds, few low bushes up to 1 m high
MEDIUM VEGETATION	<ul style="list-style-type: none"> Grass, weeds, individual bushes, medium to high density, 1-2 m high Few individual trees up to 10 cm in diameter
HIGH VEGETATION	<ul style="list-style-type: none"> Bushes, weeds, grass High density Greater than 2 m high Individual trees with diameter greater than 10 cm
SPECIFIC CONDITIONS	<ul style="list-style-type: none"> Specific conditions where the other classes are not applicable Conditions to be described in the report



Drawings © GICHD (1)



Low vegetation



Medium vegetation



High vegetation

Figure C.1

C.6 Acceptance test procedure

C.6.1 Test conditions

Testing of a demining machine on APM and ATM is executed outside a work site, on a surveyed and safe ground, with all protection measures not endangering human lives or damaging material goods.

When a machine is operated by remote controls, the operator could be situated in a supporting armoured vehicle or cabin, or walking, on safe ground, behind the machine, wearing protective equipment:

- a) The supporting armoured vehicle moves/stands behind the demining machine at a safe distance on land that has been surveyed and has been determined as safe. If an armoured cabin is used the cabin will

be located in such area from where the operator either has visual control of the machine or is controlling it through video images.

b) The operator is located in the armoured vehicle on a seat with the safety belt. The operator wears a flak jacket and a helmet with a communication system installed, for communication with the test leader and the work site.

c) The operator, wearing protective equipment, is walking/standing behind the machine at a safe distance. The operator must walk/stand on land that has been surveyed and determined as safe.

C.6.2 Prior to test

— Moisture content in soil to be measured.

— The soil to be classified.

— The vegetation to be classified.

C.6.3 Live mine test

C.6.3.1 Number and type of mines to be used

— APM – 20 items

— ATM – 5 items

C.6.3.2 Types of mines to be used

Types of mines to be used, depending on the machine type:

— The type of APM and ATM shall reflect the main mine threat in the region (see guidelines in Annex D).

— Light demining machines and excavators are tested against APM.

— Medium-size demining machines are tested against both APM and ATM. Limitation to APM may be specified by the manufacturer in pre-test (pre-trial) conditions

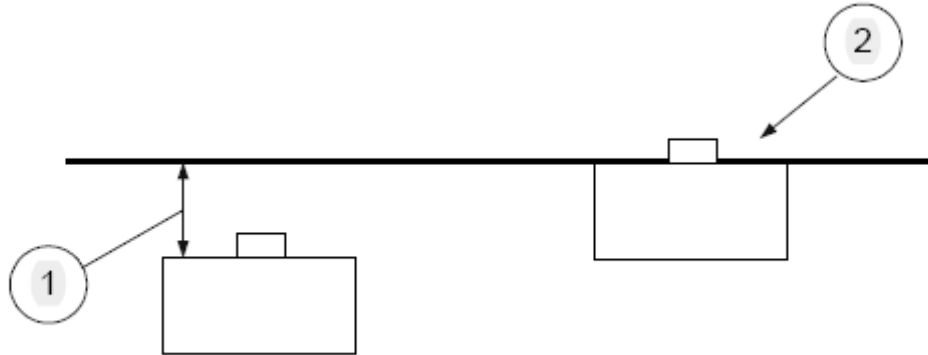
— Heavy demining machines are tested against both APM and ATM.

C.6.4 Deployment of mines

The national mine action authority shall determine the appropriate mines or targets to be used. For some national authorities it may be desirable to use live mines to test the interactions between the machine and the mine, or to give the machine operator a sense of confidence in the machine. For other authorities the use of live mines may create unacceptable safety or logistics concerns. The individual national mine action authorities must determine the goals of the acceptance tests and the restrictions under which those tests will be conducted. Based on those decisions, the national mine action authorities will select mines or acceptable targets for use in the tests.

C.6.4.1 Antipersonnel mines

- APM or other appropriate targets are placed in a line, with the distance between them of about 4 m and flush with surface, at the depth 10 cm and the national specified clearance depth or the depth claimed by the manufacturer, whichever is the greater and measured from surface to the top of the mine body.

