Mechanical Demining Equipment Catalogue

2002

Geneva International Centre for Humanitarian Demining
Centre International de Déminage Humanitaire – Genève

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The **Geneva International Centre for Humanitarian Demining** supports the efforts of the international community in reducing the impact of mines and unexploded ordnance. It is active in the area of Humanitarian Mine Action through research, operational assistance and contributions to the implementation of the Mine Ban Treaty. It is an independent and impartial Foundation supported by 18 governments.

The **UN Mine Action Service (UNMAS)** serves as UN focal point for all mine-related issues and activities. At the global level, its coordination role involves the development of appropriate policies and standards, the ongoing assessment and monitoring of the mine and UXO threat, the collection and dissemination of information, including information on technology, the mobilization of resources, and advocacy in support of a global ban on antipersonnel landmines. At the field level, UNMAS is responsible for providing mine action assistance in the context of humanitarian emergencies and peacekeeping operations. UNMAS is part of the Department of Peacekeeping Operations (DPKO) of the United Nations Secretariat.

The **German Federal Foreign Office** started to compile a list of existing equipment in close cooperation with the United Nations Mine Action Service in 1998 and distributed the first edition of the Humanitarian Mine Action Equipment Catalogue in September 1999.
As a result of many requests from the mine action community for the guide and the intention to have a continuously updated and improved version, the Geneva International Centre for Humanitarian Demining has been asked to take responsibility for continuing the catalogue.

CONTENTS

FOREWORD

Many countries still suffer from the presence of landmines and unexploded ordnance (UXO), which threaten the lives of the population, prevent the cultivation of food crops and the redevelopment of infrastructure.

The struggle to remove landmines and UXO continues, and improvements are continually sought by which to increase the safety and cost-effectiveness of clearance. One major area of potential improvement is the use of mechanical equipment to assist in mine clearance activities. To investigate the potential of such equipment, the Geneva International Centre for Humanitarian Demining (GICHD) has been asked by the United Nations Mine Action Service (UNMAS) to carry out a study into mechanical equipment, and to prepare this equipment catalogue. The catalogue is a development of the one originially published by the German Government, in cooperation with UNMAS. Responsibility for maintaining it has now been passed to the GICHD, which will be updating and issuing it on an annual basis.

This catalogue is intended to be a useful handbook and information tool for those needing specific information about mechanical equipment for their demining projects.
The GICHD did not itself test the equipment listed in the catalogue, but where possible has included evaluation reports and given points of contact. Where test results are shown, we have quoted the test authority concerned, but we can take no responsibility for the accuracy of the information provided.

If you have any comments, experience or test reports on the equipments shown, or reports of any new developments or technologies, please contact:

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This catalogue is neither an advertisement brochure, nor a comprehensive test and evaluation authority. The GICHD can assume no responsibility for the data given on the listed products, which are based on manufacturer's information.

Lastly, I would like to thank the German Government for generously funding this important project.

Martin Dahinden

Ambassador
Director GICHD

INTRODUCTION

Aim of the GICHD Mechanical Catalogue

The aim of the GICHD catalogue is to inform the international mine clearance community at field level about the choice of machines currently or potentially available on the international market. Presented in a comprehensive but succinct document, the catalogue will assist the field user to make the appropriate choice of machine for the right task in a particular environment.

The catalogue gives an indication of costs and the level of manufacturer logistical support that a programme could expect to receive in the event of a purchase being made. Contact details of machine producers are provided.

Where possible, reference has been made to evaluations and tests conducted as part of the development of a particular system. Although such tests are not officially sanctioned by the GICHD, they do give an indication of performance. Full test results are not published in the catalogue, but information as to where test results can be obtained is given. It is a fact that a standard international system for the evaluation and testing of mechanical demining equipment does not currently exist. There are differences in test procedures between countries and organizations.

In certain cases, experiences of other field users with a machine are mentioned. This may influence the choice of system for potential buyers. The purchase price of machines, costs of spare parts and logistics, transport implications, amount of land cleared by a system and occasionally, the cost per square metre achieved are set out. Manufacturers have not provided equal levels of information. Some reports within the catalogue are more detailed than others. A comparative analysis of machines grouped in categories is presented at Annexes A – F.

The information published in the catalogue represents the situation as at the end of October 2001. Some of the machines are at the prototype stage and continue to be developed before becoming available on the market. Certain systems may reach maturity before the publication of the next catalogue at the end of 2002.

Equipment developers may also benefit from the mechanical catalogue. A cross-pollination of ideas between manufacturers is likely to occur, ultimately better serving deminers in the future. In a relatively young profession, it is to be expected that many changes of design concept and completely new ideas will enter the field of mechanical mine clearance. The catalogue will inevitably provide free advertising for the manufacturers featured. By being directly compared with their competitors however, the catalogue may induce healthy competition within the market, eventually leading to improvements.

Some of the systems in the catalogue were originally developed for military use. They are included because they have been subsequently adapted for humanitarian demining.

The catalogue does not list every machine applicable to mine clearance worldwide. Some system producers were approached but did not provide the minimum information required, and there are other manufacturers that may have escaped notice. It is planned that the catalogue will be updated annually, and that by 2002, all humanitarian mechanical mine clearance systems will be featured. Apart from the GICHD catalogue, mechanical mine clearance devices are also listed in Jane's, The U.S. DoD Humanitarian Demining Developmental Technologies 2000-2001 document, and various websites worldwide (e.g. UNMAS).

As a technical document, some of the terms used in the narrative may be misunderstood. To avoid this, a short glossary of terms is provided at page 3.

The GICHD catalogue is available in hard copy, CD, or on the GICHD web site at www.gichd.ch .

It is hoped by the GICHD that the mechanical mine clearance catalogue serves those for whom it is intended - the deminers in the field.

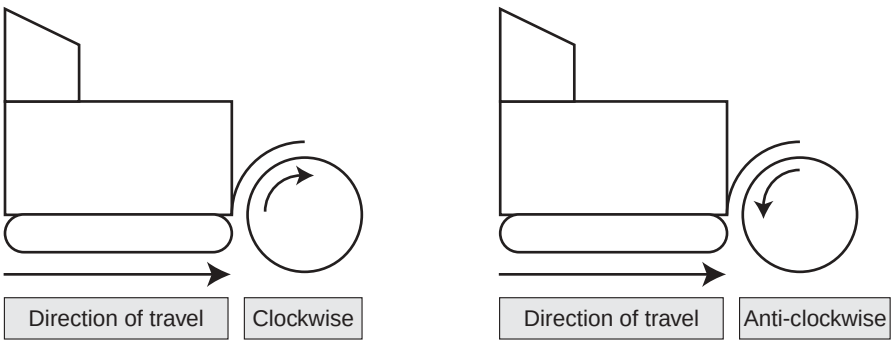
GLOSSARY OF TERMS

1. Equipment listed in the catalogue is referred to as *mechanical demining equipment.* Various military forces use some of the equipment featured. The GICHD catalogue deals solely with demining by civilian organizations.

2. Systems using chains on a rotating drum or shaft are referred to as *flails.* The varying weights of flail machines make it sensible to place them in three categories; *mini flails* (up to 5t); *midi flails* (5-20t); *heavy flails* (20t +).

3. Systems employing a heavy revolving drum fixed with steel spikes or teeth are referred to as *tillers.* They are grouped in one category, as they are mainly heavy.

4. To express the direction in which a system rotates, the terms *clockwise* and *anti-clockwise* are used. As this definition depends on which side the observer is standing, the diagram below gives the point of reference:



5. A glossary of acronyms is given in Annex J on page 202 - 203.

Section 1

Flail Systems

Bozena – 3

Figure 1 **Bozena clearing in Kosovo**

1. General Description

The Bozena is a remote-controlled mini flail designed to destroy surface-laid AP and AT mines, to cut vegetation and rip out trip-wires. The vehicle is remotely controlled out to a range of 500m by an operator in an air-conditioned cabin placed in line of sight. The truck-mounted cabin is part of the purchasing package (the truck is not). An armoured shield is mounted behind the flail to protect the machine from blast and flying debris. An armoured hood protects the vehicle against blast.

WAY Industry a.s. have produced three models of Bozena mini flail, Bozena 1, 2 and 3. Design upgrades between the model 2 and 3 are minor.

The Bozena has been designed with versatility beyond mechanical demining. Nineteen other tool attachments can be fitted to the machine for a variety of engineering tasks, and humanitarian support. Dismounting of the flail and attachment of another tool takes approximately 30mins.

2. Clearance Methodology

The 36 chains of the flail unit are each tipped with a strengthened steel hammer. Depending on terrain and soil conditions, the Bozena can achieve an approximate clearance depth of 15cm. The flail is designed to detonate or fragment AP and AT mines.

Figure 2 **The Bozena – 2 is unloading flail unit**

3. Machines in Use to Date

- **Bosnia and Herzegovina:** 6 x Bozena 1 and 2 purchased by NATO SFOR (1998, 2000) used by local Entity Armies.
- **Croatia:** 7 x Bozena 1, 2 and 3, under various local and international private demining companies currently deployed to the field.
- **Kosovo:** 3 x Bozena (Bozena 1), two with Slovakian Army KFOR units, one with UNMACC mine action projects.
- **Northern Iraq:** 9 x Bozena 2 with UN mine action projects as a part of "Oil for Food" programme.
- **Eritrea:** 5 x Bozena 2 with Slovakian Army units.
- Currently, more than 40 machines sold worldwide.

4. Engine, Fuel and Oil

- The vehicle is equipped with a Japanese YANMAR diesel engine with 51kW requiring 9.4 l of oil SAE 15W/40.
- Water-cooled by a double cooling system with 16 l capacity.
- Fuel consumption approx. 7 l/hr[1]. Fuel tank capacity 50 l.
- 50 l hydraulic oil capacity.

5. Factory Support

- Basic spare parts set included as part of purchase package.
- Extended spare parts kit for 6 months operation is offered by WAY Industry, based on manufacturer's experience of commonly required items, including losses.
- 6 month warranty.
- Two phase training course as part of purchase package. Phase 1 approx. five days in Slovakia regarding maintenance and troubleshooting. Phase 2, also approx. five days, practical training on-site. Three instructors are provided, one of which will act as interpreter.
- Trainees receive instruction manual and technical notes (spare parts catalogue etc.) in relevant language. Also part of purchase package.

Figure 3 **Bozena – 2 loaded on truck and trailer**

- Spare parts replaced during warranty period and not classed as lost materials will be replaced free of charge.

[1] CROMAC test report

6. Maintenance and Support

- WAY Industries recommend a two man crew: 1 operator, 1 driver.
- WAY Industries advise employment of one of their technicians to maintain the system.

7. Test and Evaluations

- Slovakian Army carried out tests with types of AP and AT mines. The client may obtain test results through the manufacturer.
- CROMAC (Croatia) tested Bozena 2 February-March 2001. Tests did not include PROM-1 (AP) on instruction from WAY Industry. During this test, 42000m^2 of ground were cleared.

8. Known Limitations and Strengths

a. Limitations

- The maneuverability of the Bozena 2 on wet ground is limited, and combined with inclined terrain can be very difficult.[2]
- Due to the construction of the flail, the Bozena showed problems in clearing PMA-2 mines, the smallest AP mine tested in Croatia.[3]

b. Strengths

- Well designed cooling system permitting constant work without engine stop during 5hr working shift.[4]
- Transportation of the machine simple. Easy to handle with a light low-bed trailer.[5]
- Good results are achieved in forested areas due to small size.[6]
- The reinforced armour is of high quality. Vital parts of the machine are well protected.[7]

Figure 4 **Bozena – 2 in working mode**

9. Point of Contact

Way Industry, a.s.
Valer Repko
Director of Bozena Dept.
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Jasikova 2
821 03 Bratislava
Slovakia

Tel: +421 2 48 291 320
Fax: +421 2 43 33 75 29
e-Mail: bozena@windustry.sk
Web site: www.way-industry.sk[8]

[2] CROMAC test report
[3] CROMAC test report
[4] CROMAC test report
[5] CROMAC test report
[6] CROMAC test report
[7] CROMAC test report
[8] Until the printing date the Web site does not contain any useful information

10. Technical data sheet Bozena-3

a. Dimensional data

1. Length without attachment:	3 102 mm
2. Length total:	5 282 mm
3. Width without attachment:	1 750 mm
4. Width total:	2 680 mm
5. Clearing width:	1 985 mm
6. Height, minimum:	2 020 mm
7. Height, overall:	2 200 mm
8. Weight, basic vehicle:	3 690 kg (with tracks)
9. Weight, Demining Unit:	860 kg
10. Weight, total:	4 550 kg

b. Driving specifications

11. Wheels/tracks:	Rubber tyres with Caterpillar steel tracks
12. Ground pressure, max weight:	0.66 kg/cm^2 (with tracks); Front wheels: 2.82 kg/cm^2; rear wheels: 1.46 kg/cm^2
13. Hill climbing ability:	Up to 20°[9]

c. Clearance performance

14. Number of chains:	36
• Length of chains	593 mm
15. Gap between chains:	Not given
16. Rotation speed:	Up to 400 rpm
17. Clearance depth, max:	Up to 150 mm
18. Working speed[10]	
• light soil/small vegetation:	500 m^2/h
• heavy soil/dense vegetation:	350 m^2/h
19. Control of clearing depth:	Mechanically by a sledge attached to the flail
20. Machines in use:	More than 40
21. Other types:	Bozena 1, Bozena 2
22. Location of use:	Bosnia and Herzegovina, Croatia, Eritrea, Kosovo, Northern Iraq
23. Totally cleared so far:	Not known

d. System specifications

24. Engine:	YANMAR 4TNE98 4-stroke, direct fuel injection
25. Fuel capacity:	50 l
26. Fuel consumption:	Max. 7 l/hour (see footnote 1)
27. Separate engine for tilling unit:	No
28. Cooling system engine:	Water (16 l)
29. Oil capacity:	9.4 l
30. Hydraulic oil capacity:	50 l

e. Comfort and security

31. Air condition:	In the cabin
32. Operator comfort:	Not given
33. Armour:	6 mm steel shield of the flail unit and 8 mm steel of the bodywork
34. Remote controlled:	Yes
• Greatest distance:	500 m

f. Costs

35. Cost of system:	Subject to negotiation
• Machine	Not given
• training	Included in the purchasing package
• spare parts	Subject to negotiation
36. Transport limitation:	The whole Bozena system can be packed in one 40ft and one 20ft container. The customer has to provide the truck for transportation
37. Possibility for rent:	Yes

[9] CROMAC test report
[10] CROMAC test report

MV-3

Figure 1 **MV-3 mini-flail with an additional vehicle for the operator and detection system**

1. General Description

The DOK-ING MV-3 is a 5t mini-flail produced in Croatia by a company which has earned it's reputation from field experience. The first model of the system, the MV-1, was produced in 1996. The MV-3 is remote-controlled, tracked and has a working width of 1.7 m. The machine can be controlled by an operator using a portable control panel, or from a second tracked vehicle protected by armour (see Fig. 1). An on-board video camera can be attached. The system is small and light and is suited to mine clearance in built up areas, forests or in other areas unsuitable for larger flails. The light-weight of the vehicle allows for easy transport by trailer. The machine is protected from explosive blast by 8mm steel armour.

The MV series has seen service in mine clearance programmes with Mechem, Gerbera, and Mungos. According to the manufacturer, the MV series have cleared 3km^2 during various projects between 1997-2000.

2. Clearance Methodology

The flail unit of the MV-3 rotates at up to 900rpm, achieving ground penetration depth of 15-20cm, depending on soil conditions. Two types of flail chain can be fitted; a 400g type for mine clearance, and 200g chain for vegetation cutting. The chains are effective against vegetation and trees up to 5cm dia. Both types of chains are tipped with steel hammers. The action of the flail is intended to detonate or fragment AP mines. A 10mm steel shield hoods the flail unit to protect the chassis. A roller is mounted behind the flail system in order to activate missed mines.

Figure 2 **The flail unit of the MV-3**

3. Machines in Use to Date

- MV-1 x 2 machines
- MV-2 x 4 machines
- MV-2S x 2 machines (MECHEM, CROMAC)
- MV-3 x 3 machines

All machines deployed in Croatia or Bosnia.

4. Engine, Fuel and Oil

- MV-3 is equipped with a 4 cyl. Perkins diesel engine 150 hp. No special fuel or oil required.
- Hydraulic oil is normal quality.

5. Factory Support

- The manufacturer, Perkins and Mannesmann-Rexrodt provide spare parts.
- Instruction manuals available in Croatian and English.
- Manuals and documentation part the purchasing package.
- Training of operators and mechanics included in the purchasing package.
- Warranty and factory follow-up for 6 months.
- General support service provided by the manufacturer.

6. Maintenance and Support

- Regular maintenance comprising daily, weekly and monthly checks as per operating instructions.
- The company recommends two-man crew: One operator and one mechanic.
- No special workshop required for repair/maintenance.

7. Test and Evaluations

- The MV-3 tested by CROMAC from December 2000 – February 2001 under CROMAC SOP for mini-flails. Test report available from the manufacturer, CROMAC and GICHD.
- During this test, the machine cleared approx. 178000m^2 in 27 working days (156hrs), an average of 1.136m^2/hr. One TMA-4 and one PMA-2 were cleared.
- In a second phase of the CROMAC SOP, the machine had to undergo tests with AP mines. The mines used were 2 x PMA-2, 2 x PMA-3, 2 x PMR-2A and 2 x PROM-1.
- MV-3 fragmented one mine and detonated seven. Of the seven, 1 x PROM-1 partially detonated.

Figure 3 **MV-3 operating in wet conditions**

8. Known Limitations and Strengths

a. Limitations

- MV-1 and MV-2 have overheating problems and are underpowered. The MV-3 has a cooling fan and a stronger engine.[1]
- Climbing ability up to 30%.[2]
- Vegetation cutting limited to 10cm dia.[3]
- During CROMAC test, the shield was seriously damaged by a PROM-1. A shock absorber was blown off and damaged.[4]
- The distance between the operator and the machine is usually 100m. If the machine were accidentally to detonate an AT mine, this would not be sufficient. The operator should control the vehicle using the video camera or from the protection of the second vehicle.[5]

b. Strengths

- Easy to transport on a simple trailer.[6]
- The small dimensions of the machine allow for flexible deployment.[7]
- Good balance between front and rear of the machine increases the mobility and maneuverability. [8]
- Maintenance and repair not difficult in field conditions.[9]

Figure 4 **Trailer mounted MV-3**

9. Point of Contact

DOK-ING d.o.o.
Vjekoslav Majtic
10 000 Zagreb
Kozarceva 38
Croatia

Tel: +385 1 48 24 134
Fax: +385 1 48 23 864
e-Mail: dok-ing@zg.tel.hr

[1] CROMAC test report, (English version) Sisak, February 2001, section 3.4.1. and 2.
[2] CROMAC test report, (English version) Sisak, February 2001, section 3.4.2.
[3] CROMAC test report, (English version) Sisak, February 2001, section 3.4.2.
[4] CROMAC test report, (English version) Sisak, February 2001, section 3.4.13.
[5] CROMAC test report, (English version) Sisak, February 2001, section 3.4.14. and 15.
[6] CROMAC test report, (English version) Sisak, February 2001, section 3.4.22.
[7] CROMAC test report, (English version) Sisak, February 2001, section 3.4.4. and 17.
[8] CROMAC test report, (English version) Sisak, February 2001, section 3.4.6
[9] CROMAC test report, (English version) Sisak, February 2001, section 3.4.23.

1. Technical data sheet MV - 3

a. Dimensional data

1.	Length without attachment:	2 500 mm
2.	Length total:	3 700 mm
3.	Width without attachment:	1 400 mm
4.	Width total:	2 100 mm
5.	Clearing width:	1 700 mm
6.	Height, minimum:	1 200 mm
7.	Height, overall:	1 400 mm
8.	Weight, basic vehicle:	2 800 kg
9.	Weight, Demining Unit:	700 kg
10.	Weight, total:	3 500 kg

b. Driving specifications

11.	Wheels/tracks:	Rubber tracks
12.	Ground pressure, max weight:	0.44 kg/cm^2
13.	Hill climbing ability:	40° [10]

c. Clearance performance

14.	Number of chains:	39
	• Length of chains:	250 mm
15.	Gap between chains:	5 mm
16.	Rotation speed:	Up to 900 rpm
17.	Clearance depth, max:	Up to 200 mm
18.	Working speed	
	• light soil/small vegetation:	1 500 m^2/h
	• medium soil/medium vegetation:	1 000 m^2/h
	• heavy soil/dense vegetation:	600 m^2/h
19.	Control of clearing depth:	Manually by operator
20.	Machines in use:	3
21.	Other types:	8 (MV-1; MV-2)
22.	Location of use:	Croatia; Bosnia
23.	Totally cleared so far:	Approximately 3 000 000 m^2

d. System specifications

24.	Engine:	Perkins 150 HP
25.	Fuel capacity:	100 l
26.	Fuel consumption:	Max. 15 l/hour
27.	Separate engine for tilling unit:	No
28.	Transition:	Hydrostatic
29.	Cooling system engine:	Water
30.	Oil capacity:	12 l
31.	Hydraulic oil capacity:	100 l

e. Comfort and security

32.	Air condition:	-
33.	Operator comfort:	-
34.	Armour:	10 mm steel shield of the flail unit and 8 mm steel of the bodywork
35.	Remote controlled:	Yes
	• Greatest distance:	1 000 m

f. Costs

36.	Cost of system:	
	• Machine	USD 250 000
	• training	included
	• spare parts	basic spare parts set included
37.	Transport limitation:	Truck or trailer min 4 ton
38.	Possibility for rent:	yes

[10] According to the manufacturer

Aardvark Mk IV

Figure 1 **Aardvark clearing in Angola**

1. General Description

The Aardvark system is probably the most commonly used mechanical mine clearance vehicle in the world. The Aardvark was first developed in 1985. The latest model is the Aardvark Mk IV.

The Aardvark Mk IV is a chain flail system designed to destroy anti-personnel and anti-tank mines. The machine uses a half-track platform giving it greater traction and stability in difficult terrain. Wheels can replace the tracks if the machine is required to transport itself. If the vehicle must move to a new location over a longer distance, it is better to transport it by low-loader.

Power to operate the flail is derived from the vehicle engine. The Mk IV is controlled by up to two operators seated in a fully armoured cab. The belly armour is angled for maximum blast deflection and the protective glass around the cab is strengthened with an internal polycarbonate liner and an external steel mesh.

2. Clearance methodology

During clearance operation, the vehicle moves rear end first into a suspect area. The flail component has an expected clearance width of 3m to a maximum depth of 58cm. The ground penetration depth is adjusted by an automatic contouring and depth control system, which can be overridden by the operator.

The flail drum rotates anti-clockwise up to a speed of 320rpm. The manufacturer states that the flail unit should detonate or break up mines.

Figure 2 **Aardvark detonating an anti-tank mine**

3. Machines in Use to Date

- To date, approx. 200 Aardvarks have been delivered to 26 countries.
- Aardvark has sold many vehicles to the international military community, including six NATO countries.
- Aardvark has been sold to non-profit and commercial humanitarian mine clearance organisations. E.g. Norwegian People's Aid (NPA) have three working in Angola. Two machines have been used by a French demining organization in Mozambique.

4. Engine, Fuel and Oil

- The Aardvark has a single 165hp turbo charged engine using standard diesel fuel.
- Oil used in the engine and hydraulic systems are of a standard type used by agricultural machines found throughout the world.
- Reference tables are supplied for all major oil suppliers recommended by the engine/transmission manufacturers.

5. Factory Support

- Aardvark provides after sales support to their customers. Manuals covering operation, maintenance and spare parts are supplied in English as part of the sales package. Translation into the customer's language is possible if required.
- A large parts inventory is maintained at the factory and spare parts can be shipped at short notice.
- The warranty covers one year from the date of delivery to final destination.
- Aardvark recommends a minimum of one-month training for users provided at a location chosen by the customer.
- The company offers to provide any other support that the customer needs including personnel for extended operations, maintenance packages etc.

6. Maintenance and Support

- Regular maintenance periods comprising daily, weekly and monthly checks are required as laid down in the operating procedures.
- The company recommends a two men crew operate the vehicle.
- Aardvark claims that no special workshop facilities are required. According to the manufacturer the machine is designed to be field repairable.

Figure 3 **Maintenance in Angola**

7. Test and Evaluations

- Due to its age and wide distribution, Aardvark is probably one of the most tested mine clearance machines on the market.[1]
- In 1999, the Dutch Army carried out a series of tests to determine the safety of the control cab for the operator on a MK III. Using a fully instrumented dummy in the cab, a series of eight anti-tank mines and other ordnance items were control detonated under and around the vehicle. No 'injuries' to the test dummy were reported.
- The MK IV was tested by the British Defence Equipment Agency (DERA) in 2000. The test proved satisfactory to DERA, which stated that the overall clearance percentage reached the UN standard.
- NPA has undertaken two field tests of the Mk III in Angola. The results suggest that the machine is capable of achieving approximately 98% clearance rate under good conditions.[2]

8. Known Limitations and Strengths

a. Limitations

- The early models had a tendency to overheat if used for more than 30 minutes in tropical climates. This effect is further increased if the machine is used in areas with heavy vegetation. It is not currently known if this problem has been rectified in the Mk IV.
- According to users of previous Aardvark models, machines often tend to break down.
- According to users of previous models, machines can throw mines out of the beaten zone.

b. Strengths

- The Aardvark Mk IV is a mature product and incorporates all the lessons learned from 16 years of operation.
- Simple mechanism. Spare parts readily available. Easy to repair.

Figure 4 **The Aardvark Mk IV from the front**

9. Point of Contact

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Shevock Estate
Insch, Aberdeenshire
SCOTLAND AB52 6XQ

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Fax: +44 (1464) 820985
e-Mail: aardmine@netcomuk.co.uk
Web site: www.aardvarklandmineclearance.co.uk

[1] According to the manufacturer
[2] NPA test carried out in 1997

10. Technical data sheet Aardvark Mk IV

a. Dimensional data

1.	Length without attachment:	5 486 mm
2.	Length total:	7 750 mm
3.	Width without attachment:	2 530 mm
4.	Width total:	3 556 mm
5.	Clearing width:	3 000 mm
6.	Height, minimum:	2 613 mm
7.	Height, overall:	3 190 mm
8.	Weight, basic vehicle:	11 506 kg
9.	Weight, Demining Unit:	3 792 kg
10.	Weight, total:	15 328 kg

b. Driving specifications

11.	Wheels/tracks:	Half track layout with foam fill tyres
12.	Ground pressure, max weight:	Wheels: 1.35 kg/cm^2 Tracks: 0.35 kg/cm^2
13.	Hill climbing ability:	33°

c. Clearance performance

14.	Number of chains:	72
	• Length of chains:	1 100 mm
15.	Gap between chains:	37 mm
16.	Rotation speed:	320 rpm
17.	Clearance depth, max:	Up to 580 mm in light soil [3]
18.	Working speed [4]	
	• light soil/small vegetation:	3 600 m^2/h
	• heavy soil/dense vegetation:	600 m^2/h
		but generally determined by mine type and depth
19.	Control of clearing depth:	By automatic contouring and depth control system which can be overridden by operator
20.	Machines in use:	More than 200 in total

d. System specifications

21.	Engine:	6 cyl in line diesel with turbo charger
22.	Fuel capacity:	200 l
23.	Fuel consumption:	Max. 23 l/hour
24.	Separate engine for tilling unit:	No
25.	Transition:	Not given
26.	Cooling system engine:	Not given
27.	Oil capacity:	68 l
28.	Hydraulic oil capacity:	90 l

e. Comfort and security

29.	Air condition:	Yes
30.	Operator comfort:	Vibration and noise reduction, dust filters, over-pressured cab, gyrocompass, dual position controls –right and left side of the cab, headphones with microphone for communication
31.	Armour:	Protection glass, minimum 10 mm steel plates
32.	Remote controlled:	Optional

f. Costs

33.	Cost of system:	Only on request
34.	Other costs:	Only on request
35.	Transport limitation:	A flat bed or articulated truck is required
36.	Possibility for rent:	Yes, if required with operator and mechanics

[3] According to the manufacturer
[4] According to the manufacturer

Armtrac 100

Figure 1 **Armtrac 100 from the front**

1. General Description

The Ground Sift and Clear Systems Ltd Armtrac 100 is a midi-flail system based on a New Holland tractor fitted with 10mm armour around the driver's cab and 6mm armour protecting the chassis. The vehicle has a 165hp engine, front steering 4 x 4 with foam fill tires. It has a top road speed of 45km/hr. A creep gearbox is incorporated into the system for the most difficult driving conditions, complete with a 16 x 16-electro shift for fast and easy gear changes. The Armtrac 100 can climb and flail slopes of up to 45 degrees[1] and clear flat areas at a rate of 1 600 square metres/hr[2]. The flail can remain attached at full road speed, or detached from the tractor in five minutes.

The flail rotors are designed to withstand AP mine blasts with fragmentation and AT mines.

The tractor is fitted with a winch to enable self-recovery without the need for support vehicles.

The Armtrac 100 has a PTO shaft and a 3-point linkage at the front and rear. The Mine Sift and Separation System produced by the manufacturer can be fitted to the rear of the tractor. Any other equipment driven by a PTO shaft can be fitted e.g. portable welders, electrical generating plants etc.

[1] According to the manufacturer
[2] According to the manufacturer

Figure 2 **Armtrac 100**

2. Clearance methodology

The overall width of the vehicle is 3m, with a working width of 2.4m. The rotor operates at up to 350rpm clockwise and clears ground to a depth of approximately 30cm. In operational mode, the special gearbox on the vehicle propels the machine at 0.3km/hr. Each chain on the flail has a hardened steel hammer attached to the end in order to cause detonation or break-up of mines. Clearance depth adjustment is regulated manually by the operator.

3. Machines in Use to Date

- Machines have been sold to G3 Systems, European Landmine Solutions and Exploration Logistics (Mineclear/Minetech).
- Two machines currently working in Bosnia and Mozambique.

4. Engine, Fuel and Oil

- The tractor has a diesel engine with an average consumption of 50 l/hr while operating the flail.

5. Factory Support

- The Armtrac 100 is based on a New Holland tractor. New Holland parts should be available worldwide.
- At extra cost, a recommended basic spare parts kit is supplied by the manufacturer as part of the purchase package.
- The manufacturer supplies special parts unlikely to be found locally.

6. Maintenance and Support

- Weekly basic greasing and oil level checks etc by driver/operator.
- Full service required every 300hrs by personnel trained by the manufacturer.

7. Test and Evaluations

- The machine will be tested by Qinetiq Chertsey (formerly DERA) in Jan-Feb 2002.

8. Known Limitations and Strengths

a. Limitations

- For transportation over longer distances, a low bed trailer is required.

b. Strengths

- A light-weight flail system that can be used against AT mines.

Figure 3 **The Armtrac 100**

9. Point of Contact

Ground Sift & Clear Systems Limited
Stephen Brown
5 Tenbell Lane
Soham, Ely, Cambs,
England CB7 5BJ

Tel: +44 (0) 1638 74 39 79
Fax: +44 (0) 1638 74 25 78
e-Mail: gscs@supanet.com
Web site: www.gscs.sagenet.co.uk

10. Technical data sheet Armtrac 100

a. Dimensional data

1. Length without attachment:	5 000 mm
2. Length total:	7 300 mm
3. Width without attachment:	2 200 mm
4. Width total:	3 000 mm
5. Clearing width:	2 400 mm
6. Height, overall:	3 150 mm
7. Weight, basic vehicle:	10 400 kg
8. Weight, Demining Unit:	2 600 kg
9. Weight, total:	13 000 kg

b. Driving specifications

10. Wheels/tracks:	4 wheels with foam fill tyres
11. Ground pressure, max weight:	Not given
12. Hill climbing ability:	45° [3]

c. Clearance performance

13. Number of chains:	54
• Length of chains:	1 000 mm
14. Gap between chains	10 mm
15. Rotation speed	350 rpm
16. Clearance depth, max:	300 mm travelling at 0.3 km/hr
17. Working speed	
• light soil/small vegetation:	Approx. 2 700 m^2/hr
• medium soil/medium vegetation:	Approx. 1 200 m^2/hr
• heavy soil/dense vegetation:	Approx. 500 m^2/hr [4]
18. Control of clearing depth:	Manually
19. Machines in use:	2
20. Location of use:	Bosnia, Kosovo, Mozambique, and Lebanon in near future
21. Totally cleared so far:	Approx. 5 400 000 m^2
22. Other types	Armtrac 325

d. System specifications

23. Engine:	New Holland diesel engine with 165 hp
24. Fuel capacity:	280 l
25. Fuel consumption:	Max. 32 l/hour
26. Separate engine for tilling unit:	No
27. Transition:	Stable axle pivot
28. Cooling system engine:	Not given
29. Oil capacity:	Not given

e. Comfort and security

30. Air condition:	Yes
31. Operator comfort:	air seat, 10 decibel cab noise
32. Armour:	Cab 10 mm armour
33. Remote controlled:	No

f. Costs

35. machine	£ 145 000
36. training	£ 2 500
37. Duration of training:	10 days
38. spare part set	£ 2 000 per year
39. repair costs	£ 1 500 over one year
40. Transport limitation:	10 000 £ to buy an own low loader
41. Possibility for rent:	Yes

[3] According to the manufacturer
[4] all figures according to the manufacturer

Hydrema 910 Humanitarian MCV

Figure 1 **The Hydrema 910 MCV with flail unit**

1. General Description

The Hydrema 910 humanitarian mine clearance vehicle is based on the pivot chassis of a commercial dumper. The running gear consists of four wheels on two axles. It is designed to clear mines with a chain flail system. Two identical but independently working 185hp Perkins engines power the system, one for driving and the other for the flail unit. During transportation, the flail unit is mounted on the platform rear of the cab. The driving speed on paved roads is up to 35km/h. The system can be transported by loader vehicle, by rail or airlifted in a Hercules C 130. The vehicle requires one operator. For self-recovery, a winch is attached at the front of the vehicle.

2. Clearance Methodology

Transformation of the flail unit from its road transport position to working configuration can be achieved in minutes using a special tilting/turning system, hydraulically operated from the cab. When working, the vehicle moves in the opposite direction to road movement. Pivot steering is designed to ensure that the front and rear wheels move in the same track. The 72 chains of the 3.5m wide flail shaft rotate clockwise at a speed of up to 400rpm. The flail action should detonate or fragment AP and AT mines. Direction of rotation can be reversed. Effective ground penetration depth is up to 50cm in sandy terrain and can be controlled automatically or manually. The vehicle must be driven in a line comprising tight zigzag movements in order that the deflector plate separating the flail from the main body does not create waves in the left soil. The deflector plate is of armoured steel and protects against blast and fragments. The operator can manually control the vehicle using a joystick or select a computerized automatic pilot steering system.

Figure 2 **Hydrema 910 MCV detonating a mine**

3. Machines in Use to Date

- 23 machines worldwide.
- In 1996, 12 machines were delivered to the Danish Army. 2 of these are currently used in Bosnia, 3 in Kosovo. 2 machines have been leased out to DCA/DDG in Eritrea.
- NPA has 2 machines in Angola.
- 1 vehicle in Croatia with demining NGO Dr. Koehler.

