



Mechanical Demining Equipment Catalogue



2003



Mechanical Demining Equipment Catalogue 2003

**Geneva International Centre for
Humanitarian Demining
Centre International de
Démunage Humainitaire - Genève**



The **Geneva International Centre for Humanitarian Demining** (GICHD) supports the efforts of the international community in reducing the impact of mines and unexploded ordnance (UXO). The Centre is active in research, provides operational assistance and supports the implementation of the Anti-Personnel Mine Ban Convention.

The **United Nations Mine Action Service** (UNMAS) was formed in October 1997 to serve as the UN focal point for mine action. At the global level, it is responsible for coordinating all aspects of mine action within the UN system. At the field level, it is responsible for providing mine action assistance in the context of humanitarian emergencies and peacekeeping operations.

The **German Federal Foreign Office** started to compile a list of existing mechanical demining equipment in cooperation with UNMAS 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 Catalogue, the German Federal Foreign Office asked the GICHD to take over responsibility for updating and producing the catalogue.

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All photographs have been provided by the respective manufacturers.

Foreword

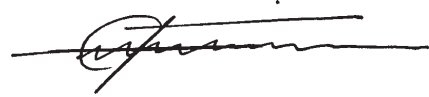
In the global effort against landmines and unexploded ordnance (UXO) the international mine action community is constantly striving to improve the safety, efficiency and cost-effectiveness of clearance methods. Currently, mechanically-assisted clearance assets appear to have a high potential. A wide variety of machines have been developed during the last few years; these have been continually improved by innovative engineers in collaboration with field users.

In order to determine the performance potential of machines and their adaptability to support specific clearance operations, the United Nations Mine Action Service (UNMAS) requested the Geneva International Centre for Humanitarian Demining (GICHD) to conduct a study of the performance and specifications of mechanical mine action equipment. One component of the study is the development and annual updating of the *Mechanical Demining Equipment Catalogue*. The Catalogue attempts to provide the user community with a clear and concise tool to compare available systems.

The equipment listed in this Catalogue has not been tested or evaluated by the GICHD. Whenever available, test and evaluation reports are cited. Accordingly, the GICHD does not assume responsibility for the accuracy or veracity of information provided by the respective manufacturers. The information contributed by manufacturers to the Catalogue does not necessarily represent the opinions of the GICHD.

The 2003 issue of the Catalogue has been modified due to the ever-increasing number of machines available on the open market. A key objective has been to make it easier for users to compare different systems. In this year's catalogue, each machine is described over two facing pages instead of the four pages used previously. Technical specifications have also been restructured to allow easier comparison between machine types. These changes have made it possible to produce a slimmer and more user-friendly catalogue, despite an overall increase in the number of machines included in it.

The GICHD would like to acknowledge and thank the Government of the Federal Republic of Germany for its generous financial support to this project.



Ambassador Martin Dahinden
Director
Geneva International Centre for
Humanitarian Demining

Introduction

The aim of the GICHD Mechanical Demining Equipment Catalogue is to inform the field-based mine clearance community about the choice of machines currently or potentially available on the international market. The Catalogue's succinct presentation of available equipment seeks to help the field user to choose the appropriate machine for a given task in a particular environment. Included are an indication of the costs involved and the level of manufacturer logistical support that a programme could expect to receive for each particular machine. Contact details of machine producers are provided.

Where possible, reference is made to the results of evaluations and tests conducted as part of the development of a particular system. Although these are not officially endorsed by the GICHD, they do give an indication of performance. It should be borne in mind, however, that an international standard for the evaluation and testing of mechanical demining equipment does not yet exist and there are differences in test procedures between countries and organisations.

Where manufacturers have provided it, the purchase price of machines, costs of spare parts and logistics, transportation requirements, the amount of land cleared by a system, and, in some cases, the cost per square metre of land cleared, are included in the catalogue. In certain cases, the experiences of field users with a particular machine are cited. A comparative analysis of machines by category is provided at the end of each section.

It is intended that the information set out in the catalogue be accurate as at the end of October 2002. Some of the machines are at the prototype stage or still under development. Some of these systems may reach the market before the publication of the next annual catalogue at the end of 2003. 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.

Equipment developers may also benefit from the mechanical catalogue. A cross-pollination of ideas between manufacturers is likely to occur, which should better serve

deminers in the future. In the relatively young field of mechanical demining equipment, innovations and changes in design concept are only to be expected. Although the catalogue may represent free advertising for the manufacturers featured, direct comparisons with their competitors should induce healthy competition within the market, ultimately leading to improvements. Appendix A contains a list of manufacturers.

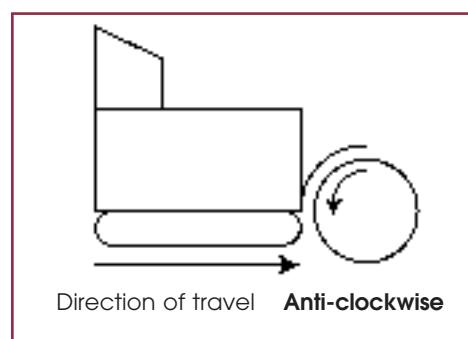
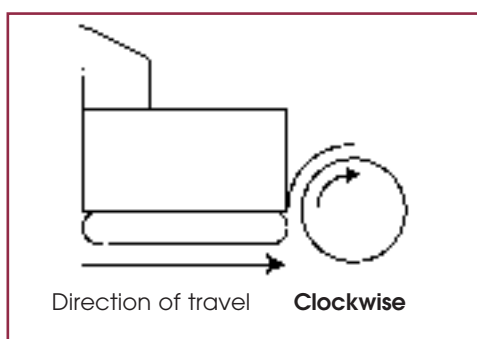
The catalogue does not list every machine applicable to mine clearance worldwide. A number of system producers who were approached failed to provide the minimum information required, and others may inadvertently have escaped notice. It is planned that the catalogue will be updated annually, with the hope that by 2003, all humanitarian mechanical mine clearance systems will be featured. In addition to this catalogue, mechanical mine clearance devices are also listed in *Jane's Mines and Mine Clearance 2001-2002*, the United States Department of Defense's *Humanitarian Demining Developmental Technologies 2000-2001*, and various websites worldwide, for example the UNMAS online database at www.mineaction.org.

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 in the technical note and in Appendix B.

The Centre hopes that this *Mechanical Demining Equipment Catalogue* serves those for whom it is primarily intended — the deminers in the field. It is available in hard copy, CD-ROM, or on the GICHD website at www.gichd.ch.

Technical note

1. Equipment listed in the catalogue is referred to as **mechanical demining equipment**. The GICHD catalogue deals solely with demining by civilian organisations, although military forces also use some of the equipment featured.
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 six tonnes); **medium flails** (6-20 tonnes); and **heavy flails** (20 tonnes or more).
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 typically heavy machines.
4. To express the direction of rotation of a flail, the terms **clockwise** and **anti-clockwise** are used. As this definition depends on which side of the machine the observer is standing, the diagram below gives the point of reference:



5. A glossary of terms is given in Appendix B.
6. The following abbreviations are used in the text and in data sheets:

cm	centimetres
cyl	cylinder
ft	feet
ha	hectares

hp	horsepower
kg	kilogrammes
kg/cm ²	kilogrammes per square centimetre

km	kilometres	m ² /h	square metres per hour
km/h	kilometres per hour	m ³	cubic metres
l	litres	mm	millimetres
l/h	litres per hour	rpm	revolutions per minute
m ²	square metres		

Please note that slope inclinations are given either as a percentage or as a gradient.

Section 1

Flail systems

Bozena 4

WAY Industry a.s., Slovak Republic



General description

The **Bozena 4** is a remotely-controlled mini-flail designed to destroy anti-personnel and anti-tank mines containing up to 8kg of explosives, and to cut low vegetation and remove tripwires. The vehicle is remotely controlled up to a range of 5,000m by an operator in an air-conditioned cabin placed in line of sight. The truck-mounted cabin is part of the purchase package. The price of the truck that carries the cabin is not included. An armoured shield is attached behind the flail to protect the machine from blast and flying debris. An armoured hood protects the vehicle against explosive blast. 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, such as a hydraulic hammer, drilling machine or concrete mixer. Detachment of the flail and attachment of another tool takes approximately 30 minutes.

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 break up anti-personnel and anti-tank mines. Remote control of the machine provides maximum security to the operator.

Machines in use to date

- Albania: 1 x Bozena 1
- Bosnia and Herzegovina: 6 x Bozena (Bozena 1 and 2) purchased by NATO SFOR (1998, 2000) and used by local entity armies.
- Croatia: 10 x Bozena (Bozena 1, 2, 3 and 4), under various local and international private demining companies currently deployed to the field.
- Eritrea: 8 x Bozena 2 with Slovak Army units.
- Kosovo: 4 x Bozena 1 — 2 with Slovakian Army KFOR units, and 2 with UNMACC mine action projects.
- Lebanon: 4 x Bozena 3 operated by BACTEC.
- Northern Iraq: 9 x Bozena 2 with UN mine action projects as a part of “Oil for Food” programme
- Currently, more than 40 machines sold worldwide.

Engine, fuel and oil

- The vehicle is equipped with a Deutz diesel engine (110hp) with direct fuel injection and air-cooling system. Fuel consumption is approx. 7l/h.¹ Fuel tank capacity is 85l.

- 130l hydraulic oil capacity (HM-46, HM-32, HL-22, HV-22, HV-46).

Factory support

- Basic spare parts set included as part of purchase package.
- Extended spare parts kit for six months operation is offered by WAY Industry, based on manufacturer's experience of commonly required items, including losses.
- Six-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 whom acts as interpreter.
- Trainees receive instruction manual and technical notes (spare parts catalogue, etc.) in the relevant language. Also part of purchase package.
- Spare parts replaced during warranty period and not classed as lost materials will be replaced free of charge.



Bozena in operation

Maintenance and support

- WAY Industry recommends a two-man crew: one operator and one mechanic.
- WAY Industry advises employment of one of their technicians to maintain the system.

Tests and evaluations

- Slovak Army carried out tests with anti-personnel and anti-tank mines. The client can obtain test results through the manufacturer.
- The Croatian Mine Action Centre (CROMAC) tested a Bozena 3 machine in October-November 2001. Tests included PROM-1, PMR 2A, PMA 1A, PMA 2, PMA 3. During this test, 36,300m² of ground were flailed. An independent field test covering the Bozena 4 model is currently not available.

Reported limitations and strengths (Bozena 3)

Limitations

- Materials used in chains and hammers could be improved.¹
- Limited mobility on wet and muddy ground.¹
- Rotation speed of the flail is insufficient.¹
- Number of chains and arrangement on the flailshaft should be improved in order to increase clearing performance.¹

Strengths

- Well-designed cooling system (no breakdown due to overheating).¹
- Clearing width is best possible in relation to engine power.¹
- High efficiency in anti-personnel mine destruction.¹
- Winch for self recovery is fitted.
- Good protection of "vital parts".¹
- Transportation of the machine is simple. Easy to handle with a light low-bed trailer. Good results are achieved in forested areas due to small size.

1. Croatia Mine Action Centre, *Testing "Bozena-3 Mine Clearance Machine"*, Sisak, January 2002.



MV-4 with raised flail and the attached roller

General description

The DOK-ING **MV-4** is a mini-flail designed for the destruction of anti-personnel mines. It consists of a rotating flail followed by a roller. The machine weight is just under five tonnes. It is produced by DOK-ING in Croatia, a company which has earned its reputation from extensive field experience. The first model of the "mini-flail", the MV-1, was produced in 1996. The MV-4 is remote-controlled, tracked and has a working width of 1,700mm. The machine can be controlled by an operator using a portable control panel, or from a second tracked vehicle protected by armour. The machine is small and light and is suited to mine clearance in built-up areas, forests or in other areas unsuitable for larger flails such as house yards or wood paths. The lightweight of the vehicle allows for transport by trailer. The driving engine and other vital parts of the machine are protected by armoured plates.

The MV series have seen service in mine clearance programmes with DOK-ING, Mechem, Gerbera, CROMAC and Mungos. According to the manufacturer, the MV series have cleared 10,000,000m² during various projects between 1997 and 2002.

Clearance methodology

The flail unit of the MV-4 rotates at up to 900rpm, achieving a ground penetration depth of up to 20cm, depending on soil conditions. According to the manufacturer a specially designed system keeps the clearing depth constant. The system is effective against vegetation and trees up to 5cm in diameter. The action of the flail is intended to detonate or break up anti-personnel mines. A 10mm steel shield hoods the flail unit to protect the chassis. A roller is mounted behind the flail system in order to reduce the risk of missed ordnance.

Machines in use to date

- MV-2 x 1 machine
- MV-3 x 5 machines
- MV-4 x 12 machines

Except two (SWEDEC and Ireland) all machines are deployed in Bosnia and Herzegovina or Croatia.

Engine, fuel and oil

- MV-4 is equipped with a six-cylinder Perkins turbocharged diesel engine (155hp). No special fuel or oil is required.
- Fuel consumption: 8-15l/h (depending on soil conditions).

Factory support

- The manufacturer provides spare parts.
- Instruction manuals available in Croat and English.
- Manuals and documentation are part of the purchase package.
- Training of operators and mechanics is provided by manufacturer at extra cost.
- Warranty and factory follow-up for 12 months.
- General support service provided by the manufacturer
- Additional equipment is available: ski in order to operate in muddy terrain, electric winch, protected remote camera, and front loading shovel.



MV-4 mounted on truck

Maintenance and support

- Recommended level of maintenance:
 - First maintenance check after 50 working hours;
 - Second maintenance check after 200 working hours;
 - Regular maintenance and repair after 200 working hours.
- The company recommends a two-man crew: one operator and one mechanic.

Tests and evaluations

- The MV-4 was tested by CROMAC in May 2002.
- Swedish military conducted comprehensive tests in 2002 and the reports are available.

Reported limitations and strengths

As no available test results cover the MV-4, comments relate to earlier versions.

Limitations

- MV-1 and MV-2 have had overheating problems and are underpowered. The MV-3 has a cooling fan and a stronger engine.¹
- Climbing ability up to 33%.²
- Vegetation cutting limited to 5cm in diameter.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 100 metres. If the machine were accidentally to detonate an anti-tank mine, this would not be sufficient. The operator should control the vehicle using the video camera or from the protection an armoured support vehicle.⁵

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
- Remote controls simple to use.

1. CROMAC test report (English version), Sisak, February 2001, section 3.4.1. and 2.
 2. CROMAC test report, *op. cit.*, section 3.4.2.
 3. According to the manufacturer.
 4. CROMAC test report, *op. cit.*, section 3.4.13.
 5. CROMAC test report, *op. cit.*, section 3.4.14. and 15.
 6. CROMAC test report, *op. cit.*, section 3.4.22.
 7. CROMAC test report, *op. cit.*, section 3.4.4. and 17.
 8. CROMAC test report, *op. cit.*, section 3.4.6
 9. CROMAC test report, *op. cit.*, section 3.4.23.

Technical data sheet **Bozena 4**

a. Dimensional data

1.	Length without attachment:	3,002mm
2.	Length total:	5,282mm
3.	Width without attachment:	1,960mm
4.	Width total:	2,716mm
5.	Clearing width:	2,000mm
6.	Height, minimum:	2,100mm
7.	Height, overall:	2,200mm
8.	Mass, total:	5,560kg

b. Driving specifications

9.	Wheels/ tracks:	Foam filled tyres/ metal tracks
10.	Ground pressure, max. weight:	0.66 kg/cm ² (with tracks) Front wheels: 2.75kg/cm ² Rear wheels: 4.55kg/cm ²
11.	Hill climbing ability:	Up to 35°

c. Clearance performance

12.	Number of chains:	36
	• length of chains:	600mm
13.	Gap between chains:	Not given
14.	Rotation speed:	Up to 400rpm
15.	Clearance depth, max:	Up to 150mm
16.	Working speed ^{a)} (depending on type and density of vegetation)	
	• light soil/ small vegetation:	Approx. 500m ² /h
	• heavy soil/ dense vegetation:	Approx. 350m ² /h
17.	Control of clearing depth:	Mechanic by a sledge attached to the flail
18.	Machines in use:	More than 40
19.	Other types:	Bozena 1, Bozena 2
20.	Location of use:	Albania, Bosnia and Herzegovina, Croatia, Eritrea, Kosovo, Lebanon, northern Iraq
21.	Total area cleared so far:	Not given

d. System specifications

22.	Engine:	Deutz BF4L913, 110hp
23.	Fuel capacity:	85l
24.	Fuel consumption:	Max. 7l/h ^{b)}
25.	Separate engine for tilling unit:	No
26.	Cooling system engine:	Air cooled
27.	Oil capacity:	11.5l
28.	Hydraulic oil capacity:	130l

e. Comfort and security

29.	Air conditioning:	In the cabin
30.	Operator comfort:	Armoured, air-conditioned cabin
31.	Armour:	4mm steel shield of the flail unit and 4mm steel of the bodywork
32.	Remote control:	Yes
	• greatest distance:	5,000m (with optical visibility only)

f. Costs

33.	Cost of system:	Subject to negotiation
	• machine	On customer request
	• training	Included in the purchase package
	• spare parts	Subject to negotiation
34.	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
35.	Availability for hire:	Yes

a) Croation Mine Action Centre, *Testing "Bozena-3 Mine Clearance Machine"*, Sisak, January 2002.

b) According to the manufacturer.

Technical data sheet MV-4

a. Dimensional data

1.	Length without attachment:	2,780mm
2.	Length total:	3,810-4,460mm
3.	Width without attachment:	1,550mm
4.	Width total:	1,980mm
5.	Clearing width:	1,700mm
6.	Height, minimum:	Not given
7.	Height, overall:	1,380mm
8.	Mass, total:	4,870kg

b. Driving specifications

9.	Wheels/ tracks:	Tracks (300mm width)
10.	Ground pressure, max weight:	0.48-0.57kg/cm ²
11.	Hill climbing ability:	33% ^{a)}

c. Clearance performance

12.	Number of chains:	31
	• Length of chains:	250mm/ 380mm operating radius during clearing
13.	Gap between chains:	45/15mm
14.	Rotation speed:	Up to 900rpm
15.	Clearance depth, max.:	Up to 200mm
16.	Working speed:	
	• light soil/ small vegetation:	700-1,500m ² /h
	• medium soil/medium vegetation:	300-800m ² /h
	• heavy soil/ dense vegetation:	100-600m ² /h
17.	Control of clearing depth:	Automatic
18.	Machines in use:	12
19.	Other types:	6 (MV-1; MV-2; MV-3)
20.	Location of use:	Bosnia and Herzegovina, Croatia
21.	Totally area cleared so far:	Approximately 10,000,000m ²

d. System specifications

22.	Engine:	Perkins 155hp
23.	Fuel capacity:	70l
24.	Fuel consumption:	8-15l/h
25.	Separate engine for tilling unit:	No
26.	Cooling system engine:	Water
27.	Oil capacity:	15l
28.	Hydraulic oil capacity:	178l

e. Comfort and security

29.	Air conditioning:	—
30.	Operator confort:	—
31.	Armour:	8mm steel armour plates
32.	Remote control:	Yes
	• greatest distance:	1,500m

f. Costs

33.	Cost of system:	
	• machine	US\$250,000
	• training	Training course takes one week both for operators and mechanics
	• spare parts	Basic spare parts set included
34.	Transport limitation:	No
35.	Availability for hire:	Yes

a) According to the manufacturer.