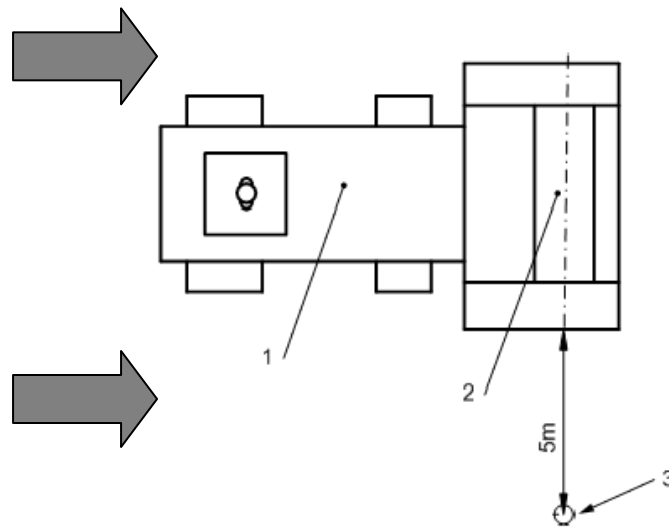


Key

- 1 Measurement of depth
- 2 Flush with surface

Figure C.2 - Charge placement for acceptance test

C.6.4.2 Fragmentation mines



Key

- 1 Machine
- 2 Tool nearest the machine
- 3 Fragmentation APM

Figure C.3 - Set up for fragmentation mine

C.6.4.3 Antitank mines

- The machine is tested against one ATM in each run.
- Before the test the ATM is placed 5 m in front of the working tool at a depth of about 10 cm to 12 cm measured from surface to the top of the mine body.
- The test shall start with the ATM that is estimated to have the lowest impact

C.6.5 Evaluation of result of the live mine test

- The working tool of the demining machine has to activate or break the mines. Broken mines shall be evaluated in accordance with Annex D.
- The final result shall be specified as number of mines:
 - Triggered (detonated)
 - Mechanically Neutralised (untriggered, damaged, non functional)
 - Live Damaged (untriggered, damaged, still functional)
 - Live (untriggered, undamaged)

The Parties can agree to repeat the test in case that the result is not seen as satisfactory

C.7 Testing of a demining machine in a mine suspected area

The testing of the demining machine shall be done in realistic conditions, in a mine suspected area. This part of the test is carried out in accordance with the SOP that is used in the region (i.e., typical demining operation with demining machines). During the test all activities and consumption of fuel, spare parts, etc. will be recorded.

C.7.1 The minimum data to be recorded during the test

Work Log:

- The place and time of work
- Actual working time of the demining machine
- The size of the treated area (to be measured at the end of a day)
- Clearance depth (20 samples a day for 5 hours of effective work of the demining machines)
- Description of the land and vegetation
- Activating, breaking, or damaging of mines by the demining machine and the impact on the machine
- Machine breakdowns
- Standstills and reasons for standstills
- Consumption of fuel, oil, spare parts, etc.

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C.7.2 Test areas depending on machine classification

C.7.2.1 Light demining machines

- a) Area of 30,000 m² (3 ha)
- b) Class I–III soil and class IV where applicable, flat with gentle longitudinal and transversal slopes, vegetation low to medium height
- c) Presence of APM

C.7.2.2 Medium-size demining machines

- a) Area of 50,000 m² (5 ha)
 - b) Class I–III soil, flat with longitudinal and transversal slopes up to 15°, vegetation low and medium height
- Presence of APM and ATM. Limiting the test to APM may be specified by the manufacturer in pre-test (pre-trial) condition.

C.7.2.3 Heavy demining machines

- a) Area of 80,000 m² (8 ha)
- b) Class I–III soil, flat with slight longitudinal and transversal slopes, vegetation height low, medium, and high
- c) Presence of APM and ATM

C.7.2.4 Excavators

- a) Area of 30,000 m² (3 ha)
- b) Slopes of channels, rivers, ditches, and dams with vegetation of low, medium, and high height
- c) Presence of APM (without ATM)
- d) The machine is moving sideways on the surveyed and safe land, and the arm of the excavator and working tool treats the slope of the channel, river, dam, and ditch
- e) Testing of excavators is performed according to the same principle as the testing of light machines having flails as a tool. When excavator has a vegetation cutter as a tool, the testing procedure is the same except there are no mines involved in the test

NOTE In this case we are referring to all machines that operate from safe ground (i.e. non-intrusive demining machines).

C.7.3 Completion

When the machine has “cleared” the test area the result shall be evaluated through manual mine clearing methods (prodding, metal detectors, dogs etc.) to determine the clearance level and state.

