	LANDMINE CLEARANCE TEST FACILITY	WTD 51

Koblenz: 23.01.2002

Summary Report

Planned object:	Mechanical Mine clearance device
Identification Nr.:	2350-14390
Manufacturer:	Fa. FFG
Model:	MINEBREAKER
Project Nr.:	E/K43A/10536/Q5204
Task:	Establishment of mine test lanes in two distinctly different types of soils and execution of clearance trials.

Report:		Pages	65	Pictures:	29	Tables:	35
Author:	TRAR Theimer	Dept.:	230	Phone:	19 73		

Main Outcome: The MINEBREAKER along the entire clearance surface maintained a nearly constant clearance depth of 30cm. An undestroyed AP-mine DM 11 was found during the search process in soil with uneven surface. In clayey soil an intact AT-mine TM 62P3 was found.

(Signature)

Comments: Translation into English: M. Garotta

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1. Task definition

The army requires a mine clearance device that is able to clear in a fast and safe way known minefields or areas suspected as mine-affected, in environments requested to be used as water treatment areas, airfields, and camps.

In the context of a trial the clearance efficiency (and safety) of COTS (commercial of the shelf) mine clearance devices from different types and manufacturers under equal conditions shall be compared.

In principle, the following works will be conducted:

- Definition of a test program for the assessment of the clearance efficiency
- Development of a plan for the placement of mines and the supply of surrogate mines.
- Execution of terrain survey
- Execution of a soil analysis
- Marking of the area for pre-trials and clearance trials
- Placement of surrogate mines according to the mine distribution plan
- Execution of the pre-trials and clearance trials in two distinctly different types of soil.
- Establishment of technical data
- Measurements of the vibration
- Transportability of the device
- Assessment of the results and evaluation of the destruction capacity of the mines
- Documentation of the results
- The definition of assessment criteria including the formulation of a proposal for the development and purchase of a device, which was discussed among the purchaser, the manufacturer, and WTD 51, will not be object of this report.

2. Test fields and time frame of the trial

2.1. Test fields:

Test field: WTD 51, Standortübungsplatz Schmidtenhöhe (StOÜbPl), Koblenz (Military Training Area)

Test field: WTD 91, Meppen (Hufeisenwall) (Military Technical Centre)

2.2. Time frame:

Preparation for the trial:	14. - 24. week 2001
Execution of the trial:	see Annex 1 (Work plan schedule status as of 12.06.2001)
Clearance results:	27. - 38. week 2001

3. Brief description of the MINEBREAKER 2000/2

(See Annex 15 pictures 1 to 6)

The mine clearance device MINEBREAKER consists of a Leopard 1 chassis, a hydraulically-powered rotating drum, mounted at the front of the vehicle, and an armored driver cabin. Due to its modular design, the tiller unit of Minebreaker can be fitted to other basic vehicles or carriers. The vehicle is powered by a 610 kW diesel engine of MTU Cie.

The tiller unit is composed of a tilling drum with steel teeth of Wolfram-Carbide.

The device has a clearance depth capacity of up to 50 cm, either detonating or destroying the mines mechanically.

Manufacturer: Fa. Flensburger Fahrzeugbau Gesellschaft mbH
Werftstraße 24
24905 Flensburg

4. Execution of the trials

4.1. Overview

Since commercially available mine clearance devices were being tested in order to compare their clearance efficiency, almost equal test conditions for all the devices had to be created.

The following requirements were satisfied:

- Nearly equal soil types
- Nearly equal terrain slopes
- Equal pre-trial test lanes and mine test fields

The trials were conducted in comparable weather conditions.

Since the trials had to be executed in two completely different soil types, they were conducted on soil with a very high sand content in the WTD 91 in Meppen and on soil with high clay content on the StOÜbPl in Koblenz.

The results of the detailed soil surveys, showing almost equal soil conditions, are attached as Annex 2.

On both soil types, pre-trials and clearance trials were conducted. The device was operated by staff from the manufacturer staff and was controlled from the armored driver cabin.

During the trial the following safety distances given by the manufacturer had to be kept.

Nr.	Mine clearance device	Side	Front	Back
1.	MINEBREAKER	10m	10m	10m

4.2. Pre-trials

During the pre-trials the mine clearance device covered a distance of 150m at WTD 91 and a distance of 125 m at StOÜbPl Schmidtenhöhe. The ground penetration depth that the system had to maintain was at least 30cm.

Next to the needed time, the clearance width and depth were determined. On the StOÜbPl Schmidtenhöhe in Koblenz also the vibration behavior of the driver cabin was determined.

The pre-trials were conducted in the same way on the WTD 91 and on the StOÜbPl Schmidtenhöhe in Koblenz.
The area of WTD 91 is almost plain with grass and moss-rose vegetation.

The grass area of the StOÜbPl Schmidtenhöhe shows limited changes in terrain topography along and across the test lanes. Annex 3 (diagram) shows a representation of the test field topography along the test lane

The crosswise slopes are:

Field 1	MINEBREAKER	0.6° to 3.4°

4.3. Clearance trials

4.3.1. Overview

At the clearance trials a test lane was given to the manufacturer. The test lane was composed of a starting track, the mine test field, and an ending track. The device was positioned at the beginning of the starting track and had to work all through the test lane. The clearance process was always conducted in one direction. As the test lane had been covered, the vehicle drove back in the same lane, placed itself in front of the next part of test lane, overlapping with the already cleared track and then cleared the next track.

The manufacturer chose an overlapping of about 50 cm.

The device had to achieve at least a clearance depth of 30 cm.
The prepared clearance lane at WTD 91 is provided in Annex 4, whereas the one at StOÜbPl Schmidtenhöhe in Annex 5.

The differences in the length of the test lanes is due to the fact that, on the paths of the StOÜbPl Schmidtenhöhe the starting area had to be shortened.

The topography along the test lane on the StOÜbPl Schmidtenhöhe is visible in Annex 6 and the crosswise slope in the context of the mine test fields amounts to:

Field 4	MINEBREAKER	1,2° to 2,3°

4.3.2. Mines

On the test field of WTD 91 the mines were distributed according to the distribution plan as in Annex 7, and on the StOÜbPl Schmidtenhöhe according to the mine distribution plan as in see Annex 8.

In the following table the mines distributed in the test field of WTD 91, in Meppen and in the one of StOÜbPl Schmidtenhöhe are listed.

Name	Type	Quantity		Comments
		WTD 91 Meppen	Schmidtenhöhe Koblenz	
Anti Personnel Blast Landmines	DM 11	20	0	
	DM 18	0	15	
	PPM-2	15	15	
Mine fuse	DM 56 A1 B1	5	3	With tripwire
Anti Personnel Fragmentation mines	DM 31	5	5	
Anti Tank blast mines	DM 21	5	5	
	TM 62P3	5	5	

See Annex 15 picture 14 and 15

For the clearance trials blast surrogate mines were used. In the weapons arsenal of WTD 91 the explosive content was taken out of the mines and to simulate real conditions it was replaced by non-explosive material (see Annex 16).

In order to understand if the mines' fuses were initiated by the clearance vehicles, the mines in the WTD test field were prepared as follows:

-	Anti-Tank blast mines (black powder)	DM 21	with blast indicating surrogate
		TM 62P3	with fuse chain
-	Anti-personnel blast mines	DM 11	with detonator
		PPM-2	with detonator
-	Anti-personnel fragmentation mines	DM 31	with propelling charge
-	Fuse for tripwires	DM 56 A1B1	with additional detonator

For the trials on the StOÜbPl Schmidtenhöhe test field, inert mines were used.

The tripwires used for the trials at StOÜbPl Schmidtenhöhe were connected to live fuses, which produced small amounts of smoke at initiation.

5. Results

5.1. Technical data

The most important technical information about the machine are listed here after:

Data on the machine:

	MINEBREAKER Fa. FFG
Measurements- working position **Length** **Width** **Height**	11.000 mm 4.510 mm 3.200 mm
Weight	50.000 kg
Transport **Length** **Width** **Height**	Equal to the measurements in the working position
Weight	50.000 kg
Velocity	4 km/h
Dismantling process for transportation	Dismantling of the clearance unit is possible (L about 8.000 mm; B about 3.280 mm; H about 3.000 mm)
Efficiency	610 kW
Engine	MTU
Protection devices	- Armoured vibration-proof cabin - Protection of air-consuming components - Ground clearance of 550 mm - Covering of all the hydraulic pipes - Clearance system linked through the vehicle's vibration-proof system

Technical clearance data

The technical clearance data of the mine clearance device are listed in Annex 9.

5.2. Pre-trials

5.2.1. WTD 91 Meppen

The vehicle took the following listed time to cover a distance of 150m:

MINEBREAKER 41 min

The clearance width corresponds to the data given by the manufacturer (see Annex 15 picture 16).

The clearance depth measurements were done in intermediate steps of 10m in the middle of the test lane. The results are given below:

Length [m]	**FFG Cie. Tiller system [cm]**
0	Starting point of the test lane
5	30
15	30
25	30
35	28,5
45	33
55	32
65	33
75	34
85	34
95	33
105	30
115	30
125	28
135	32,5
145	32
150	32
	End of test lane
Average	31,47

The device presented had no traction problems during the trials.

Observations made during the pre-trials:

The MINEBREAKER ran through the pre-trial lanes without problems.

5.2.2. StOÜbPl Schmidtenhöhe Koblenz

The Minebreaker took as the hereafter listed time to cover the distance of 125 m:

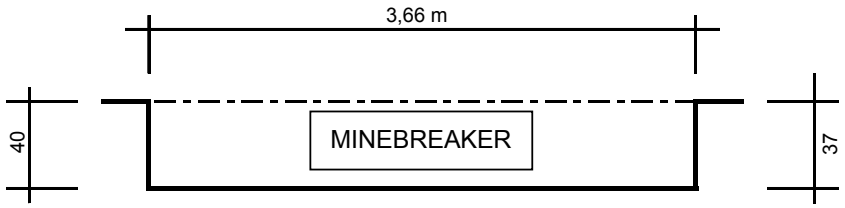
MINEBREAKER 45 min

The clearance depth measurements were done in intermediate steps of 10m in the middle of the test lane. The results are given below:

Length [m]	**FFG Cie. Tiller system [cm]**
0	Starting point of the test lane
5	32,5
25	36,5
45	39,5
65	45
85	40
105	30,5
125	29,5 (End of test lane)
Average	36,21

The clearance width corresponds to the data given by the manufacturer.

In the following sketch (not at scale) the tiller transversal section is represented:



Observations during the pre-trails:

The MINEBREAKER ran over the pre-trial test lane without problems.

5.2.3. Measurements of the vibration

The results of the vibration measurements inside the driver cabin are shown in Annex 10.

5.3. Clearance trials

5.3.1. Overview

The needed time frame, as well as the needed working conditions for clearance are attached as annexes 11 and 12 for the trials at WDT 91 and at StOÜbPl Schmidtenhöhe, Koblenz respectively.

Mine search:

Immediately after the end of each clearance trial all remaining on-surface mines and fragments were collected and separated according to the mine test fields.