4. Fuel, Engine and Oil

- The Hydrema 910 MCV has 2 x 136 kW (185-hp) Perkins turbo inter-cooler engines, one for driving and one for flailing.
- Average fuel consumption is 60 l/hr [1].
- Oil used in the engine and the hydraulic systems is of general standard.

5. Factory Support

- Manufacturer has not provided further information.

6. Maintenance and Support

- Manufacturer has not provided further information.

7. Test and Evaluations

- Tested by the Danish Army-1996/7.
- The German Army tested the Hydrema 910 MCV in October 2000.
- Tested in Croatia by CROMAC April–June 2001.
- Tested in Sweden by SWEDEC August 2001.

Figure 3 **Hydrema 910 MCV in transportation mode**

[1] Test report WTD 51 Annex 9 p. 2, dated 2001-01-15

8. Known Limitations and Strengths

a. Limitations

- Tests in Germany showed that the machine worked slower than two other competitors.[2/3]
- It is necessary to move the shield of the flail system manually in horizontal direction from the cab to insure good clearance results. [4]
- During the tests, the system induced heavy vibrations. [5]
- The engine for the flail is under-powered. [6]
- For safety reasons, the armour of the cabin must be improved.

b. Strengths

- Can easily be deployed to the area of operation. It takes only five minutes to convert the system for clearance activities.
- By changing the direction of the rotating flail, the system can also surface clear roads and areas with hard surface.
- The vehicle is equipped with two same two engines for driving and flailing. This simplifies the support and maintenance.
- The pivot steering should enable the vehicles to drive with front and rear wheels in the same track.

Figure 4 **The Hydrema 910 MCV in operation**

9. Point of Contact

A/S Hydrema Danmark
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9530 Stovring
Danmark

Tel: +45 98 37 13 33
Fax: +45 98 37 19 96
e-Mail: hydrema@hydrema.com
Web site: www.hydrema.com

[2] Test report WTD 51, dated 2001-01-15
[3] The Hydrema 910 MCV was the only flail system in this test
[4] Test report WTD 51, dated 2001-01-15
[5] Test report WTD 51, dated 2001-01-15
[6] Test report WTD 51, dated 2001-01-15

10. Technical data sheet Hydrema 910 MCV

a. Dimensional data

1.	Length (Transportation position):	9 200 mm
2.	Length (Clearing position):	10 000 mm
3.	Width (Transportation position):	2 800 mm (option: 2 500 mm)
4.	Width total:	2 420 mm
5.	Clearing width:	3 500 mm
6.	Height, minimum:	2 700 mm
7.	Height, overall:	3 600 mm
8.	Weight, basic vehicle:	Not given
9.	Weight, Demining Unit:	Not given
10.	Weight, total:	18 000 kg

b. Driving specifications

11.	Wheels/tracks:	4 standard tyres Good Year RL-2+ 17.5R25 with foam filled
12.	Ground pressure, max weight:	Not given
13.	Hill climbing ability:	34° [7]

c. Clearance performance

14.	Number of chains	72
	• Length of chains	900 mm
15.	Gap between chains	Not given
16.	Rotation speed	Up to 400 rpm
17.	Clearance depth, max:	Up to 250 mm in light soil [8]
18.	Working speed	750 – 1 000 m^2/h [9]
19.	Control of clearing depth:	by automatic depth control system which can be overridden by operator
20.	Machines in use:	23
21.	Location of use:	Denmark (Army), Bosnia – Herzegovina, Croatia, Kosovo, Angola, Mozambique

d. System specifications

22.	Engine:	Perkins 1006-6TW, 6 cyl diesel with turbo charger
23.	Fuel capacity:	300 l
24.	Fuel consumption:	max. 60 l/hour
25.	Separate engine for tilling unit:	Yes, the same engine as for driving (see 20.)
26.	Transition:	hydrostatic
27.	Cooling system engine:	Not given
28.	Oil capacity:	Not given
29.	Hydraulic oil capacity:	Not given

e. Comfort and security

30.	Air condition:	yes
31.	Operator comport:	Not given
32.	Armour:	Not given
33.	Remote controlled:	No

f. Costs

34.	Cost of system:	The manufacturer offers 4 vehicles including the whole program and support for one year for approx. 10 Mill €
35.	Other costs:	Not given
36.	Transport limitation:	Max. 35 km/hr on own wheels
37.	Possibility for rent:	Not given

[7] According to the manufacturer
[8] CROMAC test report (the system achieved during the tests in Germany 30 cm)
[9] CROMAC test report

Minecat 230

Figure 1 **The Minecat 230 during tests in Kosovo**

1. General Description

In 1998, a group of companies in Norway formed the Norwegian Demining Consortium (NoDeCo). In 1999, the first mechanical product of NoDeCo was the midi-flail Minecat 230. The Minecat weighs only 8 tons and has a working width of 230cm. The vehicle has tracks and can be controlled remotely or by an operator inside the cab. It can also be controlled using a remote cable for situations where remote control might create a RF hazard (proximity to electrical detonators).

The machine is based on a Bobcat 863 skid steer chassis. The system is for clearance of AP and AT mines. The Minecat's small size and relatively light-weight enable it to work well in urban areas or over difficult terrain where larger flails cannot operate. The Minecat can also be mounted with other Bobcat front-end tools, enhancing user flexibility.

For ease of shipment or long distance transportation, the system can be broken down into three major compartments: the driver's cab (1000kg), the chassis (4700kg), and the flail unit (2100kg).

The NoDeCo Tower is an armoured observation cabin mounted on an elevation platform. If dense vegetation or other obstacles create difficulties for control of the system, an operator is afforded an improved observation point. The maximum operating distance in line of sight is 1000m.

The Minecat is equipped with two diesel engines - one for the prime mover and one for the flail unit.

2. Clearing methodology

The flail unit attached to the front of Minecat rotates its 48 chains at a speed of 384rpm, with a stated clearance depth of 20cm, depending on soil conditions.[1] Each chain has a 60mm dia hammer attached to the end designed to detonate or fragment mines. The chains are mounted to the flail drum in a staggered pattern, giving each hammer an overlap of 10mm each side as it hits the ground.

[1] According to the manufacturer

Figure 2 **The flail unit of the Minecat 230**

3. Machines in Use to Date

- 1 machine in Kosovo donated to The HALO Trust. Previously used by NPA and MAG.
- 2 machines working in Iran for NPA.
- 1 machine currently used for sales demonstrations.

4. Engine, Fuel and Oil

- The Minecat is equipped with a Deutz diesel engine for the prime mover and a Perkins 1006-60 turbo 6 l diesel engine for the flail system. No special fuel or fuel additives are required. The fuel tank feeds both engines and has a capacity of 95 l diesel.
- Hydraulic oil is of normal quality (SAE11W40 ISO 46).

5. Factory Support

- A comprehensive spare parts support package for one year.
- Minecat chassis and base components are available via world wide service offered by Bobcat.
- NoDeCo offers the choice of factory training in Norway or on site training tailored to the customers requirements. Training normally lasts 6 weeks.
- Training, documentation, and manuals in English are part of purchase package.
- Warranty and factory follow-up provided by the manufacturer; no details given.

6. Maintenance and Support

- Regular maintenance comprising daily, weekly, monthly, and annual checks required as per the operating instructions.
- The company recommends a 3-operator crew; 1 operator, 1 observer (for additional safety), and 1 operator resting.
- The Minecat is supported by a mobile workshop that can be established in one of the two containers supplied.
- Can be shipped in 4 x 20´containers.

Figure 3 **Minecat 230 detonating a mine**

7. Test and Evaluations

- In June 1999, the Norwegian Defence Research Establishment (NDRE) carried out a test to evaluate operator risk. 10kg of TNT were detonated under the flail unit. In brief, the test concluded that against detonations of up to 10kg TNT, the operator will not suffer injury provided that:[2]

[2] FFI/RAPPORT – 99/06241 approved 20 December 1999

– The cabin has not previously been damaged

– Doors remain completely shut

– Operators wear head and ear protection

- NPA conducted testing and evaluation of the Minecat 230 over six months in Norway and two months in Kosovo in 1999. The system was found to move too quickly over suspect ground and recommendations were made to improve ground penetration by reducing speed. The machine has been subjected to more than 20 modifications since tests in Kosovo. This was in order to address weaknesses identified by a number of humanitarian demining organizations (e.g. MAG and NPA). The machine proved robust against AP and AT mine blasts, incurring the expected loss of some chains and chain hammers.[3]
- Both reports are available from the manufacturer and from the GICHD.

8. Known Limitations and Strengths

a. Limitations

- Manual depth control only.
- Frequent breakdowns while operating with MAG in Kosovo (approx. every 4 working hours).[4]

b. Strengths

- A light and compact demining tool shipped in 4 x 20' containers.
- Small size adds to deployment flexibility.
- Built to attack AP and AT mines.

c. Summary

- "Despite the fact that the Minecat is designed to support/supplement demining operations, it proved to have a high clearance rate. It is not suggested or planned to use the Minecat as a stand alone demining tool, but this high clearance rate will probably speed up manual and dog demining operations"[5]

Figure 4 **Minecat 230 working in Kosovo**

9. Point of Contact

Norwegian Demining Consortium AS
Lars Kogstad M.B.A.
Project Manager
P.O. Box 2521 Solli
0202 Oslo
Norway

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Fax:	+47 22 43 42 17
Mobile:	+47 920 51151
e-Mail:	nds@nauteknik.no
Web site:	www.nodeco.nu

[3] NPA MINECAT Test Report & Recommendations written by Michael Hands 10th February 2000
[4] MAG
[5] NPA MINECAT Test Report & Recommendations written by Michael Hands 10th February 2000, page 7

10. Technical data sheet Minecat 230

a. Dimensional data

1. Length without attachment:	4 850 mm
2. Length total:	6 000 mm
3. Width without attachment:	2 000 mm
4. Width total:	3 300 mm
5. Clearing width:	2 300 mm
6. Height, minimum:	2 060 mm
7. Height, overall:	2 700 mm
8. Weight, basic vehicle:	4 700 kg (without cab)
9. Weight, Demining Unit:	2 100 kg
10. Weight, total:	7 800 kg

b. Driving specifications

11. Wheels/tracks:	Tracks (width: 385 mm)
12. Ground pressure, max weight:	0.4 kg/cm^2
13. Hill climbing ability:	Not given

c. Clearance performance

14. Number of chains:	48
• Length of chains:	860 mm
15. Gap between chains:	50 mm (dynamically 10 mm overlap)
16. Rotation speed:	384 rpm
17. Clearance depth, max:	Up to 500 mm, depending on the ground
18. Working speed:	Approx. 2 000 m^2/h [6] (no further data available)
19. Control of clearing depth:	Manually by operator
20. Machines in use:	4
21. Other types:	Minemouse mini flail (under development)
22. Location of use:	Bosnia, Kosovo, Iran
23. Totally cleared so far:	Not given

d. System specifications

24. Engine:	Deutz 73 hp
25. Fuel capacity:	95 l (one fuel tank for both engines)
26. Fuel consumption:	9 l/hour
27. Separate engine for tilling unit:	Perkins 150 hp
28. Fuel consumption:	Max. 21 l/hour
29. Transition:	Hydraulic/Hydrostatic
30. Cooling system engines:	Not given
31. Oil capacity:	64 l (for both engines and crank case reservoir)
32. Hydraulic oil capacity:	102 l (for both engines)

e. Comfort and security

33. Air condition and operator comfort:	Not given
34. Armour:	6.5 – 13 mm armoured steel (+ 6.5 mm optional)
35. Remote controlled:	Yes
• Greatest distance:	1 000 m in line sight

f. Costs

36. Cost of system:	
• Machine	USD 400 000
• training	included
• spare parts, tools, consumables and workshop:	USD 120 000
• 10 tons transportation trailer:	USD 40 000
• NoDeCo minefield tower:	USD 70 000
• Service & support system per year:	USD 150 000
37. Transport limitation:	4 x 20' containers
38. Possibility for rent:	No

[6] According to the manufacturer

RA – 140 DS Mine Clearing Vehicle

Figure 1 **The Patria RA–140 DS in operating mode**

1. General Description

The Patria RA-140 DS is a wheeled, armoured midi-flail system designed to clear anti-personnel mines (non-directional) and anti-tank mines of up to 10kg of TNT. The driver's cab is armoured, and the windows are of protective glass. The cab will withstand explosive blast and affords ballistic protection against direct fire rounds of up to 7.62mm. A crew of two have two complete sets of controls; one for driving forward on road moves and the other for clearance operation in the reverse direction. The cab is pressure sealed, sound insulated and shock resistant. The vehicle running gear consists of six wheels on two axles.

The chain flail unit is hydraulically powered. Ground penetration depth control is automatic and manual. For transportation, the flail unit with its armoured shield lifts up to be fixed in position above the rear axle. For transport over longer distances or storage, the flail unit and shield can be disconnected and attached to the truck bed. In this position, the vehicle width is 2920mm.

The RA-140 DS does not require loader transport. On paved roads, the vehicle can travel at an average of up to 70km/hr. With the flail unit detached and put on the vehicle platform, the system can be transported by air.

A winch is attached at the front for self-recovery. During clearance operations, the transfer box has a two speed hydraulic motor for slow driving.

2. Clearance Methodology

The total width of the vehicle in working position is 4m, while the flail itself is 3.4m wide. The 84 chains of the flail rotate clockwise at up to 400rpm. The ground depth penetration of up to 370mm is achieved when set to automatic or manual depending on the mode selected by the operator. The action of the flail is designed to detonate or fragment AP and AT mines.

Figure 2 **Patria RA–140 DS vehicle in transportation mode**

3. Machines in Use to Date

- There are approx. 50 machines worldwide, mostly for military use.
- The Patria RA–140 DS has been deployed to Cambodia, Mozambique, and Kosovo for humanitarian demining operations.

4. Engine, Fuel and Oil

- The Patria RA–140 DS is powered by a 6-cyl. DEUTZ diesel engine of 141kW. It is turbo charged, air cooled and has direct injection.
- 150 l fuel capacity.
- Engine oil capacity is 16 l. Main gearbox takes 29 l. Hydraulic fluid capacity is 60 l.

5. Factory Support

- Spares specific to the RA–140 DS are provided directly from Patria Vehicles Oy.
- A package of training, spare parts and equipment support is negotiable between the purchaser and Patria Vehicles Oy.

6. Maintenance and Support

- Patria components and spare parts are available on the international commercial market. Some specialist parts for the flail unit must be ordered direct from Patria Vehicles Oy.

7. Test and Evaluations

- The Finnish Army, during development of the RA-140 DS, carried out tests and evaluation. UN representatives were present during certain stages of evaluation.

Figure 3 **The Patria RA–140 DS flail system**

8. Known Limitations and Strengths

a. Limitations

- The RA-140 DS is a wheeled vehicle with the attendant difficulties of mobility in tight spaces that this entails.
- The system showed a tendency to break down during operations in Kosovo in 2001.
- Overheating has been reported as a problem in tropical regions.

b. Strengths

- The RA-140DS can move long distances independent of a loader vehicle.

Figure 4 **The Patria RA–140 DS**

9. Point of Contact

Patria Vehicles Oy
P.O. Box 186
13101 Hämeenlinna
Finland

Tel: +358 3 6451
Fax: +358 3 619 6710
e-Mail: pauli.rumbin@patria.fi
Web site: www.patria.fi

10. Technical data sheet Patria RA–140 DS

a. Dimensional data

1. Length (Transportation position):	7 850 mm
2. Length (Clearing position):	9 450 mm
3. Width (Transportation position):	2 920 mm
4. Width total:	4 000 mm
5. Clearing width:	3 400 mm
6. Height, overall:	2 860 mm
7. Weight, basic vehicle:	Not provided
8. Weight, Demining Unit:	Not provided
9. Weight, total:	14 400 kg

b. Driving specifications

10. Wheels:	6 tyres Nokia MPT 14.00R – 20 or Michelin XS 14.00R – 20 with Hutchinson VFI safety device
11. Ground pressure:	Not provided
12. Axle weight: (clearance position)	
• Front axle	5 400 kg
• Rear axle	9 000 kg
13. Hill climbing ability:	25°

c. Clearance performance

14. Number of chains:	84
• Length of chains:	Not provided
15. Gap between chains:	Not provided
16. Rotation speed	Up to 400 rpm
17. Clearance depth, max:	Up to 370 mm
18. Working speed:	Up to 3 km/h
• light soil/small vegetation:	Not provided
• medium soil/medium vegetation:	Not provided
• heavy soil/dense vegetation:	Not provided
19. Control of clearing depth:	Automatic and manual depth control
20. Machines in use:	Approx. 50
21. Other types:	Not provided
22. Location of use:	Not provided
23. Totally cleared so far:	Not provided

d. System specifications

24. Engine:	6 cyl in line 141 kW DEUTZ BF 6L 913 C diesel with turbo charger, inter-cooled, direct injection,
25. Fuel capacity:	200 l
26. Fuel consumption:	Not provided
27. Separate engine for tilling unit:	Hydraulically driven
28. Transition:	4x4 continuous all wheel drive
29. Cooling system engine:	air cooled
30. Oil capacity (engine):	16 l
31. Oil capacity (gear box):	29 l
32. Hydraulic oil capacity:	60 l

e. Comfort and security

33. Air condition:	Available
34. Operator comfort:	Adjustable seat for driver. Adjustable and swivel seat with suspension for the operator. Both seats with four point safety belts. The cabin is pressure sealed, sound insulated and shock resistant.
35. Armour:	Protected glass and armoured steel for the cabin
36. Remote controlled:	No

f. Costs

37. Cost of system:	Not provided
38. Other costs:	Not provided
39. Transport limitation:	Given by the technical specifications as weight etc.
40. Possibility for rent:	Not provided

RM–KA 01

Figure 1 **The RM–KA 01 in operation**

1. General Description

The DEMIN – KA d.o.o. RM-KA 01 is a 12t (approx.) remote-controlled midi flail produced by a small firm in Croatia. Based on a Caterpillar chassis with Perkins engine, the prototype was built in 2001. Currently, only the prototype exists.

An operator using a joystick attached to a portable control panel remotely controls the system. The machine is protected from explosive blast by 20mm armoured steel plate. The armoured hood covering the flail unit uses a system of spring mounted pipes designed to absorb explosive energy. When the flail detonates a mine, blast passes between the pipes.

The manufacturer does not provide further information.

2. Clearance Methodology

The rotor turns the 48 chains of the flail unit at 600rpm. A mushroom shaped, strengthened steel hammer is attached at the end of each 30cm long chain. As the machine works through a suspect area at between 0.3-1.2km/hr (depending on soil conditions)[1], the chains will detonate or fragment AP and AT mines. The system achieves an average ground penetration of 20cm.[2]

[1] According to the manufacturer
[2] According to the manufacturer

Figure 2 **Joystick control of the RM-KA 01**

3. Machines in Use to Date

- 1 prototype in Croatia.

4. Engine, Fuel and Oil

- The RM–KA 01 is equipped with a Perkins diesel engine. The fuel tank has a 200 l diesel capacity.
- Fuel consumption is 14 l/hr.[3]
- Hydraulic oil capacity is 400 l. Oil capacity is 16 l.

5. Factory Support

- Further information not provided by the manufacturer.

6. Maintenance and Support

- Further information not provided by the manufacturer.

7. Test and Evaluations

- The machine was tested by CROMAC in September 2001. No further information is available.

8. Known Limitations and Strengths

a. Limitations

- Clearance depth is limited to 20 cm due to length of chains.
- The visibility of the operator is limited. The system does not have video system with a monitor.

b. Strengths

- Simple design.

Figure 3 **The RM-KA 01 from rear end**

9. Point of Contact

DEMIN – KA d.o.o.
Mladen Tucetic
Dr. Ante Starcevica 21
Karlovac
Croatia

Tel: +385 47 646 022
Fax: +385 47 646 022
Mobile: +385 98 806 206

[3] According to the Manufacturer

10. Technical data sheet RM–KA 01

a. Dimensional data

1. Length without attachment:	Not given
2. Length total:	4 490 mm
3. Width without attachment:	Not given
4. Width total:	2 500 mm
5. Clearing width:	2 000 mm
6. Height, minimum:	1 600 mm
7. Height, overall:	Not given
8. Weight, basic vehicle:	Not given
9. Weight, Demining Unit:	Not given
10. Weight, total:	12 120 kg

b. Driving specifications

11. Wheels/tracks:	Tracks (Caterpillar)
12. Ground pressure, max weight:	0.5 kg/cm^2
13. Hill climbing ability:	32°

c. Clearance performance

14. Number of chains:	48
• Length of chains:	300 mm
15. Gap between chains:	Not given
16. Rotation speed:	600 rpm
17. Clearance depth, max:	Up to 200 mm
18. Working speed	
• light soil/small vegetation:	Approx. 1 800 m^2/h
• medium soil/medium vegetation:	Approx. 1 000 m^2/h
• heavy soil/dense vegetation:	Approx. 500 m^2/h [4]
19. Control of clearing depth:	Mechanically
20. Machines in use:	1
21. Other types:	No
22. Location of use:	Croatia
23. Totally cleared so far:	200 000 m^2

d. System specifications

24. Engine:	Perkins
25. Fuel capacity:	200 l
26. Fuel consumption:	14 l/hour
27. Separate engine for tilling unit:	No
28. Transition:	Not given
29. Cooling system engines:	Water
30. Oil capacity:	16 l
31. Hydraulic oil capacity:	400 l

e. Comfort and security

32. Air condition and operator comfort:	Not given
33 Armour:	20 mm armoured steel
34 Remote controlled:	Yes
• Greatest distance:	300 m in line sight

f. Costs

35. Cost of system:	
• Machine	Not given
• training	Not given
• spare parts	Not given
Total:	350 000 €
36. Transport limitation:	Not given
37. Possibility for rent:	Yes

[4] According to the Manufacturer

Minelifta

Figure 1 **Minelifta attached to a Komatsu bulldozer**

1. General Description

The first Minelifta concept was designed and developed in 1996. In December 1997 the prototype was unveiled in London. In 1999 Minelifta was awarded "Millenium Product" status by British Prime Minister Tony Blair on behalf of The Design Council.

In July 2000, Corus took over responsibility for the project and set up a project group. After initial modifications, Minelifta was attached to a Komatsu D65EX bulldozer in January 2001. Trials were undertaken in late 2000 and in February 2001. The United Kingdom Government's Defence Evaluation and Research Agency (DERA) carried out an extensive evaluation programme.

Minelifta is a mechanical anti-personnel mine clearance system. It is not designed to clear anti-tank mines.

Minelifta is a ventilated, hooded flailing device with a tined plough-scalping blade. It is driven by an earthmover with the flail shaft driven by a separate auxiliary hydraulic pack.

It comprises a scalp to scrape off the top 20cm of soil. This is fed into a hooded, armour-plated bucket containing a flail designed to detonate serviceable anti-personnel mines. At the back of the bucket, a rear plough digs up the ground to improve soil conditions for a subsequent sweep and to create an obvious lane for manual spoil inspection.

The flail is protected by an armour-plated steel, bucket-shaped cowling. The operator's cab is fitted with bulletproofed glass and 6mm of CP50 armour.

2. Clearance Methodology

Following personnel training, detailed reconnaissance of terrain and assessment of the mine threat, Minelifta can be used in selected mined areas to clear large sections of land.

Figure 2 **Raised Minelifta system with blade ploughs**

It is intended for Minelifta to sweep a suspect mined area three times to ensure the best possible clearance.

Soil to a depth of 20cm is scooped into the cowling and is then pulverized by the flail. This should detonate or break up mines. A plough at the rear of the bucket creates furrows between the tracks into which soil and metal particles are deposited in a continuous mound at the rear of Minelifta for further examination. The rear plough blade can be set to a cutting depth of 40cm. Overlap areas and any doubtful spots will be checked and if necessary manually inspected.

The Minelifta cowling is designed to withstand the explosion of an anti-personnel mine without interruption to operation. It is not meant to work in areas where there are believed to be anti-tank mines.

Minelifta is intended for use in a variety of terrain conditions. It can cope with a range of soil types; light/sandy, dry/compacted, heavy sand, wet mud/clay. It can work through scrub, elephant grass and small trees up to 75mm in diameter. During DERA evaluations Minelifta performed easily on slopes up to 30 degrees but was not tested on ground steeper than that.

3. Machines in Use to Date

- Minelifta has not yet been deployed on an operational mine clearance programme.

4. Engine, Fuel and Oil

- Komatsu D65EX bulldozer with 406 l diesel fuel capacity.
- The hydraulic auxiliary power unit is driven by a 200kW diesel powered engine. Later units will probably feature a 150kW engine.
- The cooling system of the Komatsu contains 50 l of coolant. The flail unit is air-cooled.

5. Factory Support

- Spares specific to the flail unit provided directly from Corus Northern Engineering Services.
- A package of training, spare parts and equipment support is negotiable between the purchaser and Corus Northern Engineering Services.

6. Maintenance and Support

- Minelifta has the benefit of simplicity of design built from robust materials. Personnel experienced in basic mechanical skills will be able to deal with damage and wear and tear on the component parts.

Figure 3 **The Minelifta flail system**

- For problems such as the breakdown of the hydraulic auxiliary power unit, Corus Northern Engineering Services should be contacted.

7. Test and Evaluations

- In November and December 2000, Minelifta underwent trials by the development team from Corus Northern Engineering Services.
- In December 2000 a report from Cranfield University concluded that the system has merit.
- In February 2001 extensive evaluations were carried out by the United Kingdom Government's Defence Evaluation and Research Agency (DERA). They made recommendations for the further development of the system.

8. Known Limitations and Strengths

a. Limitations

- Minelifta is for the clearance of only anti-personnel mines and small UXOs.
- System will require transportation by low-loader over longer distances.

b. Strengths

- A unit of simple design attached to a basic and widely distributed earthmover.

Figure 4 **Minelifta undergoing tests**

9. Point of Contact

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United Kingdom

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e-Mail: CNES@corusgroup.com
Web site: www.corusgroup.com/Minelilfta

10. Technical data sheet Minelifta

a. Dimensional data

1. Length without attachment:	4 300 mm
2. Length total:	To be confirmed
3. Width without attachment:	To be confirmed
4. Width total:	To be confirmed (auxiliary pack behind driver is wider than clearance width but does not contact the ground)
5. Clearing width:	2 500 mm
6. Height, overall:	3 195 mm
7. Weight, basic vehicle:	18 400 kg
8. Weight, Demining Unit:	15 400 kg
9. Weight, total:	33 800 kg (future units will have extra 2 000 kg of cab protection).

b. Driving specifications

10. Wheels/tracks:	Tracks
11. Ground pressure, max weight:	1.09 kg/cm^2
12. Hill climbing ability:	Not tested above 30 degrees.

c. Clearance performance

13. Number of chains:	72
• Length of chains:	835 mm
14. Gap between chains:	95 mm
15. Rotation speed:	Up to 150 rpm
16. Clearance depth, max:	Up to 200 mm
17. Working speed	
• light soil/small vegetation:	Evaluations indicated potential clearance rate of 2500 m^2/hr.
• medium soil/medium vegetation:	Clearance rate under varied conditions to be confirmed
• heavy soil/dense vegetation:	
18. Control of clearing depth:	0 – 20 cm. Depth controlled by angle of bucket set by driver
19. Machines in use:	Not yet
20. Other types:	Not yet
21. Location of use:	Not yet
22. Totally cleared so far:	To be confirmed

d. System specifications

23. Engine:	Not given
24. Fuel capacity:	406 l for Komatsu dozer /fuel capacity flail engine pack to be confirmed
25. Fuel consumption:	Depending on ground conditions. To be confirmed.
26. Separate engine for tilling unit:	Yes. Flail unit driven by 200 kW diesel engine. Future units to have 150 kW diesel engine.
27. Cooling system engine:	50 l Komatsu dozer /Flail engine is air cooled
28. Hydraulic oil capacity:	50 l for Komatsu dozer /Flail engine capacity to be confirmed

e. Comfort and security

29. Air condition:	Yes
30. Armour:	6 mm of CP 50 armour on driver's cab
31. Remote controlled:	No

f. Costs

32. Cost of system:	
• Machine	To be confirmed
• training	To be confirmed
• spare parts	To be confirmed
33. Transport limitation:	Low loader
34. Possibility for rent:	To be confirmed

SCANJACK 3500

Figure 1 **Scanjack operating in overgrown vegetation**

1. General Description

The Scanjack 3500 is a heavy flail produced in Sweden by the Scandinavian Demining Group AB. Based on a Finnish de-forestation machine already long on the market, the first modified demining version was built in 1999.

The Scanjack 3500 employs a unique, front mounted double flail system, the only one of its type in the world.

The system underwent evaluation and testing in Croatia in November 1999.

The company in Sweden conducted further technical development in 2000 – 2001. An average clearance rate of 722 m^2/hr was achieved. The Swedish Army carried out tests at the end of 2001.

The Scanjack 3500 is designed to clear anti-personnel and anti-tank mines.

One operator drives the vehicle from an armoured cab protected by 8mm steel plate and 41mm of resistant glass. A second model features 69mm of resistant glass. The stated clearance width is 3.5m.

The running gear of the Scanjack 3500 is an unusual combination of wheels and tracks. Wheels provide for transport between locations. When the system is put to work in the minefield, removable caterpillar tracks are added to improve traction and maneuverability.

2. Clearance methodology

The Scanjack 3500 drives forward into a suspect area with both front mounted flails rotating at the same speed. During testing, best results were achieved with the flails rotating clockwise, although it is possible to set rotation anti-clockwise. The flails can rotate concurrently in opposite directions.

The chains of the front flail are approximately 15cm shorter that those of the second. The front flail cuts vegetation and clears the ground to a depth of 20cm. The second flail is designed to clear

Figure 2 **Scanjack with armoured hoods open**

down to 40cm. The total clearance depth of the system claimed by the manufacturer is 40cm. With a rotation speed of 360rpm, the flail unit hits the ground approximately six times per second.

Both flails have 73 chains with weighted hammer tips. The chains are hardened and can be replaced when damaged. During testing and development chains required replacement approximately once per month. Chain types other than those produced by the manufacturer can be used.

3. Machines in Use to Date

- 1 machine in Croatia on trial from April 2000-April 2001.
- 1 machine produced in Summer 2001 with changes from first machine was tested by SWEDEC in September 2001 and later transported to Croatia.

4. Engine, Fuel and Oil

- The Scanjack is equipped with a 6 cyl. Perkins 1306 – 8TI diesel engine with 210hp for the base unit. The hydraulic oil capacity is 200 l.
- The flail unit is equipped with a Scania DSI 14 tourbocharged V8 diesel engine with 550hp. The hydraulic oil capacity for this unit is 400 l.
- Mineral hydraulic oil is included in the standard equipment package.
- The machine uses the same tank for both machines.
- The fuel consumption is 60–80 l/h during flail operation, depending on conditions.

5. Factory Support

- The standard equipment comprises tools, operator manual, spare part catalogue, fire extinguisher, travel distance gauge and constant engine revolution regulator on TMC, stability brake, hydraulic steps and mineral hydraulic oil.
- Training of operators and mechanics is offered for a special price during manufacturing until end of third month after delivery.
- One year warranty for manufacturing faults of the base machine and the flail engine is included but no warranty on the flail unit itself, exept a 100% guarantee that the unit works at the time of delivery.
- Service contracts ranging from one annual check-up to a full service are available.

Figure 3 **The double flail unit of the Scanjack**

6. Maintenance and Support

- One year full service support including non-consumable spares, on site technical support once per month and technician call out can be ordered.

- The machine must be refueled every 2.5 hours and must be cleaned from dust and dirt within the same intervals.
- The manufacturer recommends daily preventive maintenance and cleaning as well as a service contract for monthly check-ups by the supplier.
- The recommended personal is three drivers and two maintenance staff including one mechanic per machine.
- Non-specialist, mechanical workshop tools and crane support on-site are required.

7. Test and Evaluations

- The first machine has been tested and certified by CROMAC in Croatia, 1999.
- The Swedish EOD and Demining Centre (SWEDEC) tested a slightly changed second machine in September 2001. Amongst others, dynamic blast tests were carried out with one 5.5kg AT metal covered mine and one 10kg non-metallic AT mine. Only minor damage was found. In the first detonation, four chains were lost. In the second detonation, one chain was lost and two hammers required replacing.

8. Known Limitations and Strengths

a. Limitations

- Little tank for approx. 2.5 working hours[1].
- Vegetation cutting is limited to trees with approx. 15 cm diameter[2].
- Large machine that requires transporting over long distances on a trailer. The flail unit is detachable and can be transported on a separate truck.
- Only manually controlled clearance depth.

b. Strengths

- The unique double flail system probably improves clearance rate.
- The experience of 40 years with the base machine under hard conditions means that many problems have been rectified.

Figure 4 **Scanjack 3500 with the articulated engine and flail unit**

9. Point of Contact

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Sweden

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e-Mail: info@scanjack.com
Web Site: www.scanjack.com

[1] According to the manufacturer
[2] According to the manufacturer

10. Technical data sheet Scanjack 3500

a. Dimensional data

1. Length without attachment:	11 000 mm
2. Length total:	14 300 mm
3. Width without attachment:	3 000 mm
4. Width total:	4 450 mm
5. Clearing width:	3 500 mm
6. Height, overall:	3 700 mm
7. Weight, basic vehicle:	24 000 kg
8. Weight, Demining Unit:	8 000 kg
9. Weight, total:	32 000 kg

b. Driving specifications

10. Wheels/tracks:	8 tyres 650/65-26.5 and 4 tracks 750 mm wide
11. Ground pressure, max weight:	Front: 0.96 kg/cm^2; Rear: 0.6 kg/cm^2
12. Hill climbing ability:	30% in operation and 35% while driving

c. Clearance performance

13. Number of chains:	78 on each rotor
• Length of chains:	First rotor: 697 mm; Second rotor: 793 mm
14. Gap between chains dynamically:	overlapping
15. Rotation speed:	Up to 360 rpm
16. Clearance depth, max:	First rotor: up to 15 cm; Second rotor: up to 30 cm
17. Working speed	
• light soil/small vegetation:	Approx.2 700 m^2/h
• medium soil/medium vegetation:	Approx. 2 100m^2/h
• heavy soil/dense vegetation:	Approx. 1 200 m^2/h
18. Control of clearing depth:	Manually by hydraulic pressure

d. System specifications

19. Engine:	Cummins 6-cyl diesel engine with 215 hp
20. Fuel capacity:	180 l in one tank for both engines
21. Fuel consumption total:	Max. 60 - 80 l/hour in operation
22. Separate engine for tilling unit:	Yes; Scania V8 diesel engine with 550 hp
23. Transition:	Hydrostatic – mechanical power
24. Cooling system engine:	Water
25. Oil capacity:	25 l for base engine
26. Hydraulic oil capacity:	360 l for both machines

e. Comfort and security

27. Air condition:	Yes
28. Operator comfort:	Ergonomic chair and controls, radio
29. Armour:	12 – 13 mm Armox 500S toughened plate for the cabin and 41mm protection glass windows.
30. Remote controlled:	No

f. Costs

31. Cost of system:	
• Machine	USD 800 000
• training	included; during manufacturing and 3 month after delivery
• spare parts set	USD 95 000
• repair costs	USD 6 000/month full service contract
• transportation	Cost of 1 trailer/truck + 1 truck with crane
Total:	USD 895 000 + service and transportation
32. Transport limitation:	3.0 m wide and 4.2 m high on low bed trailer
33. Possibility for rent:	Financial leasing pending credit approval and full demining service rental incl. crew and service

VIKING MINE CLEARING SYSTEM (VMCS)

Figure 1 **The VIKING system with flail and power pack**

1. General Description

During the first quarter of 1999, Hägglunds Moelv AS (Norway) teamed with Summa Technology Inc. (USA) and Quality Research Inc. (USA) in order to conduct a feasibility study to mount Hägglunds flail technology to a commercial prime mover. Previously, a Hägglunds flail was attached to a Leopard 1 chassis to create the Norwegian Armoured Mine Clearing Vehicle (AMCV).