COMPARATIVE ANALYSIS

	Bozena	MV-4
a. Dimensional data		
1. Length without attachment:	3,002mm	2,780mm
2. Length total:	5,282mm	3,810-4,460mm
3. Width without attachment:	1,960mm	1,550mm
4. Width total:	2,716mm	1,980mm
5. Clearing width:	2,000mm	1,700mm
6. Height, minimum:	2,100mm	Not given
7. Height, overall:	2,200mm	1,380mm
8. Mass, total:	5,560kg	4,870kg
b. Driving specifications		
9. Wheels/ tracks:	Foam filled tyres/ metal tracks	Tracks (300mm width)
10. Ground pressure, max. weight:	0.66 kg/cm ² (with tracks) Front wheels: 2.75kg/cm ² Rear wheels: 4.55kg/cm ²	0.48-0.57kg/cm ²
11. Hill climbing ability:	Up to 35°	33% ^{b)}
c. Clearance performance		
12. Number of chains:	36	31
• length of chains:	600mm	250mm/ 380mm operating radius during clearing
13. Gap between chains:	Not given	45/15mm
14. Rotation speed:	Up to 400rpm	Up to 900rpm
15. Clearance depth, max:	Up to 150mm	Up to 200mm
16. Working speed ^{a)}		
• light soil/ small vegetation:	Approx. 500 m ² /h	700-1,500m ² /h
• medium soil/medium vegetation:		300-800m ² /h
• heavy soil/ dense vegetation:	Approx. 350 m ² /h	100-600m ² /h
17. Control of clearing depth:	Mechanic	Automatic
18. Machines in use:	More than 40	12
19. Other types:	Bozena 1, Bozena 2	6 (MV-1; MV-2; MV-3)
20. Location of use:	Albania, Bosnia and Herzegovina, Croatia, Eritrea, Kosovo, Lebanon, northern Iraq	Bosnia and Herzegovina, Croatia
21. Total area cleared so far:	Not given	Approximately 10,000,000m ²
d. System specifications		
22. Engine:	Deutz BF4L913, 110hp	Perkins 155hp
23. Fuel capacity:	85l	70l
24. Fuel consumption:	Max. 7l/h ^{b)}	8-15l/h
25. Separate engine for tilling unit:	No	No
26. Cooling system engine:	Air cooled	Water
27. Oil capacity:	11.5l	15l
28. Hydraulic oil capacity:	130l	178l
e. Comfort and security		
29. Air conditioning:	In the cabin	—
30. Operator comfort:	Armoured, air-conditioned cabin	—
31. Armour:	4mm steel shield of the flail unit and 4mm steel of the bodywork	8mm steel armour plates
32. Remote control:	Yes	Yes
• greatest distance:	5,000m (with optical visibility only)	1,500m
f. Costs		
33. Cost of system:	Subject to negotiation	
• machine	On customer request	US\$250,000
• training	Included in the purchase package	Training course takes one week both for operators and mechanics
• spare parts	Subject to negotiation	Basic spare parts set included

Flail systems

	Bozena	MV-4
34. Transport limitation:	Can be packed in one 40ft and one 20ft container. The customer has to provide the truck for transportation	No
35. Availability for hire:	Yes	Yes

a) Croation Mine Action Centre, *Testing "Bozena-3 Mine Clearance Machine"*, Sisak, January 2002.
b) According to the manufacturer.

Aardvark Mk IV

Aardvark Clear Mine Ltd , United Kingdom



Aardvark Mk IV with spare container ready for road transport

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 while cutting vegetation.

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 one or 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.

Clearance methodology

During clearance operations, the vehicle moves rear-end first into a suspect area. The flail component has an expected clearance width of 3m to a maximum ground penetration 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 305rpm. The manufacturer states that the flail unit will detonate or break up mines.

Machines in use to date

- At present 30 Mk III and four Mk IV machines are in use in 25 countries.¹
- Aardvark has sold many vehicles to the international military community. Recipients include France, Italy, Jordan, Korea, Pakistan, Saudi Arabia, Sweden, the U.K. and the U.S. (Air Force, Marines, and Army).

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 is 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.

Factory support

- Aardvark provides after-sales support to its 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 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.



Aardvark working in Bosnia and Herzegovina

Maintenance and support

- Regular maintenance periods are required comprising daily, weekly and monthly checks as laid down in the operating procedures.
- The company recommends a two-man crew to operate the vehicle.
- Aardvark claims that no special workshop facilities are required. According to the manufacturer, the machine is designed to be field-repairable.
- The British Defence Evaluation and Research Agency (DERA) states that a lot of effort has gone into making the Mk IV more maintenance-friendly.

Tests and evaluations

- Due to its time in the business 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 DERA at DERA Bagshot test track on 26-30 July 2000. The trials included a water obstacle test. DERA stated that the Mk IV cleared all the surrogate model mines in its path and is a valuable asset when used in the right environment and under appropriate circumstances.²

Reported limitations and strengths

Limitations

- The early models had a tendency to overheat if used for more than 30 minutes in tropical climates. This effect was further increased if the machine was 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.
- Not ideally suited to areas of rocky terrain.¹

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.
- Air transportable when the flail and the air filter are removed.
- Good operator safety.
- Good manoeuvrability.

1. According to the manufacturer.

2. DERA, *Evaluation of Aardvark Mk IV*, Bagshot, November 2000.

Armtrac 100

Armtrac Ltd., United Kingdom

Medium flail



Armtrac 100

General description

Armtrac Limited produces the **Armtrac 100**, a medium flail system based on a New Holland tractor fitted with 10mm armour around the driver's cab, 45mm toughened glass (polycarbonate/glass laminate) and 6mm of 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/h. 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°,¹ and clear flat areas at a rate of 1,600 square metres per hour.¹ During a tilt test, the machine lost balance on a 20° side-slope. The average clearance rate recorded was reduced to 600m²/h.² The flail can remain attached at full road speed, or detached from the tractor in around five minutes.

The flail rotors are designed to withstand anti-personnel and anti-tank mine blasts. The tractor is fitted with a winch to enable self-recovery without the need for support vehicles. The Armtrac 100 has a power take-off (PTO) shaft and a three-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, e.g. portable welders, electrical generating plants, etc., can also be fitted. The flail is mounted to the front PTO shaft of the tractor. It has an extended blast plate with spring-loaded plates at the top. These are designed to prevent debris being thrown over a wide area during flailing. They open to allow blast pressure to dissipate thereby minimising damage to the vehicle.

The turning circle of the machine is at least 13.87m (on tarmac, left-hand lock, rear wheel braked). Due to the flail system and the deflector plates in front, driver visibility during transit is restricted to approximately 72m ahead.

Consideration should be given to the fact that approximately 65 per cent of the load distribution is on the front axle (with flail attached).

Clearance methodology

The overall width of the vehicle is 2.64m, with a working width of 2.08m. The rotor operates at up to 350rpm clockwise and clears ground to a depth of up to 200mm. During QinetiQ tests, the flail had a good clearance performance down to 100mm ground penetration depth over all terrain types tested. Performance degraded when mines were buried at depths of 150 and 200mm.³ In operational mode, the special gearbox on the vehicle propels the machine at 0.3km/h. 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.

Machines in use to date

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

Engine, fuel and oil

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

Factory support

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

Maintenance and support

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

Tests and evaluations

- QinetiQ (formerly DERA) tested the Armtrac 100 in February 2002. The test report of 88 pages is available at the GICHD (hard copy only). The most important results are included in this extract.
- During the above mentioned test, the Armtrac 100 flail had to clear test lanes containing 174 test mines laid to a depth of 200mm. The flail achieved a high level of clearance efficiency.
- The abstract of the report reads: "The Armtrac 100 Mine Flail is a well-designed and capable machine. It demonstrated an ability to clear anti-personnel-sized mines from terrain ranging from sandy topsoil to gravel track and heavy clay, but with limitations on clearance depth." It also concludes that the Armtrac 100 has good vegetation clearance ability and good mobility. "The machine survived a limited range of live explosive tests, although these did not fully assess the safety of the operator."



The Armtrac 100 attached vegetation cutter at the rear end

Reported limitations and strengths

Limitations

- For transportation over longer distances, a 40m low-bed trailer is required.
- The approach angle is 22.5° with the mounted flail system.
- The engine power is not sufficient for an overall clearance depth of 20cm in all types of soil.
- The tools at the end of the chains should be redesigned for more clearance efficiency. The flail causes ridges particularly in wet clay.
- Although the 4 x 4 transmission provides good traction, the weight of the flail unit and armour tends to cause the wheels to sink on soft terrain, particularly the front wheels.

Strengths

- A lightweight flail system that can withstand anti-tank mine blast under the flail unit.
- The Armtrac 100 showed good vegetation cutting ability.
- The machine has a high ground clearance (at least 43cm under the front hitch).

1. According to the manufacturer.
 2. QinetiQ International Test and Evaluation Programme, *Armtrac 100 Trial Report*, Farnborough, April 2002, pp. 22 and 24.
 3. *Ibid.*, p. 29.

Hydrema MCV 910 (Series 2)

A/S Hydrema Danmark, Denmark



The Hydrema 910 MCV with flail unit

General description

The **Hydrema MCV 910** (Series 2) is a flail system designed for clearing surface or buried anti-personnel or anti-tank mines containing up to 10kg of explosives. The system is an upgraded version of the 910 MCV, based on the pivot chassis of a commercial dumper. The running gear consists of four wheels on two axles. The machine has two 136kw diesel engines. After thorough modifications, the flail can now be powered by both engines at the same time. In this case, 272kw can be brought to bear for flailing operations. During transportation, the flail unit mounts 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.

The latest version of the Hydrema 910 (series 2) features comprehensive modifications such as improved air filters and chains, a new depth regulation control system, automatic crawling function and improved engine cooling system.

Clearance methodology

Transformation of the flail unit from its road transport position to working configuration can be achieved in approximately five 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 3.5 metre-wide flail shaft rotate clockwise at a speed of up to 350rpm. The flail action should detonate or break up anti-personnel and anti-tank mines. Direction of rotation can be reversed. Effective ground penetration depth is up to 250mm and can be controlled automatically. The Series 2 machine is equipped with a yaw control designed to prevent ridges of earth forming in a cleared lane. 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 computerised automatic pilot steering system.

The improved depth regulation system and the automatic adjustable "crawling system" achieve faster and more effective clearance.¹

Machines in use to date

- 24 machines distributed between Afghanistan, Angola, Bosnia and Herzegovina, and Croatia. A Norwegian platoon has cleared the Bagram and Kandahar airports for U.S. Marines using two MCV 910 machines.
- A Danish platoon equipped with two MCV 910 machines is involved in clearance operations at Kabul airport.

Engine, fuel and oil

- Average fuel consumption is 60l per hour.¹
- Oil used in the engine and the hydraulic systems is of general standard.

Factory support

- Spare parts (NATO-codified) sufficient for a two-year operation are part of normal purchase package.
- Training courses for operators and mechanics are part of the purchase package.
- Instruction manuals and documentation are available in English, Danish and Russian.

Maintenance and support

- Recommended level of maintenance required is similar to standard commercial engineering construction machines.

Tests and evaluations

- The German Army tested the Hydrema 910 MCV in October 2000.²
- Tested in Croatia by CROMAC April-June 2001.
- Tested in Sweden by SWEDEC August 2001.
- Lessons learned from an accident in Eritrea in 2001.



Hydrema 910 MCV flail system in action

Reported limitations and strengths (refer to the Series 1 model)

Limitations

- Tests in Germany showed that the machine worked slower than two other competitors.^{2,3}
- During the tests, the whole system suffered vibrations.²

Strengths

- Can easily be deployed to the area of operations. It takes around five minutes to ready the system for clearance activities.
- By changing the direction of the rotating flail, the system can also clear roads and areas with a hard surface.
- The vehicle is equipped with two engines for driving and flailing.
- The pivot steering enables the vehicle to drive with front and rear wheels in the same track.

A test report covering Series 2 is not available

1. According to the manufacturer.

2. Wehrtechnische Dienststelle für Pionier- und Truppengerät, *Kurzbericht*, Meppen/Koblenz, 15 January 2001.

3. The Hydrema 910 MCV was the only flail system in this test.

Minecat 230

Norwegian Demining Consortium AS (NoDeCo), Norway

Medium flail



The Minecat 230 during tests in Kosovo

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 medium flail **Minecat 230**. The Minecat weighs only 8 tonnes 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 radio frequency hazard (proximity to electrical detonators).

The machine is based on a Bobcat 863 skid steer chassis. The system is for clearance of anti-personnel and anti-tank 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 (1,000kg), the chassis (4,700kg), and the flail unit (2,100kg). 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 1,000 metres.

The Minecat is equipped with two diesel engines — one for the prime mover (73hp) and one for the flail unit (150hp).

Clearance methodology

The flail unit attached to the front of the 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-diameter hammer attached to the end designed to detonate or break up mines. The chains are mounted to the flail drum in a staggered pattern, giving each hammer an overlap of 10mm each side as they hit the ground. Because of the advanced contouring system the flail can be run either automatically or manually.

Machines in use to date

- One machine is in Croatia operated by NPA.
- Two machines are working in Iran operated by NPA.
- One machine is in Jordan operated by the Jordanian Army.
- One machine is in Lebanon operated by MAG.
- Machines are being delivered to Afghanistan, Croatia, and Lebanon.

Engine, fuel and oil

- The Minecat is equipped with a Deutz diesel engine for the prime mover and a Perkins 1006-60 turbo 6l diesel engine for the flail system. No special fuel or hydraulic oil is required.



Minecat 230 detonating a mine

Factory support

- A comprehensive spare parts support package for one year.
- A worldwide servicing and spare parts network for all components ensures the availability of spares.
- NoDeCo offers the choice of factory training in Norway or on-site training tailored to the customer's requirements. Training normally lasts six weeks.
- Training, documentation and manuals in English are part of the purchase package.
- Training, service and support is provided by NoDeCo Middle East.

Maintenance and support

- Regular maintenance is required, comprising daily, weekly, monthly and annual checks as per the operating instructions.
- The company recommends a three-operator crew: one operator, one observer (for additional safety), and one operator resting.
- The Minecat is supported by a mobile workshop container.
- It can be shipped in 2 x 20ft ISO containers.

Tests 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. The test concluded that against detonations of up to 10kg of TNT, the operator will not suffer injury provided that the cabin has not previously been damaged; doors remain completely shut; and operators wear head and ear protection.¹
- 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. Identified weaknesses were rectified. The machine proved robust against anti-personnel and anti-tank mine blasts, incurring the expected loss of some chains and chain hammers.²
- Both reports are available from the manufacturer or from the GICHD.

Reported limitations and strengths

Limitations

- Frequent breakdowns while operating with MAG in Kosovo (approximately every four working hours).³
- Low road speed (5km/h).

Strengths

- A light and compact demining tool shipped in 2 x 20ft ISO containers.
- Small size adds to deployment flexibility.
- Built to destroy anti-personnel and anti-tank mines.
- Depth control system.
- Remote control.

1. According to the manufacturer.

2. Hands, M., NPA MINECAT Test Report & Recommendations, 10 February 2000.

3. MAG statement.

Minemill MC 2002

Trademill Mejac & Co.d.n.o., Slovenia



The Minemill MC 2002

General description

The **Minemill MC 2002** is a chain flail system produced in Slovenia. The machine is based on the chassis of a commercial track-driven prime mover. Dependant on soil conditions, the manually-controlled ground penetration depth is effective to a maximum of 15cm.¹ For this reason, the manufacturer states that the Minemill is best used for area reduction and technical survey operations.

The flail unit has 66 chains, powered by a 100kw diesel engine. The system is relatively lightweight, enabling it to work in difficult to access areas where larger systems cannot operate. One operator drives the system from an armoured cab protected by 12mm of steel plate and 45mm bulletproof glass.

Clearance methodology

The total width of the vehicle with attached flail unit is 2.7m. The clearance width is 2m. The 66 chains of the flail rotate clockwise at up to 400rpm. The machine works at between 0.4-1.5km/h. The hammers attached to each chain are intended to either detonate or break up anti-personnel mines.

Machines in use to date

- One system has been in service in Bosnia and Herzegovina since March 2000.

Engine, fuel and oil

- The Minemill MC 2002 is equipped with two diesel engines: one for powering the prime mover (70kw) and the other for the flail unit (100kw). The fuel tank has a 120l diesel capacity.
- Fuel consumption is 10-13l/h.²
- Hydraulic oil capacity is 435l.

Factory support

- Manuals are available in English, Slovenian and Serb/Croat.
- The manufacturer provides a six-month warranty.
- Specific spares covering both the prime mover and the flail unit are provided by the manufacturer.

Maintenance and support

- The system has the benefit of simple and robust design. According to the operating instructions,

a full service is required every 150 hours, carried out by staff trained by the manufacturer.

Tests and evaluations

- The machine was tested by the Bosnia-Herzegovina Mine Action Centre (BHMACH). No further information is available.



Reported limitations and strengths

Limitations

- Clearance depth is limited to 15cm. This reduces task application.
- Designed for anti-personnel mine clearance only.
- Vegetation cutting of plant stems of up to approx. 80mm in diameter.

Strengths

- Simple and robust.
- Lightweight design.

1. According to the manufacturer.

Patria RA-140 DS

Patria Vehicles Oy, Finland

Medium flail



The Patria RA-140 DS in operating mode

General description

The **Patria RA-140 DS** is a wheeled, armoured medium flail system designed to clear anti-personnel mines (non-directional) and anti-tank mines containing 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 roads and the other for clearance operations 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 2,920mm.

The RA-140 DS does not require loader transport. On paved roads, the vehicle can travel at an average of up to 70km/h. 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.

Clearance methodology

The total width of the vehicle with the tiller unit in working position is 4m, while the flail clearance width is 3.4m. 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, selected by the operator. The action of the flail is designed to detonate or break up anti-personnel and anti-tank mines.

Machines in use to date

- There are around 50 machines worldwide, used mostly by the military.
- The Patria RA-140 DS has been deployed to Cambodia, Kosovo and Mozambique for humanitarian demining operations.

Engine, fuel and oil

- The Patria RA-140 DS is powered by a six-cylinder, 141kw Deutz diesel engine. It is turbo-charged, air-cooled and has direct injection.
- 150l fuel capacity.

- Engine oil capacity is 16l. The main gearbox takes 29l. Hydraulic fluid capacity is 60l.

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.

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.

Tests 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.



The Patria RA-140 DS flail system

Reported limitations and strengths

Limitations

- The RA-140 DS is a large-wheeled vehicle with the attendant difficulties of mobility in tight spaces.
- The system showed a tendency to break down during operations in Kosovo in 2001.

Strengths

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

RM-KA 01

DEMIN – KA d.o.o., Croatia

Medium flail



The RM-KA 01 in operation

General description

The DEMIN – KA d.o.o. **RM-KA 01** is a 12-tonne (approx.) remote-controlled medium flail produced by a small firm in Croatia. Based on a Caterpillar chassis with Perkins engine, the prototype was built in 2001. According to the manufacturer the upgraded version of the prototype cleared some 500,000m².

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 has not provided any further information.

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/h (depending on soil conditions),¹ the chains will detonate or break up anti-personnel and anti-tank mines. The system achieves an average ground penetration of up to 300mm.¹

Machines in use to date

- One prototype in Croatia.

Engine, fuel and oil

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

Factory support

- Further information not provided by the manufacturer.

Maintenance and support

- Further information not provided by the manufacturer.

Tests and evaluations

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



Joystick control of the RM-KA 01

Reported limitations and strengths

Owing to the lack of reliable test reports, no information can be provided.