The description of the mine collection process using a rock collector (see Annex 15 picture 26 to 28) and the evaluation of the remaining mines and components after the clearance trials done by WDT 91 – 360, are attached as Annex 16.

In order to assess the clearance depths, the mine fields in StOÜbPl Schmidtenhöhe in Koblenz were surveyed. The results for the MINEBREAKER are shown in Annex 13.

5.3.2. Observations made during the clearance trials:

5.3.2.1. WTD 91, Meppen

The MINEBREAKER ran at very slow speed over the entire distance of the lane without visible problems. Sideways ejection of the soil was not visible after the alignment of the side plates (see Annex 15 picture 17 and 18).

In order to reach the requested clearance depth the MINEBREAKER needed about 3,00 m start-up distance.

At the end of each test lane, the soil pushed in front of the tiller must, for safety purposes, be re-flailed to check that no intact mines have been carried with it.

After the clearance trials no damages were visible to the tiller and no steel teeth were missing.

The operating system: The operating system of the MINEBREAKER from the driver cabin constitutes no problems (see Annex 15 picture 20 and 21). The visibility from the driver cabin is sufficient and the right and left indications of the depth feelers (see Annex 15 picture 22) are well identifiable.
Reversing presents no problem for the vehicle, due to the fact that the rear part of the vehicle is exactly reproduced by the monitors inside the driver cabin.

5.3.2.2. StOÜbPl Schmidtenhöhe

The results of the clearance trials on the terrain of the WTD 91 in Meppen can also be used for the clearance trial on the StOÜbPl Schmidtenhöhe.
Sideward sliding of the vehicle on slight slopes, either along or across the lane, has not been observed.

5.4. Test lanes after the clearance process

Pictures showing the condition of the test lanes after the clearance trials are provided in Annex 15 picture 7 to 9.

5.5. Transportation

The transportation of the mine clearance devices between the worksites Koblenz and Meppen was done by a civilian transport company.

Due to the size and weight of the MINEBREAKER, its transport is only possible as a “special transport”. In order to reduce size and weight, the complete tiller unit can also be disassembled.

MINEBREAKER (see Annex 15 picture 23 to 25)

5.6. Preparation for clearance

After transport of the vehicle, it can be used without any preparation procedures.

6. Summary

It is necessary that the presented mine clearance device demonstrates its working capacity through the clearance of life AP -mines and AT-mines.

The mine clearance device MINEBREAKER could only partially fulfill the requested clearance tasks in soil with uneven surface as well as in clayey soil. All buried or surface-laid mines were initiated or broken up by the tiller unit with few exceptions only.

1 active AP-mine DM11 was found in soil with uneven surface during the search process.

1 active AT-mine TM62P3 was pulled out of the ground during a clearance trial in clayey soil, and rolled out of the test lane.

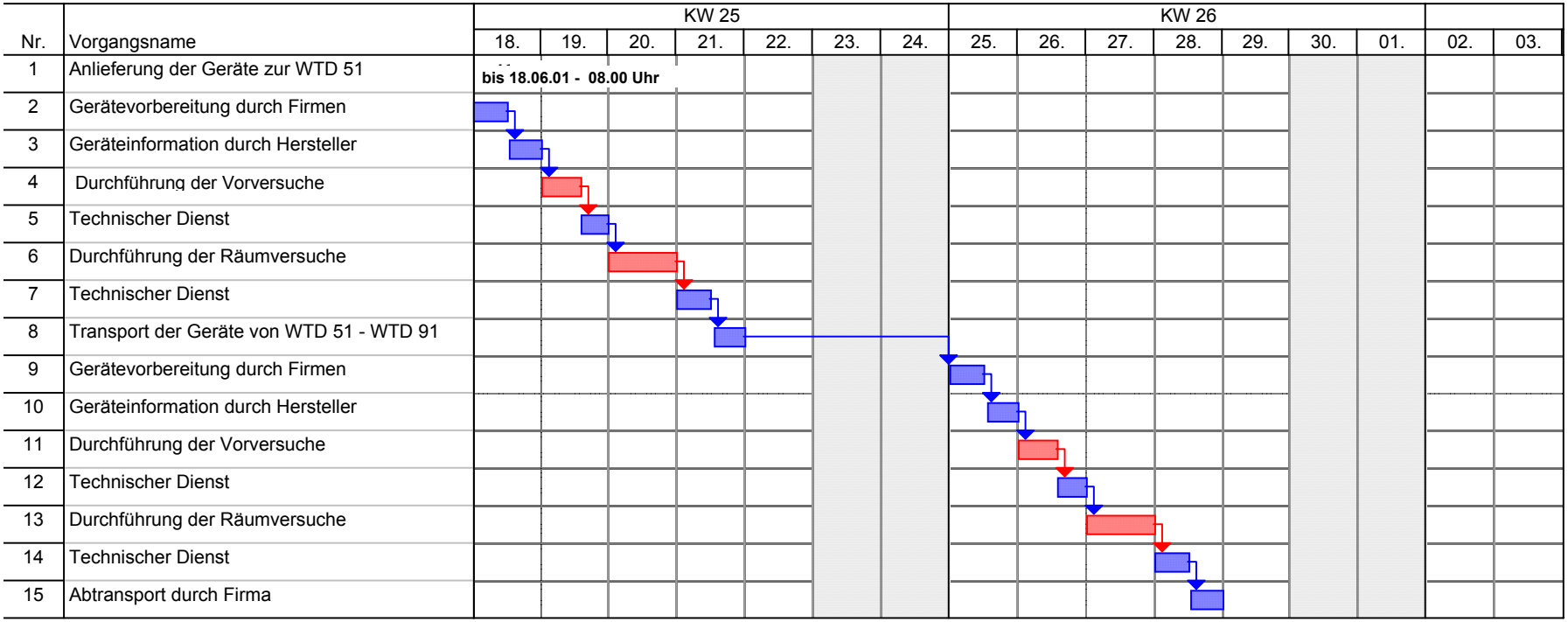
The amount of soil pushed by the tiller unit to the end of the test lane must be re-flailed, since undetonated mines could still be present. The operating system of the MINEBREAKER constitutes no problem and the visibility from the driver cabin is sufficient.

Annex 1

WTD 51 - 230

Koblenz, 12.06.2001

Erprobung von Minenräumgeräten Phase II
Terminablaufplan vom 18.06. bis 28.06.2001



	WEHRTECHNISCHE DIENSTSTELLE FÜR PIONIER- UND TRUPPENGERÄT - LABOR FÜR BODENMECHANIK -	**WTD 51**

Koblenz, den 20.08.2001

Laborbericht

Berichts-Nr. : 004/01

Vorhaben : Bodenuntersuchungen Versuchsphase II Minenräumfahrzeug

Auftrag : WTA - Nr.: E/K43A/10536/Q5204
WTD 51 - 230

Aufgabe : Untersuchung von 8 Testbahnen auf ihre Kornverteilung
(Siebung und Schlämmung) und bodenmechanischen Eigenschaften

Bearbeiter : TRHS Schlemmer **Org.-Einheit:** Dez 230

Telefon

Öffentliches Netz : (0261) 400-1999/1981

AllFspWN Bw : 4424-1999/1981

Berichtsumfang Seiten : 56

Im Auftrag

Schlemmer

Bemerkungen:

Verteiler:
WTD 51-230 2x

1 Description of the phase II working procedure

(Phase 1= comparison trials of the mine clearance devices – October 2000)

Assessment of soil characteristics of the test lanes on two mechanically different soil types (sandy soil in the test field of WTD 91, Meppen and clayey soil on the StOÜbPl Schmidtenhöhe, Koblenz).

Assessment of the test lanes on their grain size distribution and mechanical soil characteristics with as scope the selection of homogenous test lanes for the comparison of mine clearance devices.

Evaluation of the available moisture content during the execution of the trial.

Assessment of the effective possibility to compare the mechanical characteristics of the soil with the results of phase 1.

2 Execution of the trials

The trials were executed in the test field (WTD 91, Meppen and StOÜbPl Schmidtenhöhe, Koblenz) and in the laboratory of the WTD 51.

In the field the following trials were executed:

Survey according to DIN 4094,

Soil drilling according to DIN 4021,

Determination of the soil compactness according to DIN 18125 part 2

Laboratory tests:

Determination of the grain size distribution according to DIN 18123,

Determination of the flow and rolling borders according to DIN 18122,

Determination of the water content according to DIN 18121 part 1

3 Summary of the results

The analysed soil of the two test lanes (for the clearance trials) and of two test lanes at WTD 91 in Meppen (for the pre-trials) can be described as a homogenous sand having silt and clay content. The silt and clay contents are very little and therefore irrelevant. The soil compactness and the soil water content were almost on all test lanes identical.

The analysed soil of the two test lanes (for the clearance trials) of the StOÜbPl Schmidtenhöhe, Koblenz can be described as a homogenous soil having clay, sandy and gravelly characteristics. The soil compactness and its soil water content were almost on all two test lanes (for the clearance trials) the same. The soil of the two test lanes for the pre-trials was sandier and more gravelly, with from time to time stony clay.

Summarising, the results clearly show that the soil properties, grain size distribution as well as mechanical characteristics, on both test fields WTD 91 Meppen and StOÜbPl Schmidtenhöhe, Koblenz, were for all 4 devices identical, so that from the soil mechanics point of view, the devices were tested under the same operating conditions.

Assessment and comparison of the test lanes of phase I and phase II.