The civilian version currently under development combines a Hägglunds flail with a 21t, Austrian built Liebherr 742 tractor. The flail is powered by an External Power Pack (EPP) mounted to the back of the vehicle. The EPP is a diesel engine that runs the flail unit hydraulically. The EPP operates independently to the tractor engine.

The remote control system consists of the Flail Assembly Control System (FACS), the Vehicle Control Unit (VCU) and the Operator's Control Unit (OCU) featuring command link, video link and emergency radio link.

2. Clearance Operation

The Viking flail unit has 96, 116cm chains, each tipped with a hardened steel hammer. The prime mover drives forward into the mine suspected area while rotating the flail clockwise. The 4m wide flail rotates at up to 300rpm (depending on the ground), with an approximate clearance depth of 25cm.[1] The flail can be elevated or depressed between 25° to 15° from ground level in order to make it easier to compensate for ground undulation. Viking is built to detonate or fragment AP and AT mines.

[1] According to the manufacturer

Figure 2 **The flail unit chains and hammers**

3. Machines in Use to Date

- One prototype currently undergoing tests in Huntsville, Alabama, USA. The final tests will take place in Norway.
- System should be available late 2002.

4. Engine, Fuel and Oil

- Tractor and the external power pack use diesel.
- The combined fuel tank capacity is 900 l.
- Tractor engine gives 172kW/234hp. Fuel consumption is 17–25 l/hr under normal conditions.[2]
- The Cummins engine for the EPP gives 525hp with fuel consumption of 60–70 l/hr during flailing.

5. Factory Support

- System certified by International Standards Organization (ISO) 9001 in 2000.
- No further information provided by the manufacturer.

6. Maintenance and Support

- No further information provided by the manufacturer.

7. Test and Evaluations

- Tests started in September 2001.
- No further information available.

Figure 3 **The Viking flail system in operation**

[2] According to the manufacturer

8. Known Limitations and Strengths

a. Limitations

- The flail unit must be disassembled before low-loader can transport the system. Total width of flail unit is 5m.

b. Strengths

- Compensates well for ground undulation.

Figure 4 **The Viking system**

9. Point of Contact

Hägglunds Moelv AS
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2391 Moelv
Norway

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Direct: +47 62 35 46 32
Fax: +47 62 35 46 01
e-Mail: mail@haggmo.no
Web site: www.haggmo.no

10. Technical data sheet Viking

a. Dimensional data

1. Length without attachment:	4 800 mm
2. Length total:	10 500 mm
3. Width without attachment:	3 400 mm
4. Width total:	5 000 mm
5. Clearing width:	4 000 mm
6. Height, minimum:	3 300 mm
7. Height, overall:	4 000 mm
8. Weight, basic vehicle:	21 500 kg
9. Weight, Demining Unit:	5 700 kg
10. Weight, total:	32 000 kg

b. Driving specifications

11. Wheels/tracks:	Tracks
12. Ground pressure, max weight:	Not given (depends on type of tracks)
13. Hill climbing ability:	27°

c. Clearance performance

14. Number of chains	96
• Length of chains	116 mm
15. Gap between chains	42 mm
16. Rotation speed	Up to 300 rpm
17. Clearance depth, max:	Up to 250 mm
18 .Working speed[3]	
• light soil/small vegetation:	2 800 - 8 400 m^2/hr (surface laid mines)
• medium soil/medium vegetation:	Not given
• heavy soil/dense vegetation:	1 120 – 4 200 m^2/hr (buried mines)
19. Control of clearing depth:	hydraulic
20. Machines in use:	1 prototype
21. Other types:	Flail system attached to Leopard 1 (Norwegian Army)
22. Location of use	USA for tests
23. Totally cleared so far:	1 000 000 m2

d. System specifications

24. Engine:	Not given
25. Fuel capacity:	450 l
26. Fuel consumption:	17 – 33 l/hr depending on ground conditions[4]
27. Separate engine for tilling unit:	Yes. Cummins diesel engine with 525 hp
28. Fuel consumption:	Approx. 60 – 70 l/hr[5]
29. Cooling system engine:	Not given
30. Hydraulic oil capacity:	250 l

e. Comfort and security

31. Air condition:	Yes
32. Armour:	Not given
33. Remote controlled:	Yes
• Greatest distance	3 000 m in line sight

f. Costs

34. Cost of system:	Not known yet
• Machine	Not known yet
• training	Not known yet
• spare parts	Not known yet
35. Transport limitation:	Low loader and the flail unit needs to be disassembled before road transportation
36. Possibility for rent:	Not for the moment – will be available late 2002/early 2003

[3] According to the manufacturer
[4] According to the manufacturer
[5] According to the manufacturer

Section 2

Tiller Systems

FMR 2000

Figure 1 **FMR 2000**

1. General Description

The FMR 2000 is based on a self-propelled milling crusher built by HADI Maschinenbau GmbH (Austria) for the restoration of forestry, particularly in mountainous areas. The first vehicle was built in 2000.

It is designed to clear anti-personnel mines, although tests with anti tank mines up to 7.5kg did not cause serious damage.

The system consists of an armoured, tracked vehicle equipped with a front mounted tilling drum, operated by remote control. The transmitter is incorporated into a 2kg portable control desk and has a battery life of 8 hours for one charge of the accumulator. The protected 70cm-frequency band transmits all control signals out to 800m, guaranteeing sufficient safety distance for the operator. If the radio link fails, the machine automatically stops and switches off.

A second radio link transmits a video signal. Video cameras mounted front and rear broadcast on a TFT-LCD monitor, showing the action in front and behind the machine. The FMR 2000 can be operated from within a protected cabin, negating control from line of sight.

The total weight of the machine is 36t, driven by a 503hp Mercedes Benz turbo diesel engine. The overdrive achieves 6.5km/h on paved roads. For transportation over longer distances, a low-loader or flatbed truck is used (see Figure 4).

2. Clearance Methodology

The FMR 2000 is a tiller system with a multi graduated crushing chamber. The tiller uses its carbide-tipped milling chisels to detonate or crush AP mines. The tiller rotates clockwise at 400-700rpm. If mines that are detonated by the tiller cause damage to chisels, they can be replaced easily. Particles of mines that have not detonated are fed into the crushing chamber, where the pieces are further fragmented by a special steel plated cutting blade into pieces no larger than 30mm x 30mm. Rock and scrap metal that enter the system will be similarly shredded. The 255cm wide tiller drum has an automatically controlled clearance depth to a maximum of 400mm. A grader at the back of the vehicle distributes loosened soil evenly.

Figure 2 **The portable remote control desk**

3. Machines in Use to Date

- 1 prototype finished in early 2001. By mid 2001, the machine had begun clearance in Bosnia – Herzegovina.

4. Engine, Fuel and Oil

- Hydraulic pumps for drive and tool hydraulic system are driven by a Mercedes Benz water-cooled diesel engine requiring normal diesel fuel.
- Fuel tank capacity is 900 l. Average consumption/hour is 40 l, depending on soil/terrain.
- Hydraulic tank capacity is 700 l.

5. Factory Support

- Chisels and crushing tools can be changed quickly. Where possible, off the shelf spare parts are used.
- HADI provide a call out service.
- Spare parts provided for two years as part of purchase package.
- Operator training provided by the manufacturer, either at the factory or on-site.
- The instruction manuals and SOP will be translated into the required language.

6. Maintenance and Support

- Visual check of chisels, oil level, and tightness of hoses and gaskets to be carried out daily.
- HADI recommends a 100% check by a manufacturer's mechanic annually.
- One controller and one mechanic are recommended to crew the machine.

7. Test and Evaluations

- Currently the only test involving a live AT mine was conducted by the manufacturer. According to the manufacturer, they did not harm the machine.
- The clearance efficiency was tested with dummy mines.
- In mid 2001, a minefield in Bosnia-Herzegovina was cleared with assistance from the NGO HELP e.V. as part of evaluation and testing. Results not yet given.

Figure 3 **FMR 2000 operating in vegetation**

8. Known Limitations and Strengths

a. Limitations

- For clearance of anti-personnel mines only.
- Hill climbing ability limited to 20°. [1]
- Trees more than 12cm dia could be a problem. [2]
- The maximum operating temperature of the prototype is 35°C. After modifications of the cooling system it will be raised to 45°C. [3]

b. Strengths

- The machine can be used in rocky areas.

Figure 4 **FMR 2000 on a commercial low-bed loader**

9. Point of Contact

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E-mail: office@hadi.at
Web Site: www.hadi.at

[1] According to the manufacturer
[2] According to the manufacturer
[3] According to the manufacturer

10. Technical data sheet FMR 2000

a. Dimensional data

1. Length total:	7 800 mm
2. Width without attachment:	2 665 mm (transportation width)
3. Width total:	3 335 mm
4. Clearing width:	2 580mm
5. Height, minimum:	3 080 mm (transportation height)
6. Height, overall:	4 080 mm (with antenna)
7. Weight, basic vehicle:	35 t
8. Weight, Demining Unit:	3 t
9. Weight, total:	38 t

b. Driving specifications

10. Wheels/tracks:	Tracks with a width of 700 mm
11. Ground pressure, max weight:	Not given
12. Hill climbing ability:	20°

c. Clearance performance

13. Number of chisels:	Not given
14. Gap between drum and chisels:	30 mm
15. Diameter of drum:	750 mm
16. Rotation speed:	From 400 to 700 rpm
17. Clearance depth, max:	Normal operation 0 – 400 mm, max. 600 mm [4]
18. Working speed	
• light soil/small vegetation:	500 m/h; i.e. approx. 1 300 m^2/h
• medium soil/medium vegetation:	400 m/h; i.e. approx. 1 000 m^2/h
• heavy soil/dense vegetation:	200 m/h; i.e. approx. 500 m^2/h
19. Control of clearing depth:	Automatically or manually
20. Machines in use:	1 prototype
21. Other types:	no
22. Location of use	Bosnia - Herzegovina
23. Totally cleared so far:	100 000 m^2/h

d. System specifications

24. Engine:	Mercedes Benz OM 442 LA VB Turbo + charge air
25. Fuel capacity:	900 l
26. Fuel consumption:	Approx. 40 l/h
27. Separate engine for tilling unit:	No
28. Transition:	Not given
29. Cooling system engine:	Water cooled
30. Oil capacity:	Not given
31. Hydraulic oil capacity:	700 l

e. Comfort and security

32. Operator comfort:	TV-monitor with cameras in front (movable) and rear,
33. Armour:	Yes, no further information
34. Remote controlled:	Yes
• Greatest distance	800 m

f. Costs

35. Cost of system:	On customers request
36. Other costs:	On customers request
37. Transport limitation:	Max. speed on tracks 6.5km/h. Normally on trailer
38. Possibility for rent:	Not yet

[4] According to the manufacturer

KMMCS

Figure 1 **KMMCS vehicle 2 with double rotating tiller drums**

1. General Description

The Krohn Mechanical Mine Clearance System (KMMCS) was first developed in 1992. The current design of the tiller machine within the system is based on Caterpillar or Liebherr chassis. They are the products of many years of experience in the manufacture of machines for soil and forest cultivation and road construction.

Between 1992-93, the KMMCS tiller was evaluated during mine clearance operations along the former inner German border. From 1995-1998, the tiller was deployed on UN demining operations in Mozambique. The US Army employed the system in 2000 in order to clear a live firing range at CMTC Hohenfels, Germany, and it was tested in the same year in Croatia by the Croatian Mine Action Centre (CROMAC).

Walter Krohn Gmbh & Co KG has built four systems. Each system consists of one coarse tiller, one double tiller and one armoured bulldozer with rear harrow.

The coarse tiller features a front mounted, 60cm dia rotating tiller drum fitted with steel chisels. The action of the tiller is designed to detonate or fragment AP and AT mines.

The double tiller is based on the same chassis as the coarse tiller. It's two opposite rotating tiller drums are designed to mince the ground previously worked by the coarse tiller, increasing the chance of clearing ordnance that may have escaped the first sweep.

The tiller drums of the two systems can be changed in approximately five hours.

The armoured bulldozer with rear mounted harrow is used to reprocess the soil tilled by the lead machines in order to bring mine fragments to the surface and prepare the ground for subsequent use.

2. Clearing Methodology

The tiller unit of the coarse tiller is 2.6m wide, hydraulically driven and protected by a steel cowling. It is attached to the vehicle chassis by hydraulically operated arms, controlled from the cab. The dual motors protectively mounted within the tiller drum rotate the unit at 80-130rpm. The direction of rotation can be reversed for cleaning clogged teeth. The action of the 4cm thick chisels will detonate or fragment mines. The 25cm long tiller teeth are set in staggered formation to ensure complete coverage of ground. The tiller will cut vegetation up to 20cm diameter. Depending on terrain, the coarse tiller can cover approximately 2500-3000 square metres per hour (see para 10, Technical Data Sheet).

The second machine of the KMMCS employs a double tiller unit. It is intended to follow the coarse tiller at a minimum safety distance of 300m. It can work independently of the coarse tiller in areas where only AP mines are suspected. The double tiller verifies the work carried out by the coarse tiller, as its teeth are closer together. The front, lower mounted tiller rotates anti-clockwise at up to 120rpm while the smaller drum 15cm behind it rotates up to 700rpm clockwise. The soil that passes between the two oppositely rotating tiller drums is left in small particles. The working speed is faster than the coarse tiller as the soil has previously been loosened, with an expected approximate clearance rate of 6500-12000 square metres per hour, depending on terrain. The rotation of the tiller drums can be reversed to aid cleaning.

Figure 2 **Tiller of vehicle 1**

Both tilling machines penetrate the ground to an average depth of 40-50cm. The pre-set tilling depth automatically adjusts itself to maintain depth over inconstant or undulating terrain.

The third machine within the system, an armoured bulldozer, features ploughs and a harrow mounted at the rear. With a working depth of 40cm, the machine is designed to bring fragments of mine or UXO left by the previous systems to the surface for removal by EOD staff. The rear harrow is intended to prepare the ground for subsequent agriculture.

3. Machines in Use to Date

- The machines were initially designed for deforestation to render land suitable for cultivation.
- Four systems are deployed. One system = 1 x coarse tiller, 1 x double tiller, 1 x armoured bulldozer.
- Systems are deployed in Mozambique (since 1995, however currently not operational) and Croatia.

4. Engine, Fuel and Oil

- Prime mover and tiller unit rely on one diesel engine. Standard diesel oil is used.
- Fuel consumption depends on terrain, clearance depth set, and thickness of vegetation. The tilling machines average 60-80 l/hr, while the bulldozer averages 20 l/hr. If all three machines were to operate on the same task, total fuel consumption would be approximately 140-180 l/hr.

5. Factory Support

- A small truck for carrying tools and spare parts provided on request.
- Operator training for approximately 2 weeks is included in purchase price.

6. Maintenance and Support

- The three vehicles of the system require transport by low loader over longer distances. Loading/unloading by an experienced crew takes approximately 15mins.[1]
- Ancillary equipment required for the system as per the manufacturer's SOP:
  - → 1 x flatbed truck
  - → 1 x repair truck
  - → 1 x crane truck
  - → 1 x personnel transport
  - → Minimum 2 x diesel fuel tank trailers.

Figure 3 ***The*** **third machine with the attached rake**

7. Tests and Evaluations

- In 1992/3 system tests in Germany: Mine clearance along the inner German border.
- Tested in Mozambique 1995-1998.
- In 2000 by EOD Technology, Inc. U.S.A., U.S. Army Engineering & Support Center, Huntsville (USAESCH) at CMTC Hohenfels, Germany.
- From August–December 2000 the system was tested by the Croatian Mine Action Centre (CROMAC). Test results exist in German and Croatian.

Figure 4 **side view of vehicle 2 and the tilling drum of vehicle 1**

[1] CROMAC test report (German version) page 7

8. Known Limitations and Strengths

a. Limitations

- Large logistical task to transport all three vehicles to place of work. Fording depth is 1m.
- The double tiller had technical problems during CROMAC tests.[2]
- Maximum clearance depth approximately 50cm.[3]

b. Strengths

- Full operator protection against AP and AT mines.[4]
- Several auxiliary means e.g. air compressor, integrated remote control cable.
- Very robust against detonations. Proved repairable after double AT mine blast under tracks.
- Effective against heavy vegetation up to 20cm dia.[5]
- Machines are very driver responsive.[6]
- Good ground pressure distribution due to 800mm wide tracks. Operates well on wet ground.[7]
- Powerful engines good for difficult terrain.[8]

Summary:

During testing and evaluation in Croatia, KMMCS cleared 16 AP mines and 24 AT mines over an area of approximately 113000m^2. A PROM 1 mine damaged a hydraulic pipe and an operator error caused the double tiller on one of the systems enough damage to require replacement, an operation that was completed in 5 hours.[9]

Figure 5 **Vehicle 2 and vehicle 1 behind**

9. Point of Contact

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[2] CROMAC test report (German version) page 30;32
[3] CROMAC test report (German version) page 30
[4] CROMAC test report (German version) page 33;34
[5] CROMAC test report (German version) page 32
[6] CROMAC test report (German version) page 10
[7] CROMAC test report (German version) page 32
[8] CROMAC test report (German version) page 30
[9] CROMAC test report (German version) page13;17

10. Technical data sheet KMMCS Vehicle 1 and 2

a. Dimensional data

1.	Length without attachment:	5 000 mm
2.	Length total:	7 000 mm
3.	Width without attachment:	3 000 mm
4.	Width total:	3 000 mm
5.	Clearing width:	2 600 mm
6.	Height, minimum:	2 650 mm
7.	Height, overall:	2 850 mm
8.	Weight, basic vehicle:	34 t
9.	Weight, Demining Unit:	2 t
10.	Weight, total:	36 t

b. Driving specifications

11.	Wheels/tracks:	2 commercial tracks each 800 mm wide
12.	Ground pressure, max weight:	0.5 kg/cm^2
13.	Hill climbing ability:	40°

c. Clearance performance

14.	Number of chisels:	156
15.	Gap between drums/chisels dynamically:	42 mm
16.	Rotation speed:	up to 120 rpm
17.	Clearance depth, max:	Up to 500 mm in light soil
18.	Working speed	
	• light soil/small vegetation:	4 000 m^2/h[10]
	• medium soil/medium vegetation:	app. 2 600 m^2/h[11]
	• heavy soil/dense vegetation:	1 000 m^2/h[12]
19.	Control of clearing depth:	Manual
20.	Machines in use:	8
21.	Location of use:	Germany, Mozambique, Croatia
22.	Totally cleared so far:	3 060 000 m^2 in clearance operations[13]

d. System specifications

23.	Engine:	MTU or Caterpillar with 750 hp
24.	Fuel capacity:	1 200 l
25.	Fuel consumption:	Approx. 60 - 80 l/hour
26.	Separate engine for tilling unit:	No
27.	Cooling system engine:	Not given
28.	Oil capacity:	30 l
29.	Hydraulic oil capacity:	app. 800 l

e. Comfort and security

30.	Air condition:	Yes
31.	Operator comfort:	Not given
32.	Armour:	Not given
33.	Remote controlled:	No

f. Costs

34.	Cost of system:	Approx. 1 500 000 €
35.	Other costs:	depending on customer requirements
	• training	is included
36.	Transport limitation:	primarily low loader or unpaved/gravel roads on own tracks with max 3,8 km/h
37.	Possibility for rent:	No

[10] According to the manufacturer
[11] CROMAC test report (German version) page 15
[12] According to the manufacturer
[13] the system was first used to cultivate wooded areas of approx. 30 000 000 m2

Technical data sheet KMMCS Vehicle 3 Liebherr tractor

a. Dimensional data

1. Length without attachment:	4 000 mm
2. Length total:	6 500 mm
3. Width without attachment:	2 950 mm
4. Width total:	2 950 mm
5. Height, minimum:	3 100 mm
6. Height, overall:	3 100 mm
7. Weight, total:	34 t

b. Driving specifications

8. Wheels/tracks:	2 commercial tracks each 920 mm wide
9. Ground pressure, max weight:	0.3 kg/cm^2
10. Hill climbing ability:	40°

c. Working performance

11. Working depth, max:	Not given
12. Working speed	Not given
• light soil/small vegetation:	
• medium soil/medium vegetation:	
• heavy soil/dense vegetation:	
13. Control of working depth:	Not given

d. System specifications

14. Engine:	MTU with 150 hp
15. Fuel capacity:	360 l
16. Fuel consumption:	Approx. 20 l/hour
17. Separate engine for working unit:	No
18. Cooling system engine:	Not given
19. Oil capacity:	10 l
20. Hydraulic oil capacity:	app. 60 l

e. Comfort and security

21. Air condition:	Yes
22. Operator comfort:	Not given
23. Armour:	Not given
24. Remote controlled:	No

f. Costs

25. Cost of system:	See vehicle 1 & 2
26. Other costs:	depending on customer requirements
• training	is included
27. Transport limitation:	primarily low loader or unpaved/gravel roads on own tracks with max 3,8 km/h
28. Possibility for rent:	no

Minebreaker 2000/2

Figure 1 **Minebreaker 2000/2 in operation**

1. General Description

The Minebreaker 2000/2 is based on a Leopard 1 chassis. A hydraulically powered rotating tiller drum is mounted at the front of the vehicle. The tiller is designed to cause mines to detonate or fragment mines. The manufacturer claims that the tiller unit will withstand detonations from common types of anti-personnel and anti-tank mines. With its main battle tank chassis, the Minebreaker 2000/2 has good all terrain capability, but its overall size and weight may affect its deployment to countries where roads and bridges are poor. 20mm steel armour and 70mm glass protect the crew compartment as well as anti-blast-pressure shock absorbers. Although the tiller unit should survive an anti-tank mine detonation, a direct hit against the chassis may cause serious damage although the crew are well protected.

The chassis and tilling drum are powered hydraulically by a multi-pump transfer gear. Hydrostatic drive gives the Minebreaker a cruising speed of 4km/hr and a working speed of less than 1m/min.

Minebreaker 2000/2 is controlled by two joysticks; one to steer the vehicle and the other to adjust clearance depth. This should speed up operator training. The tilling drum is fitted with removable tungsten steel teeth that can be replaced when worn or broken.

The tiller unit of Minebreaker 2000/2 is of a modular design and can be fitted to other prime movers such as T55, T64, M48, M60, and Leopard 2.

2. Clearance Methodology

The front mounted tilling drum with tungsten steel teeth rotates anti-clockwise in order to hit the mines from below, preventing the possibility of them being compacted into the ground. Loosened soil has a tendency to build up in a heap in front of the tiller unit.

The teeth should detonate or break up mines. The system is designed to destroy anti-personnel and anti-tank mines.

During testing and evaluation, Minebreaker achieved a clearance rate of 1.5 - 2ha/day over soil in temperate regions. As part of normal operation, vegetation and trip wires are removed.

3. Machines in Use to Date

Currently there are two machines in use.

- One system purchased by the South Korean Government in September 2000 to demine the inner-Korean border.
- One system owned by FFG working in Bosnia-Herzegovina on behalf of the German Foreign Office, in co-operation with local entity forces and the German NGO Demira. With interruptions, this system has been in use since 1999.

Figure 2 **Tilling drum with tungsten teeth**

4. Engine, Fuel and Oil

- Minebreaker 2000/2 runs on ordinary diesel fuel. Hydraulic fluid should be checked and if necessary changed every 2000 running hours.
- Fuel consumption varies due to different applications from 60-100 l/operating hour.

5. Factory Support

- The Leopard tank has seen long service in the German Army and numerous other countries. Extensive data relating to the performance characteristics of the Minebreaker chassis are in existence.
- The hydraulic system of the tiller unit uses standard components widely available on the international market.
- FFG offers logistical support, training and supply of spare parts as part of the purchase price. Long term projects can be provided with a mobile workshop.
- Operating instructions are currently available in German, English, Croatian and Mandarin.
- Warranty terms are negotiable, however the standard warranty covers six months or after 500 running hours, whichever comes first.

6. Maintenance and Support

- One-year service support, on-site technical support once per month and 24hrs call out can be ordered.
- FFG offers logistical support and spares service for the system whether purchased or rented.
- Training and user handbook describing daily checks to be carried out.
- Operators are trained in all aspects of system maintenance.
- Specialist tools incorporated into purchasing price. Other standard tools purchased separately.
- For long term operations, a mobile workshop is recommended.

Figure 3 **Minebreaker 2000/2 operating in open ground**

7. Test and Evaluations

- FFG/Diehl has undertaken extensive trials including blast tests from March to October 1997.
- According to FFG, field tests under realistic conditions were carried out in Bosnia - Herzegovina from November 1997 – June 1998.
- The German Army conducted tests in June 2001.

8. Known Limitations and Strengths

a. Limitations

- Large heavy machine. Difficult to transport over poor roads and bridges.
- Operating temperature: - 20° C to + 42 ° C
- Air humidity: Can operate in climates with up to 95 % relative air humidity

b. Strengths

- Powerful engine
- Tiller system will clear vegetation and trip wires as it clears mines.
- For use in anti-personnel and anti-tank mine fields.

Figure 4 **Minebreaker with front tiller unit**

9. Point of Contact

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10 Technical data sheet Minebreaker 2000/2

a. Dimensional data

1.	Length total:	10 940 mm
2.	Width without attachment:	3 720 mm
3.	Width total:	4 510 mm
4.	Clearing width:	3 690 mm
5.	Height, overall:	3 310 mm
6.	Weight, basic vehicle:	33 500 kg
7.	Weight, Demining Unit:	13 500 kg
8.	Weight, total:	47 000 kg

b. Driving specifications

9.	Wheels/tracks:	Tracks DIEHL D 640 A
10.	Ground pressure, max weight:	9.60 N/cm^2
11.	Hill climbing ability:	50% [1]

c. Clearance performance

12.	Number of chisels:	66
13.	Gap between chisels:	60 mm
14.	Rotation speed:	Up to 100 rpm
15.	Clearance depth, max:	Up to 500 mm
16.	Working speed [2]	
	• light soil/small vegetation:	Up to 4 000 m^2/h
	• medium soil/medium vegetation:	Up to 2 400 m^2/h
	• heavy soil/dense vegetation:	Up to 1 000 m^2/h
17.	Control of clearing depth:	Mechanical
18.	Machines in use:	2
19.	Other types:	Minebreaker 2000
20.	Location of use:	Bosnia-Herzegovina, Korea
21.	Totally cleared so far:	Approximately 800 000 m^2

d. System specifications

22.	Engine:	MTU MB 838 with 10 cylinders and 830 HP
23.	Fuel capacity:	940 l
24.	Fuel consumption:	Max. 100 l/hour
25.	Separate engine for tilling unit:	No
26.	Transition:	Hydrostatic
27.	Cooling system engine:	Water
28.	Oil capacity:	65 l
29.	Hydraulic oil capacity:	840 l

e. Comfort and security

30.	Air condition:	Optional
31.	Operator comfort:	a high degree of comfort for the operator is achieved by using standard components (seat, instruments, etc.) from industry (seat, instruments, etc.) from industry
32.	Armour:	Original Leopard 1 chassis; cabin with 20 mm armoured steel and 70 mm protection glass
33.	Remote controlled:	Optional
	• Greatest distance:	1 000 m

f. Costs

34.	Cost of system:	For clearing operations 0.5 € per m^2. This includes one operator, fuel, spare parts etc. but no transportation
	• Machine	On request
	• training	Usually included in the system price
	• spare parts	Depending
35.	Transport limitation:	by road or deployed with commercially available trailers
36.	Possibility for rent:	Yes

[1] According to the manufacturer
[2] All figures according to the manufacturer

Minecrusher 2000

Figure 1 **Minecrusher without vehicle**

1. General Description

The FFG Minecrusher 2000 is a mine clearance tiller based on a Mercedes Benz Unimog chassis, designed to withstand explosive blast from common types of anti-personnel mine without serious damage. The Unimog prime mover of the system is plated with 10mm armoured steel to provide crew protection. As the Unimog is a standard Mercedes road vehicle, it has a road speed of 80km/hr. The system can take to the road with the tiller attachment stowed on the vehicle platform, enabling it to independently reach remote areas over difficult routes. The average working speed achieved during trials varies between 1.1-4.9km/hr. The Minecrusher is suitable as a primary demining system or deployed as support to manual demining operations. Minecrusher 2000 is currently undergoing development.

2. Clearance Methodology

The detachable tiller unit connects to the front of the Unimog. The action of the tiller is designed to detonate or break-up AP mines. The Minecrusher 2000 is lighter than most tiller systems.

3. Machines in Use to Date

- System currently undergoing development.

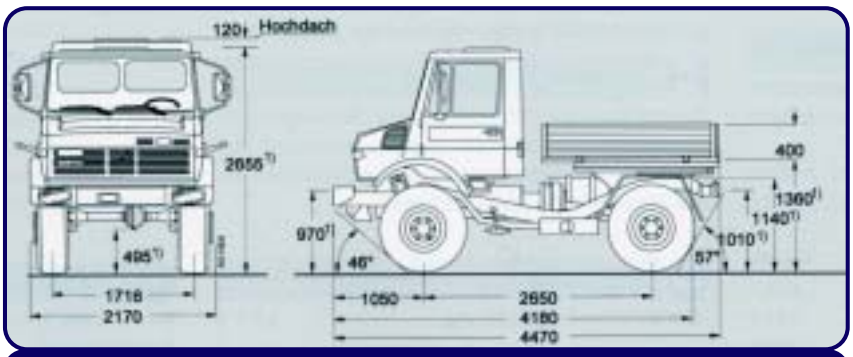

Figure 2 **The Mercedes Benz Unimog**

4. Engine, Fuel and Oil

- Mercedes Benz Unimog uses ordinary diesel fuel.
- Hydraulic fluid has to be checked/changed after 2000 running hours or once/year, depending on which comes first.
- Fuel consumption varies for different applications from 10-25 l/operating hour.

5. Factory Support

- Spare parts supply for the prime mover is guaranteed through worldwide Mercedes-Benz dealer net. Special parts will be provided by FFG. The supply of original spare parts is guaranteed.
- Training and spare parts package is usually included in the system purchase price.
- FFG offers tailor-made logistical support service and spare parts supply as part of purchase package.
- Detailed operating instructions for the prime mover currently available in many languages.
- Operating instructions are part of the purchasing package.

6. Maintenance and Support

- Warranty can be negotiated. FFG usually provide warranty for 6 months or 500 running hours, whichever come first.
- Daily routine checks set out in maintenance manual.
- The Minecrusher 2000 is best operated and maintained by one member of staff.
- No special tools are required.

7. Test and Evaluations

- Not yet.

8. Known Limitations and Strengths

a. Limitations

- Not yet known.

b. Strengths

- A light and useful tool for the demining of AP mines.

Figure 3 **Vehicle with Minecrusher in front**

9. Point of Contact

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10. Technical data sheet — Mercedes Benz Unimog with Minecrusher

a. Dimensional data

1. Length without attachment:	4 470 mm
2. Length total:	Approx. 5 900 mm
3. Width without attachment:	2 170 mm
4. Width total:	3 100 mm
5. Clearing width:	2 550 mm
6. Height, overall:	2 660 mm
7. Weight, basic vehicle:	7 400 kg
8. Weight, Demining Unit:	1 600 kg
9. Weight, total:	9 000 kg

b. Driving specifications

10. Wheels/tracks:	4 wheels
11. Ground pressure, max weight:	Not given
12. Hill climbing ability:	50%

c. Clearance performance

13. Number of chisels:	60
14. Gap between chisels:	Tool to tool: negative overlay
15. Rotation speed:	Up to 280 rpm
16. Clearance depth, max:	Up to 250 mm
17. Working speed	
• Light soil/small vegetation:	Up to 4000m²/h
• Medium soil/medium vegetation:	Up to 2400m²/h
• Heavy soil/dense vegetation:	Up to 1000m²/h
18. Control of clearing depth:	mechanical

d. System specifications

19. Engine:	MB OM 366 LA with 6 cylinders and 214 HP
20. Fuel capacity:	130 l
21. Fuel consumption:	Max. 25 l/hour
22. Separate engine for tilling unit:	no
23. Cooling system engine:	water
24. Oil capacity:	10 l
25. Hydraulic oil capacity:	31 l

e. Comfort and security

26. Air condition:	optional
27. Operator comfort:	a high degree of comfort for the operator is achieved by using standard components (seat, instruments, etc.) from industry
28. Armour:	Cabin with 10 mm armoured steel

f. Costs

29. Cost of system:	
• Machine	On request
• Training	Usually included in the system price
• Spare parts	depending
30. Repairs costs:	depending
31. Transport limitation:	no
32. Possibility for rent:	yes

Mine-Guzzler

Figure 1 **Mine-Guzzler with Caterpillar engine**

1. General Description

In 1995 Bofors Defence began developing mechanical demining equipment and the first test vehicle was completed towards the end of that year. A second test vehicle has been operationally tested in the field in Bosnia.

The two test vehicles were built on the Leopard I main battle tank chassis. The optimised demining vehicle is now redesigned and based completely on commercial components for easy maintenance, easy repair, and high accessibility of spare parts.

Bofors Mine-Guzzler is based on a double track arrangement used commercially. A demining roller is located on hydraulic supports at the front of the vehicle and powered by a 640kW engine with hydrostatic drive. The complete vehicle is fully protected against fragments from detonated mines. Any plates that become damaged can be easily replaced in the field by oxyacetylene cutting and welding. Each vehicle can be equipped with a spare roller to enable the demining work to continue while a roller is undergoing repair. A complete roller change can be effected in less than 30 minutes using the hydraulic supports to lift the roller for access or to load/unload the roller onto a transport vehicle.

The 45 ton Bofors Mine-Guzzler may be operated either by remote control using onboard television cameras or from the protection of the driver's cabin. This is further protected against fragments by a raised armoured superstructure. The driver's cabin is designed to withstand detonations from 12kg of explosives (TNT).

The Mine-Guzzler is made up of four parts – the protected cabin, the chassis, the engine compartment and the roller unit – that can be easily disassembled for transportation if required. This facilitates transport in countries that have had their roads destroyed in war or where the road network is substandard.

2. Clearance methodology

The vehicle drives forward into the suspect area, revolving the tiller unit. It rotates clockwise with a speed up to 190rpm. The demining roller, which can be angled to follow ground undulations, is adjustable for depth and automatically maintains the depth set. The roller comprises a series of circular plates fitted with tungsten carbide teeth around their outer perimeter, which either cause mines (anti-personnel and anti-tank) to detonate or breaks them into small pieces.

The Mine-Guzzler can clear anti-personnel and anti-tank mines to a depth of 50cm over an effective width of 3m. Maximum demining speed is 4km/h, depending on ground conditions.

3. Machines in Use to Date

- 1 machine
- 2 prototypes made earlier on Leopard 1 chassis.

