	LANDMINE CLEARANCE TEST FACILITY	WTD 51

Koblenz: 09.08.2002

Summary Report

Planned object:	Mechanical mine clearance device
Identification Nr:	2350-14390
Manufacturer:	Fa. FFG
Model:	MINEBREAKER 2000/2
Project - Nr.:	E/K43A/20601/Q5204
Task:	Clearing of life AT-mines (explosive up to 7,0 kg TNT) through the use of MINEBREAKER 2002 in the test area of the Military Technical Centre (WTD 91) in Meppen. Carrying out of acceleration measurements at the driver seat and execution of acoustic measurements. Determination of the repair costs after the mine detonation.

Report:		Pages:	59	Photos:	77	Tables:	15
Author:	TRAR Theimer	Department:	230	Phone:	19 73		

Main Outcome:

The MINEBREAKER system cleared the following AT-mines: three DM 21, one TM 62 and one TM 57. The driver is sufficiently protected in the vibration proof driver cabin (up to 7 kg TNT) as far as the mines explode inside the tiller's working area. The measured figures are below the limits set for mine-protected vehicles. After each explosion the vehicle was checked for damages and repaired if needed. The damages that occurred during the trials can be assessed as small.

(Signature)

Remarks:

Translation into English:	M. Garotta	
Mailing List :	BWB - KG IV 3	10x
	FIST BWB	1x
	WTD 91	1x
	WTD 41	1x

Index

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.

For operation in Afghanistan a MINEBREAKER from FFG Cie. was procured.

This mine clearance device was tested in a trial in June 2001 by WTD 51, whereby its clearance efficiency (and safety) had been proved (see report WTD 51 of 23.01.2002). These trials took place in clayey and sandy soil, using inert and blast surrogate mines.

The device had already cleared mines operationally in Croatia, Bosnia and Korea, though the effects of mine detonations had not been documented sufficiently. Hence the WTD51 was tasked to evaluate the effect of AT-mine detonation during clearing on the vehicle and its operator.

In principle, the following tasks shall be conducted:

- Participation in a detailed theoretical and practical instruction on the vehicle.
- Assignment to WTD 91 for the preparation of the terrain and the provision of a sufficient number of life AT-mines.
- Assignment to WTD 41 for the comparative assessment during the clearance process with the military mine clearance vehicle Keiler.
- Execution of acoustic measurements inside the driver cabin.
- Execution of acceleration measurements on the ground and on the driver seat inside the driver cabin.
- Determination of the physical and psychological effects on the driver.
- Determination of the damages to the vehicle.
- Assessment of the repair costs and efforts.
- Assessment of the effects on the ongoing clearance process after AT-mine detonation.
- Evaluation of the results and assessment of the damages to the vehicle.

2 Test fields and time frame of the trial

Test fields:	WTD 91, Meppen	
Time frame:	Trial preparation up to	05.07.2002
	Instruction on vehicle	08.07. to 12.07.2002
	Trials with life mines	15.07. to 19.07.2002

3 Brief description of the MINEBREAKER 2000/2

The mine clearance device MINEBREAKER is based on a modified Leopard 1 chassis, a hydraulically-powered rotating drum, mounted at the front of the vehicle, and an armoured driver cabin. Due to its modular design, the tiller unit of the Minebreaker can be fitted to other prime movers. 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 Instruction

On the basis of the operating instructions of the MINEBREAKER 2000/2 (edition September 2000) the operating staff, consisting of personnel from BWB KG IV 3, WTD 51, WTD 41, WTD 91 and from the Army Engineer School, were trained practically and theoretically on the mine clearance device and the mine clearing process.

During the instruction, a discussion was held with all staff about safety during the operation of the mine clearance device in areas with life AT-mines. This discussion was managed by the Security Department of WTD 91 and resulted in the permission to conduct the trials.

During the instruction, blast surrogate mines (with an initiating charge of about 100 to 200 g black powder in the original cases) were used.

4.2 Clearance of life AT-mines

The clearance of life AT-mines with the MINEBREAKER is only allowed to be carried out by instructed personnel, and requires specific technical experience of the vehicle, as well as good knowledge about the safety regulations described in the operating manual.

During the trials, the following security distances had to be kept:

Operating without mines:	about 10 m from the external sides of the vehicle
Operating with mines:	about 1000 m from the external sides of the vehicle (Personnel in protected area e.g. bunker)

After the instructions about the MINEBREAKER given to the personnel tasked to clear the AT-mines, the trials were conducted as follows:

- Positioning of the MINEBREAKER, engine remains switched on; driver sits in the protected driver cabin.
- Installation and switching on of the measurement instruments (acceleration and acoustic measurements).
- Switching on of the armoured video camera inside the driver cabin.
- Placement and activation of AT-mines (by experts). The mines were buried 5 cm deep, positioned in the centre of the tiller drums and about 10 m away from the MINEBREAKER. All staff was positioned in the protected area.
- Checking of the radio connection between the driver and the control station.
- Starting of the tilling process after commanding by the control station.
- The speed of movement was fixed between 3 and 6 m/min.
- The clearance depth was up to 30 cm.
- After detonation of the mine or initiation of the mine fuse, the driver was instructed to stop the vehicle, to lift the tiller drum from the ground and stop it rotating.
- After proving the safety by an expert, the measurement instruments and the cameras were stopped.
- Determination of the repair costs and damages to the vehicle.

After each detonation of an AT-mine, the measurement results were checked and evaluated. Furthermore, after each mine cleared, the damage, including repair costs,, was assessed.

The WTD 91, Department 360, allocated the following AT-mines:

DM 21	with about 4,5 kg explosive	aluminium mine case
TM 62 P3	with about 7,0 kg explosive	plastic mine case
TM 57	with about 6,5 kg explosive	steel mine case

See report of WTD 91 Annex 1 and Annex 4 pictures 1 to 3.

5 Results

5.1 Instructions

The following persons were instructed on the MINEBREAKER:

Mr. Reutter,	Army FSH/BauT
Mr. Gewald,	Army FSH/BauT
Mr. Sponfeldner,	Army FSH/BauT
Mr. Kronjäger,	BWB – KG IV 3
Mr. Lang,	WTD 41 – 320
Mr. Leszke,	WTD 91 – 360
Mr. Kölzer,	WTD 51 – 230
Mr. Kirfel,	WTD 51 – 110
Mr. Theimer,	WTD 51 – 230

Everybody who took part in the instruction process received an instruction manual.
On top of the instruction manual a brief instruction document was created, which is attached as Annex 2. The latter document is only valid when used together with the instruction manual mentioned before.

Cie. FFG issued certificates for the above mentioned personnel, giving them permission to operate and run the vehicle.

5.2 Clearance of life AT-mines

The AT-mines were cleared as follows:

Trial Nr.	Date	Mines	Driver	Mine Detonated	Position of detonation
1	15.07.02	DM 21	Mr. Kasischke Fa. FFG	yes	Right side of tiller drum
2	16.07.02	DM 21	Mr. Kirfel WTD 51	yes	Centre of tiller drum
3	16.07.02	DM 21	Mr. Gewald PiS	yes	Centre of of tiller drum
4	17.07.02	TM 62 P3	Mr. Lang WTD 41	yes	Right under the side protection
5	18.07.02	TM 62 P3	Mr Reutter PiS	Explosive tilled Fuse initiated	Centre of the tiller drum
6	18.07.02	TM 62 P3	Mr Sponfeldner PiS	Explosive tilled Fuse detonated	Centre of the tiller drum
7	18.07.02	TM 62 P3	Mr Sponfeldner PiS	Explosive tilled Fuse detonated	Centre of the tiller drum
8	19.07.02	TM 62 P3	Mr Theimer WTD 51	Explosive tilled Fuse detonated	Centre of the tiller drum
9	19.07.02	TM 57	Mr Kölzer WTD 51	yes	Left side of the tiller drum

5.3 Damages to the mine clearance device

Damages after trial 1, see Annex 4 photo 29

(Detonation of AT-mines DM 21)

Damages	Repairs	see photo
Right side plate, tiller end and side plate 3mm Niro right, bent	No	4
Left side plate, tiller end and side plate 3mm Niro right, bent	No	5
T-beam with tiller chisel holders, fully bent and ripped in the middle	No	6
3 chisels melted	3 chisels replaced	7
Screw connections pipe support, short, and pipe fixing, short, ripped off	Connection re-established, through seal	8
Middle rubber cover and the rubber holder loosened and bent	Rubber holder mechanically straitened, rubber cover re-attached.	9

Damages after trial 2 see annex 4 photo 30

(Detonation AT-mines DM 21)

Damage	Repairs	see photo
Right side plate, tiller end and side plate 3mm Niro right, bent more	No	
Left side plate, tiller end and side plate 3mm Niro right, bent more	No	
T-beam with tiller chisel holders, fully bent, increased bending	No	
One T-beam bent upwards	No	
Pipes bent upwards	No	10
Screw connections pipe support, short, and pipe fixing, short, ripped off. Sealed connections ripped	Connection re-established through seal	11 and 12
Right rubber cover ripped off on the left, left rubber holder ripped	Rubber and rubber holder replaced	13
Middle rubber cover ripped out of clamping plate, support bent	Rubber cover mechanically straitened, rubber cover refastened	14
Left rubber cover out of position, left rubber support slightly bent	Rubber cover positioned	15
One chisel melted	One chisel replaced	
Monitor cover in the driver cabin detached	Cover refastened	

Damages after trial 3 see annex 4 photo 31

(Detonation of AT-mines DM 21)

Damage	Repairs	see photo
Right side plate, tiller end and side plate 3 mm Niro right, bent more	No	
Left side plate, tiller end and side plate 3 mm Niro right, bent more	No	
T-beam with tiller chisel holders, bent more	Replaced	16
One T-beam bent upwards	Replaced	
Pipes bent upwards or ripped off	Replaced	17
Screw connections pipe support, short, and pipe fixing, short, ripped off. Sealed connections ripped	Replaced	
Right rubber cover ripped off on the left, left rubber holder ripped	Rubber clamping plate and rubber holder replaced	
Middle rubber cover ripped out of clamping plate	Rubber clamping plate and rubber holder replaced	
Left rubber cover out of position, left rubber holder slightly bent	Rubber clamping plate and rubber holder replaced	
One chisel missing	One chisel replaced	
Gap between tiller unit, right and T-beam	Screw connections tightened until gap was closed	18

Immediately after the detonation of the third DM21 AT-mine, the damaged components of the tiller unit were replaced by new ones. Since the mines detonated within reach of the tiller drums, damages only occurred to the protective plates.