1. According to the manufacturer.



Samson 160 in operation

General description

Samson was developed by a Slovenian manufacturer and is designed for clearance of anti-personnel and anti-tank mines. The vehicle weighs 8,700 kg and has a working clearance width of 2.5m. The running gear consists of four wheels on two axles. The chassis consists of two frames coupled by a joint. This allows lateral flex and oscillation of the frames for improved manoeuvrability and adaptation to terrain. The front and back wheels run in the same track.

The flail unit is mounted in an armoured casing, ensuring the protection of all vital elements of the system (engine, hydraulic and transmission systems).

The clearance operation is controlled manually or by remote control. The rotor housing and drivers cabin are made of armoured steel.

The road speed of the vehicle is 15km/h on most surfaces. The working speed varies between 0-2km/h, depending on soil conditions and the clearance depth selected. One operator controls the vehicle. It is lightweight, reducing transport difficulties.

The system is equipped with a computer steered hydrostatic drive for the vehicle and a flail unit, which adapts the working speed automatically to ground conditions.

Currently, there are two models available: Samson 200 and Samson 260.

Clearing methodology

The flail unit attached to the front of Samson rotates 73 chains with hammers attached at a speed of up to 880rpm¹ with a stated clearance depth of at least 200mm, depending on soil conditions.¹

The hammers weigh 800g each and have a T-shape profile connected to 375mm-long chains.

Depending on soil conditions, the machine operates at an average speed of 0-2km/h.

Machines in use to date

- One machine is currently being used by a commercial company (TT- KA) in Croatia. It is reported that some 1,000,000m² had been cleared by late 2002.

Engine, fuel and oil

- The system is equipped with a water-cooled 186kw Deutz diesel engine (Samson 260) or a Perkins engine with 136kw (Samson 200). The average fuel consumption is around 10l/h.
- Oil used in the engine and the hydraulic system is of general standard.

Maintenance and support

- Regular maintenance is required, comprising daily, weekly, monthly, and annual checks as per the operating instructions.
- The Samson is supported by a mobile maintenance vehicle on the worksite.
- More complex repairs have to be carried out in the factory based in Slovenia.

Tests and evaluations

- The Samson 160 was tested by CROMAC in July-September 2001. The trials included anti-personnel mines only.
- The test report is available at the GICHD in English and Serb/Croat.
- Experience gained during tests and fieldwork was put into the development of the upgraded versions of the system (Samson 200 and 260).



The SAMSON 260 Flail System

Reported limitations and strengths² (Samson 160)

Limitations

- The flails bearing and axel joint require improvement.
- Operator's cabin has deficiencies which impact on the operator's work; e.g. there is no upholstery, air-conditioning or fixed communication system.
- The power transmission to the flail is reduced when the prime mover has to overcome obstacles or steep terrain, affecting ground penetration depth.

Strengths

- Powerful engine
- Good manoeuvrability
- Effective cooling system
- Roller installed behind the flail in order to reduce risk of missed mines.
- Remote-controlled.
- Small, therefore reducing transport problems.

¹ According to the manufacturer.

² CROMAC, *Testing of Mine Clearance Machine "SAMSON"*, 2001.

Technical data sheet Aardvark Mk IV

a. Dimensional data

1.	Length without attachment:	5,486mm
2.	Length total:	8,400mm
3.	Width without attachment:	2,530mm
4.	Width total:	3,556mm
5.	Clearing width:	3,000mm
6.	Height, overall:	3,550mm
7.	Mass, basic vehicle:	11,506kg
8.	Mass, demining unit:	3,500kg
9.	Mass, total:	15,377kg

b. Driving specifications

10.	Wheels/ tracks:	Various sizes
11.	Ground pressure, max weight:	Not given
12.	Hill-climbing ability:	33°

c. Clearance performance

13.	Number of chains:	72
	• length of chains:	1,000mm
14.	Gap between chains:	Not given
15.	Rotation speed:	305rpm
16.	Clearance depth:	100-500mm ^{a)}
17.	Working speed: ^{a)}	Depends on soil conditions and depth of mines laid
18.	Control of clearing depth:	Manual
19.	Machines in use:	30 Mk III and 4 Mk IV
20.	Location of use:	Not given
21.	Total area cleared so far:	Not given
22.	Other types:	Mk III

d. System specifications

23.	Engine:	New Holland six-cylinder in-line diesel with turbocharger (165bhp)
24.	Fuel capacity:	180L
25.	Fuel consumption:	23-30l/h
26.	Separate engine for flail unit:	No
27.	Transition:	Not given
28.	Cooling system engine:	Water/air
29.	Hydraulic oil capacity:	90l

e. Comfort and security

30.	Air conditioning:	Yes
31.	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, suspension seats
32.	Armour:	Protection glass, minimum 10mm steel plates
33.	Remote control:	Optional

f. Costs

34.	Cost of machine	Negotiable upon application
35.	Training	Not given
36.	Other costs	Not given
37.	Transport limitation:	A flat bed or articulated truck is required for long distances. Air transportable by C 130, C 17
38.	Availability for rent:	Yes

a) According to the manufacturer.

Technical data sheet Armtrac 100

a. Dimensional data

1.	Length without attachment:	4,780mm ^{a)}
2.	Length total:	6,850mm ^{a)}
3.	Width without attachment:	1,960mm ^{a)}
4.	Width total:	2,640mm ^{a)}
5.	Clearing width:	2,080mm ^{a)}
6.	Height, overall:	2,900mm ^{a)}
7.	Mass, basic vehicle:	8,610kg
8.	Mass, demining unit:	2,600kg
9.	Mass, total:	11,010kg ^{a)}

b. Driving specifications

10.	Wheels/ tracks:	4 wheels with foam fill tyres
11.	Ground pressure, max weight:	3,690kg under the front right wheel
12.	Hill climbing ability:	30° ^{b)}

c. Clearance performance

13.	Number of chains:	54
	• length of chains	1,000mm
14.	Gap between chains:	10mm
15.	Rotation speed:	350rpm
16.	Clearance depth, max:	Approx. 200mm travelling at 0.3km/h ^{c)}
17.	Working speed:	
	• light soil/ small vegetation:	Approx. 600m ² /h, ^{d,e)}
	• medium soil/ medium vegetation:	—
	• heavy soil/ dense vegetation:	—
18.	Control of clearing depth:	Manual
19.	Machines in use:	4
20.	Location of use:	Bosnia and Herzegovina, Kosovo, Lebanon, and Mozambique
21.	Total area cleared so far:	Approx. 5,400,000m ²
22.	Other types	Armtrac 325

d. System specifications

23.	Engine:	New Holland diesel engine with 165hp
24.	Fuel capacity:	332l
25.	Fuel consumption:	Max. 32l/h
26.	Separate engine for flail unit:	No
27.	Transition:	Stable axle pivot
28.	Cooling system engine:	Mechanical fan
29.	Hydraulic oil capacity:	70l

e. Comfort and security

30.	Air conditioning:	Yes
31.	Operator comfort:	Air seat, 20 decibel cab noise
32.	Armour:	Cab 10mm armour
33.	Remote control:	No

f. Costs

34.	Machine:	£165,000
35.	Training:	£3,000 (in UK)
36.	Other costs:	On request
37.	Transport limitation:	22.5° angle for the ramp ^{f)}
38.	Availability for hire:	Yes

a) QinetiQ International Test and Evaluation Programme, *Armtrac 100 Trial Report*, Farnborough, April 2002, p. 9.

b) *Ibid.*, p. 24.

c) *Ibid.*, pp. 29 and 74.

d) *Ibid.*, p. 22.

e) All figures according to the manufacturer.

f) *QinetiQ Armtrac 100 Trial Report, op. cit.*, p. 73.

Technical data sheet Hydrema MCV 910

a. Dimensional data

1.	Length, transportation position:	9,200mm
2.	Length, total:	10,000mm
3.	Width, transportation position:	2,800mm (option: 2,500mm)
4.	Width, total:	2,420mm
5.	Clearing width:	3,500mm
6.	Height, overall:	3,600mm
7.	Mass, basic vehicle:	Not given
8.	Mass, demining unit:	Not given
9.	Mass, total:	18,000kg

b. Driving specifications

10.	Wheels/ tracks:	4 standard tyres Goodyear RL-2+ 17.5R25 foam filled
11.	Ground pressure, max weight:	Not given
12.	Hill climbing ability:	34° ^{a)}

c. Clearance performance

13.	Number of chains:	72
	• length of chains	900mm
14.	Gap between chains:	Not given
15.	Rotation speed:	350-390rpm
16.	Clearance depth, max:	Up to 300mm in light soil ^{b)}
17.	Working speed:	750-1,000 m ² /h ^{b)}
18.	Control of clearing depth:	By automatic depth control system which can be overridden by operator
19.	Machines in use:	24
20.	Location of use:	Afghanistan, Angola, Bosnia and Herzegovina, Croatia, Denmark (Army), Kosovo, Mozambique
21.	Total area cleared so far:	Not given
22.	Other types:	Series 1

d. System specifications

23.	Engine:	Perkins 1006-6TW, 6 cylinder diesel with turbocharger
24.	Fuel capacity:	300l
25.	Fuel consumption:	Max. 60l/h
26.	Separate engine for flail unit:	Yes, the same engine as for driving
27.	Transition:	Hydrostatic
28.	Cooling system engine:	Not given
29.	Hydraulic oil capacity:	Not given

e. Comfort and security

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

f. Costs

34.	Costs machine:	Not given
35.	Training:	Not given
36.	Other costs:	Not given
37.	Transport limitation:	Max. 40km/h on own wheels
38.	Availability for hire:	Not given

a) According to the manufacturer.

b) CROMAC test report (the system achieved during the tests in Germany 30 cm).

Technical data sheet Minecat 230

a. Dimensional data

1.	Length without attachment:	4,850mm
2.	Length total:	5,856mm
3.	Width without attachment:	2,000 mm
4.	Width total:	3,300mm
5.	Clearing width:	2,300mm
6.	Height, overall:	2,700mm
7.	Mass, basic vehicle:	4,700 kg (without cab)
8.	Mass, demining unit:	2,100 kg
9.	Mass, total:	7,800 kg

b. Driving specifications

10.	Wheels/ tracks:	Steel tracks (width: 385mm)
11.	Ground pressure, max. weight:	0.4 kg/cm ²
12.	Hill climbing ability:	30°

c. Clearance performance

13.	Number of chains:	48
	• length of chains	860mm
14.	Gap between chains:	48mm (dynamically 10mm overlap)
15.	Rotation speed:	384rpm (free running)
16.	Clearance depth, max.:	Up to 500mm (standing still), depending on the ground
17.	Working speed:	Up to 1km/h in light soil ^{a)}
18.	Control of clearance depth:	Automatic, free-floating flail or manual
19.	Machines in use:	8
20.	Location of use:	Croatia, Iran, Jordan
21.	Total area cleared so far:	Unknown
22.	Other types:	140 Minecat 2.5 tonne mini-flail (125hp)

d. System specifications

23.	Engine:	Deutz 73hp
24.	Fuel capacity:	95l (one fuel tank for both engines)
25.	Fuel consumption:	9l/h
26.	Separate engine for flail unit:	Perkins 150hp
27.	Transition:	Hydraulic/Hydrostatic
28.	Cooling system engines:	Deutz: oil cooled / Perkins: fluid cooled
29.	Hydraulic oil capacity:	Deutz 34l, Perkins 42l

e. Comfort and security

30.	Air conditioning	Yes (optional)
31.	Operator comfort	Not given
32.	Armour:	6.5-13mm ARMOX 500
33.	Remote control:	Yes (GPS navigation optional)
	• greatest distance:	1,000m in line sight

f. Costs

34.	Cost of machine:	Not given
35.	Training:	Not given
36.	Other costs:	Not given
37.	Transport limitation:	2 x 20ft ISO containers
38.	Availability for hire:	Yes

a) According to the manufacturer.

Technical data sheet Minemill MC 2002

a. Dimensional data

1.	Length without attachment:	6,700mm
2.	Length total:	Not given
3.	Width without attachment:	2,500mm
4.	Width total:	2,700mm
5.	Clearing width:	2,000 mm
6.	Height, overall:	2,400mm
7.	Mass, basic vehicle:	5,500kg
8.	Mass, demining unit:	1,700kg
9.	Mass, total:	7,200kg

b. Driving specifications

10.	Wheels/ tracks:	Tracks (2,300x400mm)
11.	Ground pressure, max weight:	0.39 kg/cm ²
12.	Hill climbing ability:	30°

c. Clearance performance

13.	Number of chains	66
	• length of chains	600mm
14.	Gap between chains	35mm
15.	Rotation speed	350-400rpm
16.	Clearance depth, max:	Up to 150mm
17.	Working speed:	
	• light soil/ small vegetation:	Approx. 1.5km/h
	• medium soil/medium vegetation:	Approx. 1.0km/h
	• heavy soil/ dense vegetation:	Approx. 0.4-0.8km/h
18.	Control of clearing depth:	Mechanic
19.	Machines in use:	1
20.	Location of use:	Bosnia and Herzegovina
21.	Total area cleared so far:	700,000m ²
22.	Other types:	Not given

d. System specifications

23.	Engine:	Diesel
24.	Fuel capacity:	120l
25.	Fuel consumption:	4-5l/h
26.	Separate engine for flail unit:	Yes
27.	Transition:	Hydraulic
28.	Cooling system engines:	Water
29.	Hydraulic oil capacity:	435l

e. Comfort and security

30.	Air conditioning :	Yes (optional)
31.	Operator comfort:	Winch for self recovering, triple fire extinguisher system
32.	Armour:	12mm armoured steel, 45mm bulletproof windows
33.	Remote control:	Yes (optional)
	• greatest distance:	1,000m in line sight

f. Costs

34.	Costs of machine:	€200,000
35.	Training:	Not given
36.	Other costs:	
	• spares:	€204,000
37.	Transport limitation:	Not given
38.	Availability for hire:	Yes

Technical data sheet Patria RA-140 DS

a. Dimensional data

1.	Length, transportation position:	7,850mm
2.	Length, total	9,450mm
3.	Width, transportation position:	2,920mm
4.	Width, total:	4,000mm
5.	Clearing width:	3,400mm
6.	Height, overall:	2,860mm
7.	Mass, basic vehicle:	Not provided
8.	Mass, demining unit:	Not provided
9.	Mass, 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, max. weight:	Not provided
12.	Hill climbing ability:	25°

c. Clearance performance

13.	Number of chains:	84
	• length of chains	Not provided
14.	Gap between chains:	Not provided
15.	Rotation speed:	Up to 400rpm
16.	Clearance depth, max.:	Up to 370mm
17.	Working speed:	Up to 3km/h
	• light soil/ small vegetation:	Not provided
	• medium soil/medium vegetation:	Not provided
	• heavy soil/ dense vegetation:	Not provided
18.	Control of clearance depth:	Automatic and manual depth control
19.	Machines in use:	Approx. 50
20.	Location of use:	Not given
21.	Total area cleared so far:	Not given
r22.	Other types:	Not provided

d. System specifications

23.	Engine:	Six-cylinder in-line 141kw Deutz BF 6L 913 C diesel with turbocharger, inter-cooled, direct injection
24.	Fuel capacity:	200l
25.	Fuel consumption:	Not provided
26.	Separate engine for flail unit:	Hydraulically driven
27.	Transition:	4x4 continuous all wheel drive
28.	Cooling system engine:	Air cooled
29.	Hydraulic oil capacity:	60l

e. Comfort and security

30.	Air conditioning:	Available
31.	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
32.	Armour:	Protected glass and armoured steel for the cabin
33.	Remote control:	No

f. Costs

34.	Costs of machine:	Not provided
35.	Training:	Not provided
36.	Other costs:	Not provided
37.	Transport limitation:	Given by the technical specifications as weight, etc.
38.	Availability for hire:	Not provided

Technical data sheet RM – KA 01

a. Dimensional data

1.	Length without attachment:	3,235mm
2.	Length total:	4,490mm
3.	Width without attachment:	2,000mm
4.	Width total:	2,500mm
5.	Clearance width:	2,000mm
6.	Height, overall:	1,900mm
7.	Mass, basic vehicle:	10,120kg
8.	Mass, demining unit:	2,000kg
9.	Mass, total:	12,120 kg

b. Driving specifications

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

c. Clearance performance

13.	Number of chains:	48
	• length of chains:	300mm
14.	Gap between chains:	85mm
15.	Rotation speed:	600rpm
16.	Clearance depth, max:	Up to 300mm ^{a)}
17.	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 ^{a)}
18.	Control of clearance depth:	Mechanic
19.	Machines in use:	1
20.	Location of use:	Croatia
21.	Total area cleared so far:	500,000m ²
22.	Other types:	No

d. System specifications

23.	Engine:	Perkins 107kw
24.	Fuel capacity:	200l
25.	Fuel consumption:	14l/h
26.	Separate engine for flail unit:	No
27.	Transition:	Hydrostatic drive
28.	Cooling system engines:	Water
29.	Hydraulic oil capacity:	400l

e. Comfort and security

30.	Air conditioning:	Not given
31.	Operator comfort:	Not given
32.	Armour:	20mm armoured steel
33.	Remote controlled:	Yes
	• greatest distance:	300m in line sight

f. Costs

34.	Cost of machine:	€350,000
35.	Training:	Included
36.	Other costs:	Spares are included
37.	Transport limitation:	Easily transportable on a 14-tonne trailer
38.	Availability for hire:	Yes

a) According to the manufacturer.

Technical data sheet SAMSON 260

a. Dimensional data

1.	Length without attachment:	Not given
2.	Length total:	7,900mm
3.	Width without attachment:	2,300mm
4.	Width total:	3,000mm
5.	Clearance width:	2,500mm
6.	Height, overall:	2,700mm
7.	Mass, basic vehicle:	6,600kg
8.	Mass, demining unit:	2,100kg
9.	Mass, total:	8,700kg

b. Driving specifications

10.	Wheels:	4 standard tyres NOKIA TRS-LS 16 PR-steel or optional foam-filled
11.	Ground pressure, max weight:	Not given
12.	Hill climbing ability:	45° ^{a)}

c. Clearance performance

13.	Number of chains:	60
	• length of chains:	375mm
14.	Gap between chains:	Not given
15.	Rotation speed:	Up to 900rpm ^{a)}
16.	Clearance depth, max:	Approximately 200mm
17.	Working speed:	0-2km/h
18.	Control of clearance depth:	Automatic
19.	Machines in use:	1
20.	Location of use:	Croatia
21.	Totally area cleared so far:	Approx. 1,500,000m ²
22.	Other types:	Samson 200, Samson 260

d. System specifications

23.	Engine:	Deutz 186kw (Samson 260), Perkins 136kw (Samson 200)
24.	Fuel capacity:	140l
25.	Fuel consumption:	10l/h
26.	Separate engine for flail unit:	—
27.	Transition:	Hydrostatic drive
28.	Cooling system engines:	Water cooling
29.	Hydraulic oil capacity:	120l

e. Comfort and security

30.	Air conditioning:	Available
31.	Operator comfort:	—
32.	Armour:	ARMOX (6mm)
33.	Remote controlled:	Yes
	• greatest distance:	300m

f. Costs

34.	Costs of machine:	Samson 260: €288,000 Samson 200: €230,000
35.	Training:	10 days training is included
36.	Other costs:	The manufacturer offers a spare part kit sufficient for one year of field work for the following price: Samson 200: €45,000 Samson 260: €58,000
37.	Transport limitation:	Truck
38.	Availability for hire:	Yes

a) According to the manufacturer.