Figure 2 **Roller with circular plates fitted with tungsten carbide teeth**

4. Engine, Fuel and Oil

- A caterpillar 3412E 640kW engine powers Mine-Guzzler with 800 l diesel capacity. The roller unit does not have a separate engine. The hydraulic oil capacity for the tracks is 200 l, while the lift and tilt system requires 70 l.
- During two tests in Germany in October 2000, the average fuel consumption was 70 and 90 l/hr.

5. Factory Support

- Spares specific to Mine-Guzzler are provided directly from Bofors Defence AB.
- A package of training, spare parts and equipment support is negotiable between the purchaser and Bofors Defence AB.
- The company will provide trained operators to purchasers that do not wish to train local staff.

6. Maintenance and Support

- The current model of Mine-Guzzler incorporates a chassis and track system widely available on the international market, in order to facilitate local repair and parts replacement where possible.
- The roller teeth are constructed from extremely tough tungsten carbide steel.

7. Test and Evaluations

- In May and June 2000 the Mine-Guzzler was tested in Croatia together with CROMAC. A minefield of 80 000 m^2 was cleared. The machine passed the CROMAC test.

- In October 2000, a comparative test with five different machines was carried out by the BWB (Bundesamt fuer Wehrtechnik und Beschaffung) on behalf of the German Army. Mine-Guzzler achieved the best overall results.
- In February 2001 the machine was tested by the Egyptian Armed Forces in Egypt. The test was performed in live mine fields in Hurghada and Safaga.
- In July 2001 the Swedish Army (SWEDEC) at their test facilities in Eksjö, Sweden, tested the Mine-Guzzler. At this time the test results are not available.

Figure 3 **Operator inside the cab**

8. Known Limitations and Strengths

a. Limitations

- The Mine-Guzzler is a large, tracked vehicle. Over long distances on deployment to minefields it will require transporting by low-loader.
- Air filters should be improved[1].
- The oil cooling system should be technically modified to avoid overheating[2].

b. Strengths

- The Mine-Guzzler is designed to destroy anti-personnel and anti-tank mines. This allows greater flexibility for deployment and use.
- Mine-Guzzler can easily cope with thick vegetation as well as individual trees up to 20 cm[3].
- Good daily efficiency of the machine during clearing operations[4].

Figure 4 **Mine-Guzzler clearing in Egypt**

9. Point of Contact

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[1] CROMAC test report
[2] CROMAC test report
[3] CROMAC test report
[4] CROMAC test report

10. Technical data sheet Mine-Guzzler

a. Dimensional data

1.	Length without attachment:	7 560 mm
2.	Length total:	8 460 mm
3.	Width without attachment:	3 340 mm
4.	Width total:	4 120 mm
5.	Clearing width:	3 000 mm
6.	Height, minimum:	3 400 mm
7.	Height, overall:	3 550 mm
8.	Weight, basic vehicle:	33 t
9.	Weight, Demining Unit:	15 t
10.	Weight, total:	48 t

b. Driving specifications

11.	Wheels/tracks:	Tracks
12.	Ground pressure, max weight:	0.98 kg/cm^2
13.	Hill climbing ability:	More than 30° (depends of grip for the tracks)

c. Clearance performance

14.	Number of chisels:	15 discs with 405 teeth
15.	Gap between drums/chisels:	
	• dynamically:	25 mm
16.	Diameter of roller:	1 250 mm
17.	Rotation speed:	up to 190 rpm
18.	Clearance depth, max:	Up to 500 mm in light soil
19.	Working speed [5]	
	• light soil/small vegetation:	1 200 m^2/h up to 4 km/h
	• heavy soil/dense vegetation:	1 000 m^2/h up to 1 km/h
20.	Control of clearing depth:	Automatically
21.	Machines in use:	1
22.	Other types:	2 earlier prototypes, on Leopard 1 chassis
23.	Location of use:	Croatia and Egypt
24.	Totally cleared so far:	Approx. 800 000 m^2

d. System specifications

25.	Engine:	Caterpillar 3412 E
26.	Fuel capacity:	800 l
27.	Fuel consumption:	app. 40-85 l/hour (depending on depth and soil) [6]
28.	Separate engine for tilling unit:	No
29.	Cooling system engine:	170 l 50/50 water and glycol
30.	Oil capacity: :	65 l
31.	Hydraulic oil capacity:	200 l for tracks and 70 l for lift and tilt system

e. Comfort and security

32.	Air condition:	Yes; AC and heater with air inlet filter,
33.	Operator comfort:	Suspension in chair, 4 point safety belt, automatic speed control, low noise, TV-monitor with cameras in front (movable) and rear, overpressure valve, emergency hatch.
34.	Armour:	16 mm armour and 46 mm protection glass
35.	Remote controlled:	Yes
	• Greatest distance	800 m

f. Costs

36.	Cost of system:	Approx. US$ 1 500 000
37.	Transport limitation:	Max. speed on tracks 7 km/h. Normally on trailer in one or two parts
38.	Possibility for rent:	Yes

[5] CROMAC test report
[6] During the test series in Germany, 70 and 90 l/hr (Test Report WTD 51, dated 15.01.2001)

Oracle

Figure 1 **The Oracle system with the trailer-mounted power pack**

1. General Description

The Oracle demining system was first developed in Sweden in 1994. It is based on an armoured Caterpillar 973 TTL MCAP. The main mine clearance tool on the Oracle is a three-segmented, rotating tiller drum fitted with replaceable tungsten steel teeth, called Spitfire. If one of the three segments of the roller is seriously damaged, it can be replaced independently of the other two. There are two types of tiller axle assemblies available. The depth at which mines are expected to be found as well as local soil conditions will dictate the choice of axle. Depending on the axle selected, the manufacturer claims that the system will clear to a depth of 300mm or 450mm.

Spitfire features three different types of carbide bits. Depending on the configuration chosen, the number of bits mounted to the tiller drum will be 126, 168 or 252. The staggered positioning of the digging tools on the rotor is designed to prevent AP mines passing between them.[1]

The Spitfire tiller unit is powered by a commercial Caterpillar diesel engine and hydraulic pump system (HPU), towed behind the prime mover on a trailer armoured to the same specification. It features a standard Caterpillar track system.

The combined weight of the Oracle system is 53 tons, making it difficult for use in swampy/wet terrain.[2]

[1] CROMAC test report
[2] CROMAC test report

Other attachments for the Caterpillar dozer, such as a demolition bucket and a mine clearance rake, can be fitted. The Caterpillar mine rake is standard equipment to the U.S. Army. Designed to rip mines out from the soil, the rake has a clearance width of 366cm down to an average depth of 30cm. The rake uses 35 degree angled tines, replaceable when damaged. The upturned soil and hopefully any mines within it are pushed to the right-hand side of the unit in a windrow.

The Oracle system can be operated either by VHF remote control or driven directly by an operator. Manual control of the vehicle is reckoned to be physically taxing.[3]

2. Clearance Methodology

Figure 2 **Spitfire tiller unit with carbide metal cutting bits**

The tiller drum rotates clockwise at 120 – 240rpm (depending on soil conditions) and achieves an average penetration depth of 30-40cm. A depth sensor fixed to the rotor regulates the clearance depth. The working ground penetration is not always constant as the depth sensor compensates for undulations of terrain.[4] The action of the rotating tungsten steel teeth is intended to detonate or fragment mines. Oracle is designed to clear AP and AT mines. The clearance width of the system is 322cm, achieving an average clearance capacity of 800m²/hr[5] over temperate zone soil. During demining, the maximum speed of Oracle is 5km/hr. [6]

3. Machines in Use to Date

- 1 machine operating in Croatia where it is operated by Terrafirma, a daughter company of Countermine Engineering AB.

4. Engine, Fuel and Oil

- The prime mover is powered by a 210kW Caterpillar 3306 diesel engine. The HPU has a 738kW Caterpillar 3412E diesel engine. The fuel capacity for this attached unit is 1136 l.
- The fuel consumption during mine clearance operations in Croatia was approximately 200 l/hr.[7]
- The manufacturer does not provide other details.

5. Factory Support

- The Spitfire system uses Caterpillar components. Caterpillar has a worldwide service and parts logistical organization. Caterpillar claims to be able to deliver parts to any location within 48hrs.

6. Maintenance and Support

- No information provided by the manufacturer

[3] CROMAC test report
[4] CROMAC test report
[5] CROMAC test report
[6] According to the manufacturer
[7] CROMAC test report

7. Test and Evaluations

- From April to June 2000, Oracle was tested in Croatia by CROMAC. A minefield of 116000m^2 was cleared.
- Representatives of Countermine Engineering AB did not permit testing of Oracle against the effects of the PROM-1 mine. However, the machine has set off more than 20 PROM-1 mines during operations without major damage.
- Detonation of a TMM-1 caused minor damage, repairable within 30mins. A combined detonation of a TMA-3 and a TMA-4 caused the loss of small components, also repairable.
- Oracle successfully destroyed mines.

Figure 3 **Oracle in operation**

8. Known Limitations and Strengths

a. Limitations

- Oracle is large and cumbersome, not ideal for maneuvering in tight spaces. With its towed power pack, it is difficult to turn and reverse.[8]
- Over longer distances, Oracle will require transportation by low loader.
- During tests overheating of the engine was frequent. Air filters require improvement.[9]
- The driver's cab ventilation system allows the ingress of dust.[10]

b. Strengths

- The tiller unit appears well designed and withstands powerful blasts incurring minor damage.[11]
- Oracle can easily cope with thick vegetation as well as individual trees up to 20 cm.[12]
- Powerful engine.[13]

Figure 4 **Oracle in open area**

9. Point of Contact

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Web site: www.countermine.com

[8] CROMAC test report
[9] CROMAC test report
[10] CROMAC test report
[11] CROMAC test report
[12] CROMAC test report
[13] CROMAC test report

10. Technical data sheet Oracle

a. Dimensional data

1.	Length without attachment:	4 947 mm
2.	Length total:	13 800 mm
3.	Width without attachment:	2 580 mm
4.	Width total:	4 500 mm
5.	Clearing width:	3 220 mm
6.	Height, minimum:	3 640 mm
7.	Height, overall:	3 640 mm
8.	Weight, basic vehicle:	28 210 kg
9.	Weight, Demining Unit:	6 790 kg
10.	Weight, HPU:	18 200 kg
11.	Weight, total:	53 000 kg

b. Driving specifications

12.	Wheels/tracks:	Tracks
13.	Ground pressure, max weight:	0.89 kg/cm^2 (basic vehicle)
	Ground pressure, max weight:	0.82 kg/cm^2 (HPU)
14.	Hill climbing ability:	50% [14]

c. Clearance performance

15.	Number of chisels:	126,168, or 252 depending on tool configuration
16.	Gap between drums/chisels:	25 – 75 mm depending on tool configuration
	Dynamically:	not given
17.	Diameter of roller:	1 200 mm
18.	Rotation speed:	120 -240 rpm
19.	Clearance depth, max:	200, 300 or 450 mm [15]
20.	Working speed:	Approx. 800 m^2/hr
21.	Control of clearing depth:	Automatically
22.	Machines in use:	1
23.	Other types:	Not given
24.	Location of use:	Croatia and Bosnia
25.	Totally cleared so far:	600 000 m^2

d. System specifications

26.	Engine:	Caterpillar 3306, 210 kW
27.	Fuel capacity:	1 136 l
28.	Fuel consumption:	app. 200 l/hour [17]
29.	Separate engine for tilling unit:	Yes (Caterpillar 3412E, 738 kW)
30.	Cooling system engine:	300 l
31.	Oil capacity:	65 l
32.	Hydraulic oil capacity:	350 l (for clearance unit)

e. Comfort and security

33.	Air condition:	As option
34.	Operator comfort:	Not given
35.	Armour:	20 mm (ARMOX 340), all major parts and cabin
36.	Remote controlled:	As option
	• Greatest distance	Not given

f. Costs

37.	Cost of system:	USD 900 000
38.	Transport limitation:	Max. speed on tracks 10 km/hr.
39.	Possibility for rent:	Not currently

[14] According to the manufacturer
[15] According to the manufacturer
[16] CROMAC test report
[17] CROMAC test report

Rhino

Figure 1 **The Rhino in operation**

1. General Description

The Rheinmetall Landsysteme Rhino is a 58t, remote-controlled tiller system. A Caterpillar engine powers the tracked, hydraulically driven machine. A power-split gearbox diverts the engine power into three hydraulic pump groups. The machine is protected by armour. When working, the machine will be unmanned. Cameras are mounted at the front and rear, providing colour images to monitor screens with the remote operator.

The prototype was developed in 1997. Replaceable components are commercially available.

Rhino is designed to clear AP mines, including in areas with dense vegetation. Currently, Rheinmetall Landsystems is considering a machine for clearing AT mines.

The operator's remote control panel has two joysticks, one for steering and movement and the other to control the tiller unit. The maximum range for the remote system is 1000m. For safety reasons, a time-activated switch (dead man) has to be periodically pressed by the operator to prevent the machine from cutting out.

2. Clearance Methodology

The tiller unit consists of two, 3.45m wide hydraulically driven tiller drums attached to the chassis by quick connect system. The larger, bottom drum rotates anti-clockwise in order to prevent compaction of soil and mines. The tiller drum works at approx. 120rpm, while the smaller, upper tiller drum works at 600rpm in reverse direction. The lower drum cuts the soil and carries the excavated soil to the upper tiller where any object among the soil larger than 5cm x 5cm is crushed. Mines are either detonated on contact with the lower drum or are fragmented/crushed between the tillers.

The chisels attached to both drums are of tungsten steel and are replaceable. For quick cleaning or removal of sods of earth, the rotation of both tiller drums can be reversed.

Ground penetration depth is regulated automatically by feelers on either side of the unit, ensuring a near constant level during operation. This can be overridden for manual control. An average clearance depth of 50cm is achieved, according to the manufacturer.

Figure 2 **Tiller system of the Rhino**

3. Machines in Use to Date

- S/N 01 prototype
- S/N 02 in use since August 1998 in Croatia by AKD Mungos, a Croatian demining company. By end of 2000, approx. 3 000 000 m^2 were cleared.
- S/N 03 in test/operation from August 1999-May 2000 in Cambodia with CMAC/CARE.
- S/N 04 purchased by CECOM (USA) in 1999. In test/operation in 2000 with Jordanian Army. 2001 test/operation in Israel by Technion/Israeli Defense Force.
- S/N 05 in October 2000, delivered to South Korean Army.

4. Engine, Fuel and Oil

- Single engine plus auxiliary engine (generator during maintenance). Normal diesel oil required.
- Biodegradable long-life hydraulic oil is recommended. Normal mineral hydraulic oil can be used.
- Average fuel consumption is 100 l/hr but varies with working conditions.

5. Factory Support

- Choice between small spare parts package (€ 22 000) or a more comprehensive option (€ 220 000). The latter contains high value/long lead-time items.
- Consumable spares for approx. 800 operational hrs is offered (approx. € 50 000).
- Additional maintenance set (e.g. with sun cover, generator, welding equipment) is available (approx. € 18 000).
- Many Rhino components are commercially available from other producers.
- Operator course provided by manufacturer in Germany, plus on-site technical assistance (approx. € 42 000).
- Purchase price includes full tool set, English version operation and maintenance manuals, spare parts catalogue, hydraulic and electrical schematic. Translation into other languages can be arranged.
- Warranty limited to 800hrs or 6 months, whichever comes first. Explosive damage (especially from AT mines) is excluded. An extended warranty is negotiable.
- Technical advice on problems provided via telephone, e-mail, and in extreme cases, technical service on-site.
- Complete spare parts service is available.

6. Maintenance and Support

- Manufacturer recommends simple daily, weekly and 250hr (change engine oil) maintenance checks. Many of the subsystems do not require scheduled maintenance.
- Manufacturer recommends that no distinction be made between operator and mechanic. Two teams each of two men under a commander are advised. A team should operate for 2hrs before being relieved, while maintenance is a combined effort. Training by the company will teach mechanics, welding, electronic and hydraulic skills. Advisable that selected crews have previous training/experience in these skills.
- Advisable to store common spares and tools in a container close to the working site. Additional stores can stay in base locations.

7. Test and Evaluations

Figure 3 **Rear view of Rhino**

- In 1997, in co-operation with a client, Rheinmetall Landsysteme conducted tests using live and inert AP and AT mines. The copyright of the test report is owned by CECOM, USA.
- 1999/2000 tested in Cambodia by CMAC. The CMAC report is available from Rheinmetall Landsysteme and is already distributed to several agencies incl. GICHD and UNMAS.
- The Israeli Defence Force is currently testing the system in three different environments.
- In October 2000, a comparative test with five different machines was carried out by the BWB (Bundesamt fuer Wehrtechnik und Beschaffung) on behalf of the German Army.
- Operational advice based on experience is offered by Rhino user AKD Mungos, Croatia.

8. Known Limitations and Strengths

a. Limitations

- Automatic depth control struggles in sodden soil.
- Road speed limited to 3.8km/h.
- Large-caliber UXO's e.g. 100mm were not picked up by the system but dropped in front of the lower drum. The soil windrow created by the lower drum may contain mines/UXO and must be manually verified.
- Heavy weight. Requires careful planning for transport and cannot be used on soft soil.

b. Strengths

- Bridges could be bypassed and slopes could be leveled by the system with the dozer attached. Fording depth is 1m.
- Due to size and clearing capacity, it is best employed in suspect areas greater than 50 000-100 000m^2.
- Self-recovery possible.
- Full operator protection due to remote control.
- Several auxiliary means e.g. air-compressor, cable remote control.
- High survivability proven e.g. the system was field repairable even after a double AT mine detonated under the tracks (currently, system is not intended for AT mine clearance).
- Dense vegetation e.g. bamboo of medium size and trees up to 20cm can be cleared.

Figure 4 **The Rhino in Croatia**

9. Point of Contact

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Fax: +49-(0)4 31-39 99-29 66/34 50
Mobil: +49-(0)171-44 19 364
Email: manfred.joehnk@rheinmetall-ls.com

10. Technical data sheet Rhino

a. Dimensional data

1.	Length without attachment:	7 800 mm
2.	Length total:	9 600 mm
3.	Width without attachment:	3 000 mm
4.	Width total:	4 200 mm
5.	Clearing width:	3 500 mm
6.	Height, minimum:	3 150 mm
7.	Height, overall:	3 200 mm
8.	Weight, basic vehicle:	46 t
9.	Weight, dozer blade:	2 t
10.	Weight, Demining Unit:	14 t

b. Driving specifications

11.	Wheels/tracks:	2 commercial tracks each 700 mm wide
12.	Ground pressure, max weight:	1 kg/cm^2
13.	Hill climbing ability:	24°

c. Clearance performance

14.	Number of chisels	
	• lower drum:	360
	• upper drum:	174
15.	Gap between drums/chisels Dynamically:	30 mm
16.	Rotation speed	
	• lower drum:	up to 120 rpm
	• upper drum:	up to 600 rpm
17.	Clearance depth, max:	Up to 500 mm in light soil [1/2]
18.	Working speed	
	• light soil/small vegetation:	2 000 m^2/h
	• medium soil/medium vegetation:	1 000 m^2/h
	• heavy soil/dense vegetation:	600 m^2/h
19.	Control of clearing depth:	automatic by mechanical sensors/electronic controller with manual override possibility or manual
20.	Machines in use:	3
21.	Other types:	No
22.	Location of use:	Cambodia, Croatia, Israel, Jordan, Korea
23.	Totally cleared so far:	Not given

d. System specifications

23.	Engine:	Caterpillar 3412 with 660 kW
24.	Fuel capacity:	1 700 l
25.	Fuel consumption:	app. 100 l/hour
26.	Separate engine for tilling unit:	No
27.	Cooling system engine:	water/air
28.	Oil capacity:	68 l
29.	Hydraulic oil capacity:	Approx. 1 000 l

e. Comfort and security

30.	Operator comfort:	remote control desk could be used in a tent or installed in a 10`container/ truck with a/c and heating devices
31.	Armour:	protective glass in cab., minimum 10 mm steel plates
32.	Remote controlled:	bi-directual link with watch-dog, vehicles data indicated on remote control box, max distance: 1 000 m

f. Costs

33.	Cost of system:	Approx. 1.7 Mio €
34.	Other costs:	depending on customer requirements
	• machine:	Not given
	• training:	42 000 €
	• Duration of training:	Not given
	• spare part set:	220 000 € (large set); 25 000 € (small)
	• repair costs:	Not given
35.	Possibility for rent:	up to now the commercial problems for renting could not be solved

[1] According to the manufacturer
[2] During the testing in Germany, Rhino achieved between 18-43cm. 30cm were required.

Section 3

Combined Systems

Redbus Land Mine Disposal System

Figure 2 **The Redbus Land Mine Disposal System consisting of the Bigfoot (left) and Mineworm (right)**

1. General Description

The Redbus Land Mine Disposal System (LMDS) is a new concept in remote-controlled machinery for land mine detonation and unexploded ordnance removal. The company was established in May 1999. The Redbus LMDS integrates two machines: Redbus Bigfoot and Redbus Mineworm. Working in support of each other, the remote-controlled machines are capable of clearing up to 1000m^2/hr of ground.

Redbus LMDS features:

- Bigfoot initiates clearance, driving over a suspect area with its front fitted row of piston mounted feet. The steel feet are designed to withstand explosive blast. If a foot is damaged during operation, it can be replaced.
- Mineworm follows Bigfoot, lifting and sifting soil that then passes through a metal removal system followed by a crusher to ensure that no unexploded ordnance remain. Metal fragments picked up by the machine are collected for safe disposal while the sifted soil is redistributed in the trail of the vehicle.

The Redbus LMDS combines different systems in order to comprehensively cover the ground upon which it operates. These include a vegetation cutter, a soil breaker and root cropper, a rotating excavator and a metal sorter with fragmenter/crusher.

Figure 2 **The Redbus Bigfoot**

The vegetation cutter mounted on the front of Bigfoot is capable of clearing light to medium vegetation at a rate in excess of 200m^2/hr on shrubs and small trees up to 10cm diameter.

Bigfoot has been tested against fragmentation mines, various anti-personnel mines, British barmines and MK7 9kg anti-tank mines. Mineworm has less blast protection, as it will be following directly in the path of Bigfoot and is unlikely to be subjected to the same amount of peripheral detonations.

The Redbus LMDS is designed to operate in many types of weather and terrain and its relatively low weight should allow it to cope with paddy fields, canals, hills and secondary jungle. Slope limitation will depend on ground type.

2. Clearance Methodology

Redbus Bigfoot is a remote-controlled vehicle with multiple armoured feet mounted forward of the vehicle main body. The standard model has ten feet. Other models are available with an increased or decreased number of feet. The vehicle drives forward into a suspect area while the feet apply pressure to the ground, hopefully detonating mines. Foot pressure is controlled to limit soil compaction. The ground pressure applied by each foot can be adjusted from 150kg to 750kg. Redbus Bigfoot employs a unique patented system for shock absorption, blast deflection and energy dissipation that allows detonation of anti-personnel mines without incurring damage to the machine. For possible damage inflicted by anti-tank mines, the repair or replacement of low-cost parts can be performed in field conditions by semi-skilled staff, according to the manufacturer.

Redbus Bigfoot also features a vegetation cutter attached to the front of the vehicle. This helps to augment the effectiveness of the steel feet increasing the probability of mine detonation as Bigfoot moves forward.

Bigfoot is operated by remote control using closed circuit TV to monitor and maneuver the machine from a safe position. It can be driven out to a radius of 5000m from a control station.

Redbus Mineworm follows in the path of Bigfoot, excavating the soil to a chosen depth and removing UXOs, explosive particles, faulty mines and mine fragments from the route covered by

Figure 3 **The Redbus Mineworm**

Bigfoot. Smaller particles picked up by Mineworm are destroyed by its fragmenter/crusher. Larger items are identified on the monitor by the operator and directed to an onboard collector, while items deemed to be an immediate threat are put aside for separate destruction. Redbus Mineworm is remote-controlled and fitted with cameras to monitor progress and inspect excavated material. It is designed to remove all ordnance not destroyed by Bigfoot. Mounted at the front of the machine is a soil breaker/root cropper. This prepares the ground for the rotating excavator that lifts the soil and passes it through the system. A ferrous material sorter removes objects for inspection on the monitor. All other material is passed through the fragmenter/crusher where detonators, explosive materials and mine fragments are destroyed.

The depth of excavation will depend on the cutters fitted, with a maximum depth of 55cm.

Bigfoot and Mineworm are each controlled by two personnel.

The Redbus LMDS has been designed to destroy mines and unexploded ordnance (UXO) by initiating survivable detonation. UXO is lifted from the soil to be destroyed or rendered safe by a process of fragmentation. Larger ordnance is identified and separated for destruction by EOD personnel.

3. Machines in Use to Date

- 1 system is operating in Bosnia

4. Engine, Fuel and Oil

- The engines of the system require normal diesel fuel.
- Hydraulic fluids are of common use and readily available.
- The fuel tank capacity is 1000 l for the Redbus Bigfoot and the same for the Redbus Mineworm.
- The average consumption per hour is 20–40 l for the Bigfoot and 40 l for the Mineworm.
- The hydraulic tank capacity is 800 l for the Bigfoot and 900 l for the Mineworm.

5. Factory Support

- An initial comprehensive spares pack is provided with the equipment. A spares, training and equipment support package is included. The exact nature of the package is negotiable between the purchaser and Redbus LMDS Limited.

6. Maintenance and Support

- Redbus states that LMDS is practical for self transport for distances up to 30km. It should be kept in mind however that the system operates by remote control.
- Although LMDS is of a relatively low weight, in most countries it would require two low loaders to transport it to the next minefield location.

- The design technology of LMDS is relatively simple. The producers say that this increases reliability and that it is simple to operate and repair for people with basic mechanical skills.
- Electronic systems include self-diagnoses contained in a replaceable box supplied by Redbus.
- The Redbus LMDS has been designed to ease logistic support. In some cases, it is believed that parts can be locally purchased or even manufactured.

Figure 4 **Redbus Bigfoot with vegetation cutter**

7. Test and Evaluations

- The Redbus Land Mine Disposal System has undergone a series of performance tests with the United Kingdom Defence Evaluation Research Agency (DERA). Recommendations were made to the manufacturer for further development.
- The system was tested in Bosnia during summer 2001.

8. Known Limitations and Strengths

a. Limitations

- LMDS will require transporting by two low-loaders in most mine affected countries.
- Remote control and monitor system could prove complicated to repair in some countries.

b. Strengths

- Survivability successfully tested on some types of anti-tank mine.
- Remote control system guarantees operator safety.
- System employs variety of clearance techniques.

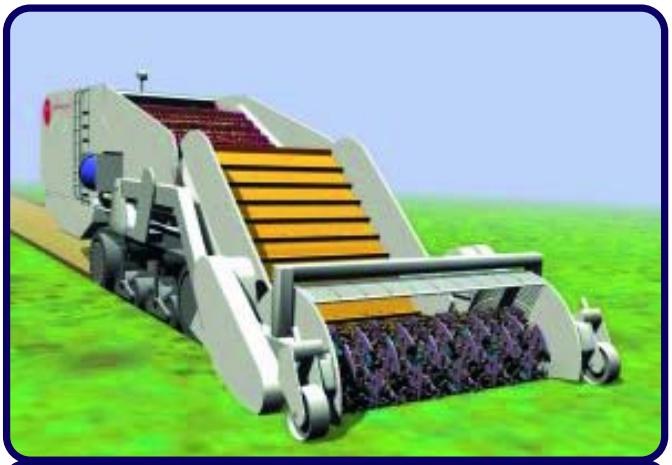

Figure 5 **Computer imagery of the Mineworm**

9. Point of Contact

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Web site: www.lmds.redbus.co.uk

10. Technical data sheet Redbus Bigfoot

a. Dimensional data

1. Length without attachment:	Not given
2. Length total:	6 700 mm
3. Width without attachment:	Not given
4. Width total:	2 800 mm
5. Clearing width:	2 000 mm
6. Height, minimum:	Not given
7. Height, overall:	2 500 mm
8. Weight, basic vehicle:	Not given
9. Weight, Demining Unit:	Not given
10. Weight, total:	10 tons

b. Driving specifications

11. Wheels/tracks:	Tracks
12. Ground pressure, max weight:	0.4 kg/cm^2
13. Hill climbing ability:	45°[1]

c. Clearance performance

14. Number of feet:	10 (standard model)
15. Gap between feet dynamically:	10 mm
16. Size of feet:	270 mm long x 200 mm wide
17. Max. pressure:	750 kg per foot
18. Min. pressure:	150 kg per foot
19. Working speed:	300 – 1 000 m^2/h^2 (no further detailed data given)
20. Control of clearing depth:	Automatically
21. Machines in use:	1 prototype
22. Other types:	no
23. Location of use:	Bosnia Herzegovina
24. Totally cleared so far:	Not given

d. System specifications

25. Engine:	250 hp
26. Fuel capacity:	1 000 l
27. Fuel consumption:	20 – 40 l/h
28. Separate engine for the feet:	No
29. Transition:	Not given
30. Cooling system engine:	Water
31. Oil capacity: :	Not given
32. Hydraulic oil capacity:	800 l

e. Comfort and security

33. Operator comfort:	2 colour TV-monitor with four colour cameras in front (movable) and rear,
34. Armour:	Foot ram assembly/front and sides
35. Remote controlled:	Yes
• Greatest distance	5000 m

f. Costs

36. Cost of system:	Not given
37. Other costs:	Not given
38. Transport limitation:	Max. speed on tracks 6.5 km/h. Normally on trailer
39. Possibility for rent:	Yes

[1] According to the manufacturer
[2] According to the manufacturer

10. Technical data sheet Redbus Mineworm

a. Dimensional data

1. Length without attachment:	Not given
2. Length total:	10 000 mm
3. Width without attachment:	Not given
4. Width total:	2 700 mm
5. Clearing width:	Not given
6. Height, minimum:	Not given
7. Height, overall:	3 400 mm
8. Weight, basic vehicle:	Not given
9. Weight, Demining Unit:	Not given
10. Weight, total:	15 t

b. Driving specifications

11. Wheels/tracks:	tracks
12. Ground pressure, max weight:	Not given
13. Hill climbing ability:	30°

c. Clearance performance

14. Number of tools:	Not given
15. Gap between drums/chisels dynamically:	60 mm
16. Diameter of drum:	750 mm
17. Rotation speed:	From 80 to 700 rpm
18. Clearance depth, max:	Up to 550 mm[3]
19. Working speed:	750m²/h[4] (no further detailed data given)
20. Control of clearing depth:	automatically
21. Machines in use:	1 prototype
22. Other types:	No
23. Location of use:	Bosnia Herzegovina
24. Totally cleared so far:	Not given

d. System specifications

25. Engine:	300 hp
26. Fuel capacity:	1 000 l
27. Fuel consumption:	40 l/h
28. Separate engine for tilling unit:	No
29. Transition:	Not given
30. Cooling system engine:	Water/Glycol
31. Oil capacity:	Not given
32. Hydraulic oil capacity:	900 l

e. Comfort and security

33. Operator comfort:	TV-monitor with cameras in front (movable) and rear,
34. Armour:	Cutter/diggers assembly protected
35. Remote controlled:	Yes
• Greatest distance:	5 000 m

f. Costs

36. Cost of system:	Not given
37. Other costs:	Not given
38. Transport limitation:	Max. speed on tracks 6.5 km/h. Normally on trailer
39. Possibility for rent:	Yes

[3] According to the manufacturer
[4] According to the manufacturer

MinenWolf

Figure 1 **MinenWolf with flail system and tiller unit**

1. General Description

STS MinenWolf is a joint German-Swiss mechanical mine clearance concept, combining a tiller machine with a chain flail. The prime mover of the system is a standard tracked bulldozer previously used for forest clearance and re-cultivation. The prototype currently under development will weigh approximately 20t, including attachments.

The German Federal Office for Defence Technology and Procurement (BWB) carried out the first series of tests. Following these, there are plans to modify the system, with major changes envisaged for the prime mover, e.g. placing the driver's cab towards the rear to allow lift potential (see Fig 2). Attachments are fitted with three-point linkage for interchange of tools (approx. 15mins).

The system is driver operated, featuring an armoured cab with protected glass.

The flail is based on a previously developed system.

2. Clearance Methodology

Clearance operations conducted by the machine will be in two phases. The first phase is to flail a suspect area. Attached to each chain is a heavy steel hammer, with a flail rotation speed of 350-400rpm. The action of the flail is designed to detonate or fragment mines. The flail is detached and the tiller unit fitted for the second phase of clearance. The tiller burrows the ground, further breaking up mine or UXO fragments left by the flail. The ground is rendered safer for subsequent inspection by EOD staff. During tests in Germany, inert AP and AT mines were used. In two different soil types, a clearance depth of approximately 30cm was achieved.

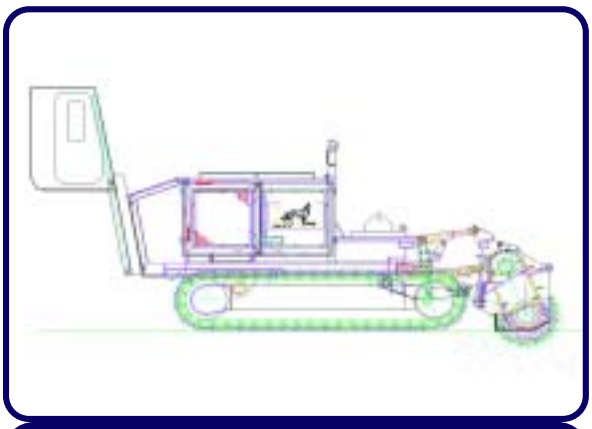

Figure 2 **Schematic of MinenWolf. Current plan with cab at rear**

3. Machines in Use to Date

- 1 prototype.
- Expected completion of first machine mid 2002.

4. Engine, Fuel and Oil

- The machine is equipped with a Deutz BF8M diesel engine with 400hp.
- Fuel consumption is 40 l/hr.
- Hydraulic system requires standard oil.

5. Factory Support

- Operator training conducted by the manufacturer: 4-5 weeks in Germany and 1-2 weeks at programme location. Training will be part of the purchasing package.
- Instruction manuals and documentation will be available in German and English.
- A spare parts package is part of purchase package (depending on location of purchaser's programme).

6. Maintenance and Support

- Manufacturer recommends a two-man crew: one driver, one mechanic.
- The MinenWolf is designed for container transport by air, road, and sea.
- Heavy-weight transporter required for road moves.
- Air transport with Transall or Hercules possible.

Figure 3 **Flail system at work**

7. Test and Evaluations

- Prototype tested by BWB (Germany) in June 2001. With flail and tiller combined, all 95 inert mines in the test were cleared (fragmented) to an average depth of 30cm.
- The flail system showed some weaknesses. Specifically, the manually set depth control appears to be inefficient. STS hopes to solve this problem with an automatic system.
- Tests involving live mines not yet conducted.

8. Known Limitations and Strengths

a. Limitations

- Will not cut vegetation of more than 10cm dia.
- Tiller unit unusable on rocky ground.
- The current depth control is inefficient.
- Clearance operations using both attachments consecutively require approximately double time as by a single tiller or flail system.

b. Strengths

- Thus far, the concept has proved effective during inert mine tests to 30cm ground penetration depth.
- The only system that combines both flail and tiller.
- For its design and role, the machine is comparatively light-weight.