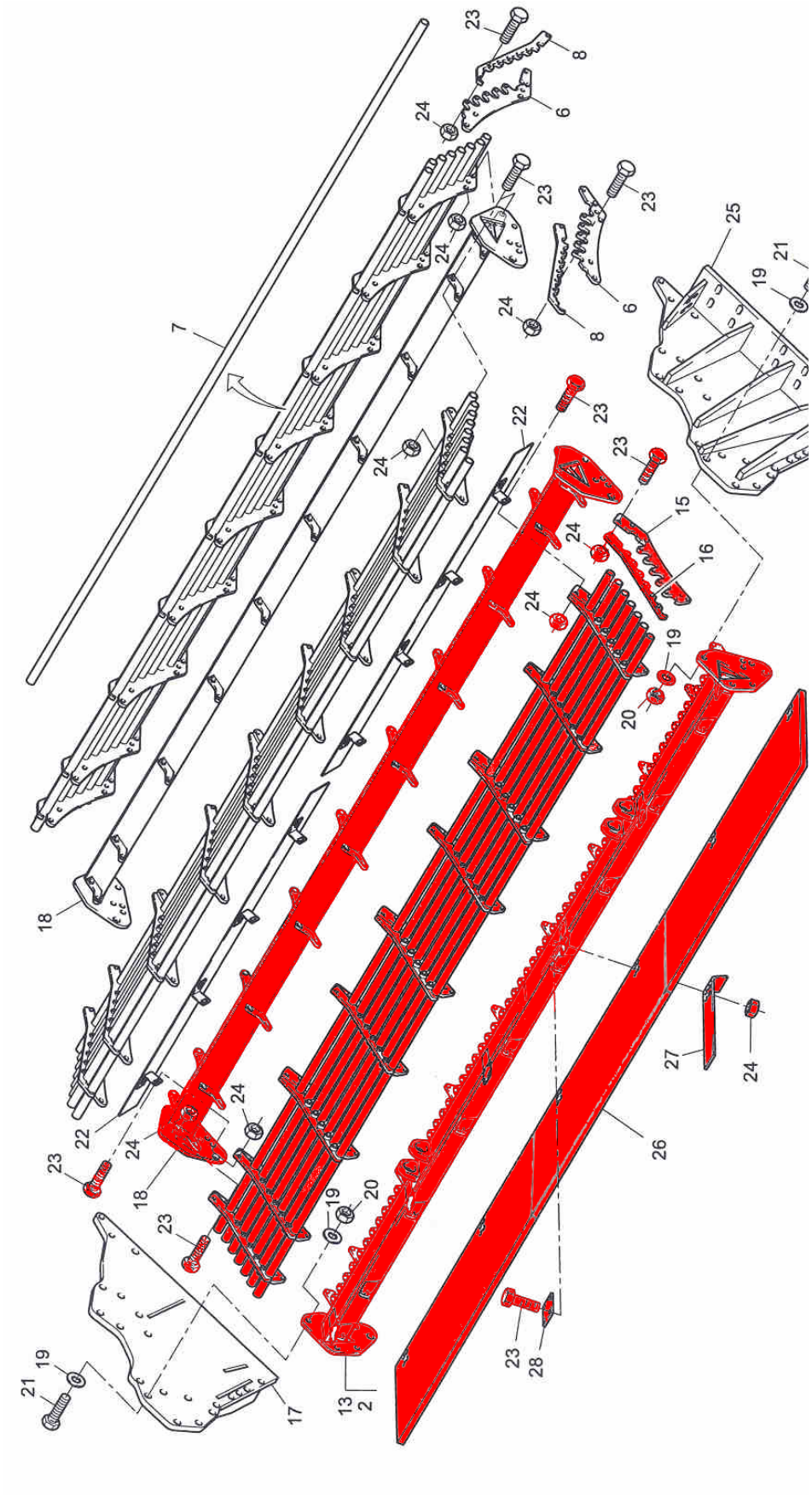
The repairs were executed by 3 to 5 people, taking up about 5 h.

The presence of a crane and a forklift truck is needed during the repair process (this was not always possible during the trials).

Note: The manufacturer guarantees that during clearing of metal cased mines with up to 7 kg TNT, detonation will not cause significant damages. Significant damages are defined as damages which cause repairs taking up more than 2 man-days.

See annex 4 pictures 19 to 22

The following picture shows the replaced components of the protective plates in red.



Damages after trial 4 see annex 4 photo 32

(Detonation of AT-mine TM 62 P3)

Damages	Reparation	See picture
Right side plate, tiller end ripped off and catapulted away.	Replaced	23
Side plate 3 mm Niro, right, ripped off and catapulted away.	Replaced	24
Levelling / depth feeler right, ripped off and catapulted away.	Replaced	
All screw connections of the components mentioned before were mostly warped or ripped off	Replaced	25
Rubber positioned at the right side	Rubber replaced in original position. No further reparation	

Damages after trial 5 to 8 see annex 4 photo 33

(Detonation of TM 62 P3 AT-mine, no full mine detonation, merely fuse with small amount of leftover explosive detonated)

No visible damages to the device were observed.

Damages after trial 9 see annex 4 photo 34

(Detonation AT-mine TM 57)

Damages	Reparation	See photo
Right side plate, tiller end partially ripped off	Side plate can be further used, screw connections had to be replaced	26
Side plate 3 mm Niro, left, partially ripped off.	Side plate can be further used, screw connections had to be replaced	27
Levelling / depth feeler left, partially ripped off and strongly warped.	Lever had to be repositioned, screw connections had to be replaced.	
Rubber, middle, lifted	Rubber repositioned, no further repairs needed.	
Rubber left, ripped off.	Rubber supports still present, rubber had to be replaced.	28

5.4 Vibration measurements

The results of the vibration measurements conducted by WTD 41 were subjected to human relevant evaluations by WTD 91. The human relevant evaluation is part of the WTD 41 report present in annex 3.

5.5 Activities WTD 41

As expert of the mine clearance tank KEILER, the WTD41 experiences during the detonation of life AT-mines had to be integrated. The results and evaluation have to be taken from the WTD 41 report in annex 3 .

5.6 General Observations

1. The mini-measurement connection devices present on the MINEBREAKER are not compatible with those normally used in the German Army; adapters are needed.
2. The front panel of the driver cabin is damaged and needs to be replaced.
3. The locking chain on the entrance ladder must be continuously fixed.
4. Hydraulic pipes of the hydraulically powered tiller drums, which heat up during the operating process, are positioned next to the ladder and contact with the ladder cannot be excluded. Therefore, these pipes should be covered (see annex 4 photo 35).
5. Rubber cover flaps over the tiller drums should not move up during operation of the tiller. They always should positioned back into the starting position. Constructive measures are needed (see annex 4 picture 36).
6. Frequent breaking occurs to the tiller chisel shafts. A correction of the chisel consistency is urgently needed.
7. The neutral position of the hand gear should lock discernibly (see annex 4 photo 37).
8. The tank hatch must be lockable.
9. After the detonation of an ATM, a check for damages has to be carried out routinely. In case of tiller repair the use of a lifting device is necessary (crane, fork-lift etc.)
10. Hydraulic leakage at one coupling of the vehicle (in the driving direction, left) in front of the hydraulic cooler. In principle, all couplings have to be checked on impermeability before delivery.
11. Hydraulic and air filter must be new at the delivery.
12. Loss of liquid from the cantilever ((in the driving direction, left).Impermeability control before the delivery to the Bw.
13. The spare parts produced and used by FFG were not always constructed well (screws were wrong or not present, side plates were wrongly drilled). Urgently needed tools are not present. The tool list needs to be revised by the manufacturer.

14. During repair bolts must be taken out. Adequate tools for doing this are missing.
15. During clearance the driver must be connected to the outside world by radio. The use of a manually operated radio creates lots of problems, since both hands are needed for the control of the joystick for driving, lifting and lowering the tiller unit. Therefore, a fixed radio installation inside the cabin with built-in loudspeaker is needed.
16. Note:
    In case pressure drops, the brakes open and the vehicle cannot brake. Normally brakes close when the pressure drops and the vehicle is not functional.

6 Summary

During the trials with life AT-mines of different type and origin, the MINEBREAKER obtained a clearance result of 100%.

The following mines were detonated by the MINEBREAKER:

3 AT-mines	DM 21,
1 AT-mine	TM 62 P3 and
1 AT-mine	TM 57

For four TM 62 P3 AT-mines, the mine cases were tilled and only the fuses were initiated. These mines can also be considered as detonated.