COMPARATIVE ANALYSIS

Aardvark MK IV Armtrac 100 Hydrema MCV 910

a. Dimensional data

1. Length without attachment:	5,486mm	4,780mm ^{b)}	9,200mm
2. Length total:	8,400mm	6,850mm ^{b)}	10,000mm
3. Width without attachment:	2,530mm	1,960mm ^{b)}	2,800mm (option: 2,500mm)
4. Width total:	3,556mm	2,640mm ^{b)}	2,420mm
5. Clearing width:	3,000mm	2,080mm ^{b)}	3,500mm
6. Height, overall:	3,550mm	2,900mm ^{b)}	3,600mm
7. Mass, basic vehicle:	11,506kg	8,610kg	Not given
8. Mass, demining unit:	3,500kg	2,600kg	Not given
9. Mass, total:	15,377kg	11,010kg ^{b)}	18,000kg

b. Driving specifications

10. Wheels/ tracks:	Various sizes	4 wheels with foam fill tyres	4 standard tyres Goodyear RL-2 + 17.5R25 foam filled
11. Ground pressure, max weight:	Not given	3,690kg under the front right wheel	Not given
12. Hill-climbing ability:	33°	30° ^{c)}	34° ^{oo)}

c. Clearance performance

13. Number of chains:	72	54	72
• length of chains:	1,000mm	1,000mm	900mm
14. Gap between chains:	Not given	10mm	Not given
15. Rotation speed:	305rpm	350rpm	350-390rpm
16. Clearance depth:	100-500mm ^{o)}	Approx. 200mm travelling at 0.3km/h ^{d)}	Up to 300mm in in light soil ^{o)}
17. Working speed:	Depends on soil conditions and depth of mines laid ^{o)}		750-1,000 m ² /h ^{o)}
• light soil/ small vegetation:	—	—	Approx. 600m ² /h, ^{a,e)}
• medium soil/ medium vegetation:	—	—	—
• heavy soil/ dense vegetation:	—	—	—
18. Control of clearing depth:	Manual	Manual	By automatic depth control system which can be overridden by operator
19. Machines in use:	30 Mk III and 4 Mk IV	4	24
20. Location of use:	Not given	Bosnia and Herzegovina, Kosovo, Lebanon, and Mozambique	Afghanistan, Angola, Bosnia & Herzegovina, Croatia, Denmark (Army), Kosovo, Mozambique
21. Total area cleared so far:	Not given	Approx. 5,400,000m ²	Not given
22. Other types:	Mk III	Armtrac 325	Series 1

d. System specifications

23. Engine:	New Holland six- cylinder in-line diesel with turbocharger (165bhp)	New Holland diesel engine with 165hp	Perkins 1006-6TW, 6 cylinder diesel with turbocharger
24. Fuel capacity:	180	332l	300l
25. Fuel consumption:	23-30l/h	Max. 32l/h	Max. 60l/h
26. Separate engine for flail unit:	No	No	Yes, the same engine as for driving

Flail systems

Minecat 230	Minemill MC 2002	Patria RA-140 DS	RM-KA 01	Samson 260
4,850mm	6,700mm	7,850mm	3,235mm	Not given
5,856mm	Not given	9,450mm	4,490mm	7,900mm
2,000 mm	2,500mm	2,920mm	2,000mm	2,300mm
3,300mm	2,700mm	4,000mm	2,500mm	3,000mm
2,300mm	2,000 mm	3,400mm	2,000mm	2,500mm
2,700mm	2,400mm	2,860mm	1,900mm	2,700mm
4,700 kg (without cab)	5,500kg	Not provided	10,120kg	6,600kg
2,100 kg	1,700kg	Not provided	2,000kg	2,100kg
7,800 kg	7,200kg	14,400 kg	12,120 kg	8,700kg
Steel tracks (width: 385mm)	Tracks (2,300x400mm)	6 tyres Nokia MPT 14.00R - 20 or Michelin XS 14.00R - 20 with Hutchinson VFI safety device	Tracks (Caterpillar)	4 standard tyres Nokia TRS-LS 16 PR- steel or optional foam-filled
0.4 kg/cm ²	0.39 kg/cm ²	Not provided	0.5 kg/ cm ²	Not given
30°	30°	25°	32°	45° ^{a)}
48	66	84	48	60
860mm	600mm	Not provided	300mm	375mm
48mm (dynamically 10mm overlap)	35mm	Not provided	85mm	Not given
384rpm (free running) Up to 500mm (standing still), depending on the ground	350-400rpm Up to 150mm	Up to 400rpm Up to 370mm	600rpm Up to 300mm ^{a)}	Up to 900rpm ^{a)} Approximately 200mm
Up to 1km/h in light soil ^{a)}	Approx. 1.5km/h Approx. 1.0km/h Approx. 0.4-0.8km/h	Up to 3km/h Not provided Not provided Not provided	Approx. 1,800 m ² /h Approx. 1,000 m ² /h Approx. 500 m ² /h ^{a)}	0-2km/h
Automatic, free-floating flail or manual	Mechanic	Automatic and manual depth control	Mechanic	Automatic
8 Croatia, Iran, Jordan	1 Bosnia and Herzegovina	Approx. 50 Not given	1 Croatia	1 Croatia
Unknown 140 Minecat 2.5 tonne Mini-flail (125hp)	700,000m ² Not given	Not given Not provided 260	500,000m ² No	Approx. 1,500,000m ² Samson 200, Samson
Deutz 73hp	Diesel	Six-cyl. in-line 141kw Deutz BF 6L 913 C diesel with turbocharger, inter-cooled, direct injection	Perkins 107kw	Deutz 186kw (Samson 260), Perkins 136kw (Samson 200)
95l (one fuel tank for both engines)	120l	200l	200l	140l
9l/h Perkins 150hp	4-5l/h Yes	Not provided Hydraulically driven	14l/h No	10l/h —

COMPARATIVE ANALYSIS

	Aardvark MK IV	Armtrac 100	Hydrema MCV 910
27. Transition:	Not given	Stable axle pivot	Hydrostatic
28. Cooling system engine:	Water/air	Mechanical fan	Not given
29. Hydraulic oil capacity:	90l	70l	Not given

e. Comfort and security

30. Air conditioning:	Yes	Yes	Yes
31. 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, suspension seats	Air seat, 20 decibel cab noise	Not given
32. Armour:	Protection glass, minimum 10mm steel plates	Cab 10mm armour	Not given
33. Remote control:	Optional	No	No

f. Costs

34. Cost of machine	Negotiable upon application	£165,000	Not given
35. Training	Not given	£3,000 (in UK)	Not given
36. Other costs	Not given	On request	Not given
37. Transport limitation:	A flat bed or articulated truck is required for long distances. Air transportable by C 130, C 17	22.5° angle for the ramp ⁹	Max. 40km/h on own wheels
38. Availability for hire:	Yes	Yes	Not given

Flail systems

Minecat 230	Minemill MC 2002	Patria RA-140 DS	RM-KA 01	Samson 260
Hydraulic/Hydrostatic	Hydraulic	4x4 continuous all wheel drive	Hydrostatic drive	Hydrostatic drive
Deutz: oil cooled / Perkins: fluid cooled	Water	Air cooled	Water	Water cooling
Deutz 34l, Perkins 42l	435l	60l	400l	120l
Yes (optional) Not given	Yes (optional) Winch for self recovering, triple fire extinguisher system	Available Adjustable seat for driver 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	Available —
6.5-13mm ARMOX 500	12mm armoured steel, 45mm bulletproof windows	Protected glass and armoured steel for the cabin	20mm armoured steel	ARMOX (6mm)
Yes (GPS navigation optional) 1,000m in line sight	Yes (optional) 1,000m in line sight	No	Yes 300m in line sight	Yes 300m
Not given	€200,000	Not provided	€350,000	Samson 260: €288,000 Samson 200: €230,000
Not given	Not given	Not provided	Included	10 days training is included
Not given	€204,000	Not provided	Spares are included	The manufacturer offers a spare part kit sufficient for one year of field work for the following price: Samson 200: €45,000, Samson 260: €58,000
2 x 20ft ISO containers	Not given	Given by the technical specifications as weight, etc.	Easily transportable on a 14-tonne trailer	Truck
Yes	Yes	Not provided	Yes	Yes

a) According to the manufacturer.

b) QinetiQ International Test and Evaluation Programme, *Armtrac 100 Trial Report*, Farnborough, April 2002, p. 9.

c) *Ibid.*, p. 24.

d) *Ibid.*, pp. 29 and 74.

e) *Ibid.*, p. 22.

f) QinetiQ *Armtrac 100 Trial Report*, *op. cit.*, p. 73.

g) CROMAC test report (the system achieved during the tests in Germany 30 cm).

Minelifta

Corus Northern Engineering Services, United Kingdom



Minelifta attached to a Komatsu bulldozer

General description

The **Minelifta** flail unit is attached to a Komatsu D65EX bulldozer. The first trials were undertaken in February 2001. Recommendations were made to improve performance, which have now been incorporated into the design. A new hydraulic unit has been added and the flailing speed increased. Minelifta is an anti-personnel mine clearance system. It is not designed to clear anti-tank mines. Minelifta features a ventilated, hooded flail combined with a tined plough/scalping blade. The flail shaft is driven by a separate auxiliary hydraulic power pack mounted at the rear of the bulldozer prime mover.

A scalping blade lifts up to 20cm of soil. This is fed into the hooded, armour-plated bucket containing a flail designed to detonate or break up anti-personnel mines. At the rear of the bucket, a plough forces flailed soil underneath the dozer to create an obvious mound for manual inspection.

The armoured, bucket-shaped cowling prevents the flail throwing soil out of the cleared area. The operator's cab is fitted with bulletproof glass and 6mm of CP50 armour.

On completion of mine clearance, the system can be employed as a standard bulldozer.

Clearance methodology

The manufacturer uses Minelifta to sweep a mined area up to three times to ensure the best possible clearance performance.

Soil to a depth of 20cm is scooped into the cowling where it is 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. Overlapped areas and any doubtful spots are checked and if necessary manually inspected. The Minelifta cowling is designed to withstand the detonation of an anti-personnel mine without interruption to operation.

Minelifta can be operated in a variety of terrain and soil conditions: light/sandy, dry/compacted, heavy sand, wet mud/clay. It can work through scrub, elephant grass and small trees up to 75mm in diameter.¹ During the United Kingdom Government's Defence Evaluation and Research Agency (DERA) evaluations Minelifta performed easily on slopes up to 30° but was not tested on steeper ground.

Machines in use to date

- One system is in existence.

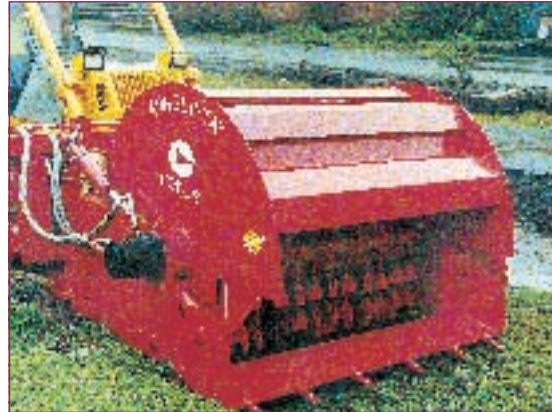
- Minelifta has not yet been deployed on an operational mine clearance programme. Corus hopes to use the system operationally in the near future.

Engine, fuel and oil

- Komatsu D65EX bulldozer with 406l diesel fuel capacity.
- The hydraulic auxiliary power unit is driven by an air-cooled 121kw diesel-powered Deutz engine. Tank capacity is 300l.
- Hydraulic reservoir capacity is 250l.
- The cooling system of the Komatsu contains 50l of coolant.
- The estimated average fuel consumption is 50l/h.

Factory support

- Minelifta will be supplied with a comprehensive recommended spares package negotiable with the purchaser.
- Corus Northern Engineering Services will provide full field support.



The Minelifta flail system

Maintenance and support

- Personnel experienced in basic mechanical skills will be able to deal with damage and wear and tear on the component parts.¹
- Full workshop manuals for the bulldozer and repair procedures for Minelifta will be provided.

Tests and evaluations

- Since December 2000, Minelifta has undergone trials by the development team from Corus Northern Engineering Services (without explosive ordnance).
- In December 2000, a report from Cranfield University concluded that the system has "merit".
- Cranfield University reviewed Minelifta operator cab protection in February 2002 and recommended materials/thicknesses, etc., which have been incorporated into the design.
- In February 2001, extensive evaluations were carried out by DERA (now QinetiQ). Recommendations were made for the further development of the system. These evaluations included mobility tests with live ordnance to simulate anti-personnel mines of up to 200g of TNT. Minor damage was reported. For further information contact Corus Northern Engineering Services.
- Rate of clearance during tests was approximately 2,300m²/h for one run in light terrain with light vegetation with 10cm flailing depth.

Reported limitations and strengths

Limitations

- Minelifta is for clearance of anti-personnel mines and small UXO – not anti-tank mines.
- System requires transportation by low-loader over longer distances.
- Manual depth control requires an experienced operator.
- The fines in front of the flail create difficulties on undulating ground.
- The shape of the hammers at the end of the chains prevents full ground coverage.

Strengths

- Mounted on a basic and widely-distributed bulldozer.
- Can be used as a bulldozer after completing mine clearance operations.

1. According to the manufacturer.

Scanjack 3500

Scandinavian Demining Group AB, Sweden



Scanjack operating in overgrown vegetation

General description

The **Scanjack 3500** is a heavy flail produced in Sweden by the Scandinavian Demining Group AB. It is based on a Finnish deforestation machine that has been on the market for a long time. 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 manufacturer in Sweden conducted further technical development in 2000-2001, achieving an average clearance rate of 722m²/h. 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 3,500mm.

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 manoeuvrability.

Clearance methodology

The Scanjack 3500 drives forward into a mined 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 than 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 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 a month. Chain types other than those produced by the manufacturer can be used.

Machines in use to date

- One machine in Croatia on trial from April 2000 to April 2001.
- One machine produced in summer 2001 incorporating changes from the earlier machine was tested by Swedish EOD and Demining Centre (SWEDEC) in September 2001 and later transported to Croatia.

Engine, fuel and oil

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

Factory support

- The standard equipment comprises tools, operator manual, spare parts 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 the end of the third month after delivery.
- A one-year warranty for manufacturing faults of the base machine and the flail engine is included but there is no warranty on the flail unit itself, except a 100 per cent guarantee that the unit works at the time of delivery.
- Service contracts ranging from one annual check-up to a full service are available.

Maintenance and support.

- A one-year full service support including non-consumable spares, on-site technical support once a month and technician call-out can be ordered.
- The machine must be refuelled every two and a half hours and must be cleaned of dust and dirt within the same interval.
- The manufacturer recommends daily preventive maintenance and cleaning as well as a service contract for monthly check-ups by the supplier.
- The recommended personnel is three drivers and two maintenance staff, including one mechanic per machine.
- Non-specialist, mechanical workshop tools and crane support on-site are required.



The double flail unit of the Scanjack

Tests and evaluations

- The first machine was tested and certified by CROMAC in Croatia, 1999.
- SWEDEC tested and slightly changed a second machine in September 2001. Among others, dynamic blast tests were carried out with one 5.5kg anti-tank metal-covered mine and one 10kg non-metallic anti-tank 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.

Reported limitations and strengths

Limitations

- Small fuel tank lasts only around two and a half working hours.¹
- Vegetation cutting is limited to trees with trunks of approximately 15cm in diameter.¹
- 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.

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.

1. According to the manufacturer.

Viking Mine Clearing System (VMCS)

Alvis Moelv AS, Norway

Heavy flail



The VIKING system with flail and power pack

General description

During the first quarter of 1999, Hägglunds Moelv AS (Norway) teamed up with Summa Technology Inc. (U.S.) and Quality Research Inc. (U.S.) 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 21-tonne, Austrian-built Liebherr 742 tractor. The flail is powered by an External Power Pack (EPP) mounted on 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.

Clearance operation

The Viking flail unit has 96 chains of 116cm length, each tipped with a hardened steel hammer. The prime mover drives forward into a mined area rotating the flail clockwise. The four-metre-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 break up anti-personnel and anti-tank mines.

Machines in use to date

- One prototype is undergoing tests in Huntsville, Alabama, U.S. The final tests will take place in Norway.
- The system was supposed to be available in late 2002.

Engine, fuel and oil

- Tractor external power pack uses diesel.
- The combined fuel tank capacity is 900l.
- Tractor engine gives 172kw/234hp. Fuel consumption is 17-25l/h under normal conditions.¹
- The Cummins engine for the EPP gives 525hp with fuel consumption of 60-70l/h during flailing.

Factory support

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

Maintenance and support

- No further information provided by the manufacturer.

Tests and evaluations

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



The flail unit chains and hammers

Reported limitations and strengths

Limitations

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

Strengths

- Compensates well for ground undulation.

1. According to the manufacturer.

Technical data sheet Minelifta

a. Dimensional data

1.	Length without attachment:	5,550mm
2.	Length total:	9,030 mm with all Minelifta parts
3.	Width without attachment:	2,900 mm with blade removed and no Minelifta parts fitted
4.	Width total:	3,340 mm with all Minelifta parts 3,970 mm with standard bulldozer blade (removeable)
5.	Clearance width:	2,740mm
6.	Height, overall:	3,580 mm
7.	Mass, basic vehicle:	15,530kg
8.	Mass, demining unit:	19,970kg
9.	Mass, total:	35,500kg

b. Driving specifications

10.	Wheels/ tracks:	Tracks (660mm width)
11.	Ground pressure, max weight:	0.82kg/cm ²
12.	Hill climbing ability:	OK up to 30° - not tested above 30°.

c. Clearance performance

13.	Number of chains:	72
14.	Gap between chains:	155mm (static centered)
15.	Rotation speed:	Up to 200rpm
16.	Clearance depth, max:	Up to 200mm
17.	Working speed: °)	
	• light soil/ small vegetation:	2,740m ² /h
	• medium soil/medium vegetation:	1,800m ² /h
	• heavy soil/ dense vegetation:	800m ² /h
18.	Control of clearance depth:	Manual from 0-20cm. Depth controlled by angle of bucket set by driver
19.	Machines in use:	Not yet; one machine available for field use from July 2002
20.	Location of use:	Not yet used; only tested in the U.K.
21.	Total area cleared so far:	None
22.	Other types:	None

d. System specifications

23.	Engine:	
24.	Fuel capacity:	406l 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 flail unit:	Yes. Flail unit driven by 200kw diesel engine. Future units to have 150kw diesel engine.
27.	Transition	Not given
28.	Cooling system engine:	50l Komatsu dozer/flail engine is air cooled
29.	Hydraulic oil capacity:	50l for Komatsu dozer/flail engine capacity to be confirmed

e. Comfort and security

30.	Air conditioning:	Yes
31.	Operator comfort:	Not given
32.	Armour:	6mm of CP 50 armour on driver's cab
33.	Remote controlled:	No

f. Costs

34.	Cost of machine:	To be negotiated
35.	Training:	Can be included
36.	Other costs:	Spares available as needed
37.	Transport limitation:	Needs low-loader for overland transport. Can be containerised for shipping.
38.	Availability for hire:	Yes

a) According to the manufacturer.