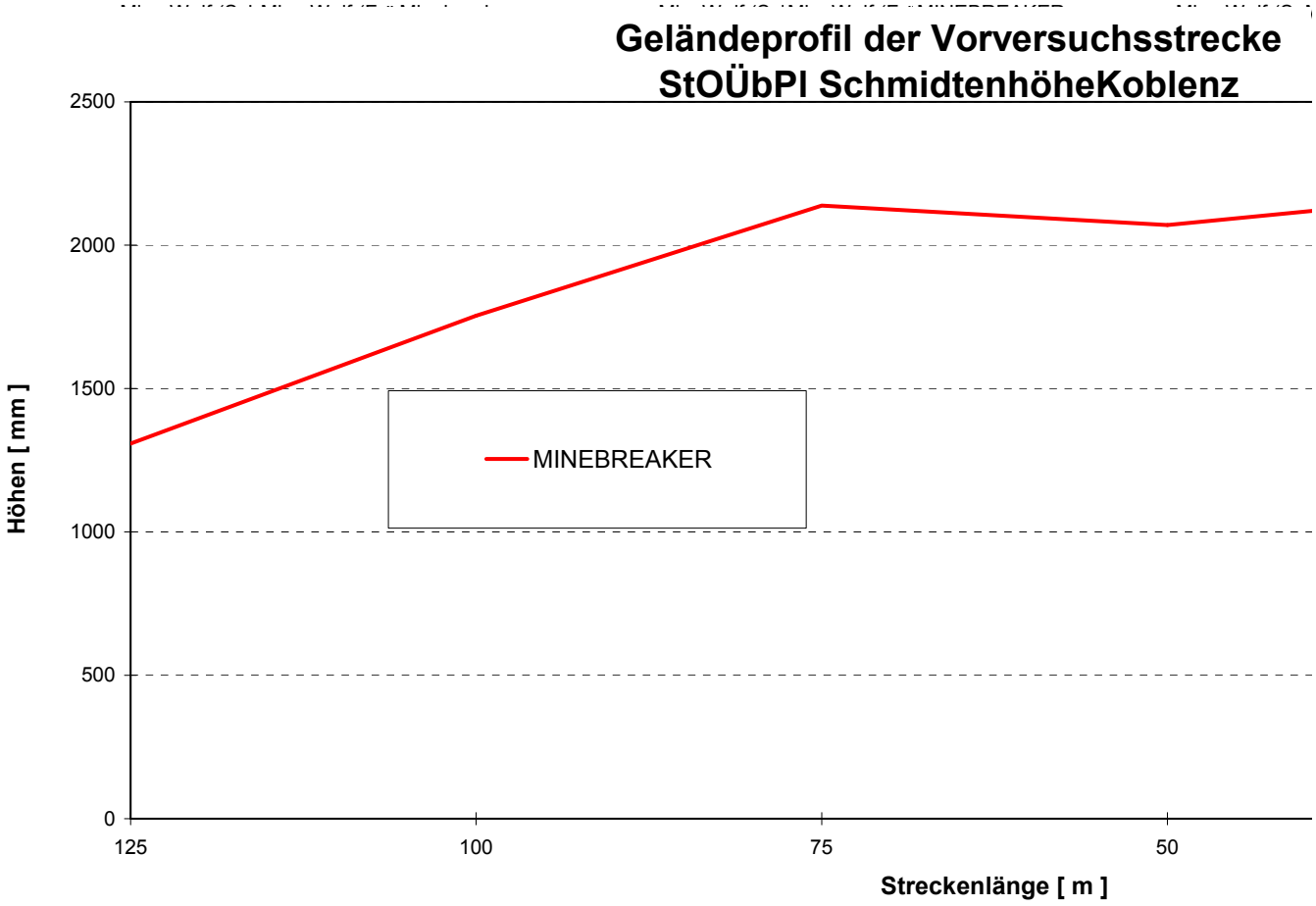
WTD 91, Meppen

The soil analysis and measurements of soil compactness of all test lanes produced similar results for the trial phases I and II. Only the soil moisture content was lower during phase II than during phase I.

StOÜbPl Schmidtenhöhe, Koblenz

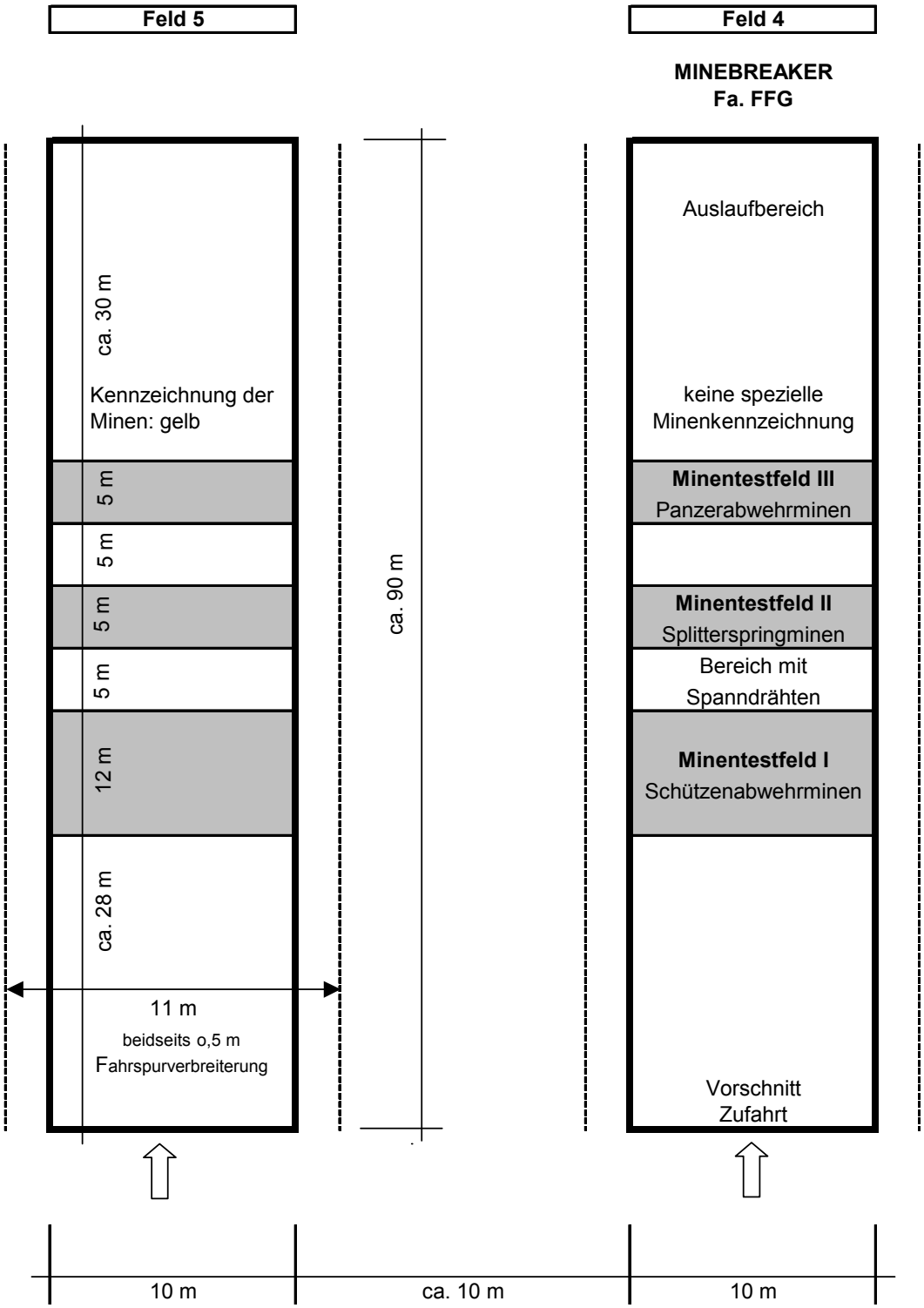
Also at this test site, the soil assessment, except for the soil moisture content, produced similar results for both trial phases.

Even after extensive watering of the test lanes, the soil moisture content available at trial phase I could not be reached, because the preceding dry period had caused the clayey soil to dry out to a depth of 70 cm.


Geländeprofil der Vorversuchsstrecke
StOÜbPl SchmidtenhöheKoblenz
2500
2000
1500
1000
500
0
Höhen [mm]
MINEBREAKER
125
100
75
50
Streckenlänge [m]