The driver is sufficiently protected, inside the vibration-proof cabin, against detonations of up to 7 kg TNT when taking place within the tiller unit area.

The injury risks for the assessed body parts (breast, lumbar spine and lower leg) are very small, and are much below the allowable limit for mine protected vehicles as determined by the Federal Armed Forces.

After each detonation, in particular after the detonation of AT-mines, the vehicle has to be checked for damages and has to be repaired if needed.

When using the Minebreaker, enough spare parts of the various components of the tiller unit should be available.

The damages that occurred during the trials are, according to the predefined definitions, to be considered as small.

Theimer

WEHRTECHNISCHE DIENSTSTELLE
FÜR WAFFEN UND MUNITION

WTD 91

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Dezernat 360

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

Protokoll Nr. : 31/02/91-360
WTA-Nr. : E/E510/20799/Q5204
TA-Nr. : 20799/001

Prüfgegenstand: Minenräumfräse „Minebreaker“

Aufgabe: Räumen scharfer Panzerminen

Ergebnis (Kurzfassung):
Die Minenräumfräse „Minebreaker“ der Fa. FFG sollte in Meppen gegen scharfe Panzerminen eingesetzt werden, um neben dem ausgelösten Schaden an dem Fräsgerät auch die Belastungen des Bedieners in seiner Bedienerkanzel messtechnisch zu erfassen.

Es wurden insgesamt 5 scharfe Panzerminen zur Detonation gebracht, 3x DM21 (mit ca. 4,5 kg COMP. B) und je 1 TM-62 P3 und 1 TM-57 (mit ca. 6,5 kg TNT).

Die Messungen der Beschleunigung an Sitz und Füßen sowie die Knalldruckmessungen in Kopfhöhe des Bedieners ergaben verträgliche Werte.
Die Schäden am Gerät werden von der WTD 51-230 dargestellt.

Dezernatsleiter
Königstein
BDir Königstein

Berichterstatter
Königstein
BDir Königstein

Index Pages

1 Task

Mandated by WTD 51-230 and in the context of WTA: E/E510/20799/Q5204, the mine clearance device Minebreaker of FFG had to be deployed for the clearance of life AT-mines, whereby the consequences of the detonations on the vehicle, as well as the physical and psychological impact on the driver, had to be assessed and evaluated.

Vibration measurements and acoustic measurements of the impact of the explosion inside the driver cabin had also to be conducted, similar as the Swedish testing of three other mine clearance devices (according to the FMV-report of 25.10.01).

The mine clearance device Minebreaker of FFG had already been deployed in June 2001, in Meppen, for the clearance of partially armed blast surrogate mines (see picture annex 1).

2 Schedule:

23.05.02	Pre-discussion on WTD 51-230.
18.06.02	Start of the planning.
20.06.02	Pre-discussion about mine protection of the mine clearance device with WTD 91-410.
25.06.02	Pre-discussion about the safety of the mine clearance device with WTD 91-110.
25.06.02	Reply to the task assigned by WTD 91-002-PK.
08.07.02	Instruction of the participants carried out by Fa. FFG.
09.07.02	Delivery of the mine clearance device „Minebreaker“.
10.07.02	Task 20799/001received.
10.07.02	Final endorsement of the safety parameters established by WTD 91-110. Authorization for the trials with life mines.
12.07.02	Termination of the training.
15.07.02	Transportation to the explosion test field Wohldhöhe.
18.07.02	Preparation of the mine clearance device for MoD Scharping.
19.07.02	Termination of the trials with life mines.

3 Pre-discussion on 23.05.02

In a pre-discussion, the project leader of Fa. FFG, H. Kamper, presented the explosion trials conducted by the company in Baumholder and the results of operations in Bosnia and Korea.

An EU- attestation of conformity for the safety of the vehicle for clearance of 7 kg mines was handed over.

For the operation of the mine clearance device the following order was proposed:

1. Fa. FFG personnel

2. WTD 51 personnel

3. Soldiers from Army Engineer School

Everybody had to be instructed on the operation of the system two weeks in advance of the clearance trials in Meppen.

The mines to be used were the same as the ones used for the clearance trials with partially armed mines, since their detonation behaviour was already known.

1. AT-mine DM21 (with 4,5 kg COMP. B)
2. AT-mine TM-62 P3 (with 6,5 kg TNT)

Three + three detonations on the mine clearance device had to be obtained and their consequences analyzed.

4 Instruction and Training:

On 08.07.02 in total 11 participants were instructed by the project leader of Fa. FFG, H. Kamper about the construction and the experiences obtained with the mine clearance device Minebreaker. This took place in the auditorium. Ten manuals were handed over. The list of participants can be found in annex 2.

The Minebreaker was built using a Leopard-1 chassis, but it became, due to the hydraulically-powered unit and the big tiller drum, a lot larger and heavier.

In four working hours the mine clearance device can be disassembled from the chassis, reducing in this way its dimensions:

Weight	50 t	→	31 t
Width	451 cm	→	328 cm
Length	11,5	→	8,0 m

Each of the three parts of the tiller drum was connected with 12 pins. This connection could not withstand detonation of a 10 kg mine and was therefore doubled.

The performance during operational field deployment of a mine clearance device is expected to be >= 1 ha for each working day, whereby the fuelling and maintenance process is included. As for the Leopard 1, the diesel tank contains 940 l, which is consumed during 1 working day.

On 09.07.02 the mine clearance device Minebreaker was delivered in Meppen by the use of a commercial tractor (SLT). Instruction of the driver, as well as of the department assigned to carry out the trial was continued.

Representatives of the shooting department of WTD 91-110, which still had to give their approval to the manned trials planned to start after 15.07.02, took also part in the training.

From 09.07.02 (13:00) to 11.07.02 (16:00), more personnel of WTD 41 and 51 and army soldiers were instructed on the operation of the mine clearance device and trained in the field, in front of the horseshoe bank.

In total six partially armed blast surrogate mines DM21 (WITH 100 G s.p.) were used in order to acquire further figures on detonation, next to the results obtained from the clearance trials with partially armed mines, carried out in June 2001. Fiveof these mines were detonated without problems. A blast surrogate mine was apparently not detonated and rolled out of the test lane.

The 100 g S.P. mine had not been activated through the fuse chain of the MIZ DM1001. This problem had already been assessed and was therefore already known. The trial was repeated and failed again. The mine body rolled at first 2x3 m in front of the tiller drum and after that disappeared completely in the tiller tracks.

The search process using prodders found the mine body, its cover, and fuse, separated one from each other within a distance of 3 m. The fuse had initiated, and therefore was counted as a clearance success.

But it must also be considered that even larger mine fragments could get through the mine clearance device.

After further discussions between the participants on 10.07.02, a note on the safety measures was endorsed, and as such the clearance of life AT-mines was authorised (see annex 3).

On 12.07.02 the mine clearance device was loaded on the SLT tractor and fuelled. After 2 days of training and deployment (without clearance capacity), the vehicle was fuelled with 566 l Diesel F-5.

5 Clearance trials with life AT-mines

5.1 Trial specifications

The clearance trials with life mines took place from the 15.07.02 to the 19.07.02 on the demolition area at Woldhöhe in front of bunker 2.

The AT-mines had been distributed in the middle of 8 m wide and 20 m long lanes and were covered with about 5 cm of earth. Their position was marked with stakes. For the life clearance trials the following measurements were executed:

1. Video recording of the vehicle from outside;
2. Video recording from the inside (head of the driver);
3. Acoustic measurements of the explosion impact inside (next to the head);
4. Measurements of the acceleration at the feet and the driver seat;
5. Photographs of the damages to the mine clearance device.

5.2 Used AT-mines

Initially, it was planned to use the DM21 and TM-62 P3 AT-mines only, since their explosion behaviour was known.

Three AT-mines DM21 (with new fuse chain) functioned effectively with the mine clearance device.

One AT-mine TM-62 P3 exploded under the pushing frame and caused large damage

On 18.07.02, one DM21 and one TM-62 P3 without fuse were tilled, in order to give the opportunity to the Bw dog training centre to search with their explosive detection dog. The dog also found the remaining TNT-parts,originated from the tilled TM-62 P3.

Because for four more of the tilled TM-62 P3 (with MIZ) only the fuse detonated, a third mine type had to be deployed during the last trial day: the TM-57 AT- mine. It has a steel case and is therefore more stable.

During the pre-trial the first MWS-57 immediately detonated (no time delay) and could not further be used.

For the she second mine the detonator time delay was short and the mine was detonated on the tiller drum during the clearance process, causing another large damage to the vehicle.

Total consumption	Mines	Fuses
	4x DM21	3x DM1001
	6x TM-62 P3	5x MWP-62
	1x TM-57	2x MWS-57

5.3 Clearance trials with AT-mines DM21

On 15 and 16.07.02 the mine clearance device Minebreaker was deployed for the clearance of three life AT-mines DM21, after waiting about 8 min. to unlock.

Trial 1 on 15.07.02 at 15:30 (driver: Kasischke, Fa, FFG):

Mine detonated through contact

Mine exploded at the centre of the tiller drum.

Small damages to the vehicle.

All measurements failed due to the stopping and restarting of the engine, since the measurement devices were connected to the 24V power system of the vehicle. For the next trials, batteries were used instead.

Trial 2 on 16.07.02 at 10:40 (driver: Kirfel, WTD 51):

Mine detonated through contact

Mine exploded at the centre right

1 rubber cover ripped off (was replaced)

1 support ripped off

pipes on the upper part were heavily bent

Inside video recording failed due to a relay-mistake

The next trial needed 2 clearance runs, since the driver missed the planned course and deviated to the left. He followed, instead of the middle marking, the left stake of the test lane borders. In this way, an AT-mine was missed, but hit by the right height feeler. The mine was re-positioned in relation to the mine clearance device location.