Technical data sheet Scanjack 3500

a. Dimensional data

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

b. Driving specifications

10.	Wheels/ tracks:	8 tyres 650/65-26.5 and 4 tracks 750mm 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 15cm; Second rotor: up to 30cm
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 clearance depth:	Manual by hydraulic pressure
19.	Machines in use:	Not given
20.	Location of use:	Not given
21.	Total area cleared so far:	Not given
22.	Other types:	Not given

d. System specifications

23.	Engine:	Cummins 6-cylinder diesel engine with 215hp
24.	Fuel capacity:	180l in one tank for both engines
25.	Fuel consumption total:	Max. 60-80l/h in operation
26.	Separate engine for flail unit:	Yes; Scania V8 diesel engine with 550hp
27.	Transition:	Hydrostatic - mechanical power
28.	Cooling system engine:	Water
29.	Hydraulic oil capacity:	360l for both machines

e. Comfort and security

30.	Air conditioning:	Yes
31.	Operator comfort:	Ergonomic chair and controls, radio
32.	Armour:	12 - 13 mm ArmoX 500S toughened plate for the cabin and 41mm protection glass windows.
33.	Remote control:	No

f. Costs

34.	Cost of machine:	US\$800,000
35.	Training	Included; during manufacturing and three months after delivery
36.	Other costs	
	• spare parts set:	US\$95,000
	• full servicecontract:	US\$6,000/month
	• cost of 1 trailer/truck + 1 truck with crane:	US\$895,000 + service and transportation
37.	Transport limitation:	3.0m wide and 4.2m high on low bed trailer
38.	Availability for hire:	Financial leasing pending credit approval and full demining service rental including crew and service

Technical data sheet Viking MSC

a. Dimensional data

1.	Length without attachment:	4,800mm
2.	Length total:	10,500mm
3.	Width without attachment:	3,400mm
4.	Width total:	5,000mm
5.	Clearance width:	4,000mm
6.	Height, overall:	4,000mm
7.	Mass, basic vehicle:	21,500 kg
8.	Mass, demining unit:	5,700kg
9.	Mass, total:	32,000kg

b. Driving specifications

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

c. Clearance performance

13.	Number of chains	96
	• length of chains	116mm
14.	Gap between chains:	42mm
15.	Rotation speed:	Up to 300rpm
16.	Clearance depth, max:	Up to 250mm
17.	Working speed ^{a)}	
	• light soil/ small vegetation:	2,800-8,400m ² /h (surface laid mines) ^{a)}
	• medium soil/medium vegetation:	—
	• heavy soil/ dense vegetation:	120-4,200m ² /h(buried mines)
18.	Control of clearance depth:	Hydraulic
19.	Machines in use:	1 prototype
20.	Location of use:	U. S. for tests
21.	Total area cleared so far:	1,000,000m ²
22.	Other types:	Flail system attached to Leopard 1 (Norwegian Armed Forces)

d. System specifications

23.	Engine:	Not given
24.	Fuel capacity:	450l
25.	Fuel consumption:	17-33l/h depending on ground conditions ^{a)}
26.	Separate engine for tilling unit:	Yes. Cummins diesel engine with 525hp
27.	Transition:	Not given
28.	Cooling system engine:	Not given
29.	Hydraulic oil capacity:	250l

e. Comfort and security

30.	Air conditioning:	Yes
31.	Operator comfort:	Not given
32.	Armour:	Not given
33.	Remote controlled:	Yes
	• greatest distance	3,000m in line sight

f. Costs

34.	Cost of system:	Not known yet
35.	Training:	Not known yet
36.	Other costs:	Not known yet
37.	Transport limitation:	Low loader and the flail unit needs to be disassembled before road transportation
38.	Availability for hire:	Not for the moment – will be available late 2002/early 2003

a) According to the manufacturer.

COMPARATIVE ANALYSIS

	Minelifta	Scanjack 3500	Viking MSC
a. Dimensional data			
1. Length without attachment:	5,550mm	11,000mm	4,800mm
2. Length total:	9,030 mm with all Minelifta parts	14,300mm	10,500mm
3. Width without attachment:	2,900 mm with blade removed and no Minelifta parts fitted	3,000mm	3,400mm
4. Width total:	3,340 mm with all Minelifta parts 3,970 mm with standard bulldozer blade (removeable)	4,450mm	5,000mm
5. Clearance width:	2,740mm	3,500mm	4,000mm
6. Height, overall:	3,580 mm	3,700mm	4,000mm
7. Mass, basic vehicle:	15,530kg	24,000kg	21,500 kg
8. Mass, demining unit:	19,970kg	8,000kg	5,700kg
9. Mass, total:	35,500kg	32,000kg	32,000kg

b. Driving specifications

10. Wheels/ tracks:	Tracks (660mm width)	8 tyres 650/65-26.5 and 4 tracks 750mm wide	Tracks
11. Ground pressure, max weight:	0.82kg/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:	OK up to 30° - not tested above 30°.	30% in operation and 35% while driving	27°

c. Clearance performance

13. Number of chains:	72	78 on each rotor	96
• length of chains:		First rotor: 697 mm; Second rotor: 793 mm	116mm
14. Gap between chains:	155mm (static centered)	Overlapping	42mm
15. Rotation speed:	Up to 200rpm	Up to 360 rpm	Up to 300rpm
16. Clearance depth, max:	Up to 200mm	First rotor: up to 15cm; Second rotor: up to 30cm	Up to 250mm
17. Working speed:			
• light soil/small vegetation:	2,740m ² /h ⁽²⁾	Approx. 2,700 m ² /h	2,800-8,400m ² /h (surface laid mines) ⁽²⁾
• medium soil/medium vegetation:	1,800m ² /h ⁽²⁾	Approx. 2,100m ² /h	—
• heavy soil/dense vegetation:	800m ² /h ⁽²⁾	Approx. 1,200 m ² /h	120-4,200m ² /h (buried mines)
18. Control of clearance depth:	Manual from 0-20cm. Depth controlled by angle of bucket set by driver	Manual by hydraulic pressure	Hydraulic
19. Machines in use:	Not yet; one machine available for field use from July 2002	Not given	1 prototype
20. Location of use:	Not yet used; only tested in the U.K.	Not given	U. S. for tests
21. Total area cleared so far:	None	Not given	1,000,000m ²
22. Other types:	None	Not given	Flail system attached to Leopard 1 (Norwegian Armed Forces)

d. System specifications

23. Engine:		Cummins 6-cylinder diesel engine with 215hp	Not given
24. Fuel capacity:	406l for Komatsu dozer/ fuel capacity flail engine pack to be confirmed.	180l in one tank for both engines	450l
25. Fuel consumption:	Depending on ground conditions. To be confirmed.	Max. 60-80l/h in operation	17-33l/h depending on ground conditions ⁽²⁾

Flail systems

	Minelifta	Scanjack 3500	Viking MSC
26. Separate engine for flail unit:	Yes. Flail unit driven by 200kw diesel engine. Future units to have 150kw diesel engine.	Yes; Scania V8 diesel engine with 550hp	Yes. Cummins diesel engine with 525hp
27. Transition	Not given	Hydrostatic - mechanical power	Not given
28. Cooling system engine:	50l Komatsu dozer/flail engine is air cooled	Water	Not given
29. Hydraulic oil capacity:	50l for Komatsu dozer/flail engine capacity to be confirmed	360l for both machines	250l

e. Comfort and security

30. Air conditioning:	Yes	Yes	Yes
31. Operator comfort:	Not given	Ergonomic chair and controls, radio	
32. Armour:	6mm of CP 50 armour on driver's cab	12 - 13mm Armox 500S toughened plate for teh cabin and 41mm protection glass windows.	Not given
33. Remote controlled: • greatest distance	No	No	Yes 3,000m in line sight

f. Costs

34. Cost of machine:	To be negotiated	US\$800,000	Not known yet
35. Training:	Can be included	Included; during manufacturing and three months after delivery	
36. Other costs:			Not known yet
• spare parts set:	Spares available as needed	US\$95,000	
• full servicecontract:		US\$6,000/month	
• cost of 1 trailer/truck + 1 truck with crane:		US\$895,000 + service and transportation	
37. Transport limitation:	Needs low-loader for overland transport. Can be containerised for shipping.	3.0m wide and 4.2m high on low bed trailer	Low-loader and the flail unit needs to be disassembled before road transportation
38. Availability for hire:	Yes	Financial leasing pending credit approval and full demining service rental including crew and service	Not for the moment - will be available late 2002/early 2003



Section 2

Tiller systems

FMR 2000

HADI Maschinenbau GmbH, Austria



FMR 2000

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 1,000m, 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 38 tonnes, driven by a 526hp Mercedes-Benz engine. The overdrive achieves 6.5km/h on paved roads. For transportation over longer distances, a low-loader or flatbed truck is used.

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 anti-personnel mines. The tiller rotates clockwise at 400-700rpm. If mines that are detonated by the tiller cause damage to chisels, they can be replaced. Particles of mines that have not been 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.

Machines in use to date

- One prototype was finished in early 2001. By mid-2001, the machine had begun clearance in Bosnia and Herzegovina.

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.

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.
- Operators are trained in Amstetten, Austria, to operate and maintain the system.
- Manuals and SOPs are available in German and English.

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.

Tests and evaluations

- Currently the only test involving a live anti-tank mine was conducted by the manufacturer. According to the manufacturer, this did not harm the machine.
- In mid-2001, a minefield in Bosnia and Herzegovina was cleared with assistance from the NGO HELP e.V. as part of evaluation and testing. Results have not yet been given.
- In July 2002, the machine was tested by the "Amt für Wehrtechnik" (Austrian Government organization) using dummy mines. Clearance performance of 99.5% was reported.¹



Reported limitations and strengths

Limitations

- Mainly for clearance of anti-personnel mines.
- Weight may cause transport problems in countries with poor road infrastructure.
- The operating temperature of the prototype is 35°C. After modifications of the cooling system it will be raised to 45°C.²

Strengths

- The machine can be used in rocky areas.
- High clearance performance up to 400mm ground penetration.
- Ability to cut vegetation up to 250mm in diameter.
- Good ground pressure distribution due to 700mm wide tracks. Operates well on wet ground.

1. Amt für Wehrtechnik, *Mineneräumer FMR 2000 HADI*, Vienna, August 2002. Report available at the GICHD ("missing mine was not found").

2. According to the manufacturer.

Mine-Guzzler

Bofors Defence AB, Sweden



Mine-Guzzler with Caterpillar engine

General description

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

The two test vehicles were built on the Leopard 1 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 tiller 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 detonation of mines and UXO. 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 tiller is undergoing repair. A complete tiller change can be effected in less than 30 minutes using the hydraulic supports to lift the tiller for access or to load/unload the roller onto a transport vehicle.

The 45-tonne 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 tiller unit. These can all be easily disassembled for transportation if required. This facilitates transport in countries with poor road infrastructure.

Clearance methodology

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

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

Machines in use to date

- One machine.
- Two prototypes were previously made on a Leopard 1 chassis.

Engine, fuel and oil

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

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.

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 tiller teeth are constructed from extremely tough tungsten carbide steel.



Tests and evaluations

- In May-June 2000, the Mine-Guzzler was tested in Croatia together with CROMAC. A minefield of 80,000m² was cleared. The machine also passed the CROMAC test.
- In October 2000, a comparative test with five different machines was carried out by the BWB (Bundesamt für 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 minefields in Hurghada and Safaga.
- In July 2001, the Swedish Army at their test facilities (SWEDEC) in Eksjö, Sweden, tested the Mine-Guzzler. The test results are not yet available.

Reported limitations and strengths

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.¹

Strengths

- The Mine-Guzzler is designed to destroy anti-personnel and anti-tank mines.
- Mine-Guzzler can easily cope with thick vegetation as well as individual trees up to 20cm in diameter.¹
- Good daily efficiency of the machine during clearing operations.¹

1. CROMAC test report.

Minebreaker 2000/2

FFG Flensburger Fahrzeugbau GmbH, Federal Republic of Germany



Minebreaker 2000/2 in operation

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 detonate or break up 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. Twenty millimetre steel armour and 70mm glass and blast-pressure-decreasing shock absorbers protect the crew compartment.

The chassis and tilling drum are powered hydraulically by a multi-pump transfer gear. Hydrostatic drive gives the Minebreaker a cruising speed of 4 km/hr and a working speed of up to 20m per minute.

The Minebreaker 2000/2 is controlled by two joysticks: one to steer the vehicle and the other to adjust the clearance depth. This allows for uncomplicated 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.

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.

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 tripwires are removed.

Machines in use to date

Currently there are three machines in use:

- One system was purchased by South Korea in September 2000 to demine the inner-Korean border.
- One system owned by FFG working in Bosnia and Herzegovina on behalf of the German Foreign Office, in cooperation with local entity forces and the German NGO Demira. With interruptions, this system has been in use since 1999.
- One system purchased by German Armed Forces and was deployed to Afghanistan in August

2002 to support ISAF operations.

Engine, fuel and oil

- Minebreaker 2000/2 runs on ordinary diesel fuel. Hydraulic fluid should be checked and if necessary changed every 2,000 running hours.
- Fuel consumption varies due to different applications from 60-100l per operating hour.

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, Croat and Mandarin.
- Warranty terms are negotiable, however the standard warranty covers six months or 500 running hours, whichever comes first.

Maintenance and support

- One-year service support, on-site technical support once a month and 24 hour 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 can be purchased separately.
- For long-term operations, a mobile workshop is recommended.



Tilling drum with tungsten teeth

Reported limitations and strengths

Limitations

- Large, heavy machine with difficult transportability.
- Difficult mobility in countries where road infrastructure is poor.

Strengths

- Powerful engine
- Tiller system will clear vegetation and tripwires as it clears mines.
- For use in anti-personnel and anti-tank minefields.



The Oracle system with the trailer-mounted power pack

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 anti-personnel 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 tonnes, making it difficult for use in swampy/wet terrain.¹

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°-angled tines, replaceable when damaged. The upturned soil and hopefully any mines within it, are pushed to the right 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.¹

Clearance methodology

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.¹ The action of the rotating tungsten steel teeth is intended to detonate or break up mines. Oracle is designed to clear both anti-personnel and anti-tank mines. The clearance width of the system is 322cm, achieving an average clearance capacity of 800m²/h¹ over temperate zone soil. During demining, the maximum speed of Oracle is 5km/h.²

Machines in use to date

- One machine is operating in Bosnia and Herzegovina.

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 1,136l.
- The fuel consumption during mine clearance operations in Croatia was approximately 200l per hour.
- The manufacturer does not provide other details.

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 48 hours.



Spitfire tiller unit with carbide metal cutting bits

Maintenance and support

- No information provided by the manufacturer.

Tests and evaluations

- In April-June 2000, Oracle was tested in Croatia by CROMAC. A minefield of 116,000m² was cleared.
- Representatives of Countermine Engineering AB did not permit testing of Oracle against the effects of the PROM-1 mine.
- Detonation of a TMM-1 caused minor damage, repairable within 30 minutes. A combined detonation of a TMA-3 and a TMA-4 caused the loss of small components, also repairable.
- Oracle successfully destroyed mines.

Reported limitations and strengths

Limitations

- Oracle is large and cumbersome, not ideal for manoeuvring in tight spaces.
- With its towed power pack, it is difficult to turn and reverse.¹
- Over longer distances, Oracle will require transportation by low-loader.
- During tests overheating of the engine was frequent. Air filters require improvement.¹
- The driver's cab ventilation system allows the ingress of dust.¹

Strengths

- The tiller unit appears well designed and withstands powerful blasts incurring minor damage.¹
- Oracle can easily cope with thick vegetation as well as individual trees up to 20cm.¹
- Powerful engine.¹

1. CROMAC test report.
2. According to the manufacturer.

Rhino

Rheinmetall Landsysteme GmbH, Federal Republic of Germany



The Rhino in operation

General description

The Rheinmetall Landsysteme **Rhino** is a 58-tonne, remote-controlled tiller system based on commercially-available components. 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. The system operates by remote control. Cameras are mounted at the front and rear, providing colour images to monitor screens with the remote operator. Rhino is designed to clear anti-personnel and anti-tank mines, including in areas with dense vegetation. A newly-developed flail unit can be attached to the prime mover for use against anti-tank mines.

The range of attachments for the prime mover includes a double tiller unit, a flail unit and a dozer blade.

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, lower drum rotates anti-clockwise in order to prevent compaction of soil and mines. The tiller drum works at around 120rpm, while the smaller, upper tiller drum works at 600rpm in the opposite direction. The lower drum cuts the soil and carries the excavated soil to the upper tiller where any object among the spoil larger than 5cm x 5cm is crushed. Mines are either detonated on contact with the lower drum or are broken up between the tillers.

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.

The anti-tank flail unit operates in a manner conventional to most flail systems. Mines will detonate or be broken up by the heavy chains. The manufacturer claims that the detonation of "normal" anti-tank mines will not damage the system.

Machines in use to date

- S/N 02 in use since August 1998 in Croatia by AKD Mungos, a Croatian demining company. By the end of 2000, some 53,000,000 m² had been cleared.
- S/N 03 in test/operation from August 1999 – May 2000 in Cambodia with CMAC/CARE.
- S/N 04 purchased by CECOM (U.S.) in 1999. In test/operation in 2000 with Jordanian Army. In 2001, the S/N04 was tested and operated by the Israeli Defence Forces.
- S/N 05 was delivered in October 2000 to the South Korean Army.

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 100l per hour, but this varies with working conditions.

Factory support

- A small spare parts package or a more comprehensive option is offered by the manufacturer. Consumable spares for approx. 800 operational hours are offered.
- Additional maintenance set (e.g. with sun cover, generator, welding equipment) is available. Many Rhino components are commercially available from other producers.
- Operator courses provided by manufacturer in Germany plus on-site technical assistance
- 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 800 hours or six months, whichever comes first. An extra warranty is negotiable for explosive damage.

Maintenance and support

- Manufacturer recommends simple daily, weekly and 250 hour (engine oil change) maintenance checks. Many of the subsystems do not require scheduled maintenance.
- Manufacturer advises that no distinction be made between operator and mechanic. Two teams of two men, each under a commander are recommended. A team should operate for 2 hours before being relieved, while maintenance is a combined effort.

Tests and evaluations

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



Tiller system of the Rhino

Reported limitations and strengths

Limitations

- Automatic depth control struggles in sodden soil.
- Road speed limited to 3.8km/h.
- Heavy weight. Requires careful planning of transport.
- Due to its weight it is difficult to operate in wet terrain.

Strengths

- Due to size and clearing capacity, it is best employed in suspect areas greater than 50,000-100,000m².
- 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 anti-tank mine detonated under the tracks.