C.8 Testing of the ground penetration depth

The lessons learned document *The effect of soil condition on measurements of ground penetration depth and machine performance* (3) describes methods for measuring the ground penetration depth of machines such as flails or tillers. This is important for the standardized conditions of the Performance Tests, but is

perhaps even more important for the real-world conditions of the Acceptance Test. Indeed, even after the Acceptance Test is complete, it may be important to re-evaluate the ground penetration depth achieved by a machine when the machine is moved from one demining location to another if the soil conditions are very different. It is recommended that measurement of ground penetration depth be included as part of any Acceptance Test using the lessons learned document *The effect of soil condition on measurements of ground penetration depth and machine performance* (3) as a guide to how these measurements should be taken.

Annex D

Definitions for use with test targets

D.1 Introduction

Machine testing involves a number of different tests as outlined in Annex A, B and C, each of which requires standardised targets to ensure that test results are comparable, repeatable and credible. A variety of targets are required for different tests, it has been recognised that machines are required to undertake a range of operational functions and that all machines uses and mine threats cannot be catered for. The aim of this annex is to provide criteria and characteristics for testing agencies to develop standards for test targets.

Targets must meet the criteria and limitations of the testing agencies. There is a need to develop targets that are both explosive and non-explosive meeting both information and safety requirements.

D.2 Test Types

This CWA covers targets to meet the needs of the following tests:

- Performance Test (Annex A)
- Survivability Tests (Annex B)
- Acceptance Tests (Annex C)

D.3 Target Requirements

Targets used in machine testing are used to show the effect on the targets resulting from the mechanical actions. Machine test targets need to provide the basic characteristics associated with mines. Such as:

- Shape
- Size
- Weight
- Function
- Explosive forces

D.4 Target Type Descriptions

This CWA is based on existing target definitions found in *Target Standardization For Demining Testing*, 20/12/1999 (7) which breaks the range of targets into three main groups that are further divided into a number of sub-categories.

For the purposes of the different tests, any of the targets described are acceptable providing they meet the shape, size, weight, function, and explosive force effects defined.

D.5 Targets For Performance Tests (Annex A)

D.5.1 Target Specifications

D.5.1.1 Target Type

— Simulated Mine – simulate generic categories of mines and do not aim to replicate specific mines. May or may not contain explosive or live fuze.

— Surrogate Mine – represents a specific mine type.

— Live Mine Targets – production mines fully functional or active fuzes. Note that such targets may damage the machine and compromise the ability to conduct the test. As such, real mines may not be a practical target for the performance tests, but are, nevertheless, permitted.

D.5.1.2 Measuring Results

Mechanical systems impart violence or energies on the target that can make determining the results difficult.

For the results to be of value, target condition must be detailed and understandable. Any target mine selected must be able to provide this information after the machine has processed the test area. The target must be able to indicate the level of effect based on the following four descriptors:

— Triggered (detonated).

— Mechanically Neutralised (untriggered, damaged, non-functional).

— Live Damaged (untriggered, damaged, still functional).

— Live (untriggered, undamaged).

D.5.1.3 Definitions

— Untriggered means that the firing chain has not been completed.

— Non-functional means that the firing chain cannot be completed, the mechanism is removed from the detonator, or the detonator cannot be initiated.

— Still functional means that the firing chain can still be completed, this can include a detonator only.

D.5.1.4 AP Mine Target Specification

— Fuze description – The AP mine target should be pressure activated and should have a pressure plate area between 20 mm and 25 mm diameter. The fuze may or may not extend above the mine body as necessary, but the height of the external fuze section should be minimized to no more than 20 mm.

— Activation force – The AP mine target should trigger when subjected to a load between 10 kg and 15 kg. That is, a load under 10 kg should not trigger the target, and it should not take more than 15 kg to trigger the target.

— Dimensions – The AP mine target should be cylindrical in shape with an outer diameter not less than 50 mm and not greater than 75 mm. The height should be not less than 30 mm and not greater than 40 mm.

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— Materials – To allow the damage levels to be evaluated in accordance with the above descriptors and for these damage levels to be comparable between different trials, it is necessary to ensure that the mechanical characteristics of the AP mine targets are similar from test to test. The AP mine target casing should be made of ABS, PVC, nylon, Delrin, HDPE, or other plastic material having similar hardness and mechanical strength characteristics. Casing thickness should be 2 mm and 4 mm. All casing components must be securely screwed, glued, welded or otherwise fastened together.

D.5.2 Reporting Requirements

The test results should give clear and concise records of the condition of the targets. The definitions avoid referring to hazardous and non-hazardous; this decision is beyond the scope of the test. In order to assess the results, the firing mechanism must be detailed and must include a diagrammatic view showing the method of operation, complete with supporting photographs.

D.6 Targets For Survivability Tests (Annex B)

D.6.1 Target Specifications

D.6.1.1 Target Type

— Simulated Mine – simulate generic categories of mines and do not aim to replicate specific mines. Must contain explosive.