Trial 3 on 16.07.02 at 14:30 (driver: Gewald, army):

Mine detonated through contact.

Mine exploded at the centre of the tiller drum.

The driver had still bent to the side and to the front. shortly before the detonation

More damages to the vehicle after the 3rd mine detonation.

Therefore it was decided not to clear any further DM21 AT-mines, but to repair the mine clearance device for clearance of the next mine type TM-62 P3.

Using a crane and a fork lift, the bent upper edge was replaced and the ripped off rubber cover reattached. Apart from the larger spare parts, screws and bolts were also needed.

The repair of the middle part of the tiller drum, damaged by 3 mine explosions, lasted from about 15:00 to 12:30 of the next day; that is about 5 hours with 2 experts and other people helping.

5.4 Clearance trials with AT-mines TM-62 P3

On 17.07.02 the mine clearance device Minebreaker was deployed with life AT-mines TM-62 P3 after 15 minutes of waiting time.

Trial 4 on 17.07.02 at 13:30 (driver: Lang, WTD 41):

The tiller drum hit a buried mine at the centre right. It moved the mine about 2 m forward with the tiller drum after which it was initiated at the right lateral part.
The detonation on the right lateral part caused considerable damages:

Side part (stainless steel) thrown 5 m to the left,

Red steel part thrown 30 m to the left,

Red steel part thrown 40 m to the front,

Height feeler thrown 150m to the right.

All thick screws on the side were torn off, the remnants had to be drilled out. Screws, bearings etc. had to be obtained. For this reason the repair process took about 5 hours. During this period the mine clearance device was transported with the help of the SLT tractor to the demolition area Huentel, in order to present it to the Defence minister on the 18.07.02. During the presentation the right height feeler was missing.

After that, 2 mine bodies without fuse were cleared with the tiller drum, in order to deploy an explosive detection dog from the Bw dog training centre.

The DM21 AT-mine was moved in front of the tiller several times and rolled out of the test lane. The mine hit the tiller drums so many times that it most probably would have been initiated. Finally, the mine was buried in the tilled track.

The TM-62 P3 AT-mine was tilled after a few meters; some TNT-fragments were visible in the sand in the tiller track.

The explosive detection dog covered the lane twice and located the fresh TNT-fragments.

Trial 5 on 18.07.02 at 14:45:

The mine was tilled after 1 m and was flung before the earth berm, the plastic cover had been partially ripped off, and the TNT partially crushed, with the fuse still in it. Only after a further three clearance runs the fuse detonated inside the empty mine case.

Clearance success, but no valuable information for the effect.

Trial 6 on 18.07.02 at 15:25:

Shortly after hitting of the tiller drum by the mine, a stronger explosion was heard. It was, however, only the detonation of the fuse and some TNT-fragments. Additional TNT-fragments were found inside the ground.

Clearance success, but no valuable information for the effect.

Trial 7 on 18.07.02 at 15:55

The mine was tilled out of the ground after 2m, and then buried inside the ground again. No reaction was either seen nor heard. The search process indicated that the mine body had been tilled so much before initiation of the fuse, that all its TNT had been dispersed in the ground.

Clearance success, but no valuable information for the effect.

Trial 8 on 19.07.02 at 10:40:

The mine was tilled out of the ground after 2 m, and then buried inside the ground again. a stronger explosion was heard which was, however, only the detonation of the fuse and some TNT-fragments. Additional TNT-fragments were found inside the ground.

Clearance success, but no valuable information for the effect.

After four consecutive unsuccessful trials (with regard to the evaluation of the effect) no more TM-62 P3 with plastic cases were deployed. AT-mines TM-57 with steel cases were used instead.

5.5 Clearance processes with AT-mines TM-57

On 19.07.02 the last trial with a TM-57 AT-mine was executed. The latter mine has a steel case and keeps the explosive better together until the initiation of the fuse.

There was no need for a waiting time, because the MIZ MWS-57 was armed in less than 1 min and the mine clearance device was 10 m in front of it, corresponding to more than 2 min.

Trial 9 on 19.07.02 at 11:15 (driver Kölzer, WTD 51):

Mine detonated through contact. Mine exploded at about 60 cm from the left end of the tiller drum.

The explosion was first visible behind the drum, because of the amount of earth present in front of the tiller drum.

The detonation near the left side caused considerable damages:

Ripped off side supports

Bent height support

Since almost all the screws had been ripped off again from the side supports and therefore had to be removed, and since the bent side parts also would have had to be repositioned, the trials were suspended for that day as the repairs would have been too time-consuming.

The testing of the mine clearance device Minebreaker was therefore concluded and the device was loaded on the commercial tractor SLT. On 22.07.02 it was sent back to the manufacturer Fa. FFG for repair.

5.6 Remaining mine fragments

On the Wohldhöhe, 4 life DM21 AT-mines were used.

3 mines with fuse detonated.

1 mine without MIZ, deployed only for the use of explosive detection dogs, was dug out from the earth berm created in the clearance track. The mine had been hit several times by the tiller drums and COMP. B had been set free. No mine parts were missing and the mine body was destroyed later on.

On the Wohldhöhe, 6 life AT-mines TM-62 P3 were used.

Only one mine with MIZ MWP-62 detonated. The other 5 mines with green plastic cases were mechanically broken, even if for 4 mines with MIZ the mine fuse was still initiated. The reason for the lack of detonation was that the explosive had already been smashed into pieces and didn't come into contact with the fuse.

The terrain was searched at the 5 locations and almost half of the fragmented TNT was found. The other half had been buried deep in the soil..

Finally 1 more life TM-57 AT-mine was deployed, which detonated properly.

6 Measurements during the clearance process

6.1 Video recording of the mine clearance device

The external video-recording of the mine clearance device was carried out by the WTD 91-230. The monitor was put in a protective case about 30-50 m next to the lanes to be cleared and viewed the left side of the clearance device.

On the tape from 06.08.02, mine bodies inside the earth berm are visible and during the detonations single detached parts can also be discerned

6.2 Video recording of the driver

The video recording of the operator inside the driver cabin was executed by WTD 91-250 and is contained on the above cited tape.

For the installation of the video camera see annex 6.

Depending on the preparation by the operators for the detonation, they were shaken more or less tempestuously. All 5 drivers declared that the impact experienced by the mine detonations on the mine clearance device was absolutely bearable.

6.3 Explosion impact on the driver

The measurements of the explosion impact at head height of the operator in driving position were executed by WTD 91-630 (installation of the explosion impact recording see pictures annex 6). During the first trial, no measurements were carried out. After switching the voltage supply of the recording devices from the vehicle supply switched to a 24 V battery 4 measurements were recorded.

The values of the measurements were very variable, depending more on the location of the explosion than on the volume of the mine. The highest values amounted to 145-153 dB, the duration of the effect to 28-33 ms. During deployment of the tank cover H-280 at least 34 occurrences a day are bearable, and with ear protection Max-Lite at least 826 detonations.

For single results see annex 4.

6.4 Acceleration measurements

The acceleration measurements on the driver cabin floor, next to the operator feet and on the seat were executed with the administrative assistance of WTD 41-150.

Installation of the acceleration recording equipment: see photos in annex 6.

2 AT-mines DM21, detonating in the centre of the operator's seat pillow caused accelerations of 3,5 x 4000 ms and 2,2 g x 100 ms.

Outcome of it is a DRI-value of about 4,0 (limit value 15), which implies that the probability for a backbone injury is very low. For the AT-mines TM-62 P3 and TM-57 even lower values were obtained for the z-axis, probably because these detonations did not occur in a central position.

On the floor, peak acceleration figures of about 5 g (limit value 20 g) were measured. Hence, also the probability for a lower leg injury can be excluded. The evaluation of the WTD 41-150 measurements was executed by WTD 91-460.

The report of 05.08.02 is attached as annex 1. The comments presented in section 4 concerning detonation under the equipment main body are completely excessive; see

report on safety in annex 3. The information on trials with a detonation under the chain is instead justifiable, since this case can be defined as a real injury probability.

This type of trial should be planned using a proper measurement technique. A trial opportunity could arise when after deployment of the MInebreaker in Afghanistan, it needs to be submitted to a comprehensive overhaul process.

6.5 Photo Documentation of the damages

The WTD 91-250 department, assigned to take pictures, was instructed by the WTD 51-230 project leader to take in total 120 pictures, in order to document the trials and the resulting damages to the mine clearance device.

In this report, only 5 x 3 pictures are given as examples of the damages inflicted to the vehicle after the detonation of 5 AT-mines, see annex 6.

The detailed description and evaluation of the damages was carried out by the WTD 51-230.


Anlage 1
MINEBREAKER 2000/2

Dienststelle / *Office* / Service/Organisme
WTD 91-360 Meppen

Geschäftszeichen / *Reference* / Référence

Ruf-Nr. / *Tel.* / Tél.: 90-2422-2360

Datum / *Date* / Date: 08.07.02

Verzeichnis der Teilnehmer — *List of Participants* / Liste des Participants

[X] Die Sitzung ist OFFEN. — *Meeting is UNCLASSIFIED* / Réunion non classifiée

[ ] Die Sitzung hat den Geheimhaltungsgrad *Meeting is classified as* / Degré de classification de la réunion

Die Teilnehmer bestätigen durch ihre Unterschr... den Geheimhaltungsgrad der Sitzung ermäc... auf die Folgen einer Verletzung der Geh... *Participants confirm by signature in column ... clearance/provisional clearance for the class... been instructed on the consequences of secrecy violation.* En apposant la signature à la colonne "Observations", les participants certifient: posséder l'habilitation/l'habilitation provisoire autorisant à l'accès au niveau de classification attribué à la réunion, et avoir été avertis des conséquences d'une violation du secret.