Technical data sheet FMR 2000

a. Dimensional data

1.	Length without attachment:	Not given
2.	Length total:	7,800mm
3.	Width without attachment:	2,665mm (transportation width)
4.	Width total:	3,335mm
5.	Clearance width:	2,580mm
6.	Height, overall:	4,080mm (with antenna)
7.	Mass, basic vehicle:	32,000kg
8.	Mass, demining unit:	6,000kg
9.	Mass, total:	38,000kg

b. Driving specifications

10.	Wheels/ tracks:	Tracks with a width of 700mm
11.	Ground pressure, max weight:	0.75 kg/cm ²
12.	Hill climbing ability:	30°

c. Clearance performance

13.	Number of chisels:	Approx. 140
14.	Gap between drum and chisels:	15mm and 15/5mm
15.	Diameter of drum:	750mm
16.	Rotation speed:	400-700rpm
17.	Clearance depth, max:	Normal operation 0-400mm, max. 600mm ^{a)} depending on soil conditions.
18.	Working speed:	
	• light soil/ small vegetation:	180m/h = approx. 450m ² /h
	• medium soil/medium vegetation:	120m/h = approx. 300m ² /h
	• heavy soil/ dense vegetation:	90 m/h = approx. 225m ² /h
19.	Control of clearance depth:	Automatic
20.	Machines in use:	Yes
21.	Other types:	No
22.	Location of use:	Bosnia and Herzegovina
23.	Total area cleared so far:	100,000 m ²

d. System specifications

24.	Engine:	Mercedes-Benz OM 502 LA
25.	Fuel capacity:	900l
26.	Fuel consumption:	Not given
27.	Separate engine for tilling unit:	No
28.	Transition:	Not given
29.	Cooling system engine:	Water cooled
30.	Hydraulic oil capacity:	Not given

e. Comfort and security

31.	Air conditioning:	Not given
32.	Operator comfort:	TV monitor with cameras in front (movable) and rear.
33.	Armour:	Yes. No further information available.
34.	Remote control:	Yes
	• greatest distance	1,000m

f. Costs

35.	Cost of system:	On customer demand. 5-day training course is included in the price.
36.	Other costs:	Details on request
37.	Transport limitation:	Max. speed on tracks 6.5km/h. Normally on trailer .
38.	Availability for hire:	Yes

a) According to the manufacturer.

Technical data sheet Mine-Guzzler

a. Dimensional data

1.	Length without attachment:	7,560mm
2.	Length total:	8,460mm
3.	Width without attachment:	3,340mm
4.	Width total:	4,120mm
5.	Clearance width:	3,000mm
6.	Height, overall:	3,550 mm
7.	Mass, basic vehicle:	33,000kg
8.	Mass, demining unit:	15,000kg
9.	Mass, total:	48,000kg

b. Driving specifications

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

c. Clearance performance

13.	Number of chisels:	15 discs with 405 teeth
14.	Gap between drums/chisels dynamically:	25mm
15.	Diameter of drum:	1,250mm
16.	Rotation speed:	Up to 190rpm
17.	Clearance depth, max.:	Up to 500mm in light soil
18.	Working speed ^{a)}	
	• light soil/ small vegetation:	1,200m ² /h up to 4,000m ² /h
	• heavy soil/ dense vegetation:	1,000 m ² /h
19.	Control of clearance depth:	Automatic
20.	Machines in use:	1
21.	Other types:	2 prototypes, earlier made on Leopard 1 chassis
22.	Location of use:	Croatia and Egypt
23.	Total area cleared so far:	Approx. 800,000m ²

d. System specifications

24.	Engine:	Caterpillar 3412 E
25.	Fuel capacity:	800l
26.	Fuel consumption:	40-85l/h (depending on depth and soil) ^{b)}
27.	Separate engine for tilling unit:	No
28.	Transition:	Not given
29.	Cooling system engine:	170l (50/50 water and glycol)
30.	Hydraulic oil capacity:	200l for tracks and 70l for lift and tilt system

e. Comfort and security

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

f. Costs

35.	Cost of system:	Approx. US\$1,500,000
36.	Other costs:	Not given
37.	Transport limitation:	Max. speed on tracks 7km/h. Normally on trailer in one or two parts.
38.	Availability for hire:	Yes

a) CROMAC test report.

b) During the test series in Germany, 70 and 90l per hour (Wehrtechnische Dienststelle für Pionier- und Truppengerät, *Kurzbericht*, 15 January 2001).

Technical data sheet Minebreaker 2000/2

a. Dimensional data

1.	Length without attachment:	Not given
2.	Length total:	10,940mm
3.	Width without attachment:	3,250mm
4.	Width total:	4,510mm
5.	Clearance width:	3,690mm
6.	Height, overall:	3,310mm
7.	Mass, basic vehicle:	33,500kg
8.	Mass, demining unit:	13,500kg
9.	Mass, total:	47,000kg

b. Driving specifications

10.	Wheels/ tracks:	Tracks Diehl D 640 A
11.	Ground pressure, max weight:	960N/cm ²
12.	Hill climbing ability:	50% ^{a)}

c. Clearance performance

13.	Number of chisels:	66
14.	Gap between chisels:	60mm
15.	Diameter of drum:	Not given
16.	Rotation speed:	Up to 100rpm
17.	Clearance depth, max:	Up to 500mm
18.	Working speed ^{a)}	
	• light soil/ small vegetation:	Up to 4,000m ² /h
	• medium soil/medium vegetation:	Up to 2,400m ² /h
	• heavy soil/ dense vegetation:	Up to 1,000m ² /h
19.	Control of clearance depth:	Mechanic
20.	Machines in use:	3
21.	Other types:	Minebreaker 2000
22.	Location of use:	Afghanistan, Bosnia and Herzegovina, Republic of Korea.
23.	Total area cleared so far:	Approximately 1,500,000m ²

d. System specifications

24.	Engine:	MTU MB 838 with 10 cylinders and 830hp
25.	Fuel capacity:	940l
26.	Fuel consumption:	Max. 100l/h
27.	Separate engine for tilling unit:	No
28.	Transition:	Hydrostatic
29.	Cooling system engine:	Water
30.	Hydraulic oil capacity:	650l

e. Comfort and security

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

f. Costs

35.	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
36.	Other costs	On customer request
37.	Transport limitation:	By road or deployed with commercially-available trailers caterpillar-track vehicles.
38.	Availability for hire:	Yes

a) According to the manufacturer.

Technical data sheet Oracle

a. Dimensional data

1.	Length without attachment:	4,947mm
2.	Length total:	13,800mm
3.	Width without attachment:	2,580mm
4.	Width total:	4,500 mm
5.	Clearance width:	3,220mm
6.	Height, overall:	3,640mm
7.	Mass, basic vehicle (including HPU):	46,400kg
8.	Mass, demining unit:	6,790kg
9.	Mass, total:	53,000kg

b. Driving specifications

10.	Wheels/ tracks:	Tracks
11.	Ground pressure, max weight:	0.89 kg/cm ² (basic vehicle)
12.	Hill climbing ability:	50% ^{a)}

c. Clearance performance

13.	Number of chisels:	126, 168, or 252 depending on tool configuration
14.	Gap between drums/ chisels:	25-75mm depending on tool configuration
	Dynamically:	Not given
15.	Diameter of drum:	1,200mm
16.	Rotation speed:	120-240rpm
17.	Clearance depth, max:	200, 300 or 450mm ^{a)}
18.	Working speed: ^{a)}	Approx. 800 m ² /h
19.	Control of clearance depth:	Automatic
20.	Machines in use:	1
21.	Other types:	Not given
22.	Location of use:	Bosnia and Herzegovina, Croatia
23.	Total area cleared so far:	Not given

d. System specifications

24.	Engine:	Caterpillar 3306, 210kw
25.	Fuel capacity:	1,136l
26.	Fuel consumption:	200l approx. per hour ^{a)}
27.	Separate engine for tilling unit:	Yes (Caterpillar 3412E, 738 kw)
28.	Transition:	Not given
29.	Cooling system engine:	Not given
30.	Hydraulic oil capacity:	Not given

e. Comfort and security

31.	Air conditioning:	Optional
32.	Operator comfort:	Not given
33.	Armour:	Not given
34.	Remote control:	Optional
	• greatest distance	Not given

f. Costs

35.	Cost of system:	Not given
36.	Other costs:	Not given
37.	Transport limitation:	Max. speed on tracks 10 km/h
38.	Availability for hire:	Not given

a) According to the manufacturer.

Technical data sheet Rhino

a. Dimensional data

1.	Length without attachment:	7,800mm
2.	Length total:	9,600mm
3.	Width without attachment:	3,000mm
	Flail unit incl. level feeler:	4,400mm
4.	Width total:	4,200mm
5.	Clearance width:	3,500mm
6.	Height, overall:	3,200mm
7.	Mass, basic vehicle:	46,000kg
8.	Mass, dozer blade:	2,000kg
9.	Mass, demining unit (tiller):	14,000kg
	• flail unit	6,000-8,000kg

b. Driving specifications

10.	Wheels/ tracks:	2 commercial tracks each 700mm wide
11.	Ground pressure, max weight:	10 N/cm ²
12.	Hill climbing ability:	24°

c. Clearance performance

13.	Number of chisels/ flail elements	
	• lower drum:	360
	• upper drum:	174
	• flail unit:	16-18 elements
14.	Gap between drum and chisels:	Not given
15.	Diameter of drum:	Not given
16.	Rotation speed	
	• lower drum:	up to 120rpm
	• upper drum:	up to 600rpm
	• flail unit:	300-400rpm
17.	Clearance depth, max:	Up to 500mm in light soil ^{a)}
	• flail unit:	12 max 250mm
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 clearance depth:	Automatic by mechanical sensors/electronic controller with manual override possibility, or manually
20.	Machines in use:	3
21.	Other types:	No
22.	Location of use:	Cambodia, Croatia, Israel, Jordan, Republic of Korea
23.	Total area cleared so far:	Not given

d. System specifications

24.	Engine:	Caterpillar 3412 with 660kw
25.	Fuel capacity:	1,700l
26.	Fuel consumption:	Approx. 100l/h
27.	Separate engine for tilling unit:	No
28.	Transition:	Not given
29.	Cooling system engine:	Water/air
30.	Hydraulic oil capacity:	Approx. 1,000l

e. Comfort and security

31.	Air conditioning:	
32.	Operator comfort:	Remote control desk could be used in a tent or installed in a 10 foot container/ truck with a/c and heating devices
33.	Armour:	Protection glasses, minimum 10mm steel plates
34.	Remote control:	Bi-directional link with watch dog, vehicles data indicated on remote control box, max distance: 1,000 m
35.	Cost of system:	Approx. €1.9M
36.	Other costs:	Not given
37.	Transport limitation:	Not given
38.	Availability for hire:	Not currently.

a) During the testing in Germany 30cm were required, Rhino achieved between 18 and 43cm.

COMPARATIVE ANALYSIS

FMR 2000

Mine-Guzzler

a. Dimensional data

1. Length without attachment:	Not given	7,560mm
2. Length total:	7,800mm	8,460mm
3. Width without attachment:	2,665mm (transportation width)	3,340mm
• flail unit incl. level feeler:		
4. Width total:	3,335mm	4,120mm
5. Clearance width:	2,580mm	3,000mm
6. Height, overall:	4,080mm (with antenna)	3,550 mm
7. Mass, basic vehicle:	32,000kg	33,000kg
8. Mass, demining unit:	6,000kg	15,000kg
9. Mass, total:	38,000kg	48,000kg
• flail unit		

b. Driving specifications

10. Wheels/ tracks:	Tracks with a width of 700mm	Tracks
11. Ground pressure, max weight:	0.75 kg/cm ²	0.98 kg/cm ²
12. Hill climbing ability:	30°	More than 30° (depends on grip for the tracks)

c. Clearance performance

13. Number of chisels:	Approx. 140	15 discs with 405 teeth
• lower drum:		
• upper drum:		
• flail unit:		
14. Gap between drum and chisels:	15mm and 15/5mm	25mm
15. Diameter of drum:	750mm	1,250mm
16. Rotation speed:	400-700rpm	Up to 190rpm
17. Clearance depth, max:	Normal operation 0-400mm, max. 600mm ^{o)} depending on soil conditions.	Up to 500mm in light soil
18. Working speed:		
• light soil/ small vegetation:	180m/h = approx. 450m ² /h	1,200m ² /h up to 4,000m ² /h ^{b)}
• medium soil/medium vegetation:	120m/h = approx. 300m ² /h	—
• heavy soil/ dense vegetation:	90 m/h = approx. 225m ² /h	1,000 m ² /h ^{b)}
19. Control of clearance depth:	Automatic	Automatic
20. Machines in use:	Yes	1
21. Other types:	No	2 prototypes, earlier made on Leopard 1 chassis
22. Location of use:	Bosnia and Herzegovina	Croatia and Egypt
23. Total area cleared so far:	100,000 m ²	Approx. 800,000m ²

d. System specifications

24. Engine:	Mercedes-Benz OM 502 LA	Caterpillar 3412 E
25. Fuel capacity:	900l	800l
26. Fuel consumption:	Not given	40-85l/h (depending on depth and soil) ^{c)}
27. Separate engine for tilling unit:	No	No

Tiller systems

Minebreaker 2000/2	Oracle	Rhino
Not given	4,947mm	7,800mm
10,940mm	13,800mm	9,600mm
3,250mm	2,580mm	3,000mm
		4,400mm
4,510mm	4,500 mm	4,200mm
3,690mm	3,220mm	3,500mm
3,310mm	3,640mm	3,200mm
33,500kg	46,400kg	46,000kg
13,500kg	6,790kg	2,000kg
47,000kg	53,000kg	14,000kg
		6,000-8,000kg
Tracks Diehl D 640 A	Tracks	2 commercial tracks each
		700mm wide
960N/cm ²	0.89 kg/cm ² (basic vehicle)	10 N/cm ²
50% ^{o)}	50% ^{o)}	24°
66	126, 168, or 252 depending on tool configuration	360
		174
		16-18 elements
60mm	25-75mm depending on tool configuration	Not given
		• lower drum: up to 120rpm
		• upper drum: up to 600rpm
		• flail unit: 300-400rpm
Not given	1,200mm	Not given
Up to 100rpm	120-240rpm	
Up to 500mm	200, 300 or 450mm ^{o)}	Up to 500mm in light soil ^{o)}
		• flail unit: 12 max 250mm
Up to 4,000m ² /h	Approx. 800 m ² /h	2,000 m ² /h
Up to 2,400m ² /h		1,000 m ² /h
Up to 1,000m ² /h		600 m ² /h
Mechanic	Automatic	Automatic by mechanical sensors/electronic controller with manual override possibility, or manually
3	1	3
Minebreaker 2000	Not given	No
Afghanistan, Bosnia and Herzegovina, Republic of Korea.	Bosnia and Herzegovina, Croatia	Cambodia, Croatia, Israel, Jordan, Republic of Korea
Approximately 1,500,000m ²	Not given	Not given
MTU MB 838 with 10 cylinders and 830hp	Caterpillar 3306, 210kw	Caterpillar 3412 with 660kw
940l	1,136l	1,700l
Max. 100l/h	200l approx. per hour ^{o)}	Approx. 100l/h
No	Yes (Caterpillar 3412E, 738 kw)	No

COMPARATIVE ANALYSIS

	FMR 2000	Mine-Guzzler
28. Transition:	Not given	Not given
29. Cooling system engine:	Water cooled	170l (50/50 water and glycol)
30. Hydraulic oil capacity:	Not given	200l for tracks and 70l for lift and tilt system

e. Comfort and security

31. Air conditioning:	Not given	Yes; AC and heater with air inlet filter.
32. Operator comfort:	TV monitor with cameras in front (movable) and rear.	Suspension in chair, four-point safety belt, automatic speed control, low noise, TV monitor with cameras in front (movable) and rear, overpressure valve, emergency hatch.
33. Armour:	Yes. No further information available.	16mm armour and 46mm protection glass
34. Remote control: • greatest distance	Yes 1,000m	Yes 800m

f. Costs

35. Cost of system:	On customer demand. 5-day training course is included in the price.	Approx. US\$1,500,000
• machine:		
• training:		
• spare parts:		
36. Other costs:	Details on request	Not given
37. Transport limitation:	Max. speed on tracks 6.5km/h. Normally on trailer	Max. speed on tracks 7km/h. Normally on trailer in one or two parts.
38. Availability for hire:	Yes	Yes

Tiller systems

Minebreaker 2000/2	Oracle	Rhino
Hydrostatic	Not given	Not given
Water	Not given	Water/air
650l	Not given	Approx. 1,000l
Optional	Optional	—
A high degree of comfort for the operator is achieved by using standard components (seat instruments, etc.) from industry	Not given	Remote control desk could be used in a tent or installed in a 10 foot container/ truck with a/c and heating devices
Original Leopard 1 chassis; cabin with 20mm armoured steel and 70mm protection glass	Not given	Protection glasses, minimum 10mm steel plates
Optional 1,000m	Optional Not given	Bi-directional link with watch dog, vehicles data indicated on remote control box, max distance: 1,000 m
For clearing operations €0.5 per m ² . This includes one operator, fuel, spare parts, etc. but no transportation	Not given	Approx. €1.9M
On request		
Usually included in the system price		
Depending		
On customer request	Not given	Not given
By road or deployed with commercially-available trailers	Maximum speed on tracks 10km/h	Not given
caterpillar-track vehicles.		
Yes	Not given	Not currently

a) According to the manufacturer.

b) CROMAC test report

c) During the test series in Germany, 70 and 90l per hour (Wehrtechnische Dienststelle für Pionier- und Truppengerät, *Kurzbericht*, 15 January 2001).

d) During the testing in Germany 30cm were required, Rhino achieved between 18 and 43cm.



Section 3

Combined systems

MineWolf

STS Safety Technology Systems, Federal Republic of Germany



General description

MineWolf is a joint German-Swiss mine clearance concept, which aims to overcome the limitations of tillers (weight, size, cost and mobility) while enjoying the advantages of flail systems (ground penetration depth, vegetation cutting) by combining both systems in one machine. A standard commercial tractor on tracks is used as the prime mover. It has a 300kw Deutz diesel engine, with pendulum track.

Power transmission is provided mechanically by a heavy-duty, power take-off shaft via a turbo clutch to provide protection for the driveline.

The use of quick coupling facilitates rapid replacement of the demining tool attachments within 15 minutes. The MineWolf can be operated by locally-trained staff.

The open-basket tiller design allows expansion of mine blast through the tiller to avoid or reduce damage.

The MineWolf is a medium-size, multi-purpose, toolbox demining machine. With standard commercial attachments, it can also be used for construction, agriculture and forestry. The system is designed for container transport by road, rail, ship or air. A standard low-loader can be used for transporting between worksites.

Clearance methodology

Clearance of mixed anti-personnel/anti-tank mine fields is divided into two phases: first the flail system detonates or breaks up anti-personnel and anti-tank mines, then with a ground penetration depth of some 30cm, the tiller system breaks up partially exploded or remaining mines and explosive components not completely destroyed by the flail.

The flail attachment is produced by Armtrac Ltd., and is almost the same as that attached to the Armtrac 100. The tiller attachment is not intended for use against anti-tank mines. Of a much lighter design than most tillers, this attachment is the preferred system when operating in pure anti-personnel minefields. The flail is used for initial clearance phase against anti-personnel/anti-tank minefields, or for pure anti-tank minefields.

Machines in use to date

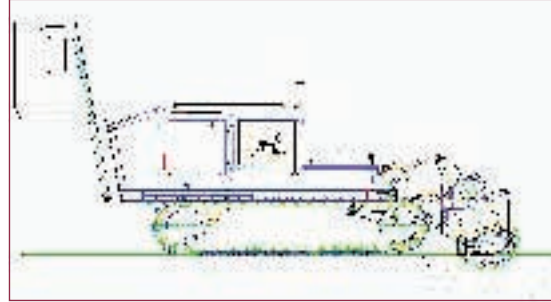
- One prototype, which has completed tests with inert and live mines.
- One pre-production machine manufactured by November 2002 was expected to deploy on live operations in early 2003.

Engine, fuel and oil

- The machine is equipped with a 300kw Deutz BF6M 1015CP diesel engine.
- Fuel consumption is 35-45l per hour.
- Hydraulic system requires standard oil.

Factory support

- Operator training is conducted by the manufacturer: four to five weeks in Germany and one to two weeks at the programme location. Training will be part of the purchase package.
- Instruction manuals and documentation will be available in German and English or, if required, the customer's language.
- A spare parts kit is included in the purchase package.