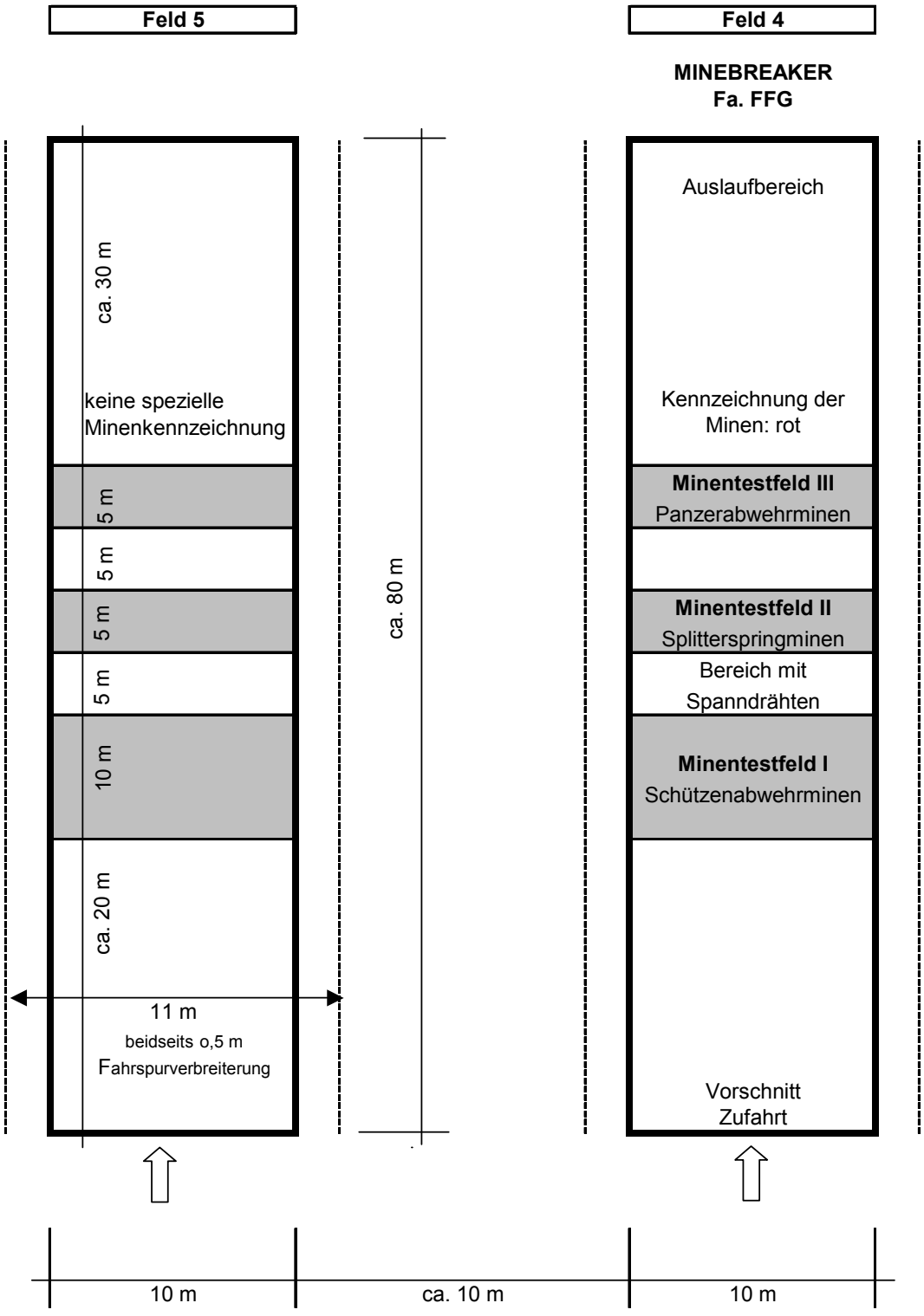
WTD 51-230 **Koblenz, 17.07.2001**

Teststrecke für Räumversuche
WTD 91, Meppen

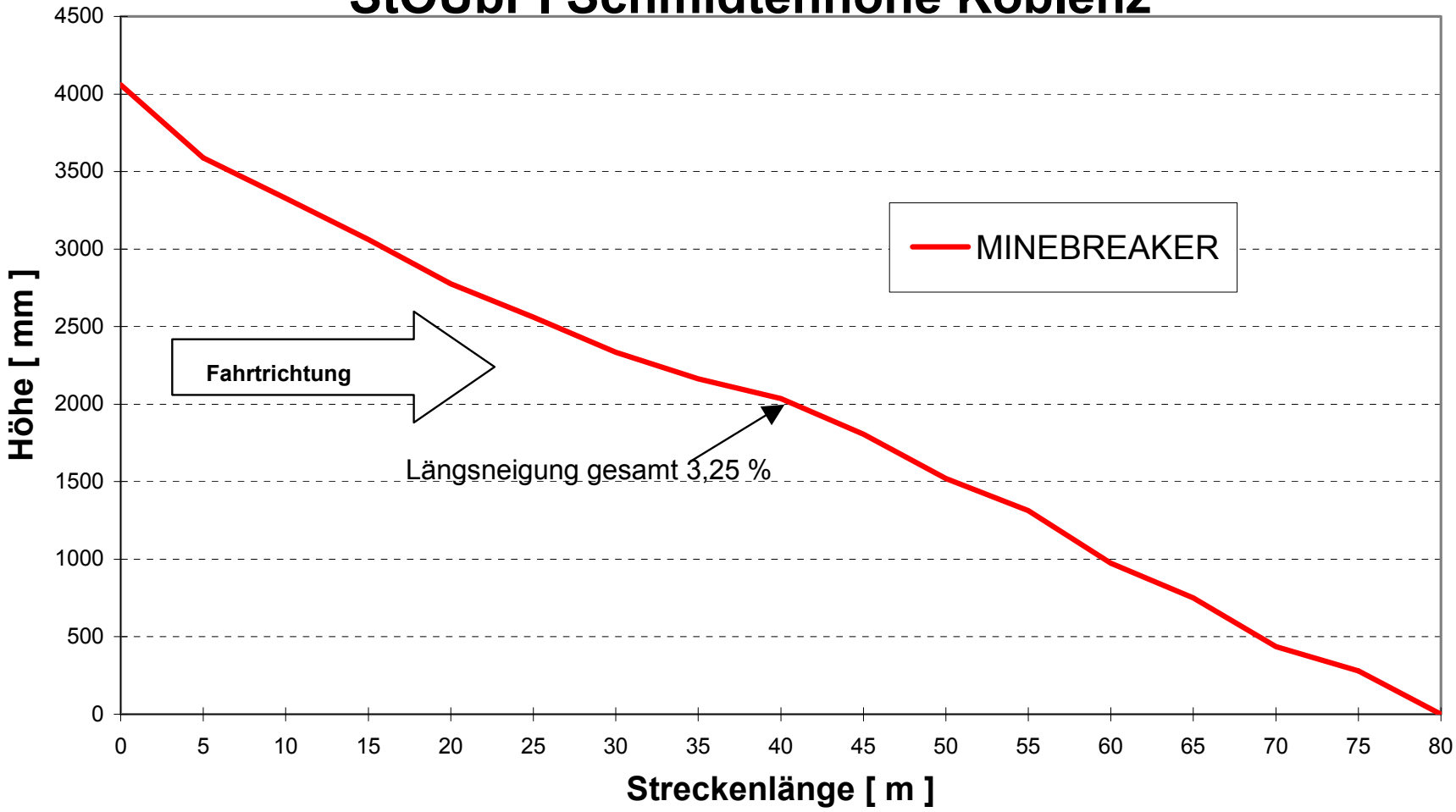


WTD 51-230 **Koblenz, 17.07.2001**

Teststrecke für Räumversuche
StOÜbPl Schmidtenhöhe, Koblenz



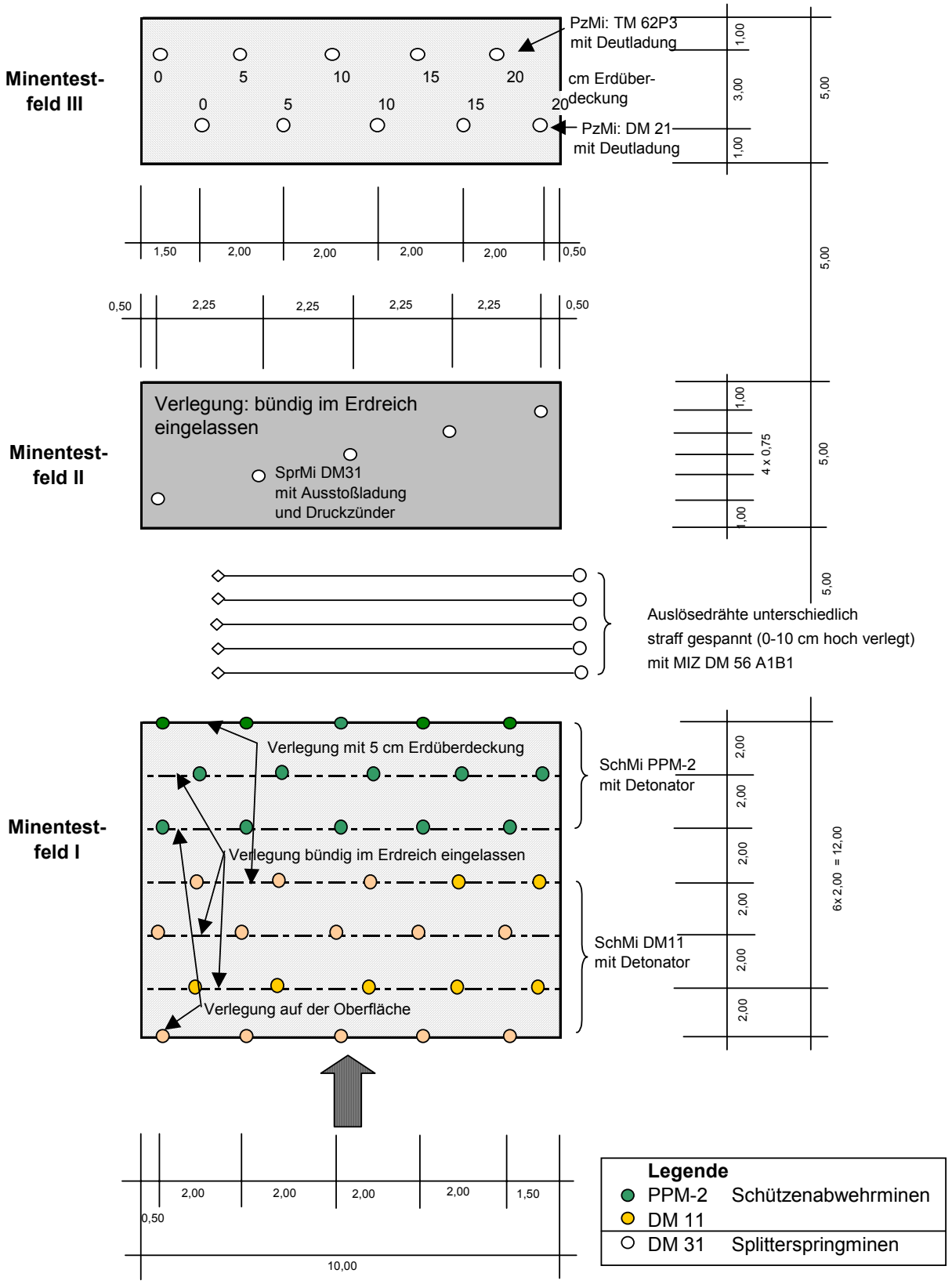
Geländeprofil der Räumversuchsstrecke StOÜbPl Schmidtenhöhe Koblenz



WTD 51-230 Koblenz, 18.07.2001

Minenverlegeplan

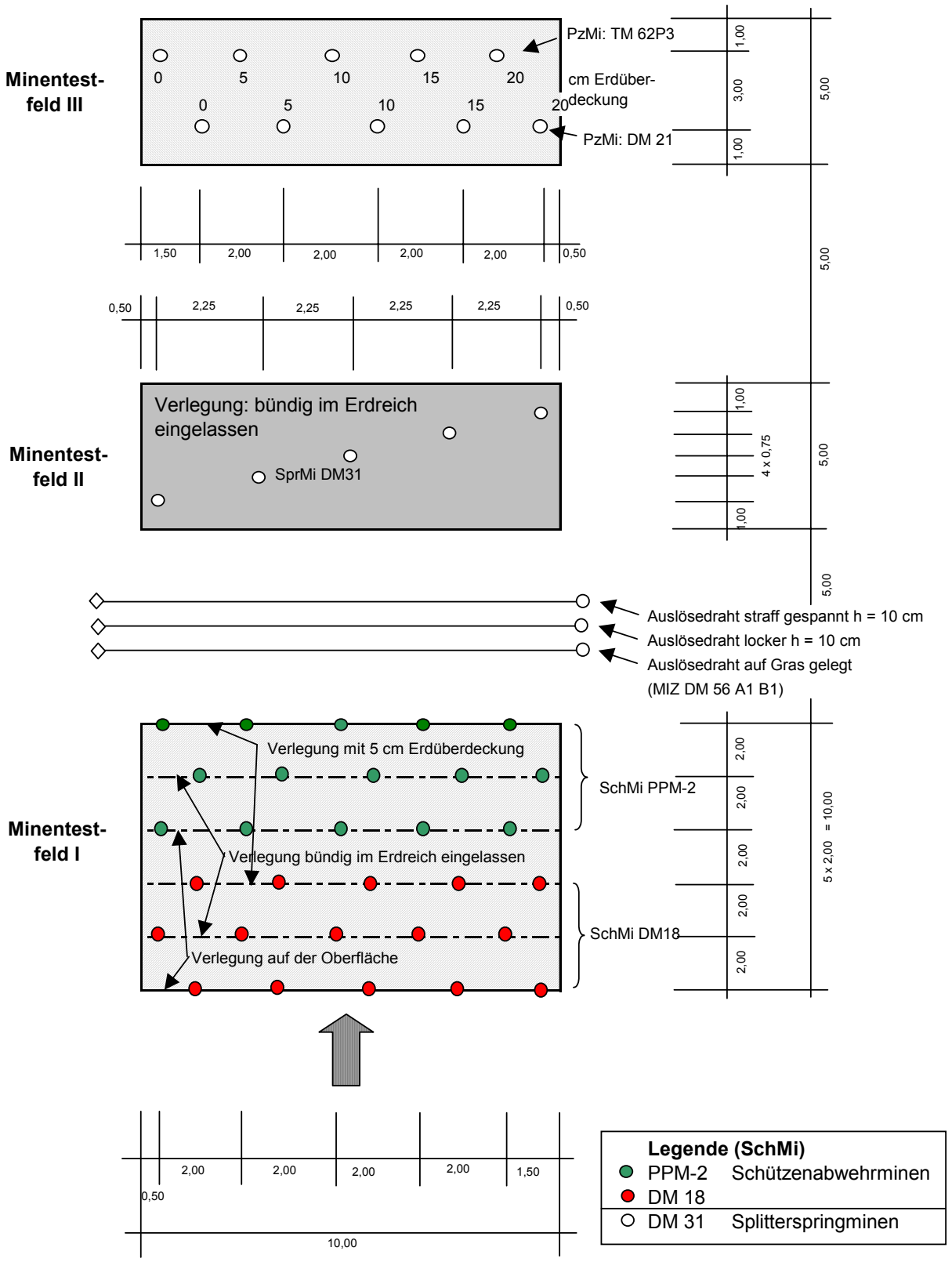
WTD 91, Meppen



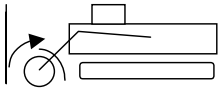
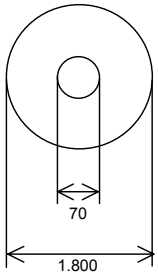
WTD 51-230 **Koblenz, 18.07.2001**