Anlage 2

Betreff / *Subject* / Objet: Minenräumfräse Minebreaker (FFG)

Veranstaltung / *Meeting* / Réunion: Ort / *Place* / Lieu: Geb. 001A Einweisung

Datum (von - bis) / *Date (from - to)* / Date (du - au): 08.07.02

Beginn / *Opening* / Début: 1445 h — Ende / *Closure* / Fin: 1600 h

LfdNr / *No.* / No.	Name, ~~Vorname~~ (in Blockschrift) Amts-/Dienstbez. / *Family Name, First Name (capital letters) Rank/Title* / Nom, Prénom (en lettres majuscules) Fonction/Titre	Dienststelle/Org.-Einheit / *Office/Organization* / Organisme/Service	Ruf-Nr / *Tel.* / Tél.	Konferenzbescheinigung / *Certificate of Security Clearence* / Certificat de sécurité ja / *yes* / oui	nein / *no* / non	Bemerkungen / *Comments* / Observations
1	Königstein, BDir	WTD91-360	2360			Königstein
2	Leszke, TROI	WTD91-360	1364			Leszke
3	Lang, Berthold	WTD41-320	2374			B. Lg
4	Kasischke, Michael	FFG				
5	Krause, Burkhardt	FFG				
6	[illegible]	PiS [illegible]				
7	Reutter, Joachim	PiSFSH/Bau T				
8	Kronjäger, Jürgen	BWB-KG IV 3	6352			J. Kronjäger
9	Thelmer, Gerhard	WTD51-230	1973			
10	Kirtel, Ludwig	WTD 51-230	1973			
11	Skupin, Detlef	WTD 91-002	2252			Skupin
12	Kamper, Jörg	FFG	-179			(Vortragender)

BWB A 1127/12.87 — bitte wenden

Anlage 3

WTD 91-360

Meppen, 10.07.02
90-2422-2360

Vermerk über eine Sicherheitsbesprechung
zum Einsatz der Minenräumfräse „Minebreaker"
gegen scharfe Panzerminen.

1. Auftrag:
   Im Auftrag von BWB-KG IV 3 soll die Minenräumfräse „Minebreaker" der Fa. FFG gegen scharfe Panzerminen eingesetzt werden.
   WTA-Nr.: E/E510/20799/Q5204
   Versuchsort: Wohldhöhe 5
   Termin: 15.-19.07.02

2. Geräte-Angaben:
   Eine Konformitätserklärung zur Sicherheit des Gerätes zum Einsatz gegen Panzerminen bis 7 kg lag vor, erschien aber allein nicht ausreichend zur Sicherheitsfreigabe (siehe Anlage 1).
   Eine Skizze der Fa. FFG zeigt, dass die neue Bedienkanzel etwa in Höhe des alten Turmdrehkranzes der Leopard-1-Wanne eingebaut ist. Die Bedienkanzel ist aus 20 mm Panzerstahlplatten geschweisst und ruht auf Schockabsorbern auf Traversen in der Wanne (siehe Anlage 2).

3. Sicherheitsbesprechung:
   Am 09.07.02 fand eine Sicherheitsbesprechung mit allen am geplanten Versuch Beteiligten zunächst am Gerät und dann bei der Schiessleitung statt, um alle bereits berücksichtigten Massnahmen in Augenschein nehmen zu können und alle Restrisiken anzusprechen. (Teilnehmer siehe Liste, Anlage 3.)
   Der grosse Abstand der Bedienerkanzel vom Wannenboden, die Lagerung auf Schockabsorbern und die stabile Ausführung der Kanzel mit 20 mm PzStahl am Boden und an der Frontseite bzw. mit 70 mm Panzerglas machten einen guten Eindruck.
   H. Kamper von Fa. FFG stellte die Ergebnisse von Ansprengversuchen mit 7 kg-Minen in Baumholder von 1997 vor. Die Messungen des TÜV Bayern an Dummies auf dem Bedienersitz zeigten Belastungen von ca. 1,0 – 1,5 g auf, die problemlos zu ertragen sind.
   Echte Räumversuche aus Bosnien und Korea liegen neben vielen anderen Munitionsteilen nur für ca. 20 Panzerminen vor, von denen aber nur ca. 9 detonierten.
   Das war selbst bei den US-Minen M15 mit 10 kg PETN-Ladung in Korea für die Bediener kein Problem.
   Die Sicherheit für den Bediener bei einer normalen Auslösung der Panzermine an der Räumfräse stellt also nachgewiesenermassen keine Hürde dar.
   Zündungen unter der Wanne können ausgeschlossen werden, da alle Minen mit entsprechendem Zündsystem (Knickstab, Kratzdraht, Magnetsensor) zuverlässig von der Räumfräse ausgelöst werden.

4. Zündungen unter der Kette:
   Zündungen unter der Kette sind dagegen vorstellbar.
   Da normale Druckminen etwa 350 kg Auslösekraft in der Mitte des Deckels benötigen, ist es schon beobachtet worden, dass sie eine ganze Weile vor der Räumfräse im Erdhaufen mitbewegt werden, ehe sie zünden oder zerfräst werden.

In einem Fall rollte eine Mine ganz aus der Räumspur heraus (1 von 100 Panzerminen in den Vergleichserprobungen mit teilscharfen und inerten Minen).
Es ist nicht auszuschliessen, dass eine Druckmine aus der Frässpur herausrollt und im Bogen zurückrollt. So könnte sie vor die Kette geraten und von der 1. oder 2. Laufrolle ausgelöst werden.
Die Zündung einer Druckmine unter der Kette des Räumfahrzeuges hat ein Restrisiko von ca. 10^{-4}.
Durch die Konstruktion und Lagerung der Bedienerkanzel hoch über dem Wannenboden sind die Auswirkungen auf den Bediener aber als unkritisch anzusehen, obwohl sie natürlich höher liegen dürften als beim normalen Räumen.
Auslösungen von Druckminen unter der Wanne können dagegen ausgeschlossen werden. Sie bleiben nur liegen und sind später gut zu sehen und problemlos zu vernichten.

5. Abstreifer an der Fräswalze:
Wenn ein Munitionsteil von der Fräswalze aufgespiesst und mit hochgerissen wird, soll es an der Abstreiferkante abgetrennt werden, damit es nicht über die Fräswalze nach hinten auf die Oberseite des Fahrzeuges oder gegen die Bedienerkanzel geschleudert werden kann.
Die Konstruktion der Abstreiferkante, der beweglichen Gummiplatten und der Käfigrohre um die Fräswalze herum erscheint logisch und hat bisher keine grösseren Brocken vorne auf die Wanne fliegen lassen. Dort kommt nur noch Sand an.
Da beim Abstreifen zwischen Fräswalze und Abstreifkante bei Panzerminen mit Blechhülle hohe Kräfte auftreten, ist dies der letzte mögliche Punkt einer Zündauslösung. Teile, die hier noch abgerissen werden, dürften nicht mehr funktionsfähig sein.
Ein Risiko für die Oberseite der Panzerwanne und die Bedienerkanzel durch einen direkten Minentreffer kann deshalb beim Räumen ausgeschlossen werden.

6. Sicherheitserklärung:
Die Versuche beim Minenräumen gegen einzelne Panzerminen DM 21 und TM-62 können wie geplant durchgeführt werden, da beim normalen Räumen nicht mit einer Gefährdung für den Bediener in seiner gepanzerten Kanzel gerechnet werden muss.
Voraussetzungen für den Versuch sind Gehörschutz und Funkverbindung.
(Statistische und Plausibilitätsbetrachtungen zur Sicherheit siehe Anlage 4.)

7. Hinweis:
Da nur ein Prototyp der Minenräumfräse „Minebreaker" angekauft wurde und dieser möglichst bald in Afghanistan eingesetzt werden soll, sind z.Zt. keine weiteren Ansprengversuche möglich.
Man sollte aber den Ansprengversuch unter der Kette mit allen erforderlichen Messungen in der Bedienerkanzel nachholen, sobald sich eine Gelegenheit dazu ergibt. (z.B. an einem beschädigten Gerät, das ohnehin instandgesetzt werden muss.)

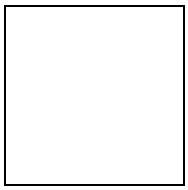
Königstein, WTD 91-360

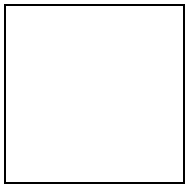
Staade, WTD 91-110

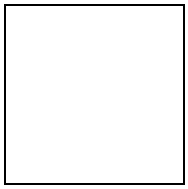
Theimer, WTD 51-230

(J. Kamper)

Kronjäger, BWB-KG IV 3







For the pictures refer to the original German document, also available in the ITEP reports database

Human relevant evaluation of the explosion trials with the FFG Minebreaker in July 2002

Index

WTD 91 – 460
Mensch & Technik, Ergonomie, Simulation
Bearb.: Nies, TROI z.A.
05.08.2002

1. Task

In July 2002 (week 28. and 29.) trials were executed at the WTD 91 with the mine clearance device Minebreaker of FFG Cie. The clearance of mine obstacles was simulated, whereby AT-mines were used. During 4 trials, acceleration measurements at the driver seat position took place, in order to evaluate the impact of a mine explosion on the driver. On the driver seat and on the floor panel between the driver's feet, an uni-axial vibrations feeler was installed (Z-direction). The measurement data had to be assessed with regard to the consequences for human beings, according to the German Federal Forces regulations for mine protected vehicles.