Figure 4 **The tiller unit of the MinenWolf**

9. Point of Contact

STS Safety Technologie Systems
Heinz Rath
Sebastian Kneipp Str. 73a
56179 Vallendar
Germany

Tel: +49 261 66 79 628
Fax: +49 261 66 79 629
Mobile: +49 170 18 45 911
e-Mail: h.rath@minenwolf.de
Web site: www.minenwolf.de

10. Technical data sheet MinenWolf (Prototype)

a. Dimensional data

1.	Length without attachment:	4 885 mm
2.	Length total:	8 310 mm (with flail), 6 237 mm (with tiller)
3.	Width without attachment:	2 500 mm
4.	Width total:	3 680 mm (with flail), 2 890 mm (with tiller)
5.	Working width:	3 000 mm (with flail), 2 600 mm (with tiller)
6.	Height, minimum:	3 050 mm
7.	Height, overall:	3 050 mm
8.	Weight, basic vehicle:	12 600 kg
9.	Weight, Attachments:	3 800 kg (flail), 4 600 kg (tiller)
10.	Weight, total:	16 400 kg (with flail), 17 200 kg (with tiller); weight without armour

b. Driving specifications

11.	Wheels/tracks:	Tracks
12.	Ground pressure, max weight:	0.5 kg/cm^2
13.	Hill climbing ability:	40°

c. Clearance performance

14.	Number of chains/chisels:	76 (chisels not given)
15.	Gap between chains/chisels:	Not given
16.	Length of chains:	1 000 mm
17.	Rotation speed:	350 – 400 rpm
18.	Working depth, max:	Up to 400 mm
19.	Control of clearing depth:	Manually
20.	Working speed:	Not yet tested
21.	Machines in use:	1 prototype
22.	Other types:	No
23.	Location of use:	Germany (for tests)
24.	Totally cleared so far:	–

d. System specifications

25.	Engine:	Deutz BF8M diesel engine with 400 hp.
26.	Fuel capacity:	Not given
27.	Fuel consumption:	Max.40 l/hour[1]
28.	Separate engine for tilling unit:	No
29.	Transition:	Not given
30.	Cooling system engine:	Not given
31.	Oil capacity: :	Not given
32.	Hydraulic oil capacity:	Not given

e. Comfort and security

33.	Air condition:	Not given
34.	Operator comfort:	Not given
35.	Armour:	Not given (still under construction by RUAG)
36.	Remote controlled:	On request

f. Costs

37.	Cost of system:	Approx. 500 000 € depending on the required equipment
38.	Other costs:	Not given
39.	Transport limitation:	For long distances transportation on a low-bed trailer is required
40.	Possibility for rent:	Leasing or rental possible

[1] According to the manufacturer

Section 4

Multi-Tool Systems

Armtrac 325

Figure 1 **Armtrac 325 with available attachments**

1. General Description

The Armtrac 325 mine clearance vehicle is a development of the Agriflail machines used in Bosnia, Croatia and Mozambique. Military and agricultural principles have been employed in the design, test, and development of the 325. The Armtrac 325 is fitted with a flail unit with optional extra ttachments: digger arm, bucket, strimmer head, and log grab.

The Armtrac 325 prime mover provides the platform to which the optional attachments can be fitted via its quick-hitch system. The box section ladder chassis provides torsion stiffness over extreme terrain plus shock absorption in case of detonations from under any of the attached tools, or from under the machine itself.

The fully welded chassis and boom structure provides the freedom to use a modular power and transmission drive-line whilst also helping to isolate the cabin from engine, transmission and detonation noise. The use of a modular design also assists maintenance and repair. All hoses and wiring looms are designed in a similar fashion, allowing each section to be 'unplugged' and replaced.

Transmission consists of 325hp Volvo engine driving through a speed-increasing gearbox to a hydraulic pump. The drive is taken to a two speed transfer box, then on to the two axles fitted with foam filled balloon tyres. This gives 16 forward and 16 reverse gears with variable speed in each gear.

Figure 2 **Armtrac 325 with flail system**

2. Clearance Methodology

The flail of the Armtrac 325 rotates at 350rpm clockwise with a working width of 3m. The 74 chains of the flail unit have a dynamic spacing of 10mm, and the approximate clearance depth is expected to be up to 30cm, with depth variations controlled by the operator. When working, the vehicle moves at 1km/hr, detonating or fragmenting mines.

3. Machines in Use to Date

- Machines have been sold to European Landmine Solutions and Exploration Logistics (Mineclear/Minetech).
- Two machines are currently working, one in Bosnia and one in Kosovo.

4. Engine, Fuel and Oil

- The Armtrac 325 is equipped with a 325hp Volvo diesel engine.
- The average fuel consumption is 50 l/hr[1] while the flail is in operation.

5. Factory Support

- At extra cost, a basic spare parts kit is supplied by the manufacturer as part of the purchase package.
- The manufacturer supplies special parts unlikely to be found locally.

6. Maintenance and Support

- Weekly basic greasing, oil level checks etc by driver/operator.
- Full service required every 300hrs by personnel trained by the manufacturer.

7. Test and Evaluations

- No information available

Figure 3 **Armtrac 325 with strimmer**

[1] According to the manufacturer

8. Known Limitations and Strengths

a. Limitations

- For transportation over longer distances, a 40m low-bed trailer is required.

b. Strengths

- Possibility to use various attachments i.e. flail, digger arm, 3 in 1 bucket, strimmer head, and log grab.

Figure 4 **The Armtrac in Kosovo**

9. Point of Contact

Ground Sift & Clear Systems Limited
Stephen Brown
5 Tenbell Lane
Soham,
Ely, Cambs,
England, CB7 5BJ

Tel: +44 (0) 1638 74 39 79
Fax: +44 (0) 1638 74 25 78
e-Mail: gscs@supanet.com
Web site: www.gscs.sagenet.co.uk

10. Technical data sheet — Armtrac 325 with flail unit

a. Dimensional data

1. Length without attachment:	6 400 mm
2. Length total:	8 200 mm
3. Width without attachment:	2 730 mm
4. Width total:	3 500 mm
5. Clearing width:	3 000 mm
6. Height, minimum:	3 200 mm
7. Height, overall:	3 200 mm
8. Weight, basic vehicle:	15 000 kg
9. Weight, Demining Unit:	3 000 kg
10. Weight, total:	18 000 kg

b. Driving specifications

11. Wheels/tracks:	4 foam filled tyres
12. Ground pressure, max weight:	Not given
13. Hill climbing ability:	45°[2]

c. Clearance performance

14. Number of chains:	74
• Length of chains:	1 000 mm
15. Gap between chains:	10 mm
16. Rotation speed:	350 rpm
17. Clearance depth, max:	Up to 300 mm
18. Working speed[3]	
• light soil/small vegetation:	Approx. 4 000 m²/h
• medium soil/medium vegetation:	Approx. 2 800 m²/h
• heavy soil/dense vegetation:	Approx. 2 800 m²/h
19. Control of clearing depth:	Manually
20. Machines in use:	2
21. Location of use:	Bosnia, Kosovo, Mozambique
22. Totally cleared so far:	Approx. 6 000 000 m²
23. Other types:	Armtrac 100

d. System specifications

24. Engine:	Volvo diesel with 325 hp
25. Fuel capacity:	455 l
26. Fuel consumption:	50 l/hour
27. Separate engine for working unit:	No
28. Cooling system engine:	Air blown over radiator
29. Oil capacity: :	46 l
30. Hydraulic oil capacity:	910 l

e. Comfort and security

31. Air condition:	Yes
32. Operator comfort:	Air cushioned seat, fully adjustable
33. Armour:	Cab 10 mm steel plates
34. Remote controlled:	No

f. Costs

35. Cost of system:	£230 000
36. Other costs:	
• Training:	£2 500; duration 10 days
• Spare part set chains/belts:	£300
• Repair costs for one year:	£2 400
• transportation:	£10 000 to buy low-loader
37. Possibility for rent:	Yes

[2] According to the manufacturer
[3] all figures according to the manufacturer

MgM Rotar Mk-II

Figure 1 **MgM Rotar Mk-II with rotar and vegetation cutter**

1. General Description

The MgM Rotar Mk-II is based on the experience gained with the MgM Rotar Mk-I sifter system, but is different from the Mk-I machine. Built in Namibia, it is based on a lighter carrier vehicle with added demining tools.

The carrier is an armoured Caterpillar 428c backhoe tractor. At the front of the machine, a MgM designed bucket sifter has been attached, but the standard Caterpillar bucket can also be fitted. Mounted on the rear hoe arm is a vegetation cutter/mulcher that can be angled to compensate for variegated terrain and obstacles.

General mobility compared with the standard CAT 428c is not adversely affected by the attachment of demining specialist tools.[1] Due to the weight of belly armour, a slight lowering of vehicle centre of gravity is imparted, improving stability.

The protected operator's cab includes a video system to enable monitoring of the contents of the rotar bucket. The cab is air conditioned. VHF radio is included in the sales package.

The MgM Rotar Mk-II is an anti-personnel mine clearance system. It is not designed to operate in locations where there is a possible presence of anti-tank mines.

[1] According to the manufacturer

Figure 2 **Mine blast within the Rotar drum**

2. Clearance Methodology

The MgM Rotar Mk-II uses its front mounted sifter drum to scoop up a bucket load of soil. The machine moves back along the safe route from which it approached the suspect area to a cleared/safe inspection area. The sifter drum rotates, causing the smaller particles less than 4cm X 4cm within the drum to fall through the round-steel bar mesh. Remaining material within the drum is driven to a second area, where the contents are released for visual inspection. Anti-personnel mines, parts of mines or any UXOs contained within the drum are destroyed by EOD specialists. The Rotar operation is in six stages: Load drum; close drum; rotate drum (sift); open drum; empty drum; visually inspect remaining contents. The drum bucket has been tested for resistance to anti-personnel mine detonation. Tests with anti-tank mine detonation have not taken place.

The rear mounted bush cutter is attached to a hydraulic arm. Depending on conditions, bush cutting can precede the rotar in order to improve its performance. The bush cutter can be employed to assist manual demining.

The MgM mine clearance systems attached to the Caterpillar 428c tractor can be removed. The vehicle can then be put to work with its regular digger bucket in order to benefit mine affected communities in tasks beyond just clearing mines, a versatility lacking in many purpose designed machines.

3. Machines in Use to Date

- 1 machine undergoing testing and evaluation in Namibia.

4. Engine, Fuel and Oil

- The Rotar Mk-II is equipped with a Caterpillar 3054 T turbocharged engine with 56 or 60kW. It is a 4-cylinder, 4-stroke, direct-injection engine. Fuel tank capacity is 128 l.
- Fuel consumption during heavy work assessed at approximately 15 l/hour.
- Engine oil capacity with filter is 7.3 l.
- The pump flow of the hydraulics is 163 l/min. Hydraulic oil capacity is 79 l.

5. Factory Support

- All Caterpillar dealers provide 'Five Star Customer Service' for the Caterpillar 428C.
- A VHF radio, manuals and a spare parts package are included as a matter of course.

Figure 3 **Rotar-II preparing for transportation**

6. Maintenance and Support

- Daily fluid servicing is from the left side of the machine.
- Single location for fluid level check.
- Visual indicators for checking the air cleaner and hydraulic oil level.
- All filters are mounted vertically for spill-free servicing.

7. Test and Evaluations

- The Rotar Mk-II has undergone testing and evaluation by the manufacturer in Namibia.

8. Known Limitations and Strengths

a. Limitations

- For anti-personnel mine clearance only.
- Requires low-loader transport for longer distances.

b. Strengths

- Based on a widely available commercial vehicle.
- MgM Rotar Mk-II can revert to tasks other than mine clearance.

Figure 4 **Rotar-II detonating a mine**

9. Point of Contact

MgM Menschen gegen Minen e.V.
Moltkestr.1
47805 Krefeld
Germany

Tel: +49 2151 55 57 55
Fax: +49 2151 51 14 48
e-Mail: info@mgm.org
Web site: www.mgm.org

10. Technical data sheet MgM Rotar Mk-II

a. Dimensional data

1. Length without attachment:	5 760 mm
2. Length total:	Not given
3. Width without attachment:	2 396 mm
4. Width total:	2 400 mm (stabilizer legs at the rear)
5. Working width:	1 800 mm (inside the drum); 1 600 mm (cutter)
6. Height, overall:	3 250 mm
7. Weight, basic vehicle:	7 415 kg
8. Weight, Attachments:	2 985 kg
9. Weight, total:	10 400 kg

b. Driving specifications

10. Wheels/tracks:	4 wheels tubeless, nylon, loader design tyres
11. Ground pressure, max weight:	Not given
12. Hill climbing ability:	30°

c. Working performance

13. Capacity of the Rotar:	600 l
14. Rotation speed:	variable
15. Working depth, max:	200 – 300 mm
16. Working speed brush cutter • light soil/small vegetation: • medium soil/medium vegetation: • heavy soil/dense vegetation:	Not given
17. Machines in use:	1
18. Other types:	Rotar-I (larger machine)
19. Location of use:	Namibia
20. Totally cleared so far:	Not given

d. System specifications

21. Engine:	Caterpillar 3054 T turbocharged diesel engine, either with 56 or 60kW and a 4-cylinder, 4-stroke, direct-injection engine.
22. Fuel capacity:	128 l
23. Fuel consumption:	Max.15 l/hour
24. Separate engine for Rotar unit:	no
25. Transition:	Not given
26. Cooling system engine:	water
27. Oil capacity:	7.3 l
28. Hydraulic oil capacity:	79 l

e. Comfort and security

29. Air condition:	yes
30. Operator comfort:	Air-suspension seat, additional option: AM/FM Stereo/Cassette package, tilt wheel, and circulating fan
31. Armour:	4 mm plate for the cabin and 35 mm protection glass windows. The engine hood, rear cab side and cab floor, and the Rotar blast deflector are toughened with 6-10 mm plates
32. Remote controlled:	no

f. Costs

33. Cost of system:	About USD 200 000
34. Other costs:	Not given
35. Transport limitation:	For long distances transportation on a low-bed trailer is required
36. Possibility for rent:	No

Pearson Survivable Demining Tractor and Tools (SDTT)

Figure 1 **Pearson SDTT with roller and loader**

1. General Description

The Pearson Survivable Demining Tractor and Tools (SDTT) offers different solutions to attack the mine clearance problem. The prime mover for the system is the Pearson tractor, although the five tools of the Pearson Tools system are compatible with most standard tractors using a three-point attachment. The Pearson tractor is a modified 160-horse power New Holland tractor fitted with an armoured cab and steel skeleton wheels. It was developed in co-operation with the U.S. Department of Defence (U.S.DoD) Humanitarian Demining Programme. Two U.S.DoD SDTs have been in service since early 2000.

The tractor with tools can be used for area reduction, to assist manual demining operations, or for mechanical mine clearance. Mounted at the front (2.5 ton lift) or rear (6 tons) of the vehicle, the tractor can operate with standard agricultural equipment or specialist demining attachments. The major implements of the SDTT are:

- Area reduction roller
- Magnet
- Sifter
- Slasher (bush cutter)
- Tree extractor

The Pearson Tractor is designed to operate in anti-personnel minefields. The driver's cab is armoured to ensure driver safety. The steel skeleton wheels are of open cage design to maximize the chance of their ability to function after detonating an AP mine. Tests include detonation of 6.35 kg of TNT directly under the rear wheel. Driver survivability was ensured. For self-transport over long distances, the steel wheels are replaced by pneumatic tyre wheels.

2. Working methodology

Figure 2 **The area reduction roller with its 50 kg discs**

2.1. The Pearson Area Reduction Roller (ARR)

The area reduction roller is a vehicle-mounted roller for rapid identification of the presence of AP mines in suspect areas and for threat reduction. The roller works by detonating any near-surface or surface pressure mines. It is capable of withstanding multiple AP mine blasts. It is not designed to withstand AT mine blasts. The roller consists of a series of steel discs each exerting a load of 50kg on the ground and each individually 'floating'. This feature ensures that the roller is effective on uneven ground.

The rolling weight is approximately 1000kg per meter width. It is not only manufactured for the Pearson tractor but is also available in any width up to 3.5m to suit the size of other prime movers.

The roller is mounted on the front of a prime mover such as the Pearson SDT or an armoured loading shovel.

The Area Reduction Roller is not intended for use where there is an AT mine threat.

The HALO Trust has approximately ten rollers in service between Abkhazia, Mozambique, Georgia, Kosovo, Somaliland, Cambodia and Afghanistan. They have been using the rollers since 1998. They are not used as a specific clearance device, but in an area reduction and verification role. The rollers are used in minefields where the definition of mine location and patterns is not clear. By using the rollers in set patterns, large areas of ground are verified for the presence and location of mines by their deliberate detonation. This inevitably speeds up clearance rates by enabling fast deployment of manual or further mechanical methods directly onto mined areas.

The robust construction and versatility of the Pearson Engineering Segmented Rollers have proven to be successful within humanitarian mine clearance.[1]

[1] Phil Straw, Mechanical Mine Clearance Operations Officer, The HALO Trust

The US DoD owns two rollers under evaluation with Thailand Mine Action Centre (TMAC).

No special training is required for either operation or maintenance of the Area Reduction Roller. A laminated instruction card is supplied. All spares are available, however spares requirement is minimal.

No routine maintenance is required.

Standard warranty period is 12 months from date of delivery.

Figure 3 **The Pearson Magnet fitted to the rear end of the tractor**

2.2. The Pearson Magnet

The Pearson Magnet is a vehicle-mounted magnet fitted with depth adjusting wheels and a hydraulic actuated ejector plate. The magnet is used as an aid to manual deminers to remove surface and near surface ferrous metal.

The magnet is fitted to a prime mover with a hydraulic lift and external hydraulic service. In use the magnet is pushed or pulled over the minefield with the depth wheels set to position the magnet 50 to 100mm clear of the ground. After each pass across the minefield the magnet is raised and carried by the prime mover to a designated dumping area. The ejector plate then dumps the collected metal.

It is recommended that the minefield is rolled with the Pearson Area Reduction Roller before using the magnet, as the magnet is susceptible to damage from the blast of an anti-personnel mine.

Alternating passes of the magnet and a cultivator will increase the amount of metal removed.

The US DoD has purchased two magnets. One has been under evaluation by Thailand Mine Action Centre (TMAC) since January 2001, following evaluation by Mines Advisory Group (MAG) in Cambodia during 2000. The second has been under evaluation by The HALO Trust in Cambodia since early 2001.

No special training is required for either operation or maintenance of the magnet. A laminated instruction card is supplied. All spares are available, however spares requirement is minimal and normally only because of blast damage.

No routine maintenance is required.

Standard warranty period is 12 months from date of delivery.

The Magnet is not intended for use where there is an AT mine threat.

From an area of one hectare TMAC removed 99kg of scrap metal using the magnet and a cultivator, ultimately clearing to a depth of 200mm after six passes with the magnet.

From a minefield cleared manually, MAG removed over 1000 pieces of scrap after cultivating the same area.

The weight of the magnet is 1600kg with ground pressure for the steel depth wheels of 1.5-2kg/cm^2. The magnet has a working width of 0.9m and a working speed of up to 6km/hr.

Figure 4 **The Pearson Sifter fitted to the rear of the SDT**

2.3. The Pearson Sifter

The Pearson Sifter is designed for sifting soil in areas with an AP mine threat. It is mounted to a prime mover fitted with an agricultural 3-point linkage, power take off shaft and hydraulic outlets. The sifter has a working width of 1.6m and can operate to a depth of up to 25cm. Operating depth is controlled by manually adjustable depth rollers.

Before using the sifter, the ground needs to be prepared by removing vegetation followed by cultivation and rolling to break up clods. The sifter cuts the soil at the selected depth with a set of horizontal shares. These lift the soil on to a slatted vibrating conveyor. The soil falls through the slats leaving mines, stones and large clods deposited in a windrow behind or to one side of the sifter for manual removal.

The US DoD has purchased two sifters. One has been under evaluation by Thailand Mine Action Centre (TMAC) since January 2001 following evaluation by Mines Advisory Group (MAG) in Cambodia during 2000. The second has been under evaluation by The HALO Trust in Cambodia since early 2001.

Operation, maintenance and parts manuals are supplied. Training is also available. No special skill is required to operate or maintain and repair the sifter. All spares are available from Pearson Engineering.

The standard warranty period is 12 months from date of delivery.

The sifter is only suitable for use in areas where there are few trees and shrub roots. The soil needs to be in a friable condition. To ensure uniform clearing depth, the ground surface should be even before cultivation.

100g AP mine blast tests on the conveyor caused bending of the conveyor bar. No further damage was recorded.[2]

The only routine maintenance required is greasing of surface bearing areas and checking the gear-box oil level. No special skills are required.

The weight of the sifter is 1600kg. The working width of the system is 1.5m while the overall width measures 3.6m.

The working speed is up to 4km/hr.[3]

2.4. The Pearson Slasher

The Slasher is a heavy vegetation cutter capable of cutting bushes and trees of up to 15cm diameter. It is mounted to a prime mover with agricultural three-point linkage, power take off shaft and external hydraulic outlets. The minimum power requirement is 100hp.

Figure 5 **The Pearson Slasher at the rear of the tractor cutting vegetation**

The Slasher consists of a 1.6m diameter, three-blade rotor mounted on a hydraulically operated swing arm. Use of the swing arm allows the Slasher to cut up to 3m width in a single pass. The height of cut is controlled by the prime mover's 3-point linkage lift, assisted by a skid plate under the rotor.

The US DoD has purchased two Slashers. One has been under evaluation by Thailand Mine Action Centre (TMAC) since January 2001, following evaluation by Mines Advisory Group (MAG) in Cambodia during 2000.

No special training is required for either operation or maintenance of the Slasher. All spares are available from Pearson Engineering.

Standard warranty period is 12 months from date of delivery.

The Slasher does not have a guard at the back of the rotor. There is a physical risk from vegetation debris thrown over a considerable radius.

Tests by both MAG and TMAC have proven the effectiveness of the Slasher as a vegetation cutter.[4]

Tests by the US DoD with 200g of TNT detonated under the rotor did not cause significant damage.[5]

The only routine maintenance required is greasing of bearing surfaces and checking of gearbox oil level.

The weight of the Slasher is 980kg. The working speed is up to 8km/hr in light vegetation.[6]

2.5. The Pearson Tree Extractor

The Tree Extractor is designed for extracting trees complete with roots. The Tree Extractor fits on to standard loader lift arms. It consists of a pair of hydraulic jaws that are clamped firmly onto a tree trunk. The tree is lifted out of the ground by raising the loader arms. The Tree Extractor is fitted with a pair of lifting legs to provide extra force to pull the tree out of the ground. Once removed, the tree is carried to a designated collection area.

[2] According to the manufacturer
[3] According to the manufacturer
[4] According to the manufacturer
[5] According to the manufacturer
[6] According to the manufacturer

There are two tree extractor models. The light tree extractor for use on agricultural loaders has a maximum force of 14 tons; the heavy tree extractor is for use on loading shovels of the 12 to 18 ton class such as the Volvo BM 4400. The lifting legs have a tear out force of up to 25 tons.

The US DoD has purchased one light and two heavy tree extractors. The light and one of the heavy tree extractors have been under evaluation by Thailand Mine Action Centre (TMAC) since January 2001, following evaluation by Mines Advisory Group (MAG) in Cambodia during 2000. The second heavy tree extractor has been under evaluation by The HALO Trust in Cambodia since early 2001.

Figure 6 **The Pearson Tree Extractor removing a tree**

Operation and parts manuals are supplied. No special skill is required to operate or maintain and repair the tree extractors. All spares are available from Pearson Engineering.

Standard warranty period is 12 months from date of delivery.

Tests by both MAG and TMAC have proven the effectiveness of the tree extractors.[7]

The only routine maintenance required is the greasing of bearing surfaces. No special skills are required.

The length for both extractors is 1.1m.

The width of the light extractor is 3m, while the heavy extractor is 2.7m wide.

The light extractor weighs 520kg. The heavy extractor weighs 1100kg.

3. Machines in Use to Date

- During 2000, Mines Advisory Group (MAG) evaluated Pearson Survivable Demining Tractors in Cambodia.
- Since January 2001, they have been operating in Thailand with TMAC along the Thai-Cambodian border.
- In February 2001, one SDTT system was included into The HALO Trust programme in Cambodia.

4. Engine, Fuel and Oil

- The tractor is driven by a 160-hp turbo diesel engine powered by normal diesel fuel.
- Fuel tank capacity is 200 l.
- Fuel consumption is approximately 5-20 l/hour depending on conditions.

5. Factory Support

- Full operation, maintenance, repair and spares manuals are available in English.
- Full spares back-up is provided by Pearson Engineering. New Holland tractor spares may be purchased through any New Holland agent.
- Operator training and follow-up support can also be provided as part of a purchasing package if required.
- As the SDT is based on a standard tractor, it is simple to operate.
- Routine maintenance undertaken by the operator. Repairs can be carried out by an agricultural or construction mechanic. No further specialist training or knowledge is required. Throughout

[7] According to the manufacturer

the evaluation, repairs were undertaken successfully by the operating crews in both Cambodia and Thailand.

- Standard warranty period is 12 months from date of delivery.

6. Maintenance and Support

- Daily maintenance consists of checking fluid levels and greasing bearing surfaces. Engine oil and filter change interval is 200 hours. The operator can undertake these tasks. No special workshop facilities are required.
- The SDT requires one operator. An assistant is required to attach and remove tools.

Figure 7 **The Pearson Tractor operating in dense vegetation**

7. Test and Evaluations

- The SDT has been tested against the effects of AP and AT mines. AT mine tests were carried out with 6.35kg of TNT placed under the rear wheel with an instrumented mannequin placed in the cab. Acceleration on the mannequin was within acceptable limits. Test reports are available from the manufacturer.

8. Known Limitations and Strengths

a. Limitations

- Before modifications there were several cases of front hub failure. Analysis showed this to be due to the fitting of steel wheels to the front axle. This was modified enabling the tractor to be fitted with steel wheels to the rear and pneumatic tyres to the front. No further front hub failures have occurred since modifications were carried out.

b. Strengths

- Pneumatic tyres should be fitted for road travel. Maximum road speed is 25km/hr. For long distance road transportation, transport by low-loader is advised.

Figure 8 **The SDT with an extracted tree**

9. Point of Contact

Pearson Engineering LTD.
Wincomblee Road
Walker
Newcastle Upon Tyne
NE6 3QS
United Kingdom

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e-Mail: pearson@pearson-eng.com
Web site: www.pearson-eng.com

10. Technical data sheet Pearson SDTT

a. Dimensional data

1. Length without attachment:	5 130 mm
2. Length total:	5 130 mm
3. Width without attachment:	3 270 mm
4. Width total:	3 270 mm
5. Working width:	Depends on the various attachments
6. Height, overall:	4 470 mm
7. Weight, basic vehicle:	9 800 kg
8. Weight, total:	Depends on the various attachments

b. Driving specifications

9. Wheels/tracks:	4 wheels, steel or pneumatic • Front steel wheel: 600 mm wide x 1716 mm diameter • Rear steel wheel: 800 mm wide x 2274 mm diameter
10. Ground pressure, max weight:	1.4 kg/cm^2 (pneumatic)
11. Hill climbing ability:	30 degree

c. Working performance

12. Working speed: • light soil/small vegetation: • medium soil/medium vegetation: • heavy soil/dense vegetation:	Depends on the various attachments
13. Working depth:	Depends on the various attachments
14. Machines in use:	2
15. Other types:	no
16. Location of use:	Cambodia, Thailand
17. Totally cleared so far:	Not given

d. System specifications

18. Engine:	Fiat, 160 hp, 6 cyl., 8.1 l turbo diesel engine
19. Fuel capacity:	200 l
20. Fuel consumption:	Max. 20 l/hour
21. Separate engine for working unit:	no
22. Transition:	Not given
23. Cooling system engine:	Water
24. Oil capacity: :	15 l
25. Hydraulic oil capacity:	78 l

e. Comfort and security

26. Air condition:	yes
27. Operator comfort:	Bucket seat with head restraint and 5 point harness
28. Armour:	Not given
29. Remote controlled:	no

f. Costs

30. Cost of system:	USD 250 000 for tractor with 3 attachments as specified by the customer[8]
31. Other costs:	Not given
32. Transport limitation:	For long distances transportation on a low-bed trailer is required
33. Possibility for rent:	Not given

[8] Humanitarian Demining Developmental Technologies 2000-2001

Section 5

Vegetation Cutter

BDM 48 Brusher Deminer

Figure 1 **PRO MAC BDM 48 attached to a CASE 9040 B excavator**

1. General Description

The PRO MAC 48 Brusher Deminer combines the functions of vegetation cutter and tiller in one machine for use in mine clearance. The unit comprises a rotating drum fitted with steel cutter bits. It is designed for attachment to most excavators, tracked or wheeled. The machine currently in use by PRO MAC is the Case 9040B tracked excavator with added cab armour. The hydraulic arm is protected against mine blast by a shock absorption system effective against up to 7kg of TNT. The hydraulics feature quick release valves to avoid blast damage. The cutter/tiller unit is also designed to withstand explosions from common types of AP mines. The bush cutter/tiller unit weighs 1820kg.

The BDM 48 is used to cut vegetation as well as destroy AP mines to a depth of 20cm. In mine clearance mode, the tiller head can grind a bite in the soil 30cm wide, 120cm long and 20cm deep. This bite can be achieved in approximately one minute.

The first system is currently operating in Thailand with the Canadian International Demining Corps (CIDC). The CIDC is using the BDM 48 against heavy vegetation, termite hills and destruction of located individual AP mines.

2. Clearance and Cutting Methodology

Once an area suspected of containing AP mines is identified, the BDM 48 operator maneuvers the cutter approximately half the width of the cutter unit into the area not yet cleared. The operator pushes the unit into the ground to take a bite of earth. After three bites are taken out of the ground from a safe base line, the vehicle moves along the base line to a new position to begin again. The unit should not operate closer than 3m to the hull of the excavator. No adjustment needs to be made to the unit when used as a bush cutter except for the angle of the cutter head. The bush cutter operates in a manner common to hydraulic arm mounted vegetation cutters.

Figure 2 **PRO MAC BDM 48 cutting vegetation**

3. Machines in Use to Date

- 1 machine operated by the Canadian International Demining Corps (CIDC) in Thailand.

4. Engine, Fuel and Oil

- The prime mover (excavator) CASE 9040B is powered by a diesel engine.
- It is recommended that performance formula diesel fuel additive should be put into the fuel tank every third fill.
- The hydraulic system of the excavator uses CASE IH Hy-Tran Ultra (MS 1209) hydraulic oil.
- Lubetec anti-friction treatment is used in both the hydraulic and engine oil systems.

5. Factory Support

- PROMAC offers a training package for machine operators and for service and repair personnel at the factory. This package is part of the unit purchase.
- Spare parts for the BDM 48 head are shipped with the unit. These spare parts consist of several sets of spare cutter bits, bearings, seals and a spare drive motor and shaft assembly.
- Spare parts for the excavator are available through authorized distributors for the specific make of excavator. The Thailand system is mounted on a CASE 9040B, the same unit as a Link Belt 3400 or a Sumitomo 220. Many types of excavator can be used provided that they have the necessary flow and hydraulic pressure (190 l per min and 282bar) required for the BDM 48.
- In hotter regions of the world, it is necessary to increase the cooling system capacity of the excavator for the engine and hydraulic system. These modifications would be standard for South East Asia and other high ambient temperature areas.
- Instruction manuals are included as part of the sale. They will be provided in the relevant language of the purchaser and are part of the purchase package.
- Additional operator training and attachment overhaul training packages are available.

6. Maintenance and Support

- Operators and servicing personnel must be able to perform basic service requirements such as:

→ Oil and filter changes on excavator

→ Lube and service deminer head

→ Inspect and clean the unit after each working day

→ Cutter bits are subject to wear and tear and will often require replacement. Maintenance personnel for the system will be required to weld new cutter bits. Rates of wear and tear will depend on soil conditions.

7. Test and Evaluations

- The BDM 48 system underwent evaluation by CCMAT (Canadian Centre for Mine Action Technologies), DRES (Defense Research Establishment Suffield) and TMAC (Thailand Mine Action Centre) from April to June 2001.

  During evaluation, Mechanical Reproduction Mines (MRM) and M14 AP mines were used.

- The test results are available from PRO MAC and the GICHD.

Figure 3 **PRO MAC BDM 48 maintenance team**

8. Known Limitations and Strengths

a. Limitations

- The BDM 48 head is not designed for clearance of anti-tank mines. [1]
- Complete with armoured excavator, the system weights 34tons. For transport over longer distances, a low-loader is required. [2]
- The clearance depth is limited to 20cm.

b. Strengths

- A useful tool that combines bush cutting with the ability to 'spot' clear AP mines.

Figure 4 **Example of a bite from the PRO MAC BDM 48**

9. Point of Contact

PRO MAC MANUFACTURING LTD.
2940 Jacob Road
Duncan, B.C.
Canada V9L 6W4

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Tel:	+1 250 746 5181
Fax:	+1 250 746 5168
Email:	promac@promac.bc.ca
Web site:	www.promac.bc.ca

[1] PROMAC Manufacturer letter dated 2001-08-10
[2] PROMAC Manufacturer letter dated 2001-08-10

10. Technical data sheet PRO MAC 48 Brusher Deminer

a. Dimensional data

1. Total Length:	9 880 mm
2. Maximum reach radius:	9 000 mm
3. Width total:	3 380 mm
4. Clearing width:	1 220 mm
5. Height, minimum:	3 070 mm
6. Height, overall:	As per boom position
7. Weight, basic vehicle:	32 t
8. Weight, Demining Unit:	1 820 kg
9. Weight, total:	34 t

b. Driving specifications

10. Wheels/tracks:	Tracks
11. Ground pressure, max weight:	Not given
12. Hill climbing ability:	35°

c. Clearance performance

13. Number of chisels:	23 cutter bits
14. Gap between drums/chisels dynamically:	Overlapping bits
15. Rotation speed:	1 900 to 2300 rpm
16. Clearance depth, max:	Up to 200 mm
17. Working speed	
• In thick underbrush and bamboo:	4 – 8 m^2/min [3]
18. Control of clearing depth:	Manually
19. Machines in use:	1
20. Location of use:	Thailand
21. Totally cleared so far:	Not given

d. System specifications

22. Engine:	Cummins GT830 (CASE 9040B)
23. Fuel capacity:	310 l
24. Fuel consumption:	Not given
25. Separate engine for tilling unit:	No
26. Transition:	Not given
27. Cooling system engine:	35 l
28. Oil capacity: :	20.8 l
29. Hydraulic oil capacity:	216 l

e. Comfort and security

30. Air condition:	Not given
31. Operator comfort:	Not given
32. Armour:	Not given
33. Remote controlled:	No

f. Costs

34. Cost of system:	Not given
35. Other costs:	Not given
36. Transport limitation:	Max. speed on tracks 5 km/h. Normally on trailer
37. Possibility for rent:	Not given

[3] Technical Assessment of the PROMAC Brush-Deminer 48, dated 2001-05-26, page 9.