— Surrogate Mine – represents a specific mine type. Must contain explosive.

— Live Mine Targets – production mines.

Survivability tests aim to subject the machine to explosive forces and focus on two distinct areas as detailed below. As such, targets used for survivability testing do contain explosives and are command detonated or engaged by the machine until detonation.

Target specifications provide the basic criteria for establishing controlled blast tests. The targets can be manufactured or use appropriate live mine targets. The standards recognise the limitations faced by various agencies in obtaining live mines and certain explosive types.

D.6.1.2 AP mine target specifications

— Explosive fill – 240 g +/- 10 g TNT or equivalent based on brisance (6850 m/s)

— Explosive fill dimensions – 76 mm (3") nominal diameter; height to be approximately 32 mm (1.25") tall to allow 240 g TNT at 1.65g/cc density.

— Casing – the explosive fill must be fully enclosed in a plastic casing. Standard ABS or PVC plumbing pipe and fittings are acceptable as casing materials. All casing components must be securely screwed, glued, welded or otherwise fastened together.

— Initiation – the charge may be initiated remotely at the top, bottom or side as desired.

D.6.1.3 AT mine target specifications

— Explosive fill – 8 kg +/- 100 g TNT or equivalent based on brisance (6850 m/s)

— Explosive fill dimensions – 250 mm (9.84") nominal diameter; height to be approximately 100 mm (3.9") tall to allow 8000 g TNT at 1.65g/cc density.

— Casing – the explosive fill must be fully enclosed in a pressed steel casing measuring 1 mm +/- 0,3mm thick. All casing components must be securely welded or otherwise fastened together.

— Initiation – the charge may be initiated remotely at the top, bottom or side as desired.

D.7 Targets for Acceptance Tests (Annex C)

D.7.1 Target Specifications

D.7.1.1 Target Type

- Simulated Mine – simulate generic categories of mines and do not aim to replicate specific mines.
- Surrogate Mine – represents a specific mine type.
- Live Mine Targets – production mines

Reference list

1. Geneva International Centre for Humanitarian Demining (GICHD), *Mechanical Demining Handbook* (<http://www.gichd.org/en/operational-assistance-research/clearance-technology/mechanical-clearance/mechanical-demining-handbook/>)
2. *International Mine Action Standards on Mechanical Demining* (IMAS) 9.50 (http://www.mineactionstandards.org/IMAS_archive/MRE/IMAS%2009.50%20Mechanical%20demining%20Edition%201_.pdf)
3. International Test and Evaluation Program for Humanitarian Demining (ITEP), Working Group on Test and Evaluation of Mechanical Assisted Clearance Equipment (ITEP WGMAE), *The effect of soil condition on measurements of ground penetration depth and machine performance* (http://www.itep.ws/pdf/LL_CWA15044PartOne.pdf)
4. International Test and Evaluation Program for Humanitarian Demining (ITEP), Working Group on Test and Evaluation of Mechanical Assisted Clearance Equipment (ITEP WGMAE), *The interpretation of ground penetration depth measurements* (http://www.itep.ws/pdf/LL_CWA15044PartTwo.pdf)
5. International Test and Evaluation Program for Humanitarian Demining (ITEP), Working Group on Test and Evaluation of Mechanical Assisted Clearance Equipment (ITEP WGMAE), *Measuring the soil compactness and soil moisture content in areas for testing of mechanical demining equipment* (http://www.itep.ws/pdf/LL_CWA15044PartThree.pdf)
6. International Test and Evaluation Program for Humanitarian Demining (ITEP), Working Group on Test and Evaluation of Mechanical Assisted Clearance Equipment (ITEP WGMAE), *Statistical methods used to calculate demining machine performance and performance confidence intervals* (http://www.itep.ws/pdf/LL_CWA15044PartFour.pdf)
7. *International Test Operations Procedures (ITOP), Target Standardization For Demining Testing*, 20/12/1999 (<http://www.itep.ws/standards/pdf/TSFDTnon4.2.521.pdf>)
8. Swedish Defence Material Administration, *VoVC 14 910:1142/03 Mine Clearance Vehicles—Crew Safety Standard* (<http://www.itep.ws/standards/pdf/ReportCrewSafety.pdf>)
9. *NATO Research and Technology Organisation, HFM-090 Task Group-25, Test Methodology for Protection of Vehicle Occupants against Anti-Vehicular Landmine Effects* (<http://www.rta.nato.int/pubs/rdp.asp?RDP=RTO-TR-HFM-090>)