2. Execution and Evaluation criteria

4 trials were executed with the integrated measurement system, two of them with ATM DM 21 (5,6 kg TNT), one with an AT-mine TM 57 (6,5 kg TNT) and one with a TM 62 (7,6 kg TNT). The mines detonated in the area of the mine clearance device, that is, not under the chain or under the vehicle.

The acceleration on the seat was measured uni-axial in the Z-axis direction. The acceleration present in this position has, first of all, an impact on the breast and lumbar spine of the driver. For the impact evaluation with regard to the backbone injury probabilities, the "Dynamic Response Index" is used (DRI), in which the backbone is described as a spring-compound-damper system. As input parameter, the duration of the acceleration in Z-axis direction is applied. Using the latter input parameter the backbone deformation and therefore the injury probability in Z-axis direction, is then determined. The injury probability according to the German Federal Forces regulations for mine protected vehicles, is not allowed to exceed the 5%.

The acceleration present at the driver's feet was measured using a feeler placed on the floor panel of the driver cabin. For the evaluation of the injury probability at the driver's lower legs, the measurement data are not fully appropriate. The criterion that needs to be applied for mine protected vehicles is the "Lower Leg Threshold", where a maximum allowable force on the lower leg is attributed a certain allowable exposure time.

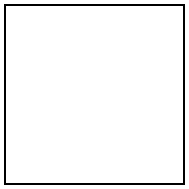
In the present case the acceleration was measured instead of the force. Furthermore, the measurements were taken not at the lower leg, but on the floor of the driver cabin, and not under one foot, but in between both feet. Since the acceleration transmission mechanism from the floor panel to the feet cannot be precisely determined (e.g. unknown damping characteristics of the footwear etc.), only an estimation of the injury risks can be provided.

Next to the measurement values, also the personal impression of the drivers were taken into consideration for the final assessment.

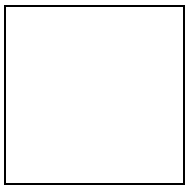
3. Results and Evaluation

3.1 Impact on the backbone

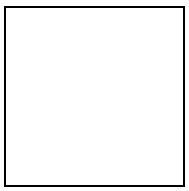
Pictures 1 to 4 show the vibrations present in the seat pillow and the calculated deflections on the backbone.



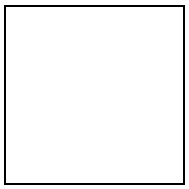
Picture 1: DRI-course Z-axis direction, Mine DM 21 (trial 1)



Picture 2: DRI-course Z-axis direction, Mine DM 21 (trial 2)



Picture 3: DRI-course Z-axis direction, Mine TM 57



Picture 4: DRI-course Z-axis direction, Mine TM 62

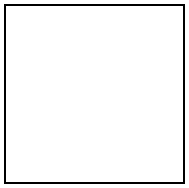
For the pictures refer to the original German document, also available in the ITEP reports database

Measurements were executed only for the z-axis direction, and not for the other two interested directions,.As in case of mine impact, the z-axis direction represents always the most critical direction of impact, the present data allow for an estimate of the injury risks. The vibrations chart for the trial with the TM 57 mine clearly indicates an incorrect measurement. In particular, the sudden jump to 200 ms seems unreliable. Probably, for this trial a failure occurred during the recording of the vibration. As a result, no DRI-value can be determined for this specific case. Presumably, the loading will be compared with those of other trials.

In all other cases, the calculated injury probability lies around 0,1%, that is, much under the maximum allowable value of 5 %, for mine clearance devices. On the basis of the on average low maximum vibration values, also in case of higher degrees of loading, it can be concluded with high confidence that no permanent damages in the breast and lumbar spine area are developed. According to the Impact Ride Quality Index (IRQI), realised by PAYNE, and based on the DRI, up to 20 loadings with values of an order of magnitude of the ones recorded in the present trials are not possible.

3.2 Impact on the lower leg

Picture 5 shows the vibrations measured in between both feet.



Picture 5: Courses of vibrations in the foot area (Z-axis direction)

For the picture refer to the original German document, also available in the ITEP reports database

As mentioned before, only limited conclusions can be drawn about the real impact on the lower leg of the driver from the executed measurements. Indeed, the lower leg vibration is going to be lower than the acceleration directly measured on the floor panel, since e.g the damping created by the footwear has to be taken into consideration.

In general, an acceleration of up to 20g in terms of a single lower leg impact, independently from the impact duration, is considered as not critical. The values measured in z-axis direction, and shown in picture 5, indicate that the resulting acceleration in the lower leg area does not exceed this limit value. This observation is also confirmed by the driver, who confirmed that the impact on the feet and lower leg was barely noticeable.

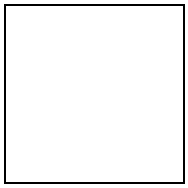
An injury in the lower leg area of the driver can therefore, also in case of multiple loadings, be excluded with high confidence.

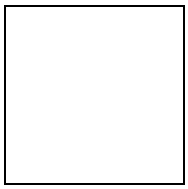
4. Conclusion

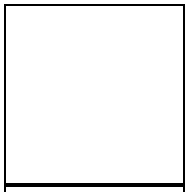
The Minebreaker driver cabin offers enough protection against the detonations of DM 21, TM 57 and TM 62 AT-mines, if they detonate inside the area of the mine clearance device. The injury risks for the analyzed body parts (breast, lumbar spine and lower leg) are very low and are much under the limit values adopted for mine protected vehicles by the German Armed Forces. The driver's impressions coincide with this analysis.

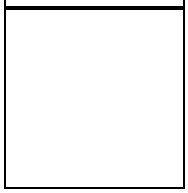
A detonation of a mine under the vehicle main body is not probable due to the way of working of the Minebreaker during the clearance process: mines are detonated or broken up by the tiller unit. If a mine would roll away from the mine clearance device, it would most likely detonate under the tracks, or next to the device. The effects of a detonation occurring under the tracks of the Minebreaker can not be assessed based on the present measurements. It can be, however, assumed that, in this case, critical impacts could be generated. If, for any reason, a detonation occurs under the vehicle, fatal consequences for the driver could be assumed, since the Minebreaker is only based on the Leopard chassis 1 without any specific protection.

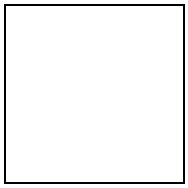
It is therefore recommended that that the effects of detonation in the track area and under the vehicle are tested as soon as possible.

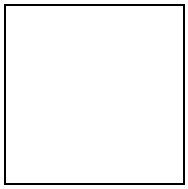


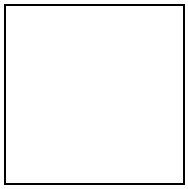












For the pictures refer to the original German document, also available in the ITEP reports database

MINEBREAKER Fa. FFG

Brief instructions

1. Check-up before the start

Check that all the levers, switches, potentiometers are positioned on “0”
Check that the speed controller is “switched off”, the potentiometer at stop position left and the safety switch control lever (right of the driver’s position) is pressed.

2. Starting the engine

Put the main switch in position 2
Press the Reset switch
Press the test light switch
Bring the control lever in the middle position (blue light switches on)
Allocate control lever
Put “Engine switched on” lever in position 1 and hold it until spiral-wound filament glow.
Put “Engine switched on” lever in position 2 and at the same time press “engine switched off” switch for 10 seconds.
Release “engine switched off” lever (engine starts)
Switch on speed controller
Adjust engine speed to at least 1100 u/min.

3. Driving with the MINEBREAKER

Put functioning lever on position 1 (cruising speed)
Wait until a hydraulic oil temperature of approx. 30 degrees is reached
Increase engine speed to 1500 U/min
Press safety switch next to the control lever
Run the device with the operating handle

4. Flailing with the MINEBREAKER

Reduce speed engine on about 1100 U/min
Put functioning lever on “working mode”
Switch flailing lever on 1 “ unterschlächtig”
Switch flailing potentiometer on maximum speed
Adjust engine speed on 1800 up to 1900 U/min
Switch driving device on 3 m/min (vehicle moves)
Lower tiller slowly (with left lever by pressing to the front)
Check height feeler and maintain level
Adjust speed according to the terrain and soil characteristics while lowering the tiller

5. End of flailing process

Reduce speed to 1m/min and lift thereby the tiller slowly
As soon as the tiller has been lifted and taken out of the soil, stop the vehicle

Switch flailing potentiometer to position “0”
Switch engine speed to about 1100 U/min
Switch flailing lever on 1 “cruising speed”
e.g. drive backwards out of the minefield

Office	Clearance of life mines with the	Date	
WTD 41		09.08.02	
Dept	**MINEBREAKER**	Page Nr.	Page total
320		1	21
Editor	**Short Report**		
Lang			

1 Task description

In the context of an urgent requirement, the mine clearance device Minebreaker from the Flensburger Fahrzeug Gesellschaft (FFG) had to be prepared for its deployment in Afghanistan.

Prior to the deployment, the following clearance tests with life ATM's had to be evaluated:

- the effects of mine detonations on the vehicle's crew and on the vehicle itself and
- the clearance efficiency in the clearance mode

The trials were executed in week 28 and 29 at WTD 91, managed by WTD 51. Because of their experiences with the Mine Clearing Vehicle (MCV) Keiler in clearing of life ATM's, the WTD 41 took part in order to check and evaluate the process (WTA: E/E510/20976/Q5204).