Digger

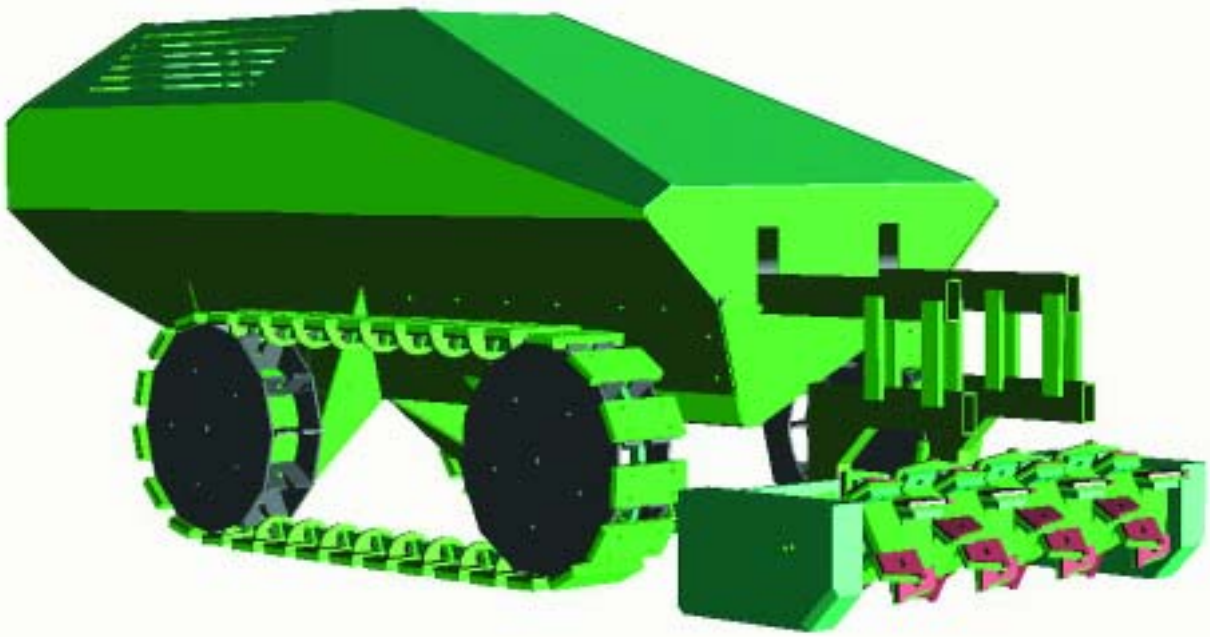

Figure 1 **Computer animation of the Digger vegetation cutter**

1. General Description

The Digger DTR is a light-weight, remote-controlled vegetation cutter currently undergoing development by the Swiss NGO, Digger DTR, with a mine clearance background in Croatia and Cambodia. It is scheduled for initial deployment in June 2002.

The vehicle will consist of an armoured, 'V' shaped hull with a vegetation cutter fixed to the front. This small vehicle will be controlled from behind a protection shield from approximately 100m distance. The Swiss Army has previously tested the vegetation cutter unit in May 2001.

2. Clearance and Cutting Methodology

The Digger DTR is designed to operate in areas where anti-personnel mines are suspected. The rotor on the cutting unit operates at approximately 500rpm, using 44 adjustable cutting tools to remove thick vegetation and trees. The overall width of the vehicle is 1.4m with a working width of 1.2m.

Figure 2 **The cutting system undergoing trails**

3. Machines in Use to Date

- One prototype in existence.
- Planned to deploy the first machine to Albania to work with the Swiss Federation for Mine Clearance in June 2002.

4. Engine, Fuel and Oil

- Current plans are to equip the Digger with a 2700cm^3 diesel engine.
- Fuel capacity will be approximately 50 l with a fuel consumption of 14 l/hr.
- The engine oil capacity is 12.5 l. Hydraulic fluid capacity 150 l.

5. Factory Support

- Operator training by the manufacturer.
- Stock of necessary spare parts provided.
- Manuals and documentation in English, French and German will be included in the purchase package.
- 1 year factory warranty.
- On-line (internet) technical service.

6. Maintenance and Support

- Daily servicing is required. Major servicing after 200 working hours.
- Recommended crew: One operator (remote control), one mechanic.
- System would be well served by a mobile workshop (not provided).

7. Test and Evaluations

- The Swiss Army carried out tests of the system's chassis and cutter unit's resistance to explosive blast. Six detonations of 730g TNT with fragmentation placed at between 0.04m to 1m were carried out against the cutter unit. Five detonations of 200g TNT were set off beneath the vehicle tracks. In neither case were any serious damages reported.
- Test report is available from the manufacturer.

8. Known Limitations and Strengths

a. Limitations

- The hill climbing ability will be limited to 30%.

b. Strengths

- The machine (2.6t) can be transported on a trailer attached to a 4 x 4 or on a small truck.

Figure 3 **The vegetation cutter during blast tests**

9. Point of Contact

Digger Demining Technologies Research
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Web site: www.digger.ch

10. Technical data sheet Digger

a. Dimensional data

1. Length without attachment:	2 800 mm
2. Total Length:	3 500 mm
3. Width without attachment:	1 400 mm
4. Width total:	1 400 mm
5. Working width:	1 200 mm
6. Height, minimum:	1 500 mm
7. Height, overall:	1 700 mm
8. Weight, basic vehicle:	2 200 kg
9. Weight, working tool:	500 kg
10. Weight, total:	2 700 kg

b. Driving specifications

11 .Wheels/tracks:	2 tracks
12. Wheel suspension:	No
13. Ground pressure:	Approx. 0.7 kg/cm^2
14. Hill climbing ability:	30%

c. Working performance

15. Number of cutting tools:	44
16. Gap between drums/chisels:	Overlap
17. Rotation speed:	500 rpm
18. Working depth, max:	Only vegetation cutting above the ground
19. Working speed[1]	
• light soil/small vegetation:	4 000 m/h
• medium soil/medium vegetation:	2 000 m/h
• heavy soil/dense vegetation:	600-1000 m/h
20. Control of working depth:	Mechanically
21. Machines in use:	1 prototype

d. System specifications

22. Engine:	2 700 cm^3 diesel
23. Fuel capacity:	50 l
24. Fuel consumption:	14 l
25. Separate engine for tilling unit:	No
26. Cooling system engine:	2 radiators and 2 fans for the hydraulic and one radiator and one fan for the engine
27. Oil capacity: :	12.5 l
28. Hydraulic oil capacity:	150 l

e. Comfort and security

29. Armour:	Not given
30. Remote controlled:	Yes
• Greatest distance:	300 m

f. Costs

31. Cost of system:	CHF 70 000
32. Other costs:	
Spare parts set:	CHF 5 000
33. Total:	About CHF 90 000
34. Transport limitation:	Not included in the price
35. Possibility for rent:	Yes, probably

[1] According to the manufacturer

Hydrema M1220 Light Armoured

Figure 1 **Hydrema M1220 Light armoured with bush cutter**

1. General Description

The Hydrema M1220 Light Armoured is based on the commercial Hydrema excavator series. The boom is available as a one or two piece implement. In excavator role, the machine can be fitted with three different excavator buckets. The operator is protected from blast and fragments and the cab has been tested for ballistic protection against 7.62mm bullets (NATO). The cab is mounted to the chassis on a rubber platform to reduce noise levels. The machine has permanent 4 wheel drive, with an optional gear allowing the machine to travel at up to 30km/hr on paved roads.

The manufacturer has not provided further information.

2. Working Methodology

The role of the machine is to cut vegetation. The working width of the bush cutter is 1m, with 18 cutter bits mounted to the 10cm dia rotating drum. The arm of the Hydrema can reach the 392kg bush cutter out to 8.5m. With a digger bucket, the boom can extend its reach to 9.4m. The M1220 has a maximum lift of 7t.

The manufacturer has not provided further information.

3. Machines in Use to Date

One system sold to MgM in Namibia for use in Angola.

4. Engine, Fuel and Oil

- Perkins 1004–40 T turbo-diesel engine, 4 cyl. 4.0 l water-cooled with 102 hp.
- 250 l fuel tank capacity.
- 180 l hydraulic tank capacity.

5. Factory Support

- The manufacturer has not provided further information.

6. Maintenance and Support

- The manufacturer has not provided further information.

7. Test and Evaluations

- The manufacturer has not provided further information.

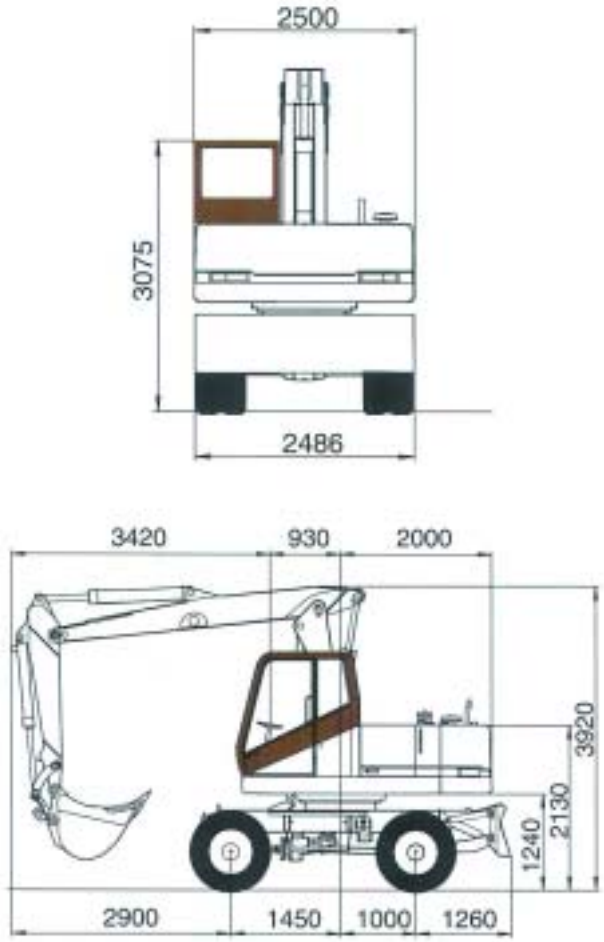

Figure 2 **Dimensional data of Hydrema M1220**

8. Known Limitations and Strengths

a. Limitations

No information available

b. Strengths

No information available

Figure 3 **The armoured cab of Hydrema M1220**

9. Point of Contact

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9530 Stovring
Danmark

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Fax: +45 98 37 19 96
e-Mail: hydrema@hydrema.com
Web site: www.hydrema.com

10. Technical data sheet Hydrema M1220

a. Dimensional data

1. Length without attachment:	Not given
2. Length total:	6 610 mm
3. Width total:	2 486 mm
4. Working width:	1 000 mm (for bush cutter head)
5. Height, overall:	3 920 mm (in transportation mode)
6. Weight, basic vehicle:	Not given
7. Weight, Attachments:	392 kg (for bush cutter head)
8. Weight, total:	Max. 13.5 tons

b. Driving specifications

9. Wheels/tracks:	4 wheels 8 x 9 – 20 EM (with twin tyres 4 x 600/40 – 22.5)
10. Ground pressure, max weight:	Not given
11. Hill climbing ability:	Not given

c. Working performance

12. Working depth, max:	5 700 mm (max. digging depth)
13. Working speed brush cutter	Not given
• light soil/small vegetation:	
• medium soil/medium vegetation:	
• heavy soil/dense vegetation:	
14. Machines in use:	1
15. Other types:	Not given
16. Location of use:	Angola
17. Totally cleared so far:	Not given

d. System specifications

18. Engine:	Perkins 1004 – 40 T turbo-diesel engine, 4 cyl., 4.0 l, with 102 hp
19. Fuel capacity:	250 l
20. Fuel consumption:	Not given
21. Separate engine for tilling unit:	Not given
22. Transition:	Not given
23. Cooling system engine:	water-cooled
24. Oil capacity: :	Not given
25. Hydraulic oil capacity:	180 l

e. Comfort and security

26. Air condition:	optional
27. Operator comfort:	Comfortable drivers seat damped against shock from mine explosions, vibration damped cab, heating system. Other equipment is optional.
28. Armour:	Light 'sandwich' construction
29. Remote controlled:	Not given

f. Costs

30. Cost of system:	Not given
31. Other costs:	Not given
32. Transport limitation:	For long distances transportation on a low-bed trailer is required
33. Possibility for rent:	Not given

Hydrema Weimar M900, M1000, M1520 with the flail head MFV-1000

Figure 1 **The Hydrema Weimar M900 with the MFV-1000 flail head**

1. General Description

The Hydrema Weimar series with the Croatian MFV-1000 attachable flail head is a combination of different developments by two manufacturers. During tests and accreditation in Croatia, the flail head was attached to three Hydrema excavator models, the M900, M1000 and M1520. The MFV-1000 flail head is made by Franjo Vukic Automehanika/automlimaria, trgovina I usluge, Progornica 1A, Zagreb, Croatia.

The Hydrema excavators are armoured by Hydrema-Weimar, with a special layered construction. Windows are of protective glass. At para 10., Technical Data Sheet, information about the M1520 only is given. The M900 and M1000 are no longer in production.

The manufacturer provided no further information.

2. Clearance Methodology

The MFV-1000 is a cutter head consisting of steel teeth on a rotating drum. Successfully proven as a vegetation cutter, it has limited application for the clearance of AP mines down to a ground penetration depth of 5cm. The system has been successful on sloped terrain such as channels, trenches and dykes.[1]

3. Machines in Use to Date

- Three machines using the three excavator models are in use in Croatia. The Croatian demining organisation, AKD Mungos purchased the refurbished machines from Hydrema and attached the MFV-1000 cutter.

Figure 2 **Early model of the Hydrema-Weimar bush cutter**

4. Engine, Fuel and Oil

- A Perkins 1004-40 TW turbo-diesel engine with 85kW/115hp powers the HYDREMA M1520.
- 250 l fuel tank capacity. 180 l hydraulic tank capacity.

5. Factory Support

- Manufacturer has not provided further information.

6. Maintenance and Support

- Manufacturer has not provided further information.

7. Test and Evaluations

- The Hydrema-Weimar 900 with the MFV-1000 flail head was tested in Croatia by CROMAC, October-December 2000.
- CROMAC tested the system as a mini-flail. Only AP mines featured on the tests. For the purpose of the GICHD catalogue, it has been listed as a vegetation cutter.
- CROMAC test was carried out using AP mines of various types: 2 x PMA-1A, 2 x PMA-2, 2 x PMA-3, 2 x PMR-2A and 2 x PROM-1. No damage reported.
- During the test, the machine cleared a 31500m^2 area.

[1] CROMAC test report.

8. Known Limitations and Strengths

a. Limitations

- Engines showed tendency to overheat[2].
- For AP demining role, the system ground penetration depth is only 5 cm.[3]

b. Strengths

- The engines have sufficient power for moving the machine and the working tool.[4]
- The armoured hood of the flail protects the excavator (particularly the hydraulics of the vehicle) from the impact of AP mine blast.[5]
- During tests, replacement of damaged parts was fast and simple (10-20mins).[6]
- The machine is effective in channels, trenches, ditches, dykes etc.[7]
- In vegetation cutting mode, the flail is effective against vegetation of up to 10cm dia.[8]
- The machine is easily maneuvered.[9]

Figure 3 **Commercial version of the Hydrema Weimar M1520**

9. Point of Contact

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99427 Weimar
Germany

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Fax: +49 3643 461 402
e-Mail: hydrema@hydrema.com
Web site: www.hydrema.com

[2] CROMAC test report
[3] CROMAC test report
[4] CROMAC test report
[5] CROMAC test report
[6] CROMAC test report
[7] CROMAC test report
[8] CROMAC test report
[9] CROMAC test report

10. Technical data sheet Hydrema Weimar M1520

a. Dimensional data

1.	Length (transportation position):	6 180 mm
2.	Length (clearing position):	Not given
3.	Width (transportation position):	2 500 mm
4.	Width total:	2 500 mm
5.	Clearing width:	1 000 mm
6.	Height, minimum:	3 980 mm
7.	Height, overall:	Not given
8.	Weight, basic vehicle:	Not given
9.	Weight, Demining Unit:	Not given
10.	Weight, total:	16 000 kg

b. Driving specifications

11.	Wheels/tracks:	wheels
12.	Ground pressure, max weight:	Not given
13.	Hill climbing ability:	Not given

c. Clearance performance

14.	Number of tools:	Not given
15.	Gap between tools:	Not given
16.	Rotation speed:	Not given
17.	Clearance depth, max:	5 cm
18.	Working speed:	140 – 250 m^2/hr[10]
19.	Control of clearing depth:	Manually by the operator
20.	Machines in use:	3
21.	Other types:	M900; M1000
22.	Location of use:	Croatia
23.	Totally cleared so far:	Not given

d. System specifications

24.	Engine:	Perkins 1004-40 TW turbo-diesel engine
25.	Fuel capacity:	250 l
26.	Fuel consumption:	16 l/hr[11]
27.	Separate engine for tilling unit:	No
28.	Transition:	Not given
29.	Cooling system engine:	Water
30.	Oil capacity: :	Not given
31.	Hydraulic oil capacity:	180 l

e. Comfort and security

32.	Air condition:	optional
33.	Operator comfort:	Not given
34.	Armour:	Not given
35.	Remote controlled:	No

f. Costs

36.	Cost of system:	Not given
37.	Other costs:	Not given
38.	Transport limitation:	Transportation speed up to 20 km/hr; optional 30 km/hr
39.	Possibility for rent:	Not given

[10] CROMAC test report
[11] CROMAC test report

Tempest Mk 3

Figure 1 **Tempest Mk 3 cutting dense vegetation**

1. General Description

Development Technology Workshops began production of the Mk I Tempest in 1998/99. Currently, the Tempest Mk III is in production. Tempest is a unique concept, in that it was developed for manufacture in mine affected countries where it is deployed. This is an advantage for maintenance and problem solving, and aids understanding by indigenous users. Machines are currently being produced in Cambodia. They are working in Cambodia, Thailand, and Bosnia. Nine Tempest machines are in operation with a further five in production as of October 2001. The Tempest Mk III is a remote-controlled, light-weight vegetation cutter and trip-wire clearance system.

The Mk III chassis is 'V' shaped with 8mm steel plate in order to minimize damage from anti-personnel mine or UXO detonation. Each of its four hydrostatic wheels is driven by an independent motor, improving maneuverability. This design cancels out the need for major components such as gearbox, clutch, prop-shaft, differentials and breaks. The wheels are made of 20mm x 6mm steel and are easy to remove, repair or replace. Although the vehicle should not operate in areas where anti-tank mines are suspected, evaluations and tests have indicated that the wheels are capable of withstanding an AT mine blast.

The design principles of the Tempest Mk III are low running costs, small and light-weight for ease of transport and agility over difficult terrain.

2. Operating methodology

Tempest Mk III is remote-control driven into a suspect area. The front-mounted flail has thirty-six chains that cut vegetation down to 25mm and can deal with shrubs and small trees up to 20mm

diameter. The flail removes tripwires encountered during normal operation. A hydraulic motor powers the chain driven flail shaft to speeds of up to 1300rpm. The 330mm long chains of the flail unit have an effective clearance width of 1.2m. The expected cutting rate of the system is from 200-800m²/hr[1], depending on soil type and vegetation density.

3. Machines in Use to Date

- Currently 9 machines are in use between Cambodia (Mines Advisory Group), Thailand (Thailand Mine Action Centre), and Bosnia (Norwegian People's Aid).
- Approximately 5 machines are in production as of October 2001.

4. Engine, Fuel and Oil

- The vehicle is equipped with a DEUTZ 4 cylinder diesel turbocharged engine BF4L1011F/T with 52kW (70hp).
- The fuel capacity is 42 l with a fuel consumption of 7–10 l/hr.
- A single hydraulic gear pump serves the individual wheel motors, flail lift arm ram and main hydraulic motor for the flail unit. In-line return to tank filtration with magnetic mesh.
- Hydraulic tank capacity is 113 l.
- The fuel tank is protected by 8mm steel plate.

Figure 2 **Tempest bush cutting flail system**

5. Factory Support

- The Tempest is manufactured in Cambodia. Repairs and maintenance are said to be easy and inexpensive. According to the manufacturer, spares are supplied with the unit and available worldwide, or are easily fabricated.
- Factory engineers based in Cambodia are sent with machines ordered for training of operators, maintenance and repair. Training is an additional cost as every demining operation has variations on requirements.
- Manuals and documentation are in English. Documents in other languages can be supplied but are part of the purchasing package.
- One year factory warranty from date of arrival on-site.
- Additional services for South-East Asia markets, e.g. 48-hour call out, regular checks for operational performance monitoring, factory rebuilds or major repairs are provided.

6. Maintenance and Support

- Daily, weekly and monthly routine check lists have to be followed.
- The manufacturer recommends a 3 man crew, all three trained as operator/mechanic, with one of these on standby for maintenance and support.
- Workshop facilities are standard. The manufacturer states that Tempest can be shipped in a 20ft 'containerised' mobile workshop.

[1] According to the manufacturer

7. Test and Evaluations

- The prototype Tempest underwent extensive tests in Cambodia for anti-personnel and anti-tank mines.
- The US Army has tested Tempest in the USA.
- Full test reports and photographs are available from the manufacturer.

Figure 3 **Rear end of the Tempest**

8. Known Limitations and Strengths

a. Limitations

- The first Tempest machines had overheating problems when working above 38°C. This problem should be solved with slight design changes to the Mk3.[2]
- The Tempest is designed for heavy tropical vegetation where it works best. It is not suitable for very thin or limited vegetation.[3]
- The machine is not intended to be used in areas where AT mines are present.[4]
- The steel wheels provide limited traction in muddy conditions, but increase the system survivability. [5]

b. Strengths

- Removes vegetation to greatly increase the speed of subsequent clearance by manual or dog teams.
- Removes the tripwire threat.
- Tempest was designed for ease of transportation. 4x4 with trailer, or 5 ton flat bed truck can transport it.
- The blast of live mines of 0.25 kg under the flail, skids, and wheels did not affect the operational capability of the system and repairs took only minutes to perform. [6]

Figure 4 **Tempest from the front**

9. Point of Contact

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Cambodia

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Fax: +855 (0) 23 43 02 38
e-Mail: dtw@bigpond.com.kh
Web site: www.dtwuk.fsnet.co.uk

[2] According to the manufacturer
[3] According to the manufacturer
[4] US DoD Humanitarian Demining Developmental Technologies 2000-2001, p. 33
[5] US DoD Humanitarian Demining Developmental Technologies 2000-2001, p. 33
[6] US DoD Humanitarian Demining Developmental Technologies 2000-2001, p. 33

10. Technical data sheet Tempest

a. Dimensional data

1. Total Length:	3 500 mm
2. Width total:	1 500 mm
3. Working width:	1 200 mm
4. Height, overall:	1 500 mm
5. Weight, total:	2 700 kg

b. Driving specifications

6. Wheels/tracks:	Steel fabricated wheels
7. Wheel suspension:	individual hydrostatic wheel motors for every wheel
8. Hill climbing ability:	No tests carried out

c. Clearance performance

9. Number of chains:	36
10. Length of chains:	300 mm
11. Gap between drums/chisels:	30 mm
12. Rotation speed:	1 300 rpm
13. Working depth, max:	Cuts vegetation down to 25 mm from the ground
14. Working speed[7]	
• light soil/small vegetation:	600 – 800 m^2/h
• medium soil/medium vegetation:	350 – 600 m^2/h
• heavy soil/dense vegetation:	200 – 350 m^2/h
15. Control of working depth:	Automatically by skids attached to the flail hood
16. Machines in use:	9
17. Location of use:	Bosnia, Cambodia, Thailand
18. Totally cleared so far:	Not given

d. System specifications

19. Engine:	DEUTZ 4 Cylinder Diesel turbocharged engine BF4L1011F/T with 52 kW (70 hp)
20. Fuel capacity:	42 l
21. Fuel consumption:	7 – 10 l
22. Separate engine for tilling unit:	No
23. Cooling system engine:	Integrated oil cooling
24. Hydraulic oil capacity:	113 l

e. Comfort and security

25. Operator comfort:	Remote-control
26. Armour:	8 mm steel plates
27. Remote controlled:	Yes
• Greatest distance:	400 m

f. Costs

28. Cost of system:	USD 85 000
29. Other costs:	
• Training:	Approx. USD 10 000 subject to country
• Duration of training:	5 weeks
• Spare parts set:	USD 11 500 (for approx. one year)
• Repair costs:	included in spares subject to the operations, AP and AT replacement components are included in the spare parts set
30. Total:	USD 106 500
31. Transport limitation:	20' container
32. Possibility for rent:	Only in South East Asia

[7] According to the manufacturer

Section 6

Sifter

MgM Rotar Mk-I

Figure 1 **MgM Rotar Mk-I with the rotar in front sifting suspect soil**

1. General Description

The MgM Rotar Mk-I is a commercial, off-the-shelf attachment for construction equipment used primarily to separate different sizes of rubble from construction sites. Worldwide, a total of more than eight-hundred Rotar systems are in operation. There are nine different models for wheel loaders and five models for excavators. The models are named according to their soil capacity, ranging from 350-6000 l. The model chosen by MgM is HPL 1500S, with special fittings and customized armour. The Rotar is a cylindrical grid encased by an opening/closing bucket. 10 teeth at the front of the bucket allow for penetration into hard ground. It is possible to lock or open the upper part of the bucket hydraulically.

MgM estimates that the MgM Rotar System is able to process approximately 0.3 cu metres of sandy soil in 3-5mins.

Armour is attached between the machine and the Rotar. The grid spacing has been modified to 4.5cm x 4.5cm (smaller than the R2M2, a small South African AP mine). For sandy conditions, solid plate covers approximately 1/3 of the bucket to prevent the sifting process from beginning during movement from the suspect area to the inspection area. The modified/armoured MgM Rotar is attached to an armoured CAT 916, wheeled front-end loader.

MgM initially employed the machine to dismantle power pylon berms in northern Namibia.

The MgM Rotar does not operate independently. Other mechanical assets, such as an armoured tipper truck or a machine with similar capabilities must support it.

The operator's cab and other vital areas of the vehicle are fully protected with 6mm-armour plate and bullet/fragmentation proof windows. The machine operates in AP mine fields only.

Due to the armouring and sealing of the operator's cab, an air conditioner is fitted. The cab is equipped with HF, VHF and HF PGS radio equipment.

The MgM Rotar can be separated at the same points as a standard bucket attachment so that other working modules can be fitted.

The MgM Rotar system is able to move between locations. For journeys of over 50km, a flatbed truck or low-loader should be used.

2. Working Methodology

Once the Rotar bucket is filled with soil, the operator raises it and closes the top lid onto the bucket. The lower section of the bucket is lined with 2mm metal plate while the upper section features a steel grid sieve. During this part of the process, locks on either side of the bucket prevent it from rotating. The vehicle moves to a clear site and releases the locks to rotate the Rotar while its jaws remain closed. As the bucket drops, the spoil within it passes through the grid. Pieces smaller than 4.5cm x 4.5cm sift through it, larger pieces remaining within the Rotar. The left debris is released into the back of a tipper truck (armoured). The spoil is examined as it falls by a deminer positioned in an observation tower on the roof of the tipper truck (in Namibia, MgM use an armoured Samil 100 tipper). When the observer sees an item requiring further investigation, he orders the operator to stop tipping. The observer exits the tower through the cab and steps out onto the metal walkway attached to the side of the truck. The suspect item is examined from the walkway by the deminer, dressed in individual protective equipment (visor, body armour). If a mine or UXO is found in the bed of the tipper, EOD trained personnel are notified. If it is determined that a suspect item is safe to handle, it is removed manually to a demolition pit/site. If the suspect item is deemed unstable, then it is carried in the Rotar to a demolition site where it is safely deposited for later destruction.

In Namibia, a commander in an armoured Wolf vehicle equipped with radio and surveillance camera usually supervises the Rotar.

Figure 2 **The Rotar sifting dry soil**

3. Machines in Use to Date

- 1 machine in Namibia

4. Engine, Fuel and Oil

- No information provided by MgM

5. Factory Support

- The ROTAR System proved relatively simple to operate with an experienced crew, with minimum of maintenance to sustain operations.[1]
- Any major repairs or spares requirements should be available through Caterpillar's worldwide field support facilities.[2]
- No further information provided

6. Maintenance and Support

- No information provided by MgM

[1] According to MgM
[2] According to MgM

7. Test and Evaluations

Figure 3 **Rotar Mk-I with open bucket**

- The Rotar Mk-I was tested by MgM's own development organization in Namibia, from August-September 1999. The following statements by observers were given:
- "The trial clearly demonstrated the ability of the Rotar-System to clear mine-fields with anti-personnel mines buried down to 15cm or possibly even deeper. The negative factor was the big amount of earth and stones which had to be moved in order to extract the mines from the ground. This again took a considerable time."[3]
- "At the end of the clearance by the Rotar, the actual area that had been processed equated to approximately 250 to 300 m^2 against the original mined area of 50 m^2."[4]
- "The machine cleared 99 out of 100 mines in 4 hours and 16 minutes. The time spent for the clearance of 50m^2 is far from satisfactory. The problem of berm creation is the greatest obstacle to effective use of the machine."[5]
- "RT03 determined minimal damage to the rotar drum after the blast of a J69 mine. We have inspected the inside of the drum and found the damage to be limited to dents in the drum caused by shrapnel."[6]

8. Known Limitations and Strengths

a. Limitations

- System is relatively slow and time consuming.
- The machine showed tendency to push the soil to the sides, creating berms that can contain mines.

b. Strengths

- Most of the tools, and the vehicle, are produced commercially.
- Rotar performed well against detonation of AP mines within the bucket.

Figure 4 **Rotar-I emptying suspect debris into a tipper**

9. Point of Contact

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Germany

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Web site: www.mgm.org

[3] Dr. Gunter Mulack, Director for Policy Coordination, German Federal Foreign Office
[4] G. T. R. Pritchard, EOD & Mines Consultant, Coral Stand Consultants
[5] Havard Bach, GICHD
[6] Hans Hashagen, Price Waterhouse Coopers

10. Technical data sheet MgM Rotar MK-I

a. Dimensional data

1. Length without attachment:	Not given
2. Length total:	7 380 mm
3. Width without attachment:	Not given
4. Width total:	2 904 mm
5. Working width:	2 224 mm (drum width)
6. Height, overall:	3 400 mm
7. Weight, basic vehicle:	7 900 kg
8. Weight, Attachments:	1 700 kg (without screen/hinge plate)
9. Weight, total:	9 600 kg

b. Driving specifications

10. Wheels/tracks:	4 wheels
11. Ground pressure, max weight:	Not given
12. Hill climbing ability:	Not given

c. Working performance

13. Capacity of the Rotar:	1 500 l
14. Rotation speed:	variable
15. Working depth, max:	Not given
16. Working speed	
• light soil/small vegetation:	Approx. 20 m^2/hr [7]
• medium soil/medium vegetation:	Not given
• heavy soil/dense vegetation:	Not given
17. Machines in use:	1
18. Other types:	Rotar-II (smaller machine, listed as multi-tool)
19. Location of use:	Namibia
20. Totally cleared so far:	Not given

d. System specifications

21. Engine:	Not given
22. Fuel capacity:	Not given
23. Fuel consumption:	Not given
24. Separate engine for sifting unit:	no
25. Transition:	Not given
26. Cooling system engine:	Not given
27. Oil capacity:	Not given
28. Hydraulic oil capacity:	Not given

e. Comfort and security

29. Air condition:	yes
30. Operator comfort:	HF, VHF and HF PGS radio communication equipment
31. Armour:	6 mm plates
32. Remote controlled:	no

f. Costs

33. Cost of system:	192 500 €
34. Other costs:	Not given
35. Transport limitation:	For long distances, transportation on a low-bed trailer is required
36. Possibility for rent:	No

[7] Havard Bach, GICHD

Section 7

Mine Protected Vehicles

Casspir Mine Protected Vehicle with Steel Wheels and VAMIDS

Figure 1 **Casspir Mine Protected Vehicle with optional steel wheels**

1. General Description

The Casspir Mine Protected Vehicle has been in service with a number of military forces for 20 years. For humanitarian mine action, it is currently in use with South African based Mechem and NPA in Angola.

Casspir is a versatile Mine Protected Vehicle (MPV), successfully adapted to support mine action. Casspir is able to integrate with technical attachments such as the Vehicular Array Mine Detection System (VAMIDS) vapour suction equipment (for REST sampling) and steel wheels. VAMIDS is used to detect the metal content of sub-surface land mines and UXO. VAMIDS can be mounted on a variety of vehicle platforms, but is currently used with one Casspir and one Tapir. Mechem have used both on mine action projects in Mozambique and conducted trials in South Africa since 1997.

Casspir is part of a series of mine protected vehicles adapted for military, peacekeeping and humanitarian operations. The monocoque hull is constructed from high grade alloy and armour plated steel. The hull has been proven against anti-tank mine blasts and some types of high velocity projectile.

For the demining role, Casspir can exchange rubber tyred road wheels for special steel wheels. The steel wheels are specifically designed to withstand detonation of most types of AP mines, but will take substantial damage from AT mine detonations. The steel wheels are attachable to Casspir and Tapir MPVs.

2. Specifications

- Casspir can be employed in multiple roles, e.g. provide safe access for REST sampling teams, personnel carrier, ambulance, utility freight carrier, tanker and recovery vehicle.
- Although the vehicle would be damaged, the crew is protected against up to three stacked AT mines (up to 21kg TNT).[1] Effective ballistic protection up to 7.62mm, as well as shrapnel.[2]
- Casspir can be equipped with VAMIDS.
- VAMIDS can detect zones of ground of 2-6m. Paint spray nozzles mark mines or UXOs (or areas of interest) while moving up to 10km/hr. The detection heads can be mounted at either side or at the rear of Casspir. Casspir is suited to area survey, route survey, area reduction and Quality Assurance (QA).
- The Casspir has been modified to accommodate the VAMIDS system. The vehicle dimensions and weight differ from the original specification.
- VAMIDS performs good scanning at the relatively high speed of 10km/hr.[3]
- The diagram below shows detection data collected at U.S. Army Fort AP Hill, Virginia, using a two metre flexible array at approx. 1m/sec.

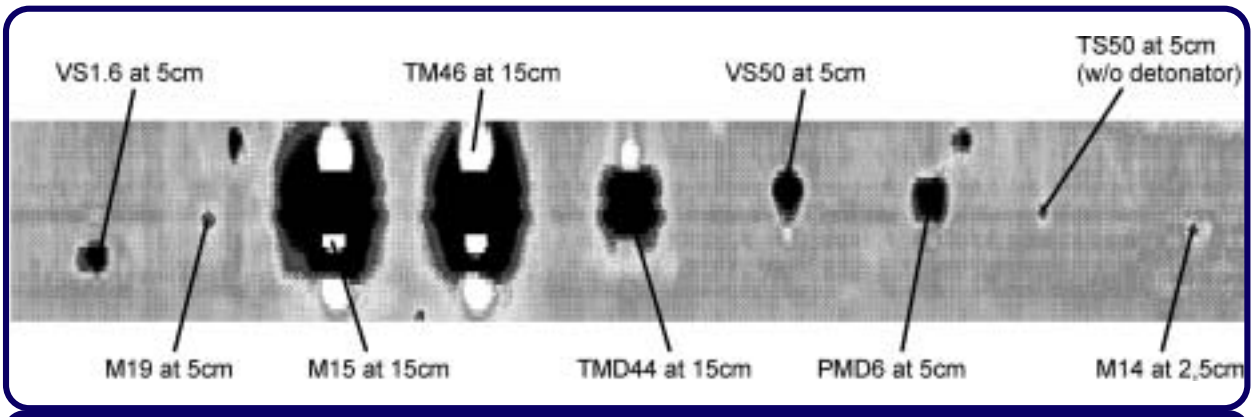

Figure 2 **Detection performance**

- VAMIDS converts the readings on each channel to a digital format. The data is read on a console, from which it can be recorded and stored. The data appears in a 'rolling map' format. The computer contains stored images of known mine types at different distances (from the detector to the ground). During operation, if the detector picks up a matching image, it will indicate a 'match'. The system can detect UXOs and mines with a large metal content such as TM 46 and TM 47 (down to approx. 1m depth). With user experience, false alarms can be reduced.[4]
- Technical data for VAMIDS system:

[1] According to the manufacturer
[2] According to the manufacturer
[3] According to the manufacturer
[4] According to the manufacturer

One Metre Flexible Array Segment

Effective detection width:	1000mm (39.40")
Dimensions:	1168mm (45.60") wide, 613mm (24.10") deep
Weight:	27kg (59lbs)
Number of detection heads:	8
Bend angle per detection Head:	+/- 2°
Bend angle per segment:	+/- 14°
Operational temperature range:	-40°C to +85°C
Storage temperature range:	-55°C to +85°C

The given weights and dimensions include the VAMIDS frame. For wider array of detector heads add 1m (39.40") in width and 27kg (59lbs) for each additional metre of segmented detector head.