Minenverlegeplan

StOÜbPl Schmidtenhöhe, Koblenz



Technische Räumdaten

	MINEBREAKER Fa. FFG
Räumprinzip	Fräse
Bedienung	von Fahrerkabine Einbau einer Fernbedienung ist möglich
Drehrichtung (Räumrichtung)	
Walzendurchmesser	
U/min	0 bis 100
Anzahl Fräsköpfe/ Schlegel	66 Stück
Räumbreite	3,69 m
Räumtiefe	0 bis 50 cm
	MINEBREAKER Fa. FFG
Räumprinzip	Fräse
Räumgeschwindigkeit / Räumleistung	1 bis 20 m/min bis 20.000 m²/Tag je nach Bodenart und Bodenbeschaffenheit
dynamischer Spalt	0 cm
Minensprengkraft	AP und AT
Kraftstoffverbrauch während der	40 bis 100 l/h

Wehrtechnische Dienststelle
für Kraftfahrzeuge und Panzer

Anlage zum Untersuchungs-/ Erprobungsbericht

Trier, den 15.08.2001
App.: 2633

Dok.-Nr.:

Dezernat: !50

Verfasser: Philippi

Versuchs- und Messergebnisse

WTA - Nr.: E E510 10593 Q5204

TA - Nr.: 10593 / 001

Auftragstext: Durchführung von humanrelevanten Schwingungsuntersuchungen an zwei Minenräumgeräten.

Der Bericht besteht aus 4 Seiten.

Kurzreferat:
An zwei Minenräumgeräten sollte untersucht werden, ob die auftretenden Schwingungen am Fahrerplatz zur Einschränkung der Einsatzzeit führen oder eventuelle Gesundheitsschäden für die Fahrer zu erwarten sind.

Verfasser

Office		Date:	
WTD 41	Human relevant Vibrations analysis	15.08.2001	
Dept		Paper Nr.	Page total
150			3
Philippi	Test report		

1. Project-Nr.: **10593/001**

Avw: W. Philippi

2. Device to be tested: **Mine clearance device Minebreaker**

3. Prerequisite

3.1 Description of the test lanes.

The vibration analysis was conducted during the clearance process on the test field of Koblenz (Schmidtenhöhe).

3.2 Measured points

The acceleration process was acquired from the base of the driver seat and from the driver seat itself, each time from three directions.

3.3 Description of the measurements devices

DAT-Recorder Sony PC 208 (S-Nr. - 070000-066005)
Seat cover of the company B & K Type 4322 (S-Nr.: 030116-055001, 055002)
Accelerator receiver, B & K Type 4321 (S-Nr.: 030116-044001, 044002)
Calibrator, B & K Type 4291 (S-Nr.: 070000-050050)
Real time analyzer, B & K Type 2143 (S-Nr.: 070000-022011)

4. Method and Procedure

The analysis was conducted according to gem. AVTP 09-40 (procedure for the standard testing of mechanical equipment), to determine the vibration felt by the driver. The results of the measurements were evaluated according to ISO 2631-1 of 1987 in order to compare the present results with available measurements.

The assessment of the human relevant vibration load follows the assessment model of VDI 2057 in connection to the 2. Regulation for professional disease (bulletin 2110) of May 1993.

For the assessment only the data delivering the highest results was used, according to VDI 2057.

The test lanes to be cleared were divided into 10 sections and for each section 1 Keq-value was acquired.

Table 1 lists the acquired Keq-values with the relative allowed exposure times in minutes for the maintenance of proper health conditions (Tgmin). Since a particular attention was given to the transmission of the vibration to the driver seat, the so-called seat transmission factor SEAT was calculated, see Table 2.

5. Results

In the following tables the acquired Keq-values, of the accelerations, taking into consideration the relevant allowed exposure times for the maintenance of proper health conditions, together with the arithmetic average values, are represented.

Test lane: grassland	v in km/h	Driver seat Base			Driver seat Seat			TGmin
		KX	KY	KZ	KX	KY	KZ	
Section 1	about 0,5	2,6	2,0	2,7	3,0	4,0	2,2	> 8 h
Section 2	about 0,5	1,6	2,6	2,4	3,3	4,8	2,3	> 8 h
Section 3	about 0,5	1,8	1,6	3,0	2,6	5,4	2,6	> 8 h
Section 4	about 0,5	2,4	1,8	3,1	2,9	4,7	2,9	> 8 h
Section 5	about 0,5	1,9	1,2	3,3	2,3	4,8	2,8	> 8 h
Section 6	about 0,5	2,2	1,2	3,2	2,2	4,5	2,6	> 8 h
Section 7	about 0,5	2,5	1,3	3,1	2,5	4,0	2,7	> 8 h
Section 8	about 0,5	2,4	1,4	3,0	2,4	4,8	2,2	> 8 h
Section 9	about 0,5	2,1	1,2	3,0	2,6	4,4	2,6	> 8 h
Section 10	about 0,5	2,3	1,2	2,6	1,9	3,9	2,2	> 8 h

Table 1: Keq-values (Model Minebreaker)

Calculation of the transmission seat factors SEAT

$$\mathbf{SEAT} = \frac{a_{wis}}{a_{wip}} \qquad \mathbf{i = x, y, z}$$

a_{wis} = Acceleration from the seat

a_{wip} = Acceleration from the base

	During the clearance process		
Test lane: grassland	SEAT		
	KX	KY	KZ
Minebreaker	1,23	2,8	0,86

Table 2: Arithmetic average values of the transmission seat factors SEAT

5.1 Final assessment of the results

- For the mine clearance device the vibrations during the clearance process are acceptable.
- The daily time to be invested can amount to 8 hours and more, without expecting any health damages.
- By looking at the transmission seat values in Table 2, it can be determined that the seat in the mine clearance device reaches a sufficient vibration attenuation in the Z direction, whereas the partial increase in vibration in the X and Y direction is not critical, since the vibration load is low.
- Furthermore, it can be determined that the vibration level in the mine clearance device on the driver is so low, that no restrictions have to be taken into consideration in regard to the working time.

230 **Koblenz, 25.07.2001**

Räumzeiten/Randbedingungen bei WTD 91, Meppen

	MINEBREAKER Fa. FFG
Datum	27.06.01
Beginn Uhrzeit	13.41
Räumzeit für 1. Spur [min]	32
Gesamtzeit [min]	140
Anzahl der Fahrspuren	4
Räumstrecke Länge/Breite [m]	90/10
Wetter-bedingungen	sonnig zeitweise Regen
Temperatur [°C]	ca. 23 °C
Farbe der Minen	unlackiert

230 **Koblenz, 25.07.2001**

Räumzeiten/Randbedingungen auf StOÜbPl Schmidtenhöhe Koblenz

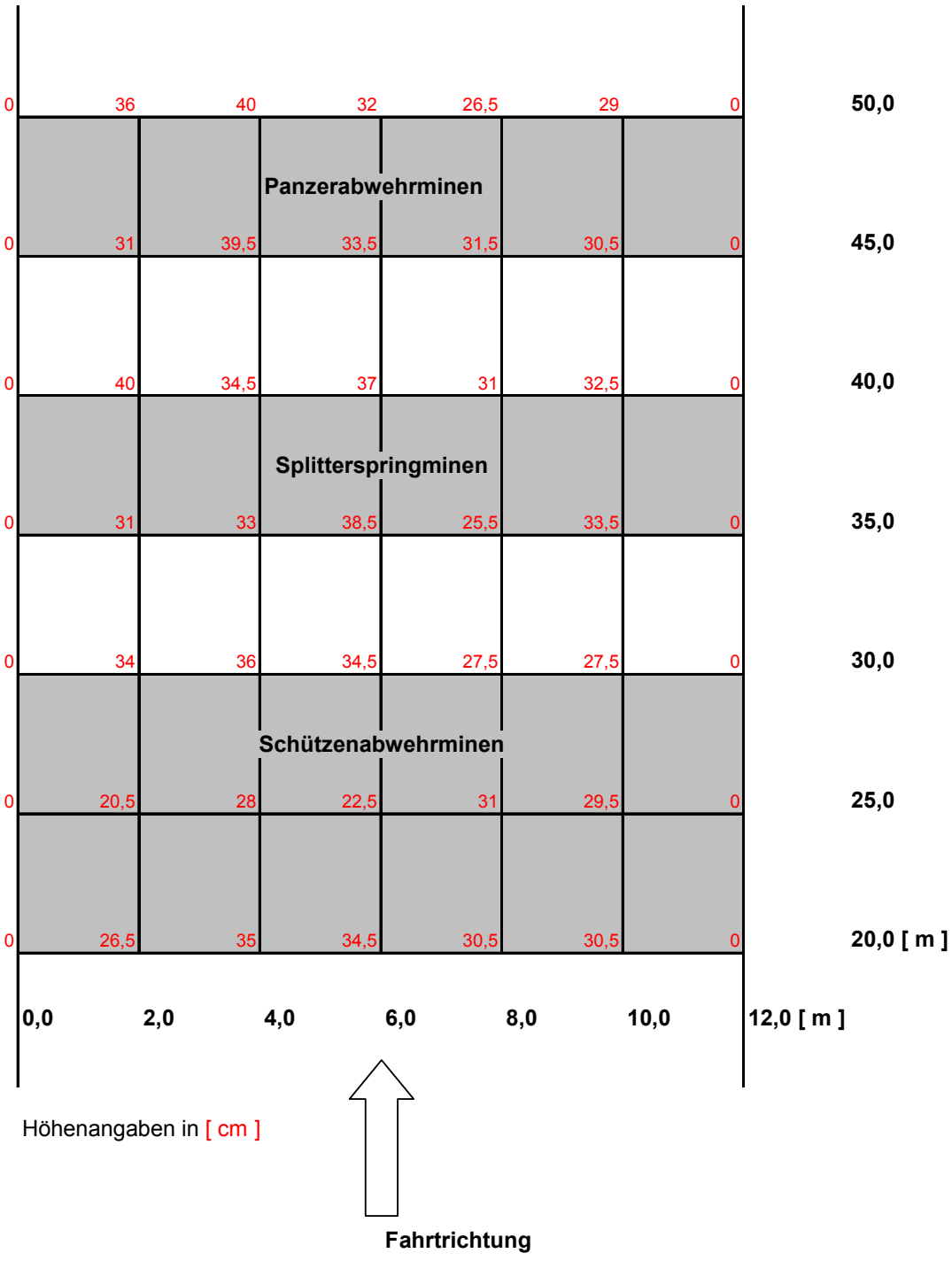
	MINEBREAKER Fa. FFG
Datum	20.06.01
Beginn Uhrzeit	10.00
Räumzeit für 1. Spur [min]	26
Gesamtzeit [min]	118
Anzahl der Fahrspuren	5
Räumstrecke Länge/Breite [m]	80/10
Wetter-bedingungen	sonnig
Temperatur [°C]	ca. 23 bis 25 °C
Farbe der Minen	rot

