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Testing the Effectiveness and Survivability of the Mini MineWolf

Thomas Sponfeldner
MineWolf Systems AG

Testing the Effectiveness and Survivability of the Mini MineWolf

The following test results illustrate the Mini MineWolf's viability in the field. First, Mini MineWolf's ability to neutralize simulated anti-personnel mines was tested in three different soil types and at varying depths. The machine was then subjected to live anti-tank blasts by the German Army and the Canadian Centre for Mine Action Technologies.

by Lieutenant-Colonel Thomas Sponfeldner (Ret.) [MineWolf Systems AG]

Mechanical demining machines are becoming increasingly accepted as useful tools for improving the speed, safety and efficiency of humanitarian-demining operations, as well as for lowering overall costs per square meter cleared. As adoption of machines increases, two crucial issues emerge:

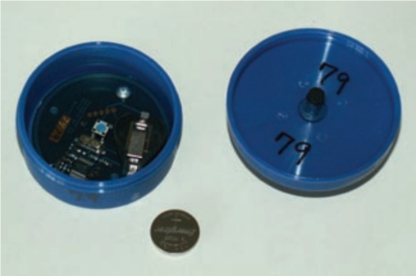
1. To prove their cost-effectiveness, mechanical demining machines must be able to neutralize the vast majority of anti-personnel mines encountered in a variety of soil conditions and depths down to 20cm, significantly reducing the task and risk of manual deminers.
2. To be a practical option in remote regions, demining machines must be able to survive heavy anti-tank mine blasts and still be functional or at least repairable in the field.

To put these criteria to the test, MineWolf Systems enlisted the help of the German Army's Centre for Weapons and Ammunition in Meppen, Germany, along with the Canadian Centre for Mine Action Technologies.

During a four-week trial in August and September 2007, the effectiveness of the Mini MineWolf (8.1 metric tons) was tested against simulated AP mines. The flail and tiller attachments were both tested. Survivability of the machine against live AT mines with explosive yield up to 13.5kg of TNT was also demonstrated to prove the viability and reparability of the machine in high-risk environments.

To simulate AP mines, wirelessly operated reproduction mines were used. Designed by CCMAT, WORM mines simulate the physical properties of typical AP mines, and are equipped with sensors and radio-frequency transmitters to detect and report damage inflicted by

A detonation sequence of the Mini MineWolf activating an anti-tank mine during the German Army tests (above and opposite).
ALL PHOTOS COURTESY OF MINEWOLF SYSTEMS



A disassembled WORM mine.

the machine via a wireless link to a remote, personal computer.[1]

The trial, held at the Germany Army weapons testing site in Meppen, followed formal guidelines set down by the European Committee for Standardization for the testing and evaluation of demining machines.[2]

The CEN Workshop Agreement 15044 was initiated in June 2003 and is the result of a Swedish Explosive Ordnance Disposal and Demining Center initiative, with participation from the Croatian Mine Action Centre and the Geneva International Centre for Humanitarian Demining, which culminated in the European Commission funding a workshop to develop an agreement for the testing of mechanical demining machines.

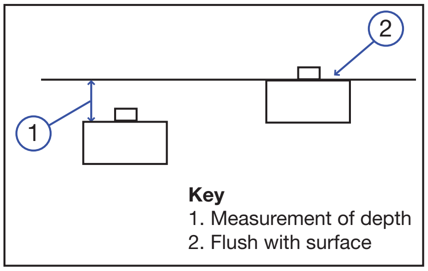
A main reason for establishing the testing guidelines for mechanical demining machines was that "a lot of [the] test and evaluation work … performed in the demining world today, in many instances … is not what most of the demining community or developers need. To improve this situation it was necessary to provide an agreement whereby each piece of equipment would be tested under the same conditions, using criteria that can withstand technical scrutiny."[2]

The German Army clearance test of the Mini MineWolf followed the workshop guidelines: to test, under controlled and reproducible 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 was performed in three different ground configurations at three depths from flush with the surface to the maximum penetration depth of 20 cm. All test conditions are dictated by CEN agreement specifications.

Test Conditions

Three lanes were prepared, each with a homogenous soil type (gravel, sand and topsoil). The soil in the lanes was separated from the surrounding soil. The lanes had such width and depth that the machine and its tool did not interfere with the soil outside the lane.