Figure 3 **Casspir with road wheels**

3. Machines in Use to Date

- Mechem has 8 Casspir/Tapir vehicles fitted with steel wheels between Croatia and Mozambique.
- More than 10mil square metres of ground covered by steel wheeled Casspir. Over 10 years, more than 10000 AP mines have been detonated by steel wheels without crew injury.[5]
- Mechem has employed one Casspir and one Tapir equipped with VAMIDS in Mozambique, as well as trials in South Africa since 1997.
- NPA is using 3 Casspirs in Angola, mainly in a REST role but also as a platform for steel wheel clearance.

4. Engine, Fuel and Oil

- Casspir is equipped with a 6 cylinders-in-line turbo charged diesel engine with 124kW.
- The engine has a pressurized liquid cooling system.
- The auxiliary engine for the VAMIDS detection system requires diesel.
- The fuel capacity for the vehicle is 220 l.

5. Factory Support

For the VAMIDS system:

- Mechem can supply all spare parts. Many parts also available on international commercial market.
- Main spares for pneumatics by the international firm Festo.
- Technical and operator training manuals included in purchase price.
- Manuals available in English.
- 1 year warranty on complete VAMIDS system.
- The system with complete crew can be hired from Mechem.

[5] According to the manufacturer

Steel wheels:

- Mechem can supply new or reconditioned steel wheels on order. Delivery period of 6-8 weeks from date of order.
- Manufacturer has not provided further information.

6. Maintenance and Support

Casspir vehicle:

- Main components are robust and commercially available. Time and money saved.
- Specialist mechanics not required.
- The vehicle is usually field reparable after a mine detonation incident.

VAMIDS:

- The VAMIDS system requires an operator familiar with Windows 95/98 or 2000. Basic knowledge of computer and software diagnostics, installing drives and software, Windows Explorer and E-mail. Basic knowledge of electronics and pneumatics.
- Basic hydraulic knowledge required for the system.

Steel wheels:

- Minor maintenance required.
- Simple to replace.

7. Test and Evaluations

VAMIDS:

- Mechem carried out significant evaluations of the system over 4 year period and assess it as a highly useful tool.
- Test reports of the system available from Mechem on request.

Steel wheels:

- Steel wheels have been used extensively in Angola, Mozambique, and Croatia.
- Technical tests have been conducted. Results available from Mechem on request.

- Manufacturer has not provided further information.

8. Known Limitations and Strengths

a. Limitations

Steel wheels and general aspects:

- Very heavy system requiring special equipment to be fitted to the vehicle. Requires special arrangements for transportation.
- Maximum speed is 10km/h.
- Special driver training required. Incorrect driving techniques could damage the drive train of the vehicle.

VAMIDS:

- Although the system can detect mines with minimum metal content, it became impractical when deployed to areas with high occurrence of metal debris.

b. Strengths

Steel wheels and general aspects:

- Unique axle construction facilitates fast and easy repair after AT mine detonations (rubber wheels).
- Robust.
- Good for most terrain.
- Claimed to detonate more than 80% of anti-personnel mines in area covered.
- Requires little technical support.

VAMIDS:

- The system is useful for QA, area reduction, surveying and detection of mines with higher metal content e.g. PMN, PMD and anti – group mines (fragmentation).

Figure 4 **Early version of Casspir mounting steel wheels**

9. Point of Contact

Mechem
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Centurion
0046
South Africa

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Fax: + 27 12 803 7189
Web site: www.denel.co.za

10. Technical data sheet Casspir as standard personnel carrier

a. Dimensional data

1.	Length total:	6 900 mm
2.	Width total:	2 450 mm
3.	Height, overall:	2 850 mm
4.	Weight, basic vehicle:	Not given
5.	Payload:	Not given
6.	Gross Vehicle Mass:	10 800 kg
	Ground clearance:	Not given

b. Driving specifications

7.	Wheels/tracks:	4 wheels 1 400x20
8.	Ground pressure, max weight:	Not given
9.	Hill climbing ability:	Up to 60%[6]
10.	Maximal speed:	98 km/hr
11.	Turning circle diameter:	18 360 mm

c. System specifications

12.	Engine:	6 cylinders in-line turbo charged diesel engine with 124 kW
13.	Fuel capacity:	220 l
14.	Fuel consumption:	25 l/hour
15.	Tracking:	4x4
16.	Cooling system engine:	Pressurized liquid cooling
17.	Oil capacity: :	Not given
18.	Hydraulic oil capacity:	Not given
19.	Vehicles in use:	1 (with VAMIDS); 8 Casspir/Tapir with steel wheels; 3 Casspirs with NPA
20.	Location of use:	Angola, Croatia, Mozambique

d. Comfort and security

21.	Air condition:	Only dual expeller fans
22.	Operator comfort:	Not given
23.	Armour:	Not given
24.	Remote controlled:	Not given

e. Costs

25.	Cost of system:	Not given
26.	Other costs:	Not given
27.	Possibility for rent:	Not given

[6] According to the manufacturer

Wer'wolf MKII Modular Mine Protected Vehicle

Figure 1 **The Wer'wolf MKII Modular Mine Protected Vehicle personnel carrier**

1. General Description

The Wer'wolf MKII Modular Mine and Ballistic Protected Vehicle (MPV) is the product of a collaboration between Military International Ltd. (MIL) of Canada and Windhoeker Maschinenfabrik (1998) Pty Ltd (WMF) of Namibia. The first WMF Mine Protected Vehicle (MPV) was produced in 1977.

All WMF vehicles are based on commercially available MAN (Germany) automotive components. MAN is a business with worldwide logistical support. The Wer'wolf MKII is in full series production, currently in service with the Namibian Defence Force.

Wer'wolf comprises a full running chassis fitted with mine-protected belly armour and a ballistic double-cab at the front. The rear of the vehicle is a flatbed configuration, twist-locked onto the forward cab, enabling different rear modules to be fitted within minutes, depending on the task. Nine modules are available to facilitate different roles, e.g. recovery, ambulance, command, mobile workshop.

The vehicle is suitable for mounting mobile detection equipment. The automatic transmission version can be converted to remote-control operation.

2. Specifications

Wer'wolf features a 6 speed manual transmission providing 6 synchronized forward gears and 1 reverse gear. Automatic shift transmission is available and can be fitted to the vehicle without modification.

The driver can select tractive effort through 4 pneumatically activated switches. In addition to permanent 4 X 4 drive, the operator can select front and rear differential locks independently. Transfer case lock-up for high/low range selection as well as a 50:50 tractive effort split in 4-wheel drive mode. Power steering is standard.

Top speed is 125 km/h with a cruising speed of 90 km/h on paved roads. Operating range is 960 km on a full tank. Wer'wolf can be driven up gradients of 70% and for its size, has a tight turning circle of 16m.[1]

The vehicle is of monocoque design, offering all-round protection against the most common ball rounds from as close as 10m. The Wer'wolf hull provides ballistic protection against mortar and artillery fragments.

Wer'wolf protects against triple anti-tank mine blasts (21 kg TNT) under any wheel and double anti-tank mine blasts (14 kg TNT) under the hull.

The vehicle defends against IED detonations of 14 kg TNT, with a standoff distance of 3m from either side.

Due to the axle design and spare axle capacity, the vehicle can be fitted with an add-on belly plate to provide protection against explosive formed projectile mines (e.g. TMRP-6).

Figure 3 **Wer'wolf after detonation of 14 kg TNT under the front axle**

3. Machines in Use to Date

- Approx. 400 vehicles in service with the Namibian Defence Force.

4. Engine, Fuel and Oil

- Wer'wolf MKII is powered by a MAN straight-six, turbo-charged diesel engine fitted with an intercooler. The engine develops 224hp and 825Nm of torque, which translates into a power to weight ratio of 23hp/t.

5. Factory Support

- Wer'wolf is based on a standard, commercial MAN vehicle.
- 12-month vehicle warranty with unlimited mileage from MAN.
- Spare parts logistical support through MAN international dealership (not through WMF).

6. Maintenance and Support

- Access to the engine compartment is through a swing-open front grill for convenient engine checks. Engine and transmission pull out on a rail-mounted sledge for easy maintenance access. Engine replacement is fast and efficient.

[1] All data according to the manufacturer

- Air pressure point provided inside the engine compartment linked to the vehicles air pressure system for checking and adjusting tyre pressures and cleaning air filters.

7. Test and Evaluations

- The Wer'wolf MkII has undergone blast and ballistic tests by the manufacturer in Namibia. Test results available from MIL Canada and the GICHD.

Figure 3 **Chassis platform of Wer'wolf MKII**

8. Known Limitations and Strengths

a. Limitations

- Heavy due to extensive protection.

b. Strengths

- Based on widely available MAN commercial automotive parts.
- Reliable defence against mine blasts.

Figure 4 **Wer'wolf MKII personnel carrier**

9. Point of Contact

Military International Limited
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Calgary, Alberta
Canada T2C 2K3

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Fax: +1 403 236 1831
Mobile: +1 403 650 7315
e-Mail: andy.wotherspoon@milcanada.com
Web site: www.milcanada.com

10. Technical data sheet Wer'wolf MkII

a. Dimensional data

1. Length total:	6 360 mm
2. Width total:	2 500 mm
3. Height, overall:	2 650 mm
4. Weight, basic vehicle:	9 860 kg
5. Payload:	1 500 kg
6. Gross Vehicle Mass:	11 360 kg
Ground clearance:	355 mm laden, 380 mm un-laden

b. Driving specifications

7. Wheels/tracks:	4 wheels and one spare (Michelin 365/80R20)
8. Ground pressure, max weight:	Not given
9. Hill climbing ability:	Up to 70% on paved roads
10. Maximal speed:	• 125 km/hr on paved roads • 90 km/hr on hard, even dirt road
11. Turning circle diameter:	16 m

c. System specifications

12. Engine:	MAN D0826 LF – Euro 2 turbo charged, intercooled diesel engine with 224 hp, 6.87 l, 6 cylinder in-line
13. Fuel capacity:	240 l
14. Fuel consumption:	25 l/hour
15. Transition:	Not given
16. Cooling system engine:	Water & ethylene glycol mixture 1 : 1
17. Oil capacity: :	Not given
18. Hydraulic oil capacity:	Not given
19. Brakes	
• Service brake:	Dual circuit full pneumatic with integral emergency brake
• Park brake:	Pneumatic spring actuated on rear wheels
• Exhaust brake:	Optional
20. Gear box:	6 speed manual – optional automatic transmission, synchronized on all forward gears, 6 forward and 1 reverse
• Power take off	optional
21. Vehicles in use:	Approx. 400
22. Location of use:	Namibia

d. Comfort and security

23. Air condition:	Not given
24. Operator comfort:	Not given
25. Armour:	Not given
26. Remote controlled:	Optional

e. Costs

27. Cost of system:	Not given
28. Other costs:	Not given
29 Possibility for rent:	Not given

Annex A

Comparative Analysis

Mini Flails

A. Comparative Analysis

Technical data sheet	Bozena - 3	MV-3
a. Dimensional data		
1. Length without attachment:	3 102 mm	2 500 mm
2. Length total:	5 282 mm	3 700 mm
3. Width without attachment:	1 750 mm	1 400 mm
4. Width total:	2 680 mm	2 100 mm
5. Clearing width:	1 985 mm	1 700 mm
6. Height, minimum:	2 020 mm	1 200 mm
7. Height, overall:	2 200 mm	1 400 mm
8. Weight, basic vehicle:	3 690 kg (with tracks)	2 800 kg
9. Weight, Demining Unit:	860 kg	700 kg
10. Weight, total:	4 550 kg	3 500 kg
b. Driving specifications		
11. Wheels/tracks:	Rubber tyres with Caterpillar steel tracks	Rubber tracks
12. Ground pressure, max weight:	0.66 kg/cm^2 (with tracks); Front wheels: 2.82 kg/cm^2; rear wheels: 1.46 kg/cm^2	0.44 kg/cm^2
13. Hill climbing ability:	Up to 20°[1]	40°[2]
c. Clearance performance		
14. Number of chains:	36	39
• Length of chains:	593 mm	250 mm
15. Gap between chains:	Not given	5 mm
16. Rotation speed	Up to 400 rpm	Up to 900 rpm
17. Clearance depth, max:	Up to 150 mm	Up to 200 mm
18. Working speed:		
• light soil/small vegetation:	500 m^2/h	1 500 m^2/h
• medium soil/medium vegetation:		1 000 m^2/h
• heavy soil/dense vegetation:	350 m^2/h	600 m^2/h
19. Control of clearing depth:	Mechanically by a sledge attached to the flail	Manually by operator
20. Machines in use:	more than 40	3
21. Other types:	Bozena 1, Bozena 2,	8 (MV-1; MV-2)
22. Location of use:	Bosnia and Herzegovina, Croatia, Eritrea, Kosovo, Northern Iraq	Croatia; Bosnia and Herzegovina
23. Totally cleared so far:	Not known	Approximately 3 000 000 m^2
d. System specifications		
24. Engine:	YANMAR 4TNE98 4-stroke, direct fuel injection	Perkins 150 HP
25. Fuel capacity:	50 l	100 l
26. Fuel consumption:	Max. 7 l/hour (see footnote 1)	Max. 15 l/hour
27. Separate engine for tilling unit:	No	No
28. Transition:	Not given	Hydrostatic
29. Cooling system engine:	Water (16 l)	Water
30. Oil capacity:	9.4 l	12 l
31. Hydraulic oil capacity:	50 l	100 l
e. Comfort and security		
32. Air condition:	In the cabin	-
33. Operator comfort:	Not given	-
34. Armour:	6 mm steel shield on the flail unit and 8 mm steel on the bodywork	10 mm steel shield on the flail unit and 8 mm steel on the bodywork
35. Remote controlled:	Yes	Yes
• Greatest distance:	500 m	1 000 m
f. Costs		
36. Cost of system:		
• machine	Not given	USD 250 000
• training	Included in the purchasing package	included
• duration of training:	2 weeks	Not given
• spare part set	Subject to negotiation	basic spare parts set included
• repair costs	Subject to negotiation	Not given
37. Transport limitation:	The whole Bozena system can be packed in one 40ft and one 20ft container. The customer has to provide the truck for transportation	Truck or trailer min 4 ton
38. Possibility for rent:	Yes	Yes

[1] CROMAC test report
[2] According the the manufactuer

Annex B

Comparative Analysis

Midi Flails

B. Comparative Analysis

Technical data sheet	Aardvark MkIV	Armtrac 100	Hydrema 910 MCV	Minecat 230	Patria RA – 140 DS	RM – KA 01
a. Dimensional data						
1. Length without attachment:	5 486 mm	5 000 mm	9 200 mm	4 850 mm	7 850 mm	Not given
2. Length total:	7 750 mm	7 300 mm	10 000 mm	6 000 mm	9 450 mm	4 490 mm
3. Width without attachment:	2 530 mm	2 200 mm	2 800 mm (option: 2 500 mm)	2 000 mm	2 920 mm	Not given
4. Width total:	3 556 mm	3 000 mm	2 420 mm	3 300 mm	4 000 mm	2 500 mm
5. Clearing width:	3 000 mm	2 400 mm	3 500 mm	2 300 mm	3 400 mm	2 000 mm
6. Height, minimum:	2 613 mm	Not given	2 700 mm	2 060 mm	Not provided	1 600 mm
7. Height, overall:	3 190 mm	3 150 mm	3 600 mm	2 700 mm	2 860 mm	Not given
8. Weight, basic vehicle:	11 506 kg	10 400 kg	Not given	4 700 kg (without cab)	Not provided	Not given
9. Weight, Demining Unit:	3 792 kg	2 600 kg	Not given	2 100 kg	Not provided	Not given
10. Weight, total:	15 328 kg	13 000 kg	18 000 kg	7 800 kg	14 400 kg	12 120 kg
b. Driving specifications						
11. Wheels/tracks:	Half track layout with foam fill tyres	4 wheels with foam fill tyres	4 standard tyres GoodYear RL-2+ 17.5R25 foam filled	Tracks (width: 385 mm)	6 tyres Nokia MPT 14.00R - 20 or Michelin XS 14.00R – 20 with Hutchinson VFI safety device	Tracks (Caterpillar)
12. Ground pressure, max weight:	Wheels: 1.35 kg/cm^2 Tracks: 0.35 kg/cm^2	Not given	Not given	0.4 kg/cm^2	Not provided	0.5 kg/cm^2
13. Hill climbing ability:	33°	45°	34°	Not given	25°	32°
c. Clearance performance						
14. Number of chains: ● Length of chains:	72 1 100 mm	54 1 000 mm	72 900 mm	48 860 mm	84 Not provided	48 300 mm
15. Gap between chains:	37 mm	10 mm	Not given	50 mm (dynamically 10 mm overlap)	Not provided	Not given
16. Rotation speed:	320 rpm	350 rpm	Up to 400 rpm	384 rpm	Up to 400 rpm	600 rpm
17. Clearance depth, max:	Up to 580 mm in light soil[3]	300 mm travelling at 0.3 km/h	Up to 250 mm in light soil[4]	Up to 500 mm, depending on the ground	Up to 370 mm	Up to 200 mm
18. Working speed			750 – 1 000 m^2/h[6]	Approx. 2 000 m^2/h[7]	Up to 3 km/h	
● light soil/small vegetation:	3 600 m^2/h[5]	Approx. 2 700 m^2/h		(no further data	Not provided	Approx. 1 800 m^2/h[8]
● medium soil/ medium vegetation:	Not given	Approx. 1 200 m^2/h		available)	Not provided	Aprrox. 1 000 m^2/h[8]
● heavy soil/ dense vegetation:	600 m^2/h but generally determined by mine type and depth	Approx. 500 m^2/h[5]			Not provided	Approx. 500 m^2/h[8]
19. Control of clearing depth:	Automatic contouring and depth control system which can be overridden by operator	Manually	Automatic depth control system which can be overrridden by operator	Manually by operator	Automatic and manual depth control	Mechanically
20. Machines in use:	More than 200	2	23	4	Approx. 50	1
21. Other types:	Mk I - III	Armtrac 325	no	Minemouse mini flail (under development)	Not provided	No
22. Location of use:	Not given	Bosnia, Kosovo, Mozambique and Lebanon in near future	Denmark (Army), Bosnia-Herzegovina, Kosovo, Angola, Mozambique	Bosnia, Kosovo, Iran	Not provided	Croatia
23. Totally cleared so far:	Not given	Not given	Not given	Not given	Not provided	200 000 m^2

[1] According to the manufacturer
[2] According to the manufacturer
[3] According to the manufacturer
[4] Cromac test report (the system achieved 30 cm during the tests in Germany)
[5] All figures according to the manufacturer
[6] Cromac test report
[7] According to the manufacturer
[8] According to the manufacturer

Technical data sheet	Aardvark MkIV	Armtrac 100	Hydrema 910 MCV	Minecat 230	Patria RA – 140 DS	RM – KA 01
d. System specifications						
24. Engine:	6 cyl in line diesel with turbo charger	New Holland diesel engine with 165 hp	Perkins 1006-6TW, 6 cyl diesel with turbo charger	Deutz 73 hp	6 cyl in line 141 kW DEUTZ BF 6 L 913 C diesel with turbo charger, intercooled, direct injection	Perkins
25. Fuel capacity:	200 l	280 l	300 l	95 l (one fuel tank for both engines)	200 l	200 l
26. Fuel consumption:	Max. 23 l/hour	Max. 32 l/hour	max. 60 l/hour	9 l/hour	Not provided	14 l/hour
27. Separate engine for tilling unit:	No	No	Yes, the same engine as for drive (see 24.)	Perkins 150 hp	Hydraulically driven	No
28. Fuel consumption:	–	–	Not given	Max. 21 l/hour	–	–
29. Transition:	Not given	Stable axle pivot	hydrostatic	Hydraulic/ Hydrostatic	4x4 continuous all wheel drive	Not given
30. Cooling system engine:	Not given	Not given	Not given	Not given	air cooled	Water
31. Oil capacity:	68 l	Not given	Not given	64 l (for both engines and cranck case reservoir)	16 l 29 l (gear box)	16 l
32. Hydraulic oil capacity:	90 l	Not given	Not given	102 l (for both engines)	60 l	400 l
e. Comfort and security						
33. Air condition:	Yes	Yes	yes	Not given	Available	–
34. Operator comfort:	Vibration and noise reduction, dust filters, over-pressured cab, gyrocompass, dual position controls –right and left side of the cab, headphones with microphone for communication	air seat, 10 decibel cab noise	Not given	Not given	Adjustable seat for driver, adjustable and swivel seat with suspension for the operator. Both seats with four point safety belts. The cabin is pressure sealed, sound insulated and shock resistant.	Not given
35. Armour:	Protection glass, minimum 10 mm plates	Cab 10 mm armour	Not given	6.5 – 13 mm armoured steel (+ 6.5 mm optional)	Protection glass and armoured steel for the cabin	20 mm armoured steel
36. Remote controlled:	Optional	No	No	Yes 1 000 m in line sight	No	Yes 300 m in line sight
f. Costs						
37. Cost of system:	Only on request		The manufacturer offers 4 vehicles including the whole programm and support for one year for approx. € 10 Mill		Not provided	350 000 Euro
38. Other costs:	Only on request		Not given		Not provided	Not given
• machine		£ 145 000		USD 400 000	Not provided	Not given
• training		£ 2 500		included	Not provided	Not given
• Duration of training:		10 days			Not provided	Not given
• spare part set		per year £ 2 000		USD 120 000 (including tools, consumables, and workshop)	Not provided	Not given
• repair costs		Over one year £ 1 500		USD 150 000 (for service & support system per year)	Not provided	Not given
39. Transport limitation:	A flat bed or articulated truck is required for long distances	£ 10 000 to buy on an own low loader	Max. 35 km/hr on own wheels	4 x 20' containers	Given by the technical specifications as weight, etc.	Not given
40. Possibility for rent:	Yes, if required with operator and mechanics	Yes	Not given	No	Not provided	Yes

Annex C

Comparative Analysis

Heavy Flails

C. Comparative Analysis

Technical data sheet	Minelifta	Scanjack 3500	Viking
a. Dimensional data			
1. Length without attachment:	4 300 mm	11 000 mm	4 800 mm
2. Length total:	To be confirmed	14 300 mm	10 500 mm
3. Width without attachment:	To be confirmed	3 000 mm	3 400 mm
4. Width total:	To be confirmed (auxiliary pack behind driver is wider than clearance width but does not contact the ground)	4 450 mm	5 000 mm
5. Clearing width:	2 500 mm	3 500 mm	4 000 mm
6. Height, overall:	3 195 mm	3 700 mm	4 000 mm
7. Weight, basic vehicle:	18 400 kg	24 000 kg	21 500 kg
8. Weight, Demining Unit:	15 400 kg	8 000 kg	5 700 kg
9. Weight, total:	33 800 kg (future units will have extra 2 000 kg of cab protection).	32 000 kg	32 000 kg
b. Driving specifications			
10. Wheels/tracks:	Tracks	8 tyres 650/65-26.5 and 4 tracks 750 mm wide	Tracks
11. Ground pressure, max weight:	1.09 kg/cm^2	Front: 0.96 kg/cm^2; Rear: 0.6 kg/cm^2	Not given (depends on type of tracks)
12. Hill climbing ability:	Not tested above 30 degrees.	30% in operation and 35% while driving	27°
c. Clearance performance			
13. Number of chains: • Length of chains:	72 835 mm	78 on each rotor First rotor: 697 mm; Second rotor: 793 mm	96 116 mm
14. Gap between chains:	95 mm	overlapping	42 mm
15. Rotation speed:	Up to 150 rpm	Up to 360 rpm	Up to 300 rpm
16. Clearance depth, max:	Up to 200 mm	First rotor: up to 150 m; Second rotor: up to 300 m	Up to 250 mm
17. Working speed			
• light soil/small vegetation:	Evaluations indicated potential clearance rate of 2500 m^2/hr	Approx.2 700 m^2/h	2 800 - 8 400 m^2/hr (surface laid mines)
• medium soil/medium vegetation:	Not given	Approx. 2 100m^2/h	Not given
• heavy soil/dense vegetation:	Clearance rate under varied conditions to be confirmed	Approx. 1 200 m^2/h	1 120 – 4 200 m^2/hr (buried mines)
18. Control of clearing depth:	0 – 20 cm. Depth controlled by angle of bucket set by driver	Manually by hydraulic pressure	hydraulic
19. Machines in use:	Not yet	2	1 prototype
20. Other types:	Not yet	No	Flail system attached to Leopard 1 (Norwegian Army)
21. Location of use:	Not yet	Croatia	USA for tests
23. Totally cleared so far:	To be confirmed	Approx. 2 000 000 m^2	1 000 000 m^2

Technical data sheet	Minelifta	Scanjack 3500	Viking
d. System specifications			
24. Engine:	To be confirmed	Cummins 6-cyl diesel engine with 215 hp	Not given
25. Fuel capacity:	406 l for Komatsu dozer /fuel capacity flail engine pack to be confirmed	180 l in one tank for both engines	450 l
26. Fuel consumption:	Depending on ground conditions. To be confirmed.	Max. 60 - 80 l/hr in operation	17 – 33 l/hr depending on ground conditions
27. Separate engine for tilling unit:	Yes. Flail unit driven by 200 kW diesel engine. Future units to have 150 kW diesel engine.	Yes; Scania V8 diesel engine with 550 hp	Yes. Cummins diesel engine with 525 hp
28. Fuel consumption:	To be confirmed	See 26.	Approx. 70 l/hr
29. Transition:	Not given	Hydrostatic – mechanical power	hydraulic
30. Cooling system engine:	50 l Komatsu dozer / Flail engine is air cooled	Water	Not given
31. Oil capacity:	To be confirmed	25 l for base engine	250 l
32. Hydraulic oil capacity:	50 l for Komatsu dozer / Flail engine capacity to be confirmed	360 l for both machines	250 l
e. Comfort and security			
33. Air condition:	Yes	Yes	Yes
34. Operator comfort:	To be confirmed	Ergonomic chair and controls, radio	Not given
35. Armour:	6 mm of CP 50 armour on driver's cab	12 – 13 mm Armox 500S toughened plate for the cabin and 41mm protection glass windows.	Not given
36. Remote controlled:	No	No	Yes 3 000 m in line sight
f. Costs			
37. Cost of system:	To be confirmed	USD 895 000 + service and transportation	Not known yet
35. machine:	To be confirmed	USD 800 000	Not known yet
36. training:	To be confirmed	included; during manufacturing and 3 month after delivery	Not known yet
37. Duration of training:	To be confirmed	Not given	Not known yet
38. spare part set:	To be confirmed	USD 95 000	Not known yet
39. repair costs:	To be confirmed	USD 6 000/month full service contract	Not known yet
40. Transport limitation:	Low loader	3.0 m wide and 4.2 m high on low bed trailer	Low loader and the flail unit needs to be disassembled before road transportation
41. Possibility for rent:	To be confirmed	Financial leasing pending credit approval and full demining service rental incl. crew and service	Not for the moment – will be available late 2002/early 2003

Annex D

Comparative Analysis

Tiller Systems

D. Comparative Analysis

Technical data sheet	FMR 2000	KMMCS (Vehicle 1 and 2)	Minebreaker 2000/2
a. Dimensional data			
1. Length without attachment:	Not given	5 000 mm	7 980 mm
2. Length total:	7 800 mm	7.000 mm	10 940 mm
3. Width without attachment:	2 665 mm (transportation width)	3.000 mm	3 720 mm
4. Width total:	3 335 mm	3 000 mm	4 510 mm
5. Clearing width:	2 580mm	2.600 mm	3 690 mm
6. Height, minimum:	3 080 mm (transportation height)	2.650 mm	Not given
7. Height, overall:	4 080 mm (with antenna)	2 850 mm	3 310 mm
8. Weight, basic vehicle:	35 000 kg	34 000 kg	33 500 kg
9. Weight, Demining Unit:	3 000 kg	2 000 kg	13 500 kg
10. Weight, total:	38 000 kg	36 000 kg	47 000 kg
b. Driving specifications			
11. Wheels/tracks:	Tracks with a width of 700 mm	2 commercial tracks each 800 mm wide	Tracks DIEHL D 640 A
12. Ground pressure, max weight:	Not given	0.5 kg/cm^2	0.95 kg/cm^2
13. Hill climbing ability:	20°	40°	29°
c. Clearance performance			
14. Number of chisels:	Not given	156	66
15. Gap between drum chisels:	30 mm (between drum and chisels)	42 mm dynamically	60 mm
16. Diameter of drum:	750mm	600 mm	Not given
17. Rotation speed	From 400 to 700 rpm	up to 120 rpm	Up to 100 rpm
18. Clearance depth, max:	Normal operation 0 - 400mm, max. 600 mm^2	Up to 500 mm in light soil	Up to 500 mm
19. Working speed			
• light soil/small vegetation:	500 m/h; i.g. approx. 1 300 m^2/h	4 000 m^2/h[6];	Up to 4 000 m^2/h
• medium soil/ /medium vegetation:	400 m/h; i.g. approx. 1 000 m^2/h	i.g. approx. 2 600 m^2/h[7]	Up to 2 400 m^2/h
• heavy soil/heavy vegetation:	200 m/h; i.g. approx. 500 m^2/h	1 000 m^2/h[8];	Up to 1 000 m^2/h
20. Control of clearing depth:	Automatically or manually	manually	Mechanical
21. Machines in use:	1 prototype	8	2
22. Other types:	no	no	Minebreaker 2000
23. Location of use:	Bosnia - Herzegovina	Germany, Mozambique, Croatia	Bosnia-Herzegovina, Korea
24. Totally cleared so far:	100 000m^2/h	3 060 000 m^2 in clearance operations[9]	Approximately 800 000 m^2

[2] According to the manufacturer
[6] According to the manufacturer
[7] CROMAC test report (German version) page 15
[8] According to the manufacturer
[9] The system was first used to cultivate wooden areas and this are approx. 30 000m^2

Minecrusher	Mine-Guzzler	Oracle	Rhino
4 470 mm (vehicle)	7 560 mm	4 947 mm	7.800 mm
Approx. 5 900 mm	8 460 mm	13 800 mm	9.600 mm
2 170 mm	3 340 mm	2 580 mm	3.000 mm
3 100 mm	4 120 mm	4 500 mm	4.200 mm
2 550 mm	3 000 mm	3 220 mm	3.500 mm
Not given	3 400 mm	3 640 mm	3.150 mm
2 660 mm	3 550 mm	3 640 mm	3.200 mm
7 400 kg	33 000 kg	28 210 kg	46 000 kg
1 600 kg	15 000 kg	6 790 kg	14 000 kg
9 000 kg	48 000 kg	53 000 kg (with HPU)	60 000 kg
4 wheels	Tracks	Tracks	2 commercial tracks each 700 mm wide
Not given	0.98 kg/cm^2	0.89 kg/cm^2 (basic vehicle)	1 kg/cm^2
29°	More than 30° (depends of grip for the tracks)	29° [1]	24°
60	15 discs with 405 teeth	126,168, or 252 depending on tool configuration	360 (lower drum) 174 (upper drum)
Tool to tool: negative overlay	25 mm dynamically	25 – 75 mm depending on tool configuration	30 mm dynamically
Not given	1 250 mm	1 200 mm	Not given
Up to 280 rpm	up to 190 rpm	120 -240 rpm	Up to 120 rpm (lower drum) Up to 600 rpm (upper drum)
Up to 250 mm	Up to 500 mm in light soil	200, 300 or 450 mm [3]	Up to 500 mm in light soil[4]
Up to 4 000 m^2/h	1 200 m^2/h up to 4 km/h	Approx. 800 m^2/hr (±20%; overall estimation)[5]	2.000 m^2/h
Up to 2 400 m^2/h	Not given		1000 m^2/h
Up to 1 000 m^2/h	1 000 m^2/h up to 1 km/h		600 m^2/h
mechanical	Automatically	Automatically	automatic by mechanical sensors/ electronic controller with manual override possibility or manual
1 (prototype)	1	1	3
-	2 prototypes, earlier made on Leopard 1 chassis	Not given	No
-	Croatia and Egypt	Croatia and Bosnia	Cambodia, Croatia, Israel, Jordan, Korea
-	Approx. 800 000 m^2	Not given	Not given

[1] According to the manufacturer
[3] According to the manufacturer
[4] According to the manufacturer
[5] CROMAC test report

D. Comparative Analysis

Technical data sheet		FMR 2000	KMMCS (Vehicle 1 and 2)	Minebreaker 2000/2
d. System specifications				
25.	Engine:	Mercedes Benz OM 442 LA VB Turbo + charge air	MTU or Caterpillar with 750 hp	MTU MB 838 with 10 cyl. and 830 HP
26.	Fuel capacity:	900 l	1 200 l	940 l
27.	Fuel consumption:	Approx. 40 l/h	Approx. 60 - 80 l/hour	Max. 100 l/hour
28.	Separate engine for tilling unit:	No	No	No
29.	Fuel consumption:	-	-	-
30.	Transition:	Not given	Not given	Hydrostatic
31.	Cooling system engine:	Water cooled	Not given	Water
32.	Oil capacity:	Not given	30 l	65 l
33.	Hydraulic oil capacity:	700 l	app. 800 l	840 l
e. Comfort and security				
34.	Air condition:	-	yes	optional
35.	Operator comfort:	TV-monitor with cameras in front (movable) and rear	Not given	a high degree of comfort for the operator is achieved using standard components (seat, instruments, etc.) from industry
36.	Armour:	Yes, no further information	Not given	Original Leopard 1 chassis; cabin with 20 mmd armoured steel and 70mm protection glass
37.	Remote controlled:	Yes	No	Optional
	• Greatest distance:	800m		1 000 m
f. Costs				
38.	Cost of system:	Only on request	Approx. €1 500 000	For clearing operations € 0.5 per m². This includes one operator, fuel, spare parts etc. but no transportation
39.	Other costs:	Only on request	depending on customer requirements	Not given
	• machine	Only on request	Not given	On request
	• training	Only on request	is included	Usually included in the system price
	• Duration of training:	Only on request	Not given	Not given
	• spare part set	Only on request	Not given	Depending
	• repair costs	Only on request	Not given	Not given
40.	Transport limitation:	Max. speed on tracks 6.5 km/h. Normally on trailer	primarily low loader upaved/gravel roads on own tracks with max 3,8 km/h	by road or deployed with commercially available trailers
41.	Possibility for rent:	Not yet	no	Yes