Maintenance and support

- There are regular maintenance periods comprising daily, weekly and monthly checks as laid down in the operator's manual.
- The MineWolf can be operated, serviced and maintained by local staff.
- The MineWolf is designed for container transport by air, road and sea.
- Air transport with Transall or Hercules is possible.
- A standard low-loader can be used for road transport.

Tests and evaluations

- A prototype was tested by the German army at test fields in Koblenz and Meppen in June 2001. The aim of the test was to measure clearance performance against 95 inert anti-personnel and anti-tank test mines buried up to 30cm deep in various soil conditions. The German Army report concludes: "All mines and mine parts were destroyed by the MineWolf rendering the field safe."
- Testing by RUAG Land Systems (see below) of the tiller system and protection of cabin and vehicle, with live mines containing up to 7.5kg of TNT. According to the manufacturer, the tests showed that the tiller system and the mechanical power drive are robust and that the driver is safe under all conditions.
- Testing by International Test & Evaluations Program (ITEP) of the flail system with live mines up to 7.5kg of TNT. ITEP reports that: "The most significant conclusion is that the flail unit is well designed for the venting of large explosive blasts."¹

Reported limitations and strengths

Limitations

- An automatic depth control system is being developed (prototype stage).
- Clearance operations using both attachments consecutively require around twice as much time as individual tiller or flail systems.
- The flail unit left ridges of untouched soil.²
- Chains and hammers of the flail system require frequent replacement.

Strengths

- Thus far, the concept has proved effective during inert mine tests to 30cm ground penetration depth.²
- Combines flail and tiller systems.
- The machine is comparatively lightweight.
- Suited to various, non-demining roles.

1. ITEP Trial Report, 18 April 2002.

2. Bundesamt für Wehrtechnik und Beschaffung, *Kurzbericht*, July 2001, p. 18.

Redbus LMDS

Redbus LMDS Ltd., United Kingdom



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

General description

The **Redbus Land Mine Disposal System** (LMDS) comprises two machines, **Bigfoot** and **Mineworm**, and a remote control centre. The Bigfoot is a remote-controlled vehicle with armoured feet attached to a series of hydraulically-operated pistons. The feet apply pressure to the ground in a sequence to detonate landmines.

Mineworm follows behind Bigfoot and excavates the soil to a chosen depth, removing UXO for destruction in its fragmentation bin or for destruction by EOD personnel. Like Bigfoot, Mineworm is remote-controlled, with cameras to monitor progress and inspect the excavated material.

Clearance methodology

The pressure applied by the feet of Bigfoot is controlled to ensure that the soil is not compacted (to allow for future crop planting), and functioning mines are detonated rather than broken up.

A soil breaker and root cropper is attached in front of Mineworm. This prepares the ground for the rotating excavator, which lifts the soil and passes it through the Mineworm. A magnetic ferrous metal sorter removes objects for inspection. All other material is passed through a fragmenter, where any remaining detonators or explosives should be rendered harmless.

Machines in use to date

- One system is operating in Bosnia and Herzegovina.

Engine, fuel and oil

- The engines of the system require normal diesel fuel.
- Hydraulic fluids are of a type in common use and are therefore readily available.
- Average consumption is 20l per hour for Bigfoot and 40l per hour for Mineworm.

Factory support

- An initial comprehensive spares pack is provided with the equipment. A spares, training and equipment support package is included.

Maintenance and support

- Redbus claims that it is practical for the LMDS to transport itself for up to 30km.
- The system has been designed using basic technology. This enhances reliability and ensures that it can be both operated and repaired by people with simple mechanical skills.
- Electronic systems include self-diagnoses contained in a replaceable box supplied by Redbus.
- The Redbus LMDS has been designed to ensure that it can be logistically supportable.

Test and evaluations



The Redbus Bigfoot

- The Redbus LMDS 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 and Herzegovina between August 2001 and November 2002.

Reported limitations and strengths

Limitations

- Bigfoot cannot deal with non-functioning mines.
- Self-transport up to 30km impractical due to slow road speed.
- Not suitable for areas having large rocks.

Strengths

- Survivability successfully tested on some types of anti-tank mine.
- Remote control system guarantees operator safety.
- System employs variety of clearance techniques.
- Ability to operate close to walls and obstacles.

Technical data sheet MineWolf

a. Dimensional data

1.	Length without attachment:	4,910mm
2.	Length total:	7,260mm (with flail), 6,150mm (with tiller)
3.	Width without attachment:	2,500mm
4.	Width:	3,65 mm (with flail), 2,89 mm (with tiller)
5.	Height:	4,700mm in operating configuration, 3,100mm in transport configuration
6.	Mass basic vehicle:	20,500kg
7.	Mass with attachments:	24,500kg (flail), 24,750 kg (tiller)

b. Driving specifications

8.	Wheels/ tracks:	Tracks
9.	Ground pressure, max weight:	0,54kg/cm ²
10.	Hill climbing ability:	40°

c. Clearance performance

11.	Number of chains/chisels:	73/80
12.	Gap between chains/chisels:	73/40
13.	Clearing width flail/tiller:	2,800/2,590mm
14.	Clearing depth tiller:	300-400mm
15.	Length of chains:	965mm
16.	Rotation speed flail/tiller:	Up to 400rpm/270-330rpm
17.	Working speed:	1-2km/h
18.	Clearing performance:	4,000m ²
19.	Vegetation cutting ability:	Up to 150mm diameter
20.	Machines in use:	1 prototype

d. System specifications

21.	Engine:	Deutz BF8M diesel engine with 400hp
22.	Fuel capacity:	760l
23.	Fuel consumption:	Max.42 l/h ^{a)}

e. Comfort and security

24.	Air conditioning:	Yes
25.	Operator comfort:	GPS
26.	Armour:	Yes (no further details provided by the manufacturer)
27.	Remote control:	Not given

f. Costs

28.	Cost of system:	Approx. €500 000, depending on the required equipment
29.	Transport limitation:	For long distances transportation on a low-bed trailer is required
30.	Availability for hire:	Not given

a) According to the manufacturer.

Technical data sheet Redbus Bigfoot

a. Dimensional data

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

b. Driving specifications

9.	Wheels/ tracks:	Tracks
10.	Ground pressure, max weight:	0,4 kg/cm ²
11.	Hill climbing ability:	45° ^{a)}

c. Clearance performance

12.	Number of feet:	10 (standard model)
13.	Size of feet:	270mm long x 200mm wide
14.	Max. pressure:	750kg per foot
15.	Min. pressure:	—
16.	Working speed:	300-1,000m ² /h (no further detailed data given) ^{a)}
17.	Control of clearing depth:	Automatic
18.	Machines in use:	1 prototype
19.	Other types:	No
20.	Location of use	Bosnia and Herzegovina
21.	Total area cleared so far:	Not given

d. System specifications

22.	Engine:	250hp
23.	Fuel capacity:	1,000l
24.	Fuel consumption:	20l/h
25.	Separate engine for the feet:	No
26.	Cooling system engine:	Water
27.	Oil capacity	Not given
28.	Hydraulic oil capacity:	800l

e. Comfort and security

29.	Operator comfort:	Two-colour TV monitor with four colour cameras in front (movable) and rear
30.	Armour:	Foot ram assembly/front and sides
31.	Remote control:	Yes
	• greatest distance	5,000m

f. Costs

32.	Cost of system:	Not given
33.	Other costs:	Not given
34.	Transport limitation:	Max. speed on tracks 6,5km/h. Normally on trailer
35.	Availability for hire:	Yes

a) According to the manufacturer.

Technical data sheet Redbus Mineworm

a. Dimensional data

1.	Length without attachment:	Not given
2.	Length total:	10,000mm
1.	Width total:	2,700mm
2.	Clearing width:	Not given
3.	Height, minimum:	Not given
4.	Height, overall:	3,400mm
5.	Mass, total:	15,000kg

b. Driving specifications

6.	Wheels/ tracks:	Tracks
7.	Hill climbing ability:	30° ^{a)}

c. Clearance performance

8.	Gap between drums/chiselsdynamically:	60mm
9.	Diameter of drum	750mm
10.	Rotation speed	80-700rpm
11.	Clearance depth, max.:	Up to 550mm ^{a)}
12.	Working speed	750m ² /h ^{a)} (no further detailed data given)
13.	Control of clearing depth:	Automatic
14.	Machines in use:	1 prototype
15.	Other types:	No
16.	Location of use:	Bosnia and Herzegovina
17.	Total area cleared so far:	Not given

d. System specifications

18.	Engine:	300hp
19.	Fuel capacity:	1,000l
20.	Fuel consumption:	40l/hr
21.	Separate engine for tilling unit:	No
22.	Transition:	Not given
23.	Cooling system engine:	Water/glycol
24.	Oil capacity:	Not given
25.	Hydraulic oil capacity:	900l

e. Comfort and security

26.	Operator comfort:	TV monitor with cameras in front (movable) and rear
27.	Armour:	Cutter/diggers assembly protected
28.	Remote control:	Yes
	• greatest distance	5,000m

f. Costs

29.	Cost of system:	Not given
30.	Other costs:	Not given
31.	Transport limitation:	Max. speed on tracks 6.5km/h. Normally on trailer.
32.	Availability for hire:	Yes

a) According to the manufacturer.

COMPARATIVE ANALYSIS

	MineWolf	Redbus Bigfoot	Redbus Mineworm
a. Dimensional data			
1. Length without attachment:	4,910mm	Not given	Not given
2. Length total:	7,260mm (with flail), 6,150mm (with tiller)	6,700mm	10,000mm
3. Width without attachment:	2,500mm		
4. Width, total:	3,65 mm (with flail), 2,89 mm (with tiller)	2,800mm	2,700mm
5. Clearing width:		2,000mm	Not given
6. Height, minimum:	4,700mm in operating configuration, 3,100mm in transport configuration	Not given	Not given
7. Height, overall:		2,500mm	3,400mm
8. Mass basic vehicle:	20,500kg	Not given	
9. Mass with attachments:	24,500kg (flail), 24,750 kg (tiller)	Total: 10,000kg	Total: 15,000kg
b. Driving specifications			
10. Wheels/ tracks:	Tracks	Tracks.	Tracks
11. Ground pressure, max weight:	0.54kg/cm ²	0.4 kg/cm ²	—
12. Hill climbing ability:	40°	45° ^{o)}	30° ^{o)}
c. Clearance performance			
13. Number of chains/chisels:	73/80		
Number of feet:		10 (standard model)	
14. Gap between chains/chisels:	73/40		Dynamically: 60mm
15. Diametre of drum:			750mm
16. Size of feet:		270mm long x 200mm wide 750kg per foot	
17. Max. pressure:			
18. Clearing width	flail/tiller: 2,800/2,590mm		
19. Clearing depth	tiller: 300-400mm		Up to 550mm ^{o)}
20. Length of chains:	965mm		
21. Rotation speed flail/tiller:	Up to 400rpm/ 270-330rpm		80-700mm
22. Working speed:	1-2km/h	300-1,000m ² /h detailed data given) ^{o)}	750m ² /h (no further detailed data given) ^{o)}
23. Clearing performance:	4,000m ²		
Control of clearing depth:		Automatic	Automatic
24. Vegetation cutting ability:	Up to 150mm diameter		
25. Machines in use:	1 prototype	1 prototype	
26. Other types:	No		
27. Location of use:	Bosnia and Herzegovina		Bosnia and Herzegovina
d. System specifications			
28. Engine:	Deutz BF8M diesel engine with 400hp	250hp	300hp
29. Fuel capacity:	760l	1,000l	1,000l
30. Fuel consumption:	Max.42 l/h ^{o)}	20l/h	40l/h
31. Separate engine		for the feet: No	for tilling unit: No
32. Transition:			Not given
33. Cooling system engine:		Water	Water/glycol
34. Oil capacity:		Not given	Not given
35. Hydraulic oil capacity:		800l	900l

	MineWolf	Redbus Bigfoot	Redbus Mineworm
e. Comfort and security			
36. Air conditioning:	Yes		
37. Operator comfort:	GPS	Two-colour TV monitor with four colour cameras in front (movable) and rear	TV monitor with cameras in front (movable) and rear
38. Armour:	Yes (no further details provided by the manufacturer)	Foot ram assembly/ front and sides	Cutter/diggers assembly protected
39. Remote control: • greatest distance	Not given	Yes 5,000m	Yes 5,000m
f. Costs			
28. Cost of system:	Approx. €500 000, depending on the required equipment	Not given	
40. Other costs		Not given	Not given
29. Transport limitation:	For long distances transportation on a low-bed trailer is required	Max. speed on tracks 6.5km/h. Normally on trailer	Max. speed on tracks 6.5km/h. Normally on trailer
30. Availability for hire:	Not given	Yes	Yes

a) According to the manufacturer.



Section 4

Multi-tool systems

Armtrac 325

Armtrac Ltd., United Kingdom



Armtrac 325 with available attachments

General description

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

The Armtrac 325 prime mover provides the platform to which the optional attachments can be fitted with a 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.

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/h, detonating or fragmenting mines.

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 Herzegovina and one in Lebanon.

Engine, fuel and oil

- The Armtrac 325 is equipped with a 325hp Volvo diesel engine.
- The average fuel consumption is 50l/h¹ while the flail is in operation.

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.

Maintenance and support

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

Tests and evaluations

- No information available.



Armtrac 325 with strimmer

Reported limitations and strengths

Limitations

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

Strengths

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

1. According to the manufacturer.

DEMCO System

DEMCO (PTY) Ltd., South Africa



DEMCO detonating disk system

General description

DEMCO System consists of a commercial Komatsu excavator fitted with an armoured cab to protect the operator. Other wheeled and tracked excavators, loaders and bulldozers can be used as prime movers for DEMCO mine clearance attachments. Various demining tools can be attached to the extending boom to conduct ground penetration and clearance tasks. The available attachments are:

- single array of serrated disk rollers;
- double array of disc rollers used in a push pull mode; and
- flail system.

The machine is effective on rugged terrain. Simplicity of design of the attachments allows for fast interchange to suit terrain conditions.

Standard construction engineering attachments can also be fitted, giving added task flexibility. This allows for infrastructure improvement tasks on-site unrelated to mine clearance operations. The attachments are well suited to clearance of difficult ground such as ditches and banks. Attachments are available for a wide range of DEMCO machines.

Additional attachments such as filter bucket system, ripper/rake, bush cropper and magnetic debris removal system are available.

Clearance methodology

Single array of disk rollers

The single array consists of serrated discs fitted with two connecting arms each to a central shaft. This allows for individual movement up and down for each disc to conform to uneven ground and to retain contact of the disc edge with the ground between undulations. The central shaft is coupled to a frame attached to the end of the boom of the machine.

The space between the discs is approximately 50mm. This distance is smaller than the average diameter of anti-personnel mines generally encountered.

Wet clay and mud will clog up the serrated edges of the discs as well as the space between the rollers.¹

Double array of disk rollers

The double array of disk rollers consists of two single arrays similar to the single array configuration. It contains 31 disks each attached to its own shaft by connecting arms. Disk size is similar to the disks used in the single array. The discs are offset between front and rear discs to cover the entire frontal

area with both arrays. The two shafts are connected to a rectangular frame fitted to the end of the boom.

Flail system

The flail system consists of chain lengths attached to a central driving shaft connected to a hydraulic motor. Two flat plate hammers are attached to each chain to improve ground penetration. A protective screen consisting of a steel frame covered with chain links and wire mesh is fitted behind the flail to prevent debris from being thrown outside the area of operations.

Machines in use to date

- DEMCO machines are used in Mozambique in different configurations. Information as to area cleared so far not provided by the manufacturer.

Factory support

- Not given by the manufacturer.

Maintenance and support

- The system has been designed for ease of maintenance. No further information is given.

Tests and evaluations

- The DEMCO multi-tool system has undergone testing by CSIR DEFENCETEK in April 2002.
- The test was restricted to pressure-activated blast anti-personnel mines.



Detonating an anti-personnel mine

Reported limitations and strengths

Limitations

- Wet soil clogs up the edges of the disk roller.¹
- Operators' protection needs improving.¹

Strengths

- Simple design.
- Versatile.
- Can be operated with a minimum of logistical support.

1. CSIR DEFENCETEK, *Technical report on functionality tests conducted on DEMCO mine clearing equipment* by J. T. van Dyk and J.J.P. Lötter, Pretoria, May 2002.



Hitachi- Furukawa multi-tool system

General description

The **Hitachi-Furukawa Mine Clearance Equipment & System** offers various solutions to tackle the mine clearance problem in difficult-to-access areas such as slopes, ditches and trenches.

Attachable tools concentrate on particular areas to support manual, dog or larger-scale mechanical demining operations.

The tool holder is based on a commercial excavator which can revert to its original function of earthmover/excavator.

According to the manufacturer, a quick-attach coupling allows change of “off-the-shelf tools”. An electronic box connected to angular sensors is installed on the excavator. The system can operate on a pre-programmed sequence of actions related to GPS coordinates. This is designed to negate the requirement for an on-board operator and is intended as a safety feature.

Clearance methodology

Anti-personnel Demining System (AMDS)

The AMDS is an area reduction tamping device for verification of the presence of anti-personnel mines in a suspect area. The system applies pressure to the ground in order to detonate or break-up surface or sub-surface-laid, pressure-activated mines. The six independent, articulated footpad kits exert pressure to the ground through tamping. When mine detonation causes damage to a pad, the plastic pipe foot design can be replaced.

Excavator/sifter:

The system is designed for sifting soil in difficult to access areas such as slopes, ditches or dykes. It combines “mill/ripper” earth removing teeth and a “sifter drum basket” which sorts out earth removed up to a depth of 25cm. The working process is computer controlled and does not require an operator in the cabin.

An observation camera allows scanning of excavated objects in the sifter. In case of damage all components are replaceable.

Machines in use to date

- One system is planned to be deployed to a mine-affected country in 2003.

Engine, fuel and oil

- The machine is equipped with a four-cylinder Cummins B3.9-C turbocharged diesel engine (74kw).
- The average fuel consumption is 18l per hour.

Factory support

- Manuals covering operation and maintenance are provided in English and are included in the purchase package.
- Manufacturer ensures long-term availability of spares.
- Operator training courses are provided by the manufacturer.

Maintenance and support

- Weekly basic greasing, oil level checks, etc. by driver/operator.

Tests and evaluations

- Tests using live mines have been carried out by S.T.A.T. (Technical Section of French Army).



System destroying an anti-personnel mine

Reported limitations and strengths

Limitations

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

Strengths

- Based on a widely-available commercial vehicle.
- The excavator can also be used for construction work.

MgM Rotar Mk-II

Menschen gegen Minen e.V. MgM, Namibia



MgM Rotar Mk-II with rotar and vegetation cutter

General description

The **MgM Rotar Mk-II** is based on experience gained with the MgM Rotar Mk-I sifter system, but is independent of 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, an 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 differing 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 achieved, 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.

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, and the contents are released for visual inspection. Anti-personnel mines, parts of mines or any UXO 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.

Machines in use to date

- One machine is undergoing testing and evaluation in Namibia.

Engine, fuel and oil

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

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 part of purchase package.

Maintenance and support

- All daily fluid servicing is on 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.

Tests and evaluations

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



Reported limitations and strengths

Limitations

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

Strengths

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

1. According to the manufacturer.

Pearson Survivable Demining Tractors and Tools (SDTT)

Pearson Engineering Ltd., United Kingdom



Pearson SDTT with roller and loader

General description

The **Pearson Demining Tractor** is a 10 tonne 4 x 4 tractor on large-diameter steel wheels with an open cage design. The vehicle is designed to clear anti-personnel mines but it has also been tested for survivability against anti-tank mines which may be encountered. A three-point linkage and power take-off are fitted to both the front and rear of the tractor, enabling it to carry a wide range of specialised and agricultural implements. These allow implements to be fitted to either the front or to the rear, or to both at once.