The three soil types specified by the CEN Workshop agreement and implemented by the German Army during the tests were:



Measurements of mines at different soil depths.
FIGURE COURTESY OF THE AUTHOR / MAIC

1. Gravel with particle size from 0.075mm to 45mm, of which 10 percent is less than 0.4mm, and then a size distribution up to 45mm normally specified as 0–32mm
2. Sand (e.g., with particle size from 0.075mm to 20mm, with 85 percent less than 0.6mm)
3. Topsoil that may have different contents of organic material. Locally available topsoil is accepted but the particle size must be from 0.001mm up to 31mm

Before every run the soil was "cultivated, or otherwise loosened up, and then compacted to its original state again."[1] The level of compactness was measured and recorded using 10 points randomly distributed along the lane. The measurement was done with a densiometer and at the expected clearance

depth. The soil density conditions according to the CEN agreement were as follows:

- Gravel: 94-percent average of the measurement ±2 percent (e.g., 94 percent of the maximum theoretical dry density)
- Sand: 90-percent average of the measurement ±2 percent
- Topsoil: 85-percent average of the measurement ±2 percent

Target Deployment

The "mines," in this case the simulated AP, or WORM mines, were laid at three depths: flush with surface, at 10cm and at a maximum depth of 20cm. The target mines were laid without pattern along the lane within the following constraints: mines should not be within 0.5m of each other and should be distributed to cover 50 percent of the width of the working tool. The targets were placed with minimum disturbance to the surrounding ground. A total of 900 WORM mines were laid, 50 for each unique test condition.

Test	Date	Detonation	Mine	Tool used
1	10 Sep 07	no	DM 21	Flail
2	10 Sep 07	yes	DM 21	Flail
3	10 Sep 07	yes	DM 21	Tiller
4	11 Sep 07	yes	PT-MI-BA III	Flail
5	11 Sep 07	no	DM 11	Flail
6	12 Sep 07	yes	DM 11 and TM-57	Flail
7	12 Sep 07	yes	TM-57	Tiiller
8	13 Sep 07	no	DM 11	Tiller
9	13 Sep 07	yes	TM-62 P3	Flail
10	19 Sep 07	yes	TM-57	Flail
11	19 Sep 07	yes	PT-MI-BA III	Tiller
12	19 Sep 07	yes	TMA-4	Tiller
13	20 Sep 07	yes	TM-62 P3	Tiller
14	20 Sep 07	yes	TMA-4	Flail
15	20 Sep 07	yes	TM-62 M	Flail
16	26 Sep 07	yes	TM-57	Tiller
17	26 Sep 07	yes	TM-62 P3 and PT-MI-BA III	Flail
18	26 Sep 07	yes	DM 21 and TMA-4	Tiller

Mini MineWolf anti-tank mine trials: tests conducted.

Results of WORM Trials

The purpose of the trial was to determine the capability of the Mini MineWolf to neutralize AP mines at three different depths in three different types of soil: gravel, sand and topsoil, based on a statistically meaningful sample—in this case 900 WORM mines in 18 different test conditions. The results of the trial showed that the Mini MineWolf was successful against the simulated AP mines with both flail and tiller attachments. The actual results with both attachments are listed in the tables below.

Mini MineWolf during the German Army tests (gravel, 20cm).

According to the official results published by the German Army, "The total Mini MineWolf clearance rate resulting from the performance tests was approximately 99 percent. At a clearance width of 1,860 mm, the Mini MineWolf worked at an operating speed between 781 sq m/hr and 1,595 sq m/hr."[3]

Survivability Testing

The ability of the demining machine to effectively neutralize AP mines is only useful if the machine can also withstand heavy anti-tank mine blasts with minimum damage or at least damage easily repairable in the field. In many minefield environments, both AP and AT mine threats are simultaneously present.

The final test of the Mini MineWolf was therefore to demonstrate the survivability of the machine against heavy AT mine blasts with damage that could be repaired onsite. Here again, the test adhered to the CEN Workshop agreement describing "Survivability Test of Demining Machines," which states that "survivability is based on the materials used, design features and threat for which the machine has been designed. The test focuses on two distinct areas: Machine

	Depths		
	0cm	10cm	20cm
Sand	50/50	50/50	50/50
Gravel	50/50	49/50	50/50
Topsoil	50/50	50/50	49/50

Mini MineWolf: German Army tests with flail attachment—WORM mines neutralized.