2 Tested Device

The mine clearance device is a mechanical mine clearance system tasked to clear AP and AT-mines. The vehicle consists of a prime mover– chassis Leopard 1 – with an adaptable tiller unit. The main part of the clearance unit is the hydraulically powered rotating tiller drum mounted at the front of the vehicle and fixed to the prime mover by two arms on the left and right side. In
– cruising and working speed the vehicle runs on ordinary diesel fuel hydraulically powered.

The armoured driver cabin is attached to the prime mover's roof and supported by 4 shock absorbers.

The crew of the vehicle consists of one driver for cruising and working speed.

3 Evaluation procedure

Activities during week 28:

- Presentation of the vehicle by the Flensburger Fahrzeugbau Gesellschaft
- Discussion about safety (WTD 91)
- Operating instructions and clearance of 6 inert ATM's (DM21 with 100g explosive charge)

Activities during week 29:

Clearance of life ATM's with different crews. The mines were buried, in front of the vehicle, at a distance from each other of about 10 m.

Used mines:

- ATM DM 21, mine with steel case and about 5 kg of explosive
- ATMTM 62 P3, mine with plastic case and about 6,5 kg of explosive
- ATM TM 57, mine with steel case and about 6,5 kg of explosive

The following measurements were carried out during the clearance processes:

- Determination of the explosive impact (acceleration) on the driver seat and on the feet surface (Execution WTD 41, Evaluation of the measured results – human relevant assessment – through the WTD 91, ergonomics)
- Measurement of the acoustic impact of the explosion (execution by WTD 91)
- Constant video recording inside the driver cabin (execution WTD 91)

The driver was in constant contact with the management body.

Driver ear protection: Radio connection of Fa. FFG

4 Results

4.1 Operating instructions

The correction of the vehicle's moving direction in clearance mode, by the use of the potentiometer lever, requires a lot of practical experience. Furthermore, the clearance depth control through the depth feeler requires high attention by the operator.

Therefore, a qualified and effective preparation of the operator is essential, in order to avoid operation errors during the clearance process

4.2 Wear of tilling instruments (chisel spikes)

During the instruction phase 10 to 15 chisels were replaced on the tiller drum after each clearance process (breaking of the attachment shaft, soil not clayey). About 100 chisel spikes in total were replaced during the complete testing phase. A correction of the chisel consistency before deployment of the device to Afghanistan is therefore needed.

4.3 Clearance of life AT-mines

Cleared AT-mines

Date	ATM	**Mine detonated**	**Damages to the vehicle**	**Measurements of acceleration**
15.07.02	DM 21	yes	Deformation protective compound (Spoiler)	No measurements
16.07.02	DM 21	yes	Deformation protective compound (Spoiler)	Measurement o.k.
16.07.02	DM 21	yes	Deformation protective compound (Spoiler)	Measurement o.k.
17.07.02	TM 62 P3	yes	Protective side plate ripped off from arm at the left.	Measurement o.k.
18.07.02	TM 62 P3	Mine body destroyed, fuse initiated	No damages to the device (blast effect missing)	No measurements
18.07.02	TM 62 P3	Mine body destroyed, fuse with remaining explosive initiated	No damages to the device (weak blast effect)	No measurements
18.07.02	TM 62 P3	Mine body destroyed, fuse initiated	No damages to the device (blast effect missing)	No measurements
19.07.02	TM 62 P3	Mine body destroyed, fuse initiated	No damages to the device (blast effect missing)	No measurements
19.07.02	TM 57	yes	Protective side plate ripped off from arm at the right.	(Error in measurements)

4.3.1 Effects of the mine detonation on the vehicle crew (impact of explosions)

The driver's knowledge about the presence of AT-mines causes already a psychological stress, which creates a negative influence on his operational readiness. Therefore the main goal of the trial was to prove the safety with regard to the impact of the explosion (effect of the acceleration) and the acoustic impact at the driver position inside the cabin during mine detonation.

The evaluation of the acoustic impact of the explosion was done by the experts of the acoustic department at WTD 91.

4.3.1.1 Subjective evaluation – Clearance process with ATM TM 62 (Trial on 17.07.02, Operator: WTD 41 staff)

Clearance process:

The buried ATM was dug out by the tiller drum and carried through the rotating movement to the right steel guide rod. The fuse was hit and, at the same time, the mine detonated. The detonation caused the operator to be frightened. A vibration impact in z-axis direction was felt at the driver seat. In the feet area the vibration impact was not felt. The fear of a collision between body and installations inside the driver cabin did not exist.

The acoustic impact of the explosion was not felt as critical thanks to the ear protection used and the short duration of the impact.

The impact of the mine detonation (ATM TM 62 P3) felt inside the driver cabin was estimated to be reasonable by the operator. In case of mine detonations with similar blast impact as the TM 62 P3 (reference mine) in front of the vehicle and in the vehicle's clearance area, the protection of the vehicle itself as well as of the cabin is considered as sufficient because of the blast effect in front of the vehicle no danger exists for the crew.

In order to build operator confidence in the protection of the mine clearance device, life mine targets should be used during future training.

4.3.1.2 Result of the human relevant evaluation done by WTD 91 (Acceleration impact on the driver seat and on the feet area, see annex)

The probability of injury at the driver's breast, lumbar spine and lower leg, caused by the incoming vibration in z-axis direction, have been evaluated in the seat area as well as at the feet area, According to the Armed Forces mine protection criteria, the injury probability inside a vehicle in case of mine threat is not allowed to exceed the figure of 5%.

The human relevant evaluation of the explosion impact, caused by the blast effect of the used mines (detonation in the tiller area of the vehicle), corresponds exactly to the impact felt by the driver on the driver seat. This subjective statement was confirmed by the evaluation of the measured results. The injury risk for the operator is very low or even zero, (calculated value for the injury probability = 0,1 %, limit figure 5%). According to WTD 91 (ergonomics) no permanent injury danger in the breast and lumbar spine is likely to occur due to the low acceleration figures, also in case of multiple impacts of the same force. According to the measured impacts an injury in the lower leg area can be excluded.

4.3.2 Effects of the mine detonation on the vehicle (Repairing expenses of the device's protective compound)

The installed protective compound of the device consist of a radially placed guide rod above the upper tiller area (made of 4 protective bars with attached sections of protected pipe) and protective plates on the right and left arms.

The main utility of this protective compound is:

- Reduce the blast and splinter effects on the vehicle and driver cabin.
- Careful elimination of AP-mines and explosive remnants from the rotating circle of the tiller drum
- Avoid that the dug out and undetonated or broken mines detonate outside of the clearance lane.

The protective compound and the tiller drum are directly exposed to the blast effects. Already after the first mine detonation (DM 21, inside the test lane) the following damages to the compound above the tiller drum, were visible:

- Deformation of the elimination bars and of the protected pipe bar sections (from time to time the pipes were also broken)
- Breaking of the protection pipe supports
- Damage (ripping) of the rubber covers and of the respective supports.

The replacement process of the protective bars and of the protected pipes requires a relatively large amount of material and time (about 10 men/hrs after 2 to 3 mine detonations of up to 5 kg TNT) and the deployment of determined lifting devices (cranes or recovery tank).

The TM 62 and TM 57 AP-mines both detonated very close to the protective plates present on the left and right side of the device. In both cases the protective plates were heavily deformed and the screws on the arms (18 hexagonal head screw M16, strength category 8.8) were destroyed. In the upcoming repairing process (replacement of the protective plate), the removal of the screws remaining on the arm was difficult and took up a lot of time.

Damages to the protective compound cannot be avoided due to the existing blast effect of detonating mines. Using constructive measures, such as implementing a more stable construction of the protective bars and pipes (tolerating up to 7 kg TNT), an improved replacement procedure of the single components with proper instruments fitted on board (e.g. lifting device present on the vehicle), the preparation of the vehicle for re-deployment could be accelerated remarkably.

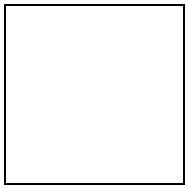
4.3.3 Clearance efficiency

In total 9 life AT-mines were cleared. The DM 21 and TM 57 mines, both with steel cases were initiated during the clearance (danger risk excluded). For the plastic cased TM 62 mine type, a mine was initiated by simple contact with the right protective plate, the remaining mines were broken by the tiller and the corresponding fuses were detonated.

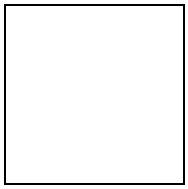
Assessment: The danger risk caused by the ATM at the trial area was no longer existent after the clearance process (the mines were either completely broken or their case was destroyed and the fuse initiated). In case of a deployment of the vehicle to mine-affected areas with unknown mine threat, a search phase for mine fragments and for remaining life fuses should be carried out.

Further remark: The clearance efficiency of the Minebreaker was determined in June 2001 and assessed by WTD 51. The result was satisfactory (report WTD 51 of 23.01.02).