230 Koblenz, 19.07.2001

Gemessene Tiefen des Minentestfeldes

StOÜbPl Schmidtenhöhe, Koblenz

MINEBREAKER; Fa FFG



Not available

WTD 51	**Mine clearance device - Samples**	Koblenz, 21.08.2001
Dept. 230		Project Nr.: 10536
TRAR Theimer	Pictures	Page 1 of 10

Picture 1

MineBreaker
Overall view, front right

Picture 2

MineBreaker
Overall view, rear left

Picture 3

MineBreaker
Overall view, front

WTD 51	**Mine clearance device - Samples**	Koblenz, 21.08.2001
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TRAR Theimer	Pictures	Page 2 of 10

Picture 4

MineBreaker
During the clearance process

Picture 5

MineBreaker
During the clearance process

Picture 6

MineBreaker
During the clearance process

WTD 51	**Mine clearance device - Samples**	Koblenz, 21.08.2001
Dept. 230		Project Nr.: 10536
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Picture 7

MineBreaker
test lanes / moving track

Picture 8

MineBreaker
test lanes / moving track

Picture 9

MineBreaker
Test lanes / moving track

WTD 51	**Mine clearance device - Samples**	Koblenz, 21.08.2001
Dept. 230		Project Nr.: 10536
TRAR Theimer	Pictures	Page 4 of 10

Picture 10

MineBreaker
Tiller condition after the trials at the Schmidtenhöhe

Picture 11

MineBreaker
Tiller condition after the trials at the WTD 91

Picture 12

MineBreaker
Tiller coverage after the trials at the WTD 91

WTD 51	**Mine clearance device - Samples**	Koblenz, 21.08.2001
Dept. 230		Project Nr.: 10536
TRAR Theimer	Pictures	Page 5 of 10

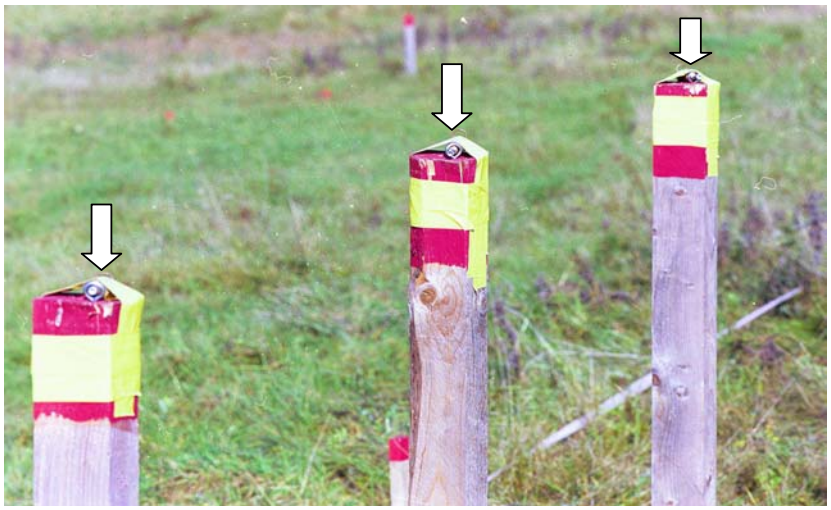
Picture 13

Schmidtenhöhe test field prior to the trials

Picture 14

Used mines

1	DM 31	Splitterspringmine
2	DM 21	Panzerabwehrmine
3	TM 62P3	Panzerabwehrmine
4	PPM-2	Schützenabwehrmine
5	DM 18	Schützenabwehrmine



Picture 15

Mine fuse
MIZ DM 56 A1B1

WTD 51	**Mine clearance device - Samples**	Koblenz, 21.08.2001
Dept. 230		Project Nr.: 10536
TRAR Theimer	Pictures	Page 6 of 10

Picture 16

MineBreaker
Tilled parts

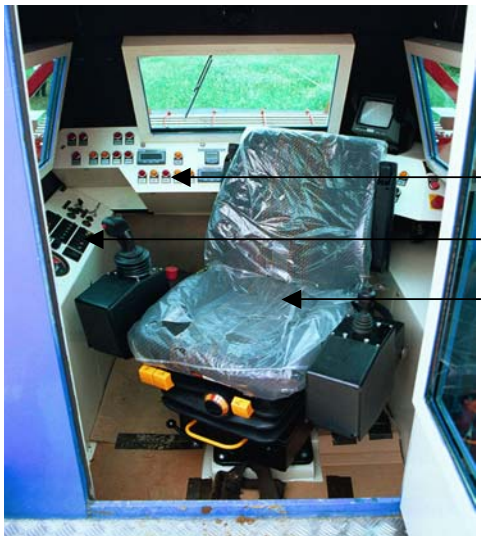
Picture 17

MineBreaker
Side plates

Picture 18

MineBreaker
Because of the side plates no soil was pushed sideways of the clearance track

WTD 51	**Mine clearance device - Samples**	Koblenz, 21.08.2001
Dept. 230		Project Nr.: 10536
TRAR Theimer	Pictures	Page 7 of 10



Picture 19

MineBreaker
protected driver cabin

Picture 20

MineBreaker
protected driver cabin

Picture 21

MineBreaker
view during the clearance process

WTD 51	**Mine clearance device - Samples**	Koblenz, 21.08.2001
Dept. 230		Project Nr.: 10536
TRAR Theimer	Pictures	Page 8 of 10

Picture 22

MineBreaker
View on the depth feeler system

Picture 23

MineBreaker
Transportation,
overall view

Picture 24

MineBreaker
Transportation
Rear attachment

WTD 51	**Mine clearance device - Samples**	Koblenz, 21.08.2001
Dept. 230		Project Nr.: 10536
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Picture 25

MineBreaker
Transportation
Front attachment

Picture 26

Rock collector, overall view

Picture 27

Search for mine fragments using the rock collector

WTD 51	**Mine clearance device - Samples**	Koblenz, 21.08.2001
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Picture 28

Search for mine fragments using the rock collector

Anhang 16

**WEHRTECHNISCHE DIENSTSTELLE
FÜR WAFFEN UND MUNITION**

WTD 91

49716 Meppen, 19.12.2001
Telekom: 05931-43-2360
Bw-Netz: 90-2422-2360
Fax: 05931-43-2091

Dezernat 360

Ausfertigung	Verteiler
1. - 8.	WTD 51 - 230
9. – 10.	WTD 91 - 360

Bericht Nr.: 23/01/91 - 360
WTA-Nr. : E/E510/10594/Q5204
TA-Nr. : 10594/001

Prüfgegenstand: Vergleichserprobung von Minenräumfräsen

Aufgabe: Vorbereitung und Bewertung der Räumergebnisse an Panzer- und Schützenminen

Ergebnis (Kurzfassung):

Die großen Panzerminen wurden in Meppen von dem Minenräumgerät zu 100% geräumt. Dabei wurden die meisten zur Zündung gebracht.
Die Schützenspringminen wurden über den Zugdraht nur zu 60% ausgelöst, mit dem Druckzünder wurden alle durch Abbrechen des Zünders unschädlich gemacht.
Bei den kleinen Schützenminen konnten nicht alle nachgewiesen werden. Eine Schützenmine DM11 wurde in gefährlichem Zustand in der Räumspur gefunden.
In Koblenz war der Boden viel schwerer. Der Nachweis der vermutlichen Räumerfolge war aber z.T. sogar noch besser. Allerdings rollte eine ungezündete Panzermine aus der Räumspur heraus.

Stichworte: Minenräumfräsen, Panzerminen, Schützenminen, Deutladungsminen, Räumerfolg

Dezernatsleiter

Königstein

Königstein, BDir

Result (summarised version):

In Meppen the large AT-mines were cleared by the mine clearance device in object. at 100% Most of them initiated during the clearance process.
The AP-fragmentation mines with tripwire were only initiated in 60% of the cases, whereas through the pressure fuse all of them were initiated.

The small AP-mines could not all be verified. One AP-mine was found in dangerous condition in the cleared lane.

In Koblenz the soil was a lot heavier. The evidence of the presumed clearance success for the AP-mines was however even better. One AT-mine which had not been initiated was thrown out of the clearance track.

Index:

Pages:

1 Background:

The WTD 51 – 230 had the task to execute comparative trials of up to 5 different mine clearance devices at two different places with different soil characteristics.

WTD 91- 360 was supposed to choose the terrain in Meppen, to prepare it, to measure it and to follow up the trial. Moreover, in Meppen partially loaded blast surrogate mines had to be prepared, and the clearance success had to be evaluated on the basis of the uncleared mines and found mine fragments

For Koblenz inert mines had to be prepared to be used in the same mine fields and to be evaluated later on.

2 Preparation of the test fields

The distribution of the AP-mines and the AT-mines was equal for all the test lanes.

After the start-up section, 2 different types of AP-mines were encountered: 20 DM11 and 15 PPM-2 mines. These mines contained only the detonators.

After that, 5 MIZ DM56 A1B1 of the AP-fragmentation mine DM31 followed, which were fixed to wooden sticks and connected with tripwires. All the wooden sticks and the tripwires were collected after the first clearance action.

The 5 AP-fragmentation mines DM31 were buried at slightly varying depths. Their MIZ DM56 A1B1 had to be set off without tripwires, as pressure fuses. These mines contained only the initiation charge.

Later on, 2 series of AT-mines followed, 5 DM21 and 5 TM-62 P3, which had been buried at varying depths up to 20 cm. The DM21 contained the fuse and 100g of black powder explosive charge. The TM-62 P3 contained the whole fuse with about 10g of extra charge.

The mine field in Meppen with a surface of 10 x 90 m was organized on moss-grass vegetation in front of the horseshoe bank. The soil was old, sandy with some rocks.

The Schmidtenhöhe minefield in Koblenz was prepared clayey soil.

3 Preparation of the mines

In Meppen blast surrogate mines were used for the trials, whereas for Koblenz only inert mines were used.

The available stock had to be supplemented.