	Depths		
	0cm	10cm	20cm
Sand	47/50	48/50	49/50
Gravel	50/50	49/50	50/50
Topsoil	50/50	49/50	49/50

Mini MineWolf: German Army tests with tiller attachment—WORM mines neutralized.

Date	AT Mine	Explosive Weight	Explosive Type	Impact		Time to Repair	Operational Without Repair
				Destroyed	Detonated		
10.09.2007	DM 21	5.0 kg	TNT		X	7.0 hr	No
12.09.2007	TM 57	6.5 kg	TNT		X	1.0 hr	Yes
13.09.2007	DM 11	7.0 kg	TNT	X		0.0 hr	Yes
19.09.2007	TMA 4	5.5 kg	TNT		X	0.25 hr	Yes
19.09.2007	PT-Mi-Ba-III	7.2 kg	TNT		X	1.5 hr	Yes
20.09.2007	TM 62 P3	6.3 kg	TNT		X	0.5 hr	Yes

AT mine survivability results: Mini MineWolf tiller.

Date	AT Mine	Explosive Weight	Explosive Type	Impact		Time to Repair	Operational Without Repair
				Destroyed	Detonated		
10.09.2007	DM 21	5.0 kg	TNT		X	1.0 hr	Yes
11.09.2007	PT-Mi-Ba-III	7.2 kg	TNT		X	1.0 hr	Yes
11.09.2007	DM 11	7.0 kg	TNT	X		0.0 hr	Yes
12.09.2007	DM 11/TM 57 (stacked mines)	13.5 kg	TNT		X	1.0 hr	Yes
13.09.2007	TM 62 P3	6.3 kg	TNT		X	1.0 hr	Yes
19.09.2007	TM 57	6.5 kg	TNT		X	2.5 hr	Yes
20.09.20047	TMA 4	5.5 kg	TNT		X	0.0 hr	Yes
20.09.2007	TM 62 M	8.3 kg	RDX=12.5 kg TNT		X	1.0 hr	Yes

AT mine survivability results: Mini MineWolf flail.

survivability—the blast effect from mines on the machine—and operator survivability—the level of protection afforded to operators subjected to the effects of blast."[2]

In the case of the Mini MineWolf, which is remotely controlled, only the first criterion is relevant. During tests of the Mini MineWolf against live AT mines during 10–26 September 2007, the blast effects on the tool were evaluated under controlled conditions using live anti-tank mines TM-57, TM-62M, DM-11, DM-21, TMA-4, TM-62 P3, PT-MI-BA III.[4] Three tests including DM 21/TMA 4 and PT-Mi-Ba-III/TM 62 P3 mine stacks with an explosive yield of up to 13.5 kg were conducted. Both tiller and flail attachments were tested.

At the conclusion of the AT mine tests, survivability of the Mini MineWolf was established—after 14 detonations, no operational damage to the prime mover was inflicted.

Reparability of the working tools in the field was also established; "the repairs, mainly welding work, could be performed on site the same day," according to the official German Army report.[3]

At the conclusion of the trials, Colonel Radlmeier, Chief of the Development Division of the German Army Engineering School, reported that "the ability to provide safe clearance capabilities in areas contaminated with explosive remnants of war is becoming increasingly significant to the future tasks of the German Army's Corp of Engineers. … We need a reliable, quickly deployable mechanical mine-clearance tool. The Mini MineWolf is, based on real-world tests and its convincing results, a very interesting option to fill this gap."

A full report entitled "Mini MineWolf Test and Evaluation, August–September 2007; German Army (*Bundeswehr*) Technical Center for Weapons and Ammunition (WTD 91)" has been published by the German Army in both English and German and is available from the International Test and Evaluation Program for Humanitarian Demining.[3]

See Endnotes, page 114

Thomas Sponfeldner is Project Manager at MineWolf Systems. He holds a degree in engineering and has served 30 years in the German Army (Lt.-Col, Ret.). He has spent the past nine years at the Development Division of the German Army Engineering School, being responsible for demining equipment and training, as well as testing of mechanical demining systems.

Thomas Sponfeldner
Project Manager
MineWolf Systems AG
Seedammstrasse 3
8808 Pfäffikon SZ / Switzerland
Phone: +41 555 111 500
Fax: +41 555 1 11 599
E-mail: t.sponfeldner@minewolf.com
Web site: www.minewolf.com