Office	Clearance of armed AT mine with the MINEBREAKER	Date	
WTD 41		09.08.2002	
Dept		Page Nr.	Total Page
320		5	
Editor			
Lang			



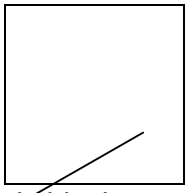
Picture 1: Minebreaker in working mode



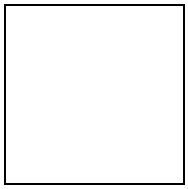
Picture 2: Tiller made of tiller drum with steel chisel

For the pictures refer to the original German document, also available in the ITEP reports database

Office	Clearance of armed AT mine	Date	
WTD 41		09.08.2002	
Dept	**with the MINEBREAKER**	Page Nr.	Page total
320		6	
Editor			
Lang			

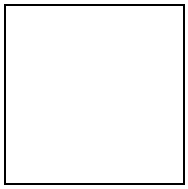


Picture 3 and 4: Drum with steel chisel

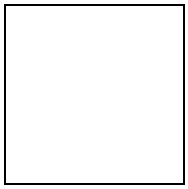


For the pictures refer to the original German document, also available in the ITEP reports database

Office	Clearance of armed AT mine	Date	
WTD 41		09.08.2002	
Dept	**with the MINEBREAKER**	PageNr.	Page total
320		7	
Editor			
Lang			



Picture 5: Driver cabin



Picture 6: Driver cabin, operating system with view through the front armored window.

For the pictures refer to the original German document, also available in the ITEP reports database

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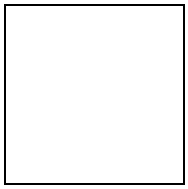
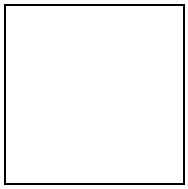
Office	Clearance of armed AT mine	Date	
WTD 41		09.08.2002	
Dept	**with the MINEBREAKER**	Page Nr.	Page total
320		8	
Editor			
Lang			



Picture 7 and 8: Tiller unit after detonation of the 3rd ATM DM 21



For the pictures refer to the original German document, also available in the ITEP reports database

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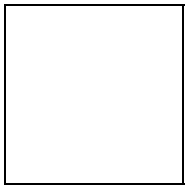
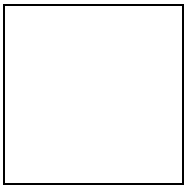
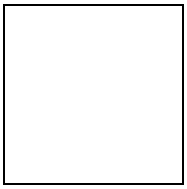
Office	Clearance of armed AT mine	Date	
WTD 41		09.08.2002	
Dept	**with the MINEBREAKER**	PageNr.	Page total
320		9	
Editor			
Lang			





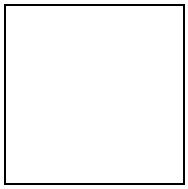
Picture 9 and 10: Deformed protective bars and damaged protective pipes



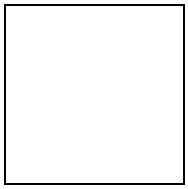
Picture 11: Replacement of the protective bars and the protective pipes

For the pictures refer to the original German document, also available in the ITEP reports database

Office	Clearance of armed AT mine with the	Date	
WTD 41		09.08.2002	
Dept	**MINEBREAKER**	Page Nr.	Page total
320		10	
Editor			
Lang			



Picture 12 and 13: Clearance process, ATM TM62 P3 with mine detonation



For the pictures refer to the original German document, also available in the ITEP reports database

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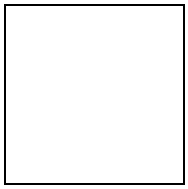
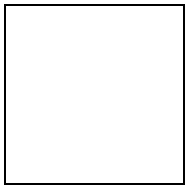
Officle		Date	
WTD 41	**Clearance of armed AT mine**	09.08.2002	
Dept		PageNr.	Total Page
320	**with the MINEBREAKER**	11	
Editor			
Lang			



Picture 14 and 15: Tiller unit after the clearance process of ATM TM62 P3.
Left protective plate is missing



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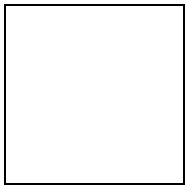
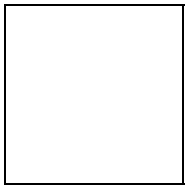


Picture 16 and 17: Deformed and ripped off protection plate (left one). Position in which it was found after the explosion of the ATM TM 62 P3.



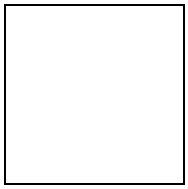
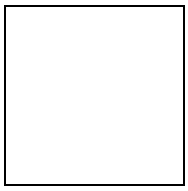
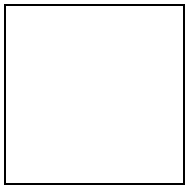
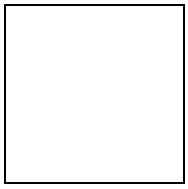
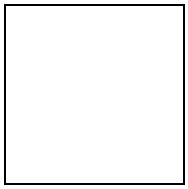
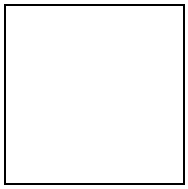
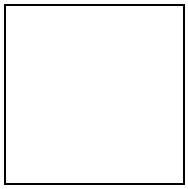
For the pictures refer to the original German document, also available in the ITEP reports database

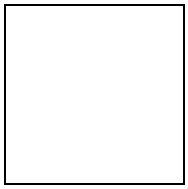
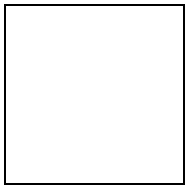
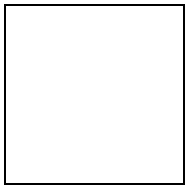
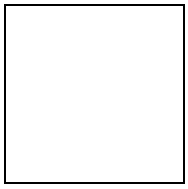
WTD 51	**Mine Clearance Device - Samples**	Koblenz, 21.08.2001
Dept 230		Project Nr.: 10536
TRAR Theimer	Pictures *refer to original German document, also available in the ITEP reports database*	Page 1 of 13
		Picture 1 AT-mine DM 21
		Picture 2 AT-mine TM 62 P3
		Picture 3 AT-mine TM 57
TRAR Theimer	Pictures *refer to original German document, also available in the ITEP reports database*	Page 2 of 13
		Picture 4 Trial 1 side plate, bent at the left
		Picture 5 Trial 1 side plate, bent at the left
		Picture 6 Trial 1 T- beam ripped off with chisel drum holder
TRAR Theimer	Pictures *refer to original German document, also available in the ITEP reports database*	Page 3 of 13

WTD 51	**Mine Clearance Device - Samples**	Koblenz, 21.08.2001
Dept 230		Project Nr.: 10536
		Picture 7 Trial 1 chisels damaged by detonation
		Picture 8 Trial 1 Screw connections, pipe support, short, and pipe fixer, short, ripped off
		Picture 9 Trial 1 middle rubber cover
TRAR Theimer	Pictures *refer to original German document, also available in the ITEP reports database*	Page 4 of 13
		Picture 10 Trial 2 pipe bent upwards
		Picture 11 Trial 2 screw connections ripped off
		Picture 12 Trial 2 screw connections ripped off
TRAR Theimer	Pictures *refer to original German document, also available in the ITEP reports database*	Page 5 of 13
		Picture 13 Trial 2 right rubber cover missing

WTD 51	**Mine Clearance Device - Samples**	Koblenz, 21.08.2001
Dept 230		Project Nr.: 10536
		Picture 14 Trial 2 right rubber cover missing
		Picture 15 Trial 2 left cover covering raised
TRAR Theimer	Pictures *refer to original German document, also available in the ITEP reports database*	Page 6 of 13
		Picture 16 Trial 3 bent T- beam with chisel drum holder
		Picture 17 Trial 3 pipe bent upwards
		Picture 18 Trial 3 gap between tiller unit right and 1st T-beam
TRAR Theimer	Pictures *refer to original German document, also available in the ITEP reports database*	Page 7 of 13
		Picture 19 Comparison: dismantled pipes after 3 detonations (DM 21) – new pipes
		Picture 20 Repair process: replaced components

WTD 51	**Mine Clearance Device - Samples**	Koblenz, 21.08.2001
Dept 230		Project Nr.: 10536
TRAR Theimer	Pictures *refer to original German document, also available in the ITEP reports database*	Page 8 of 13
		Picture 21 Repair process with fork lift
		Picture 22 Repair process with crane
TRAR Theimer	Pictures *refer to original German document, also available in the ITEP reports database*	Page 9 of 13
		Picture 23 Trial 4 ripped off side plates
		Picture 24 Trial 4 ripped off side plates
		Picture 25 Trial 4 ripped off screw connections
TRAR Theimer	Pictures *refer to original German document, also available in the ITEP reports database*	Page 10 of 13
		Picture 26 Trial 9 damages to the left side of the vehicle

WTD 51	**Mine Clearance Device - Samples**	Koblenz, 21.08.2001
Dept 230		Project Nr.: 10536
		**Picture 27** Trial 9 torn out side plate
		**Picture 28** Trial 9 torn out side plate
TRAR Theimer	Pictures *refer to original German document, also available in the ITEP reports database*	Page 11 of 13
		**Picture 29** MINEBREAKER after trial 1
		**Picture 30** MINEBREAKER after trial 2
		**Picture 31** MINEBREAKER after trial 3
TRAR Theimer	Pictures *refer to original German document, also available in the ITEP reports database*	Page 12 of 13
		**Picture 32** MINEBREAKER after trial 4
		**Picture 33** MINEBREAKER after trial 8 (only fuse with leftovers of explosive detonated)

WTD 51	**Mine Clearance Device - Samples**	Koblenz, 21.08.2001
Dept 230		Project Nr.: 10536
		**Picture 34** MINEBREAKER after trial 9
TRAR Theimer	Pictures *refer to original German document, also available in the ITEP reports database*	Page 13 of 13
		**Picture 35** Hot hydraulic conduction next to the ladder
		**Picture 36** Erected rubber cover
		**Picture 37** Joystick inside the driver cabin