Mines	for Meppen Remainings + new supply	for Koblenz Remainings + new supply
AP-mines DM11 Explosive body replaced by wax (Detonator about 0,1 g screwed in)	19 + 21 = 40	7 + 23 = 30
AP-mines PPM-2 Explosive body taken out	15 + 15 = 30	11 + 19 = 30

(Detonator about 0,1 g used) AP-fragmentation mines DM31 Explosive body filled (S.P.- propelling charge (about 5 g)	6 + 4 = 10	2 + 8 = 10
AT-mine DM21 Explosive body inert filled (S.P.- propelling charge (about 100g)	5 + 5 = 10	3 + 7 = 10
AT-mine TM 62 P3 Explosive body inert filled MIZ loaded with about 10g	5 + 5 = 10	5 + 5 = 10

4 Schedule of trials

27.03.2001	Discussion with WTD 51 – 230 Decision on the ground in Meppen Request for mines made at WF II 5
23.04.2001	Release of the AP-mines
24.04.2001	Assignment of contract 10594/001
02.05.2001	Marking of two mine fields in Meppen
08.05.2001	Photographing of mine field during the soil assessment of WTD 51
25.06.2001	Distribution of the mines in Meppen, presentation of the mine clearance device
26.06.2001	Pre-trials on a distance of 150 m
27.06.2001	Clearance in mine field 10 x 90 m
28.06.2001	Transport of the vehicle
02.07.2001	Fa. Hoogen arrived with the rock collector
09.07.2001	Photographing of the mine fragments found in the minefield
07.06.2001	Inert mines used in Koblenz were picked up by WTD 51
12.06.2001	Distribution of the inert mines at Schmidtenhöhe in Koblenz
20.06.2001	Clearance in minefield
23.07.2001	Mission to Koblenz-Rübenach for fragment survey of the test fields at Koblenz-Schmidtenhöhe

5 Mine clearance trials in Meppen

5.1 Preparation of the mine test fields:

In May 2001, the test field Nr. 4 had been measured and marked on the grass-moss vegetation in front of the horseshoe bank for the Minebreaker.

On 25.06.01, blast surrogate mines were distributed by WTD 91 - 360 in the mine field, more precisely, 35 small AP-mines, 5 AP-fragmentation mines and 10 AT-mines. These mines were all armed at the moment, of deployment due to time needed for activation, especially the AP-mines PPM-2. .

The 5 MIZ DM 56 A1B1 fuses mounted on wooden sticks and the 5 MIZ installed as pressure fuses on DM31 mines, were armed immediately before the clearance trial.

5.2 Clearance process done by Fa. FFG

On 27.06.01, in the afternoon the Minebreaker of the Fa. FFG cleared the fourth mine field (mines without identification colour). It ran slowly from 13.40 – 16.00 over 4 tracks. Three tracks could have already been enough, but a fourth run was introduced to close a clearance gap in between two tracks.

Not a lot could be heard, only from the larger AT-mines 7 initiations were heard.

For details see Annex 1 – 3.

During the clearance process the fuel consumption resulted to be (for the test lane and the mine field) of 347 l Diesel.

5.3 Searching with mine prodder and spade

On 02.07.01, the surface of the mine field was searched for mine fragments with mine prodders and spade, whereby lots of AP-fragmentation mines and AT-mines were found. The TM62 P3 was found in fragments.

Later on three other AP-fragmentation DM31 mines were found.

5.4 Sieving with the rock collector

On 02.07.01, the company Hoogen came with a field tractor and rock collector Grimme CS1700.

The sand was dug away from the mine fields with the use of a loader and poured into the rock collector.

The extreme quantity of generated dust resulted in limited visibility so that the observation of smaller mine pieces was difficult.

After 4 half filled shovels, the rock collector emptied its bucket and moved forward over the sand heap for about 5 m to restart the loading process. The output was finally combed with the fingers. The amount of sand was surface-combed only.

The whole operation took two full working days.

5.5 Single results

Results and comments on the initiations heard, the dug- up mine fragments and the mine fragments found by the rock collector in the Meppen Mine Field 4 are shown in

Annexes 1 – 6 for field 4 „Minebreaker“ of Fa. FFG

The first three annexes contain the results for the single sections of the mine fields, that is the AP-mines, the AP-fragmentation mines and the AT-mines sections.

Three pictures are included providing an overview of the found mine fragments, the AT-mines and the AP-mines.

The results of the Minebreaker of Fa. FFG, were not entirely convincing.

Out of the 35 small AP-mines, 26 were cleared demonstrably, whereby most of them had initiated. An AP-mine DM11, although damaged, remained uncleared and active inside the cleared test lane.

The 5 AP-fragmentation mines were all cleared.

Out of 10 AT-mine, 7 initiated and 3 were tilled. Two intact parts of the fuse chain remained inside the cleared test lane.

Table 5.7 shows an overview of the clearance results of the machine with blast surrogate mines in Meppen on 27.06.01.

5.6 Overview of the used mines

Mines	Results	Clearance success
ATM TM-62 P3	7 x initiated 3 broke and were tilled 2 x fragments of fuse chains	≤ 100 %
ATM DM21	8 x initiated 2 broke and were tilled	100 %
AP-fragmentation mine DM31	10 x broken fuse	100 %
MIZ DM56 A1B1	6 x initiated 4 x tripwire detached	> 60 %
APM PPM-2	In field 4 a better verification could not be executed due to the fact that no mine fragments were found	≤ 100 %
APM DM11	In field 4, 15 clearance proofs were found, but 1 AP-mine DM11 was still harmful!	< 100 %

The AT-mines were cleared, whereby most of them were initiated.

In field 4 (Minebreaker) two fuse chains of AT-mines TM-62 P3 remained intact.

The AT-fragmentation mines with pressure fuse were cleared up to 100%, whereby the fuses broke without initiating. From the pull initiated fuses only 60% were triggered via tripwire. The remaining mines were supposed to be cleared later, when the mine clearance device passes directly over them.

The small AP-mines are the most difficult to assess, since their initiations are hard to hear, and their fragments difficult to find due to the small cases and high amount of dust generation.

Most of the AP-mines initiated; only a few were made harmless by crushing.

For field 4 (Minebreaker) one AP-mine DM11 remained only damaged, but still harmful inside the already cleared mine field! This can be explained by the easy detachment of the abutment in the soil.

This shows again that a clearance success of almost 100% can be considered, but that full safety cannot be reached.

5.7 Overview of the clearance results in the Meppen mine field prepared with blast surrogate mines for the mine clearance device "Minebreaker" on 27.06.01

Machine / Mines	Field 4 FFG Cie. „Minebreaker“
ATM TM-62 P3 5 x	1 x initiated 4 x broken (whereby 2 MIZ initiated + 2 fragments of fuse chains)
ATM DM 21 5 x	4 x initiated 1 x broken (1 body remained intact)
APM DM 31 5 x	5 x broken
MIZ DM56 5 x	2 x initiated 3 x tripwire torn off
APM PPM-2 15 x	2 x heard 11 x O-rings found 10 x rings found
APM DM 11 20 x	4 x heard 15 x cases found 1 was still harmful

6 Mine clearance trials in Koblenz

6.1 Preparation of the test fields

In week 24, 2001 the mine field was measured, marked and inert mines were placed in order to test the mine clearance device by WTD 51-230 at the StOÜbPl Schmidtenhöhe in Koblenz.

Different from in Meppen, in Koblenz only 15 small AP-mines were distributed.

Only 3 MIZ DM56 A1B1 fuses were used, fixed to on wooden sticks.

All inert MIZ had been armed prior to the trial.

6.2 Execution of the trials

On 20.06.01, the “Minebreaker” of Fa. FFG cleared the fourth mine field (with the red colour marking).

One ATM TM-62 P3 was observed to roll out of the mine field. It had been hit twice, but the mine fuse had not been initiated. On a cleared surface the mine would have been easily observed during the search. Therefore, in practice, such a marginal event can be accepted. .

6.3 Sieving with the rock collector

In the week 28, 2001 the mine field at the Schmidtenhöhe was searched for tilled mine parts with the rock collector Grimme CS 1700.

Since the traction force of the trailer and the penetration depth of 25 cm of the rock collector was insufficient, the tilled soil was first dug away and then laid down in strips.

6.4 Single results

Details about the mine fragments found by the rock collector in the mine field in Koblenz are shown in:

Annexes 7 – 11 for field 4 „Minebreaker“ of Fa. FFG

The annexes contain 2 overviews of the mine fragments found. After that, 3 pictures are showing an overview of the test field, the AT-mine section and the AP-mine section.

The result of the Minebreaker of Fa. FFG was excellent.

All 30 small AP-mines could be proofed and presumably, all AP-mines had been initiated or tilled.

The 5 AP-fragmentation mines were all cleared.

Out of the 10 AT-mines, 8 had been initiated, 1 was tilled and 1 rolled out of the track without having been initiated. However, it would have been easily found during the searching phase.

An overview of the clearance results for the inert mines in Koblenz-Schmidtenhöhe on 20.06.01 is shown in table 6.6.

6.5 Overview of the deployed mines

Mine	Results	Clearance success
ATM TM-62 P3	7 x totally tilled 2 x fuses initiated 1 x rolled out (!)	< 100 %
ATM DM21	1 x totally tilled 9 x fuses initiated	100 %
AP-fragmentation mine DM31	10 x fuse broken	100 %
MIZ DM56 A1B1	5 x initiated 1 x tripwire detached	> 84 %
APM PPM-2	22 x totally tilled 6 x presumably initiated (2 x were missing)	< 100 %
APM DM11	22 x totally tilled 4 x presumably initiated (4 x were missing)	< 100 %

Almost all the AT-mines were cleared.

One ATM TM-62 P3 rolled out of the track without having been initiated. During the search phase, this ATM would not have created any problems.

The AT-fragmentation mines would all have been cleared. A tripwire was found detached without having caused initiation. This means that only the directly tilled surface can be defined as cleared and that next to this area fragmentation mines with pressure fuses can still be encountered.

From the small AP-mines not all fragments could be found. Following the experience in Meppen, presumably, most of them would have initiated, whereas the remainder would have been tilled.

In view of the mine fragments found after the clearance process, it can be assessed that for the AP-mines a clearance success of almost 100% was reached.

6.6 Overview of the „Minebreaker's" clearance results in the Koblenz Schmidtenhöhe mine field prepared with inert mines on 20.06.01

Machine / Mines	Field 4 Fa. FFG „Minebreaker"
ATM TM-62 P3 5 x	2 x totally tilled 2 x MIZ initiated 1 x Mine rolled away
ATM DM 21 5 x	1 x totally tilled 4 x MIZ initiated
APM DM 31 5 x	5 x broken
MIZ DM56 3 x	2 x initiated 1 x trip wire was pulled off
APM PPM-2 15 x	6 x cases found intact 9 x Lower part – pieces 8 x Upper part – pieces
APM DM 11 15 x	4 x cases found intact 6 x found in fragments 4 x cases

7 Clearance results for the mine clearance device

The mine clearance device "Minebreaker" of Fa. FFG is based on an anti-clockwise tiller drum. The device ran very slowly and needed a lot of time for the clearance operation.

The clearance success was mostly very good. Most of the mines were initiated and the remainder of the mines broke. There were also some outliers:

- 1 AT-mine TM-62P3 rolled out of the track without having been initiated
- Out of 8 MIZ DM 56 A1B1 fuses, 4 times the tripwires did not cause initiation, but had only been detached by the sides of the tiller drums.
- 1 AP-mine DM11 was damaged but remained active (therefore harmful) inside of the cleared test lane.