[1] during the test series in Germany 70 and 90 l/hr (Test report WTD 51, dated 15.01.2001)
[2] CROMAC test report[3] According to the manufacturer
[3] According to the manufacturer
[4] According to the manufacturer
[5] CROMAC test report

Minecrusher	Mine-Guzzler	Oracle	Rhino
MB OM 366 LA with 6 cylinders and 214 HP	Caterpillar 3412 E	Caterpillar 3306, 210 kW	Caterpillar 3412 with 660 kW
130 l	800 l	1 136 l	1.700 l
Max. 25 l/hour	app. 40-85 l/hour (depending on depth and soil) [1]	app. 200 l/hour[2]	app. 100 l/hour
no	No	Yes (Caterpillar 3412E, 738 kW)	No
-	-	See 27.	-
Not given	Not given	Not given	Not given
water	170 l 50/50 water and glycol	Not given	water/air
10 l	65 l	Not given	68 l
31 l	200 l for tracks and 70 l for lift and tilt system	Not given	Approx. 1.000 l
optional	Yes; AC and heater with air inlet filter	As option	-
a high degree of comfort for the operator is achieved using standard components (seat, instruments, etc.) from industry	suspension in chair, 4 points safety belt, automatic speed control, low noise, TV-monitor with cameras in front(movable) and rear, overpressure valve, emergency hatch.	Not given	remote control desk could be used in a tent or installed in a 10`container/ truck with a/c and heating devices
Cabin with 10 mm armoured steel	16 mm armour and 46 mm protection glass	Not given	protection glass, minimum 10 mm steel plates
No	Yes	As option	bi-directual link with watch dog, vehicles data indicated on remote control box,
	800 m	Not given	1.000 m
	Approx. USD 1 500 000	Not given	Approx. € 1 700 000
Not given	Not given	Not given	depending on customer requirements
On request	Not given	Not given	Not given
Usually included in the system price	Not given	Not given	€ 42 000
Not given	Not given	Not given	Not given
depending	Not given	Not given	€220 000 (large set); €25 000 (small set);
depending	Not given	Not given	Not given
no	Max. speed on tracks 7 km/h. Normally on trailer in one or two parts	Max. speed on tracks 10 km/h.	Not given
Yes	Yes	Not given	Up to now the commercial problems for renting could not be solved

Annex E

Comparative Analysis

Multi-Tool Systems

E. Comparative Analysis

Technical data sheet	Armtrac 325	MgM Rotar II	Pearson SDTT
a. Dimensional data			
1. Length without attachment:	6 400 mm	5 760 mm	5 130 mm
2. Length total:	8 200 mm	Not given	5 130 mm
3. Width without attachment:	2 730 mm	2 396 mm	3 270 mm
4. Width total:	3 500 mm	Not given	3 270 mm
5. Working width:	3 000 mm (flail)	Not given	Depends on the various attachments
6. Height, minimum:	3 200 mm	Not given	Not given
7. Height, overall:	3 200 mm	Not given	4 470 mm
8. Weight, basic vehicle:	15 000 kg	Not given	9 800 kg
9. Weight, Working Unit:	3 000 kg (flail)	Not given	Depends on the various attachments
10. Weight, total:	18 000 kg (flail)	Not given	Depends on the various attachments
b. Driving specifications			
11. Wheels/tracks:	4 foam filled tyres	4 wheels tubeless, nylon, loader design tyres	4 wheels, steel or pneumatic ● Front steel wheel: 600 mm wide x 1716 mm dia ● Rear steel wheel: 800 mm wide x 2274 mm dia
12. Ground pressure, max weight:	Not given	Not given	1.4 kg/cm2 (pneumatic)
13. Hill climbing ability:	45° [1]	Not given	30°
c. Working performance			
14. Rotation speed	350 rpm (flail)	Not given	Not given
15. Clearance/Working depth, max:	Up to 300 mm	Not given	Depends on the various attachments
16. Working speed		Not given	Depends on the various attachments
● light soil/small vegetation:	Approx. 4 000 m^2/h		
● medium soil/medium vegetation:	Approx. 2 800 m^2/h		
● heavy soil/dense vegetation:	Approx. 2 800 m^2/h^2		
17. Control of clearing depth:	Manually	Not given	Depends on the various attachments
18. Machines in use:	2	1	2
19. Other types:	Armtrac 100	Rotar-I (larger machine)	no
20. Location of use:	Bosnia, Kosovo, Mozambique	Namibia	Cambodia, Thailand
21. Totally cleared so far:	Approx. 6 000 000 m^2	Not given	Not given
d. System specifications			
22. Engine:	Volvo diesel with 325 hp	Caterpillar 3054 T turbocharged diesel engine, either with 56 or 60kW and a 4-cylinder, 4-stroke, direct-injection engine.	Fiat, 160 hp, 6 cyl., 8.1 l turbo diesel engine
23. Fuel capacity:	455 l	128 l	200 l
24. Fuel consumption:	50 l/hour	Max.15 l/hour	Max. 20 l/hour
25. Separate engine for tilling unit:	No	No	No
26. Transition:	Not given	Not given	Not given
27. Cooling system engine:	Air blown over radiator	water	Water
28. Oil capacity:	46 l	7.3 l	15 l
29. Hydraulic oil capacity:	910 l	600 l	78 l

[1] According to the manufacturer
[2] All figures according to the manufacturer

Technical data sheet	Armtrac 325	MgM Rotar II	Pearson SDTT
e. Comfort and security			
30. Air condition:	Yes	Yes	Yes
31. Operator comfort:	Air cushioned seat, fully adjustable	Air-suspension seat, additional option: AM/FM Stereo/ Cassette package, tilt wheel, and circulating fan	Bucket seat with head restraint and 5 point harness
32. Armour:	Cab 10 mm steel plates	4 mm plate for the cabin and 35mm protection glass windows. The engine hood, rear cab side and cab floor, and the Rotar blast deflector are toughened with 6-10 mm plates	Not given
33. Remote controlled:	No	no	no
f. Costs			
34. Cost of system:	£ 230 000	Not given	USD 250 000 for tractor with 3 attachments as specified by the customer [3]
35. Other costs:		Not given	Not given
• machine		Not given	Not given
• training	£ 2 500	Not given	Not given
• Duration of training:	duration 10 days	Not given	Not given
• spare part set	£ 300 (for chains/belts)	Not given	Not given
• repair costs	£ 2 400 (for one year)	Not given	Not given
36. Transport limitation:	£ 10 000 to buy low loader	For long distances transportation on a low-bed trailer is required	For long distances transportation on a low-bed trailer is required
37. Possibility for rent:	Yes	Not given	Not given

[3] Humanitarian Demining Developmental Technologies 2000-2001

Annex F

Comparative Analysis

Vegetation Cutter

F. Comparative Analysis

Technical data sheet	BDM 48	Digger	Hydrema M1220	Hydrema Weimar M1520	Tempest
a. Dimensional data					
1. Length without attachment:	Not given	2 800 mm	Not given	6 180 mm (Transportation position)	Not given
2. Total Length:	9 880 mm	3 500 mm	6 610 mm	Not given	3 500 mm
3. Width without attachment:	Not given	1 400 mm	2 486 mm	2 500 mm	Not given
4. Width total:	3 380 mm	1 400 mm	2 486 mm	2 500 mm	1 500 mm
5. Working width:	1 220 mm (for bush cutter head)	1 200 mm	1 000 mm (for bush cutter head)	1 000 mm	1 200 mm
6. Height, minimum:	3 070 mm	1 500 mm	Not given	3 980 mm	Not given
7. Height, overall:	As per boom position	1 700 mm	3 920 mm (in transportation mode)	Not given	1 500 mm
8. Weight, basic vehicle:	32 000 kg	2 200 kg	Not given	Not given	Not given
9. Weight, working tool	1 820 kg	500 kg	392 kg (for bush cutter head)	Not given	Not given
10. Weight, total:	34 000 kg	2 700 kg	Max. 13 500 kg	16 000 kg	2 700 kg
b. Driving specifications					
11. Wheels/tracks:	Tracks	2 tracks	4 wheels 8 x 9 – 20 EM (with twin tyres 4 x 600/40 – 22,5)	Wheels	Steel fabricated wheels i ndividual hydrostatic wheel motors for every wheel
12. Ground pressure:	Not given	Approx. 0.7 kg/cm^2	Not given	Not given	Not given
13. Hill climbing ability:	35°	30%	Not given	Not given	No tests carried out
c. Working performance					
14. Number of cutting tools:	23 cutter bits	44	Not given	Not given	36 chains
15. Gap between drums/ chisels/chains:	Overlapping bits	Overlap	Not given	Not given	30 mm
16. Rotation speed:	1 900 to 2300 rpm	500 rpm	Not given	Not given	1 300 rpm
17. Working depth, max:	Up to 200 mm	Only vegetation cutting above the ground	Not given	5 cm	Only vegetation cutting 25 mm from the ground
18. Working speed • light soil/small vegetation: • medium soil/ medium vegetation: • heavy soil/ dense vegetation:	4 – 8 m^2/min^3	 4 000 m/h[1] 2 000 m/h[1] 600-1000 m/h[1]	Not given	140 – 250 m^2/hr^2	 600 – 800 m^2/h 350 – 600 m^2/h 200 – 350 m^2/h
19. Control of working depth:	Manually	mechanically	Not given	Manually by the operator	Automatically by skids attached to the flail hood
20. Machines in use:	1	1 prototype	1	3	9
21. Other types:	Not given		Not given	M900; M1000	Not given
22. Location of use:	Thailand		Angola	Croatia	Bosnia, Cambodia, Thailand
23. Totally cleared so far:	Not given		Not given	Not given	Not given

[1] Technical Assessment of the PROMAC Brush-Deminer 48, dated 2001-05-26 Page 9
[2] Cromac test report
[3] According to the manufacturer

Technical data sheet	BDM 48	Digger	Hydrema M1220	Hydrema Weimar M1520	Tempest
d. System specifications					
24. Engine	Cummins GT830 (CASE 9040B)	2 700 cm^3 diesel	Perkins 1004 – 40 T turbo-diesel engine, 4.0 l, with 102 hp	Perkins 1004-40 TW turbo diesel engine	DEUTZ 4 Cylinder Diesel turbocharged engine BF4L1011F/T with 52 kW (70 hp)
25. Fuel capacity:	310 l	50 l	250 l	250 l	42 l
26. Fuel consumption:	Not given	14 l	Not given	16 l/hr [4]	7 – 10 l
27. Separate engine for tilling unit:	No	No	Not given	No	No
28. Cooling system engine:	35 l	2 radiators and 2 fans for the hydraulic and one radiator and one fan for the engine	water cooled	Water	Integrated oil cooling
29. Oil capacity: :	20.8 l	12.5 l	Not given	Not given	Not given
30. Hydraulic oil capacity:	216 l	150 l	180 l	180 l	113 l
e. Comfort and security					
31. Air condition:	Not given	-	optional	optional	-
32. Operator comfort:	Not given	-	Comfort drivers seat damped against shock wave from mine explosions, vibration damped cab, heating system, other equipment is optional	Not given	Remote control
33. Armour:	Not given	Not given	Light sandwich construction	Not given	8 mm steel plates
34. Remote controlled: • Greatest distance:	No	Yes 300 m	Not given	No	Yes 400 m
f. Costs					
35. Cost of system:	Not given	CHF 70 000	Not given	Not given	USD 85 000
36. Other costs: • Training: • Duration of training: • Spare parts set: • Repair costs:	Not given	 Not given Not given CHF 5 000 Not given	Not given	Not given	 Approx. USD 10 000 subject to country 5 weeks USD 11 500 (for approx. one year) included in spares subject to the operations, AP and AT replacement components are included in the spare parts set
37. Total:	Not given	About CHF 90 000	Not given	Not given	USD 106 500
38. Transport limitation:	Max. speed on tracks 5 km/h. Normally on trailer	Not included in the price	For long distances transportation on a low-bed trailer is required optional 30 km/hr	Transportation speed up to 20 km/hr;	20' container
39. Possibility for rent:	Not given	Yes, probably	Not given	Not given	Only in South East Asia

4 Cromac test report

Annex G

Alphabetical Order of Equipment

Annex H

Alphabetical Order of Manufacturers

1) Aardvark Clear Mine Ltd

Shevock Estate
Insch, Aberdeenshire
Scotland AB52 6XQ

Tel: +44 (1464) 820122
Fax: +44 (1464) 820985
e-Mail: aardmine@netcomuk.co.uk
Web site: www.aardvarklandmineclearance.co.uk

Listed equipment: **Aardvark Mk IV** Page **14 - 17**

2) Bofors Defence AB

Allan Carlsson
691 80 Karlskoga
Sweden

Tel: +46 586 855 46
Fax: +46 586 855 77
Mobil: +46 73 668 24 00
e-Mail: allan.carlsson@boforsdefence.se
Web site: www.boforsdefence.se

Listed equipment: **Mine – Guzzler** Page **70 - 73**

3) Corus Northern Engineering Services

Stephen Grinsell
Steel House
Redcar
TS10 5Q
United Kingdom

Tel: +44 (0) 1642 498041
Fax: +44 (0) 1642 483376
e-Mail: CNES@corusgroup.com
Web site: www.corusgroup.com/Minelifta

Listed equipment: **Minelifta** Page **38 - 41**

4) Countermine Engineering AB

Oxelgrensvägen 34
152 42 Södertälje
Sweden

Tel: +46 855 080 855
Fax: +46 855 080 860
e-Mail: carl-erik.olsson@countermine.se
Web site: www.countermine.com

Listed equipment: **Oracle** Page **74 - 77**

5) DEMIN – KA d.o.o.

Mladen Tucetic
Dr. Ante Starcevica 21
Karlovac
Croatia

Tel: +385 47 646 022
Fax: +385 47 646 022
Mobile: +385 98 806 206

Listed equipment: **RM – KA 01** Page **34 - 36**

6) Development Technology Workshops

P.O.Box 1244
Phnom Penh
Cambodia

Tel: +855 (0) 23 43 06 77
Fax: +855 (0) 23 43 02 38
e-Mail: dtw@bigpond.com.kh
Web site: www.dtwuk.fsnet.co.uk

Listed equipment: **Tempest** Page **130 - 133**

7) Digger Demining Technologies Research

Frédéric Guerne
Bretin 14
2608 Courtelary
Switzerland

Tel: +41 (0) 32 944 21 31
Fax: +41 (0) 32 944 21 32
e-Mail: spiaget@bluewin.ch
Web site: www.digger.ch

Listed equipment: **Digger** Page **118 - 121**

8) DOK-ING d.o.o.

Vjekoslav Majetic
10 000 Zagreb
Kozarceva 38
Croatia

Tel: +385 1 48 24 134
Fax: +385 1 48 23 864
e-Mail: dok-ing@zg.tel.hr

Listed equipment: **MV – 3** Page **10 - 13**

9) FFG Flensburger Fahrzeugbau Gesellschaft mbh

Werftstr. 24
24939 Flensburg
Germany

Tel: +49 461 4812 176
Fax: +49 461 4812 100
e-Mail: info@ffg-flensburg.de
Web site: www.ffg-flensburg.de

Listed equipment: **Minebreaker 2000/2** Page **62 - 65**
Minecrusher Page **66 - 69**

10) Ground Sift & Clear Systems Limited

Stephen Brown
5 Tenbell Lane
Soham,
Ely, Cambs,
England. CB7 5BJ

Tel: +44 (0) 1638 74 39 79
Fax: +44 (0) 1638 74 25 78
e-Mail: gscs@supanet.com
Web site: www.gscs.sagenet.co.uk

Listed equipment: **Armtrac 100** Page **18 - 21**
Armtrac 325 Page **96 - 99**

11) HADI Maschinenbau Ges.m.b.H.

Ardaggerstrasse 96
3300 Amstetten
Austria

Tel: +43 74 72 6 27 08
Fax: +43 74 72 6 27 08-6
e-Mail: office@hadi.at
Web site: www.hadi.at

Listed equipment: **FMR 2000** Page **52 - 55**

12) Hägglunds Moelv AS

Bjorn Skjervold
Sales Manager
PO Box 244 N
2391 Moelv
Norway

Tel: +47 62 35 46 00
Direct: +47 62 35 46 32
Fax: +47 62 35 46 01
e-Mail: mail@haggmo.no
Web site: www.haggmo.no

Listed equipment: **Viking** Page **46 - 49**

13) A/S Hydrema Danmark

G.P. Daugaard
Gl. Kirkevej 16
9530 Stovring
Denmark

Tel: +45 98 37 13 33
Fax: +45 98 37 19 96
e-Mail: hydrema@hydrema.com
Web site: www.hydrema.com

Listed equipment: **Hydrema 910 MCV** Page **22 - 25**
Hydrema M1220 Light armoured Page **122 - 125**

14) Hydrema Baumaschinen GmbH

Kronsdorferstr. 18
99427 Weimar
Germany

Tel: +49 3643 461 400
Fax: +49 3643 461 402
e-Mail: hydrema@hydrema.com
Web site: www.hydrema.com

Listed equipment: **Hydrema Weimar M900, M1000, M1520 with the flail head MFV-1000**

Page **126 - 129**

15) Walter Krohn Gesellschaft für Walderneuerung mbH & Co KG

Pflanzenhof
56751 Masburg
Germany

Tel: +49-(0)2653 6494
Fax: +49-(0)2653 6496
e-Mail: contact@krohn.de
Web site: www.krohn.de

Listed equipment: **KMMCS**

Page **56 - 61**

16) Mechem

P.O. Box 8322
Centurion
0046
South Africa

Tel: + 27 12 803 7290
Fax: + 27 12 803 7189
Web site: www.denel.co.za

Listed equipment: **Casspir**

Page **142 - 147**

17) MgM Menschen gegen Minen e.V.

Moltkestr.1
47805 Krefeld
Germany

Tel: +49 2151 55 57 55
Fax: +49 2151 51 14 48
e-Mail: info@mgm.org
Web site: www.mgm.org

Listed equipment: **MgM Rotar Mk-I** Page **136 - 139**
MgM Rotar Mk-II Page **100 - 103**

18) Military International Limited

Andy Wotherspoon
3601 – 72 Avenue S.E.
Calgary, Alberta
Canada T2C 2K3

Tel: +1 403 236 2431
Fax: +1 403 236 1831
Mobile: +1 403 650 7315
e-Mail: andy.wotherspoon@milcanada.com
Web site: www.milcanada.com

Listed equipment: **Wer'wolf** Page **148 - 151**

19) Norwegian Demining Consortium AS

Lars Kogstad M.B.A.
Project Manager
P.O. Box 2521 Solli
0202 Oslo
Norway

Tel: +47 22 43 82 80
Fax: +47 22 43 42 17
Mobile: +47 920 51151
e-Mail: nds@nauteknik.no
Web site: www.nodeco.nu

Listed equipment: **Minecat 230** Page **26 - 29**

20) Patria Vehicles Oy

P.O. Box 186
13101 Hämeenlinna
Finland

Tel: +358 3 6451
Fax: +358 3 619 6710
e-Mail: pauli.rumbin@patria.fi
Web site: www.patria.fi

Listed equipment: **Patria RA-140 DS** Page **30 - 33**

21) Pearson Engineering LTD.

Wincomblee Road
Walker
Newcastle Upon Tyne
NE6 3QS
United Kingdom

Tel: +44 (0) 191 23 40 001
Fax: +44 (0) 191 26 20 402
e-Mail: pearson@pearson-eng.com
Web site: www.pearson-eng.com

Listed equipment: **Pearson Survivable Demining Tractor and Tools** Page **104 - 111**

22) PRO MAC MANUFACTURING LTD.

2940 Jacob Road
Duncan, B.C.
Canada V9L 6W4

Toll free:+1 800 665 5405
Tel: +1 250 746 5181
Fax: +1 250 746 5168
e-Mail: promac@promac.bc.ca
Web site: www.promac.bc.ca

Listed equipment: **BDM 48 Brusher Deminer** Page **114 - 117**

23) Redbus LMDS Limited

Stanton House
31 Westgate
Grantham
Lincolnshire NG31 6LX
England

Tel: +44 (0) 1476 56 99 89
Fax: +44 (0) 1476 59 11 55
e-Mail: info@lmds.redbus.co.uk
Web site: www.lmds.redbus.co.uk

Listed equipment: **Redbus LMDS** Page **84 - 89**

24) Rheinmetall Landsysteme GmbH

Dipl.-Ing. Manfred Jöhnk
Falckensteiner Straße 2
24159 Kiel
Germany

Tel: +49-(0)4 31-39 99-27 76
Fax: +49-(0)4 31-39 99-29 66/34 50
Mobil: +49-(0)171-44 19 364
e-Mail: manfred.joehnk@rheinmetall-Ls.com

Listed equipment: **Rhino** Page **78 - 81**

25) Scandinavian Demining Group AB

Lenart Berglund
Norra Uppfartsvägen 9
783 32 Säter
Sweden

Tel: +46 225 53742
Fax: +46 225 52660
e-Mail: info@scanjack.com
Web site: www.scanjack.com

Listed equipment: **Scanjack 3500** Page **42 - 45**

26) STS Safety Technologie Systems

Heinz Rath
Sebastian Kneipp Str. 73a
56179 Vallendar
Germany

Tel: +49 261 66 79 628
Fax: +49 261 66 79 629
Mobile: +49 170 18 45 911
e-Mail: h.rath@minenwolf.de
Web site: www.minenwolf.de

Listed equipment: **Minenwolf** Page **90 - 93**

27) Franjo Vukic

"Automehanika, autolimaria, trgovina i usluge"
Zagreb
Progornica 1A
Croatia

Listed equipment: **Flail head for Hydrema M900; M1000; M1520** Page **126 - 129**

28) Way Industry, a.s.

Valer Repko
Director of Bozena Dept.
Branch Office Bratislava
Jasikova 2
821 03 Bratislava
Slovakia

Tel: +421 2 48 291 320
Fax: +421 2 43 33 75 29
e-Mail: bozena@windustry.sk
Web site: www.way-industry.sk

Listed equipment: **Bozena – 3** Page **6 - 9**

Annex I

Manufacturers listed by Countries

1. Austria

HADI Maschinenbau Ges.m.b.H.
Ardaggerstrasse 96
3300 Amstetten
Austria

Tel: +43 74 72 6 27 08
Fax: +43 74 72 6 27 08-6
e-Mail: office@hadi.at
Web site: www.hadi.at

Listed equipment: **FMR 2000** Page **52 - 55**

2. Cambodia

Development Technology Workshops
P.O.Box 1244
Phnom Penh
Cambodia

Tel: +855 (0) 23 43 06 77
Fax: +855 (0) 23 43 02 38
e-Mail: dtw@bigpond.com.kh
Web site: www.dtwuk.fsnet.co.uk

Listed equipment: **Tempest** Page **130 - 133**

3. Canada

Military International Limited
Andy Wotherspoon
3601 – 72 Avenue S.E.
Calgary, Alberta
Canada T2C 2K3

Tel: +1 403 236 2431
Fax: +1 403 236 1831
Mobile: +1 403 650 7315
e-Mail: andy.wotherspoon@milcanada.com
Web site: www.milcanada.com

Listed equipment: **Wer'wolf** Page **148 - 151**

PRO MAC MANUFACTURING LTD.
2940 Jacob Road
Duncan, B.C.
Canada V9L 6W4

Toll free:+1 800 665 5405
Tel: +1 250 746 5181
Fax: +1 250 746 5168
e-Mail: promac@promac.bc.ca
Web site: www.promac.bc.ca

Listed equipment: **BDM 48 Brusher Deminer** Page **114 - 117**

4. Croatia

DEMIN – KA d.o.o.
Mladen Tucetic
Dr. Ante Starcevica 21
Karlovac
Croatia

Tel: +385 47 646 022
Fax: +385 47 646 022
Mobile: +385 98 806 206

Listed equipment: **RM – KA 01** Page **34 - 36**

DOK-ING d.o.o.
Vjekoslav Majetic
10 000 Zagreb
Kozarceva 38
Croatia

Tel: +385 1 48 24 134
Fax: +385 1 48 23 864
e-Mail: dok-ing@zg.tel.hr

Listed equipment: **MV – 3** Page **10 - 13**

Franjo Vukic
"Automehanika, autolimaria, trgovina i usluge"
Zagreb
Progornica 1A
Croatia

Listed equipment: **Flail head for Hydrema M900; M1000; M1520** Page **126 - 129**

5. Denmark

A/S Hydrema Danmark
G.P. Daugaard
Gl. Kirkevej 16
9530 Stovring
Denmark

Tel: +45 98 37 13 33
Fax: +45 98 37 19 96
e-Mail: hydrema@hydrema.com
Web site: www.hydrema.com

Listed equipment: **Hydrema 910 MCV** Page **22 - 25**
Hydrema M1220 Light armoured Page **122 - 125**

6. Finland

Patria Vehicles Oy
P.O. Box 186
13101 Hämeenlinna
Finland

Tel: +358 3 6451
Fax: +358 3 619 6710
e-Mail: pauli.rumbin@patria.fi
Web site: www.patria.fi

Listed equipment: **Patria RA-140 DS** Page **30 - 33**

7. Germany

FFG Flensburger Fahrzeugbau Gesellschaft mbh
Werftstr. 24
24939 Flensburg
Germany

Tel: +49 461 4812 176
Fax: +49 461 4812 100
e-Mail: info@ffg-flensburg.de
Web site: www.ffg-flensburg.de

Listed equipment: **Minebreaker 2000/2** Page **62 - 65**
Minecrusher Page **66 - 69**

Hydrema Baumaschinen GmbH
Kronsdorferstr. 18
99427 Weimar
Germany

Tel: +49 3643 461 400
Fax: +49 3643 461 402
e-Mail: hydrema@hydrema.com
Web site: www.hydrema.com

Listed equipment: **Hydrema Weimar M900, M1000, M1520 with the flail head MFV-1000** Page **126 - 129**

Walter Krohn Gesellschaft für Walderneuerung mbH & Co KG
Pflanzenhof
56751 Masburg
Germany

Tel: +49-(0)2653 6494
Fax: +49-(0)2653 6496
e-Mail: contact@krohn.de
Web site: www.krohn.de

Listed equipment: **KMMCS** Page **56 - 61**

MgM Menschen gegen Minen e.V.
Moltkestr.1
47805 Krefeld
Germany

Tel: +49 2151 55 57 55
Fax: +49 2151 51 14 48
e-Mail: info@mgm.org
Web site: www.mgm.org

Listed equipment: **MgM Rotar Mk-I** Page **136 - 139**
MgM Rotar Mk-II Page **100 - 103**

Rheinmetall Landsysteme GmbH
Dipl.-Ing. Manfred Jöhnk
Falckensteiner Straße 2
24159 Kiel
Germany

Tel: +49-(0)4 31-39 99-27 76
Fax: +49-(0)4 31-39 99-29 66/34 50
Mobil: +49-(0)171-44 19 364
e-Mail: manfred.joehnk@rheinmetall-Ls.com

Listed equipment: **Rhino** Page **78 - 81**

STS Safety Technologie Systems
Heinz Rath
Sebastian Kneipp Str. 73a
56179 Vallendar
Germany

Tel: +49 261 66 79 628
Fax: +49 261 66 79 629
Mobile: +49 170 18 45 911
e-Mail: h.rath@minenwolf.de
Web site: www.minenwolf.de

Listed equipment: **Minenwolf** Page **90 - 93**

8. Norway

Hägglunds Moelv AS
Bjorn Skjervold
Sales Manager
PO Box 244 N
2391 Moelv
Norway

Tel: +47 62 35 46 00
Direct: +47 62 35 46 32
Fax: +47 62 35 46 01
e-Mail: mail@haggmo.no
Web site: www.haggmo.no

Listed equipment: **Viking** Page **46 - 49**

Norwegian Demining Consortium AS
Lars Kogstad M.B.A.
Project Manager
P.O. Box 2521 Solli
0202 Oslo
Norway

Tel: +47 22 43 82 80
Fax: +47 22 43 42 17
Mobile: +47 920 51151
e-Mail: nds@nauteknik.no
Web site: www.nodeco.nu

Listed equipment: **Minecat 230** Page **26 - 29**

9. Slovakia

Way Industry, a.s.
Valer Repko
Director of Bozena Dept.
Branch Office Bratislava
Jasikova 2
821 03 Bratislava
Slovakia

Tel: +421 2 48 291 320
Fax: +421 2 43 33 75 29
e-Mail: bozena@windustry.sk
Web site: www.way-industry.sk

Listed equipment: **Bozena – 3** Page **6 - 9**

10. South Africa

Mechem
P.O. Box 8322
Centurion
0046
South Africa

Tel: + 27 12 803 7290
Fax: + 27 12 803 7189
Web site: www.denel.co.za

Listed equipment: **Casspir** Page **142 - 147**

11. Sweden

Bofors Defence AB
Allan Carlsson
691 80 Karlskoga
Sweden

Tel: +46 586 855 46
Fax: +46 586 855 77
Mobil: +46 73 668 24 00
e-Mail: allan.carlsson@boforsdefence.se
Web site: www.boforsdefence.se

Listed equipment: **Mine – Guzzler** Page **70 - 73**

Countermine Engineering AB
Oxelgrensvägen 34
152 42 Södertälje
Sweden

Tel: +46 855 080 855
Fax: +46 855 080 860
e-Mail: carl-erik.olsson@countermine.se
Web site: www.countermine.com

Listed equipment: **Oracle** Page **74 - 77**

Scandinavian Demining Group AB
Lenart Berglund
Norra Uppfartsvägen 9
783 32 Säter
Sweden

Tel: +46 225 53742
Fax: +46 225 52660
e-Mail: info@scanjack.com
Web site: www.scanjack.com

Listed equipment: **Scanjack 3500** Page **42 - 45**

12. Switzerland

Digger Demining Technologies Research
Frédéric Guerne
Bretin 14
2608 Courtelary
Switzerland

Tel: +41 (0) 32 944 21 31
Fax: +41 (0) 32 944 21 32
e-Mail: spiaget@bluewin.ch
Web site: www.digger.ch

Listed equipment: **Digger** Page **118 - 121**

13. United Kingdom

Aardvark Clear Mine Ltd

Shevock Estate
Insch, Aberdeenshire
Scotland AB52 6XQ

Tel: +44 (1464) 820122
Fax: +44 (1464) 820985
e-Mail: aardmine@netcomuk.co.uk
Web site: www.aardvarklandmineclearance.co.uk

Listed equipment: **Aardvark Mk IV** Page **14 - 17**

Corus Northern Engineering Services

Stephen Grinsell
Steel House
Redcar
TS10 5Q
United Kingdom

Tel: +44 (0) 1642 498041
Fax: +44 (0) 1642 483376
e-Mail: CNES@corusgroup.com
Web site: www.corusgroup.com/Minelifta

Listed equipment: **Minelifta** Page **38 - 41**

Ground Sift & Clear Systems Limited

Stephen Brown
5 Tenbell Lane
Soham,
Ely, Cambs,
England. CB7 5BJ

Tel: +44 (0) 1638 74 39 79
Fax: +44 (0) 1638 74 25 78
e-Mail: gscs@supanet.com
Web site: www.gscs.sagenet.co.uk

Listed equipment: **Armtrac 100** Page **18 - 21**
Armtrac 325 Page **96 - 99**

Pearson Engineering LTD.

Wincomblee Road
Walker
Newcastle Upon Tyne
NE6 3QS
United Kingdom

Tel: +44 (0) 191 23 40 001
Fax: +44 (0) 191 26 20 402
e-Mail: pearson@pearson-eng.com
Web site: www.pearson-eng.com

Listed equipment: **Pearson Survivable Demining Tractor and Tools** Page **104 - 111**

Redbus LMDS Limited

Stanton House
31 Westgate
Grantham
Lincolnshire NG31 6LX
England

Tel: +44 (0) 1476 56 99 89
Fax: +44 (0) 1476 59 11 55
e-Mail: info@lmds.redbus.co.uk
Web site: www.lmds.redbus.co.uk

Listed equipment: **Redbus LMDS** Page **84 - 89**

Annex J

Glossary of Acronyms

GLOSSARY OF ACRONYMS

APC	Armoured Personnel Carrier
AP mine	Anti-personnel mine
AT mine	Anti-tank mine
BWB	Federal Office for Defence – Technology and Procurement (Bundesamt für Wehrtechnik und Beschaffung)
CARE	Co-operative for American Relief to Everywhere (NGO)
CAT	Caterpillar
CCMAT	Canadian Centre for Mine Action Technologies
CECOM	US Army Communications Electronics Command
CIDC	Canadian International Demining Corps
CMAC	Cambodia Mine Action Centre
CMTC	Combat Maneuver Training Center
CROMAC	Croatian Mine Action Centre
Cyl	Cylinder
DERA	Defence Evaluation and Research Agency
DoD	Department of Defense
DRES	Defense Research Establishment Suffield
EOD	Explosive Ordnance Device
e.V.	registered society (eingetragener Verein)
FFG	Flensburger Fahrzeugbau Gesellschaft
GSCS	Ground, Sift & Clear Systems
HALO	Hazardous Area Life Support Organisation
hp	horse-power
HPU	Hydraulic Power Unit
IED	Improvised Explosive Device
ITEP	International Test and Evaluation Program
KMMCS	Krohn Mechanical Mine Clearance System
kW	kilowatt (approx. 1.341 hp)
LCD	Liquid Crystal Display
LMDS	Land Mine Disposal System
MAG	Mines Advisory Group
MAN	Maschinenfabrik Augsburg-Nürnberg Aktiengesellschaft
MCV	Mine Clearance Vehicle
MgM	Menschen gegen Minen e.V. (German NGO)
MIL	Military International Limited of Canada

Mk	Mark
MPV	Mine Protected Vehicle
MRM	Mechanical Reproduction Mines
MTU	Motoren- und Turbinen-Union Friedrichshafen GmbH
NATO	North Atlantic Treaty Organization
NDRE	Norwegian Defence Research Establishment
NGO	Non Governmental Organisation
NoDeCo	Norwegian Demining Consortium
NPA	Norwegian People's Aid
PMA	Anti-Personnel Blast Mine
PMR	Anti-Personnel Fragmentation Stake Mine
PROM	Bounding Fragmentation Mine
PTO	Power Take-Off
REST	Remote Explosive Scent Tracing
RF	Radio Frequency
rpm	rounds per minute
RUAG	Rüstungsunternehmen Aktiengesellschaft
SDTT	Survivable Demining Tractor and Tools
SOP	Standard Operating Procedures
STS	Safety Technology Systems
SWEDEC	Swedish EOD and Demining Centre
TFT	Thin Film Transistor
TMA	Minimum Metal Anti-Tank Blast Mine
TMAC	Thailand Mine Action Centre
TMM	Metal Cased Anti-Tank Blast Mine
TMRP	Modern Anti-Tank Blast Mine
TNT	Trinitrotoluene
UN	United Nations
UNMAS	United Nations Mine Action Service
USD	US Dollar
UXO	Unexploded Ordnance
VAMIDS	Vehicular Array Mine Detection System
VHF	Very High Frequency
WMF	Windhoeker Maschinenfabrik
WTD	Defence Technology Agency (Wehrtechnische Dienststelle)

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