The detached trip wires of the AP-fragmentation mine fuses created no problems, because the AP-mines with pressure fuses were easily cleared inside the test lane.

The other two outliers remained stuck in the anti-clock tiller drums, which have as advantage that no AT-mine can be missed by the mine clearance device, but has as disadvantage that the pressure of the counter bearing inside the soil easily decreases during the tilling.

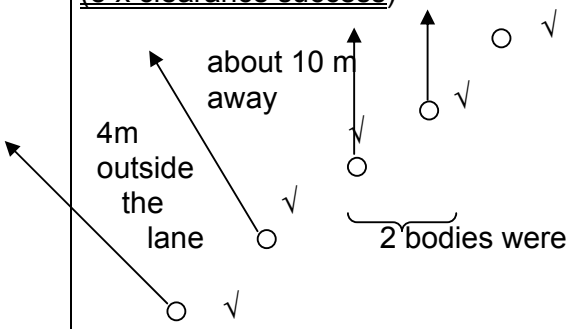
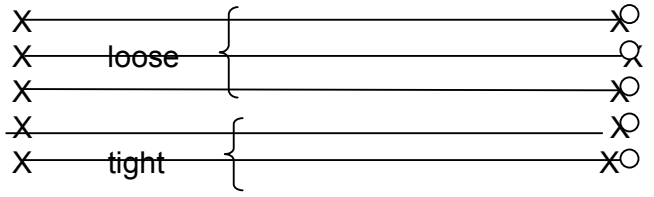
The clearance result of the presented machine shows that a final selection is only possible following further criteria:

- Capability to maintain working performance in difficult, rocky terrain,
- Capability to withstand 10 AP-mines initiated in the same tool position and 5 AT-mines distributed over the tool width,
- Time and costs of repairing after setting-off AT-mines,
- Purchase and maintenance costs of the machine,
- Transportation costs and possibilities.

Office	Mine distribution plan	Date	
WTD 91	AP-mines	27.06.01	
Dept		Paper Nr	Page total
360		1	
Editor	☐ Measurement Paper	☐ Field 4 „MINEBREAKER“	
Königstein			

10.10. 18.10.	– 2 initiations heard. – 11 O-rings found – 10 case rings – 10 splintered lower part cases – 8 splintered upper part covers	Fa. FFG (without colour)
	⊗ ⊗ ⊗ ⊗ ⊗ <u>(11 x clearance success)</u>	5 cm deep
	⊗ ⊗ ⊗ ⊗ ⊗	0 cm deep
	⊗ ⊗ ⊗ ⊗ ⊗	on top ! <u>PPM-2</u>
	○ ○ ○ ○ ○	5 cm deep
	○ ○ ○ ○ ○	0 cm deep
	○ ○ ○ ○ ○	0 cm deep
	○ ○ ○ ○ ○	on top ! <u>DM 11</u>
10.10. 18.10.	4 initiations heard. 15 rubber cases of initiated mines, 4 plastic panes found **<u>(15 x clearance success</u>)** **1x APM DM 11 got damaged but still remained harmful**!!!!	

Office	Mine distribution plan	Date
WTD 91	AP-mines	27.06.01
Dept 360		Paper Nr 2 / Page total
Editor Königstein	☐ Measurement Paper ☐ Field 4 „MINEBREAKER“	

27.06.	No initiations heard. (FFG Cie.)
04.07.	5 mines were found with broken fuse (without color) 1 broken MIZ found. (5 x clearance success)  bodies even buried DM 31 With pressure fuse
27.06.	 MIZ DM 56 A1 With trip wire bound to wooden stick 2 tightly bound tripwires were detonated. 3 with loosely bound tripwire MIZ DM56A1 were had not initiated. The wire was held down to the ground by the directing edge and torn off 30 – 100 cm by the tiller drums.

Office	Mine distribution Plan	Date
WTD 91	AT-mines	27.06.01
Dept 360		Page Nr 3 / Page Total
Editor Königstein	☐ Measurement Paper ☐ Field 4 „MINEBREAKER“	

27.06. 04.07.	3 initiations were heard (FFG Cie.) 1 mine case (without colour) (5 broken mine cases, 4 black + 2 red sealing rings, (5 bodies, ~~1 intact fuse chain found.~~ (1 fuse chain still missing.) (5 x clearance success) ⊗ 0 ⊗ 5 ⊗ 10 ⊗ 15 ⊗ 20 cm deep TM-62 P3 √ 3. √ 2. √ 1.
	√ 3. √ 3. √ 2. √ 1. ○ 0 ○ 5 ○ 10 ○ 15 ○ 20 cm deep DM 21
27.06. 04.07.	(5 initiations were heard. 1 mine was tilled before it initiated. 1 mine body was intact, but had been initiated 2 mine bodies were badly damaged and half empty 1 mine was badly damaged and completely empty, 1 mine was completely crushed (before the MIZ initiated). (5 x clearance success)


Feld 5
Minebreaker
ITG
27.06.2001


Feld 5
Minebreaker
FFG
27.06.2001


Feld 5
Minebreaker
FFG
27.06.2001

Office	Dept	Editor	Date
WTD 51	230	Theimer	20.06.01

		Page Nr.	Page total
	Measurement Paper	7	

Clearance trial in Koblenz-Schmidtenhöhe
With mine clearance device „Minebreaker“ of Fa. FFG
with inert mines in field 4 (red)

Distributed:	Mine fragments found:	Proof:
APM DM 18: (7) Result: 15	3 mine upper parts found mostly intact but they were not used as proof since they had not been armed 4 rubber cases (+)	
APM DM 11: (8)	1 mine found intact, but initiated 3 mine upper parts initiated. (+) (+) 2 mine parts destroyed, without proof. 1 mine crushed. Needle still tight. Detonator still active but detached, therefore clearance success. (+) 1 plastic case (+)	(15 x)
APM PPM-2 : 15	6 mines found intact 9 lower parts with mechanical plug-in module 8 upper parts with cover, (+) (+) 7 O-rings [6 + 9 = 15 x lower parts or more]	15 x
MIZ DM 56: 3 (with tripwire)	2 initiated. 1 tripwire torn off.	3 x

Office	Dept	Editor	Date
WTD 51	230	Theimer	20.06.01

		Page Nr.	Page total
	Measurement Paper	8	

Clearance trials in Koblenz-Schmidtenhöhe with mine clearance device „Minebreaker“ of Fa. FFG with inert Mines in field 4 (red)

Distributed were:	Mine fragments found:	Proof:
APM DM 31: 5 with pressure fuse.	5 mine bodies with broken fuses: all cases had been touched several times by the tiller.	5 x
ATM DM-21 : 5	1 body damaged, MIZ initiated. (+) 3 bodies destroyed, MIZ initiated. (+) 1 body completely destroyed, MIZ was missing, a drum tooth was found inside a mine cover.	5 x
ATM TM-62: 5	1 mine only 2 x hit, fuse not initiated! (-) This mine rolled out of the mine field. 2 cases remained intact, fuse initiated. (+) 2 cases were tilled, fuse initiated, needle missing. (+)	(5 x)


MINEBREAKER
Fa. FFG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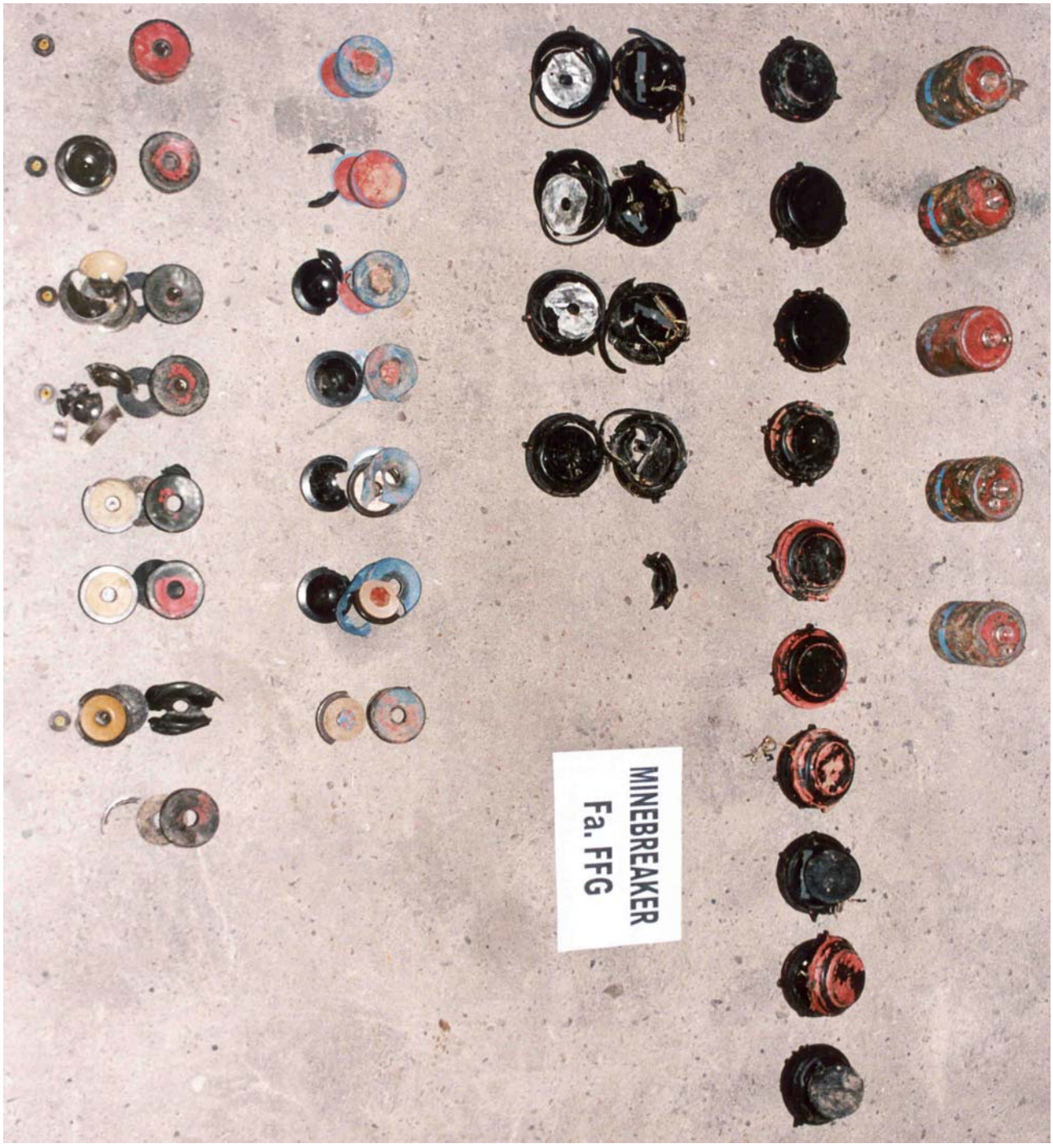
MINEBREAKER
Fa. FFG