A rotating seat and reverse controls are provided in the armoured cab and a loader may be fitted to the front of the vehicle.

The vehicle is intended to be driven into anti-personnel minefields. The cab and seating arrangements are designed to prevent injury to the driver in the event of anti-tank mine detonation. The design has been validated by blast tests.

The Pearson Demining Tractor operates in the same way as a conventional farm tractor. The attachments are a strong magnet to attract ferrous objects and fragments, a mine gripper to pick up mines and other ordnance, a tree extractor to remove trees and shrubs growing in minefields, a heavy vegetation cutter/slasher, a segmented roller for clearing anti-personnel mines by pressure activation and a mine separator to sift soil, removing mines and other large objects to one side.

Working methodology

The Pearson Area Reduction Roller (ARR)

The area reduction roller is a vehicle-mounted roller for rapid identification of the presence of anti-personnel mines in suspect areas and for area reduction. The roller works by detonating any near-surface or surface pressure-activated mines. It is designed to withstand anti-personnel mine blast only. The roller consists of a series of individually 'floating' steel discs, each exerting a load of 50kg on the ground. This feature ensures that the roller is effective on uneven ground.

The roller weight is approximately 1,000kg per metre width. It is not only manufactured for the Pearson tractor but is also available in any width up to 3.5m to suit other prime movers.

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

The HALO Trust has approximately ten rollers in service in Abkhazia, Afghanistan, Cambodia, Georgia, Kosovo, Mozambique, and Somaliland.

The robust construction and versatility of the Pearson Engineering Segmented Roller has proven successful within humanitarian mine clearance.¹



The area reduction roller with its 50 kg discs

The U.S. Department of Defense (DoD) owns two rollers, which are under evaluation with the 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, though the requirement for spares is minimal.

No routine maintenance is required.

Standard warranty period is 12 months from date of delivery.

The Pearson Magnet



The Pearson Magnet fitted to the rear end of the tractor

The Pearson Magnet is a vehicle-mounted magnet fitted with depth-adjusting wheels and a hydraulically-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 U.S. DoD has purchased two magnets. One has been under evaluation by TMAC since January 2001, following evaluation by Mines Advisory Group (MAG) in Cambodia during 2000. The second has been under evaluation by 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. Damage is normally caused by blast.

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 anti-tank mine threat.

The weight of the magnet is 1,600kg with ground pressure for the steel depth wheels of 1.5-2kg/cm². The magnet has a working width of 0.9m and a working speed of up to 6km/h.

The Pearson Sifter



The Pearson Sifter fitted to the rear of the SDT

The Pearson Sifter is designed for sifting soil in areas with an anti-personnel mine threat. It is mounted to a prime mover fitted with an agricultural three-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 250mm. 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.

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 anti-personnel 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 gearbox oil level. No special skills are required.

The weight of the sifter is 1,600kg. The working width of the system is 1.5m, while the overall width measures 3.6m. The working speed is up to 4km/h.²

The Pearson Slasher



The Pearson Slasher at the rear of the tractor cutting vegetation

The Slasher is a heavy vegetation cutter capable of cutting bushes and trees of up to 150mm in 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.

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 three-point linkage lift, assisted by a skid plate under the rotor.

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 risk of vegetation debris over a considerable radius.

Tests by both MAG and TMAC have proven the effectiveness of the Slasher as a vegetation cutter.² Tests by the U.S. DoD with 200g of TNT detonated under the rotor did not cause significant damage.²

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/h in light vegetation.⁶

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.



The Pearson Tree Extractor removing a tree

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

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.²

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 1,100kg.



The Pearson Tractor operating in dense vegetation

Machines in use to date

- During 2000, 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.

Engine, fuel and oil

- The tractor is driven by a 118kw turbo diesel engine powered by normal diesel fuel.
- Fuel tank capacity is 200l.
- Fuel consumption is approximately 5-20l per hour depending on conditions.

Factory support

- Full operation, maintenance, repair and spares manuals are available in English.
- Full spares backup is provided by Pearson Engineering.
- Operator training and follow up support can also be provided as part of purchasing package if required.
- 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 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.

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.

Tests and evaluations

- The SDT has been tested against the effects of anti-personnel and anti-tank mines. Anti-tank 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.



The SDT with an extracted tree

Reported limitations and strengths

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.

Strengths

- Simple to operate and maintain.
- Robust construction and high versatility.

1 Phil Straw, Mechanical Mine Clearance Operations Officer, HALO Trust.

2 According to the manufacturer.

Technical data sheet Armtrac 325 with flail unit

a. Dimensional data

1.	Length without attachment:	6,400mm
2.	Length total:	8,200mm
3.	Width without attachment:	2,730mm
4.	Width total:	3,500mm
5.	Clearance width:	3,000mm
6.	Height, overall:	3,200mm
7.	Mass, basic vehicle:	15,000 kg
8.	Mass, demining unit:	3,000 kg
9.	Mass, total:	18,000 kg

b. Driving specifications

10.	Wheels/ tracks:	4 foam-filled tyres
11.	Ground pressure, max. weight:	Not given
12.	Hill climbing ability:	45° ^{a)}

c. Clearance performance

13.	Number of chains:	74
	• length of chains:	1,000mm
14.	Gap between chains:	10mm
15.	Rotation speed:	350rpm
16.	Clearance depth, max:	Up to 300mm
17.	Working speed: ^{a)}	
	• light soil/ small vegetation:	Approx. 4,000m ² /h
	• medium soil/ medium vegetation:	Approx. 2,800m ² /h
	• heavy soil/ dense vegetation:	Approx. 2,800m ² /h
18.	Control of clearance depth:	Manual
19.	Machines in use:	2
20.	Location of use:	Bosnia and Herzegovina, Kosovo, Mozambique
21.	Total area cleared so far:	Approx. 6,000,000m ²
22.	Other types:	Armtrac 100

d. System specifications

23.	Engine:	Volvo diesel with 325hp
24.	Fuel capacity:	455l
25.	Fuel consumption:	50l/h
26.	Separate engine for working unit:	No
27.	Transition:	Not given
28.	Cooling system engine:	Air blown over radiator
29.	Hydraulic oil capacity:	910l

e. Comfort and security

30.	Air conditioning:	Yes
31.	Operator comfort:	Air cushioned seat, fully adjustable
32.	Armour:	Cab 10mm steel plates
33.	Remote control:	No

f. Costs

34.	Cost of system:	£230,000
35.	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 a low-loader
36.	Transport limitation:	For long distances, transportation on low-bed trailer is required
37.	Availability for hire:	Yes

a) According to the manufacturer.

Technical data sheet DEMCO

a. Dimensional data

1.	Length without attachment:	Not given
2.	Length total:	9,000mm
3.	Width without attachment:	2,600mm
4.	Width total:	2,600mm
5.	Maximum reach:	9,500mm
6.	Height:	3,100mm
7.	Mass, basic vehicle:	18,500 kg (with armour plating)
8.	Mass, demining unit:	1,500-2,000kg
9.	Mass total:	Depending on attachment

b. Driving specifications

10.	Wheels/ tracks:	Depending on prime mover used
11.	Ground pressure, max. weight:	Not given
12.	Hill climbing ability:	35° ^{a)}

c. Clearance performance

13.	Number of chains:	Not given
	• length of chains:	Not given
14.	Gap between chains:	Not given
15.	Rotation speed:	Not given
16.	Clearance depth, max:	Not given
17.	Working speed	Not given
18.	Control of clearance depth	Not given
19.	Machines in use	Not given
20.	Location of use:	Mozambique
21.	Total area cleared so far:	Not given
22.	Other types:	Not given

d. System specifications

23.	Engine:	Depending on the prime mover used
24.	Fuel capacity:	Not given
25.	Fuel consumption:	Depending on the prime mover used
26.	Separate engine for working unit:	No
27.	Transition:	Not given
28.	Cooling system engine	Not given
29.	Hydraulic oil capacity	Not given

e. Comfort and security

30.	Air conditioning:	Not given
31.	Operator comfort:	Not given
32.	Armour:	Not given
33.	Remote control:	No

f. Costs

34.	Cost of system:	Not given
35.	Other costs:	Not given
36.	Transport limitation:	For longer distances, transportation on a low-bed trailer is required
37.	Availability for hire:	Yes

a) According to the manufacturer.

Technical data sheet Hitachi-Furukawa

a. Dimensional data

1.	Length without attachment:	8,850mm
2.	Length total:	11,350mm
	Maximum reach radius:	8,750mm
3.	Width without attachment:	2,480mm
4.	Width total:	2,480mm
5.	Clearance width	5,000mm
6.	Height, overall:	4,700mm
7.	Mass, basic vehicle:	15,250 kg
8.	Mass, demining unit:	Depends on attached working tool
9.	Mass, total:	Depends on attached working tool

b. Driving specifications

10.	Wheels/ tracks:	10.00x20
11.	Ground pressure, max. weight:	Not given
12.	Hill climbing ability:	30° ^{a)}

c. Clearance performance

13.	Number of blades/ AMDS feet:	8 blades/ 6 pads (AMDS)
14.	Gap between blades/ feet:	40mm/ 5mm (AMDS)
15.	Rotation speed:	—
16.	Clearance depth, max.:	Up to 300mm
17.	Working speed:	Not given

d. System specifications

18.	Control of clearance depth:	—
19.	Machines in use:	System is on a prototype stage
20.	Location of use:	—
21.	Total area cleared so far:	—
22.	Other types:	—
23.	Engine:	Cummins turbocharged diesel (74kw)
24.	Fuel capacity:	290l
25.	Fuel consumption:	18l/h
26.	Separate engine for working unit:	No
27.	Transition:	Not given
28.	Cooling system engine:	Radiator air cooled
29.	Hydraulic oil capacity:	210l

e. Comfort and security

30.	Air conditioning:	Yes
31.	Operator comfort:	Remote and automatic control
32.	Armour:	Not given
33.	Remote control:	Yes

f. Costs

34.	Cost of system:	Not given
35.	Other costs:	Not given
36.	Transport limitation:	For long distances transportation on a low-bed trailer is required
37.	Availability for hire:	Not given

a) According to the manufacturer.

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:	2,396mm
4.	Width total:	2,400mm (stabiliser legs at the rear)
5.	Working width:	1,800mm (inside the drum); 1,600 mm (cutter)
6.	Height, overall:	3,250mm
7.	Mass, basic vehicle:	7,415kg
8.	Mass, attachments:	2,985 kg
9.	Mass, total:	10,400kg

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:	600l
14.	Gap between chains:	—
15.	Rotation speed:	Variable
16.	Clearance depth, max:	200-300mm
17.	Working speed brush cutter:	Not given
18.	Control of clearance depth:	Manual
19.	Machines in use:	1
20.	Location of use:	Namibia
21.	Total area cleared so far:	Not given
22.	Other types	Rotar MK I

d. System specifications

23.	Engine:	Caterpillar 3054 T turbocharged diesel engine, either with 56 or 60kw and a four-cylinder, four-stroke, direct-injection engine.
24.	Fuel capacity:	128l
25.	Fuel consumption:	Max. 15l/h
26.	Separate engine for Rotar unit:	No
27.	Transition:	Not given
28.	Cooling system engine:	Water
29.	Hydraulic oil capacity:	79l

e. Comfort and security

30.	Air conditioning:	Yes
31.	Operator comfort:	Air-suspension seat, additional option: AM/FM stereo/ cassette package, tilt wheel, and circulating fan
32.	Armour:	4mm 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 6-10mm plates
33.	Remote control:	No

f. Costs

34.	Cost of system:	Approx. US\$200,000
35.	Other costs:	Not given
36.	Transport limitation:	For long distances transportation by low-bed trailer is required
37.	Availability for hire:	No

Technical data sheet Pearson SDTT

a. Dimensional data

1.	Length without attachment:	5,130mm
2.	Length total:	512mm
3.	Width without attachment:	3,270mm
4.	Width total:	3,264mm
5.	Working width:	Depends on the various attachments
6.	Height, overall:	4,474mm
7.	Mass, basic vehicle:	9,800kg
8.	Mass, demining unit:	Depends on the various attachments
9.	Mass, total:	Depends on the various attachments

b. Driving specifications

10.	Wheels/ tracks:	4 wheels, steel or pneumatic
	• front steel wheel:	600mm wide x 1,716mm diameter
	• rear steel wheel:	800mm wide x 2,274mm diameter
11.	Ground pressure, max weight:	1.4 kg/cm ² (pneumatic)
12.	Hill climbing ability:	30°

c. Working performance

13.	Number of chains:	—
14.	Gap between chains:	—
15.	Rotation speed:	—
16.	Clearance depth:	—
17.	Working speed:	Depends on the various attachments
18.	Control of clearance depth:	—
19.	Machines in use:	2
20.	Location of use:	Cambodia, Thailand
21.	Total area cleared so far:	Not given
22.	Other types:	No

d. System specifications

23.	Engine:	Fiat, 118kw, six-cylinder, 8.1l turbo diesel engine
24.	Fuel capacity:	200l
25.	Fuel consumption:	Max. 20l/h
26.	Separate engine for working unit:	No
27.	Transition:	Not given
28.	Cooling system engine:	Water
29.	Hydraulic oil capacity:	78l

e. Comfort and security

30.	Air conditioning:	Yes
31.	Operator comfort:	Bucket seat with head restraint and five-point harness
32.	Armour:	Not given
33.	Remote control:	No

f. Costs

34.	Cost of system:	US\$250,000 for tractor with three attachments as specified by the customer
35.	Other costs:	Not given
36.	Transport limitation:	For long distances transportation on a low-bed trailer is required
37.	Availability for hire:	Not given

COMPARATIVE ANALYSIS

Armtrac 325

DEMCO

a. Dimensional data

1. Length without attachment:	6,400mm	Not given
2. Length total:	8,200mm	9,000mm
3. Width without attachment:	2,730mm	2,600mm
4. Width total:	3,500mm	2,600mm
5. Clearance width:	3,000mm	9,500mm
6. Height, overall:	3,200mm	3,100mm
7. Mass, basic vehicle:	15,000 kg	18,500 kg (with armour plating)
8. Mass, demining unit:	3,000 kg	1,500-2,000kg
9. Mass, total:	18,000 kg	Depending on attachment

b. Driving specifications

10. Wheels/ tracks:	4 foam-filled tyres	Depending on prime mover used
11. Ground pressure, max. weight:	Not given	Not given
12. Hill climbing ability:	45° ^{o)}	35° ^{o)}

c. Clearance performance

13. Number of chains:	74	Not given
• length of chains:	1,000mm	Not given
14. Gap between chains:	10mm	Not given
15. Rotation speed:	350rpm	Not given
16. Clearance depth, max:	Up to 300mm	Not given
17. Working speed:	^{o)}	Not given
• light soil/ small vegetation:	Approx. 4,000m ² /h	
• medium soil/ medium vegetation:	Approx. 2,800m ² /h	
• heavy soil/ dense vegetation:	Approx. 2,800m ² /h	
18. Control of clearance depth:	Manual	Not given
19. Machines in use:	2	Not given
20. Location of use:	Bosnia and Herzegovina, Kosovo, Mozambique	Mozambique
21. Total area cleared so far:	Approx. 6,000,000m ²	Not given
22. Other types:	Armtrac 100	Not given

d. System specifications

23. Engine:	Volvo diesel with 325hp	Depending on the prime mover used
24. Fuel capacity:	455l	Not given
25. Fuel consumption:	50l/h	Depending on the prime mover used
26. Separate engine for working unit:	No	No
27. Transition:	Not given	Not given
28. Cooling system engine:	Air blown over radiator	Not given
29. Hydraulic oil capacity:	910l	Not given

e. Comfort and security

30. Air conditioning:	Yes	Not given
31. Operator comfort:	Air cushioned seat, fully adjustable	Not given

Multi-tool systems

Hitachi-Furukawa	MgM Rotar Mk-II	Pearson SDT
8,850mm	5,760 mm	5,130mm
11,350mm	Not given	512mm
Maximum reach radius: 8,750mm		
2,480mm	2,396mm	3,270mm
2,480mm	2,400mm (stabiliser legs at the rear)	3,264mm
5,000mm	1,800mm (inside the drum);	Depends on the various attachments
	1,600 mm (cutter)	
4,700mm	3,250mm	4,474mm
15,250 kg	7,415kg	9,800kg
Depends on attached working tool	2,985 kg	Depends on the various attachments
Depends on attached working tool	10,400kg	Depends on the various attachments
10.00x20	4 wheels tubeless, nylon, loader design tyres	4 wheels, steel or pneumatic <ul style="list-style-type: none"> • front steel wheel: 600mm wide x 1,716mm diameter • rear steel wheel: 800mm wide x 2,274mm diameter
Not given	Not given	1.4 kg/cm ² (pneumatic)
30° ^{o)}	30°	30°
Number of blades/ AMDS feet: 8 blades/ 6 pads (AMDS)	Capacity of the Rotar: 600l	—
Gap between blades/ feet: 40mm/ 5mm (AMDS)	—	—
—	Variable	—
Up to 300mm	200-300mm	
Not given	Brush cutter: not given	Depends on the various attachments
—	Manual	—
System is on a prototype stage	1	2
—	Namibia	Cambodia, Thailand
—	Not given	Not given
—	Rotar MK I	No
Cummins turbocharged diesel (74kw)	Caterpillar 3054 T turbocharged diesel engine, either with 56 or 60kw and a four-cyl., four-stroke, direct-injection engine.	Fiat, 118kw, six-cyl., 8.1l turbo diesel engine
290l	128l	200l
18l/h	Max. 15l/h	Max. 20l/h
No	for Rotar unit: no	No
Not given	Not given	Not given
Radiator air cooled	Water	Water
210l	79l	78l
Yes	Yes	Yes
Remote and automatic control	Air-suspension seat, additional option: AM/FM stereo/cassette package, tilt wheel, and circulating fan	Bucket seat with head restraint and five-point harness

COMPARATIVE ANALYSIS

	Armtrac 325	DEMCO
32. Armour:	Cab 10mm steel plates	Not given
33. Remote control:	No	No
f. Costs		
34. Cost of system:	£230,000	Not given
35. Other costs:		Not given
• training:	£2,500; duration 10 days	
• spare part set chains/belts:	£300	
• repair costs for one year:	£2,400	
• transportation:	£10,000 to buy a low-loader	
36. Transport limitation:	For long distances, transportation on low-bed trailer is required	For longer distances, transportation on a low-bed trailer is required
37. Availability for hire:	Yes	Yes

Multi-tool systems

Hitachi-Furukawa	MgM Rotar Mk-II	Pearson SDT
Not given	4mm 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 6-10mm plates	Not given
Yes	No	No
Not given	Approx. US\$200,000	US\$250,000 for tractor with three attachments as specified by the customer
Not given	Not given	Not given
For long distances transportation on a low-bed trailer is required	For long distances transportation by low-bed trailer is required	For long distances transportation on a low-bed trailer is required
Not given	No	Not given

a) According to the manufacturer.



Section 5

Vegetation cutter

BDM 48 Brusher Deminer

Pro Mac Manufacturing Ltd., Canada



PRO MAC BDM 48 attached to a CASE 9040 B excavator

General description

The **BDM48** is mounted on a case 904B tracked excavator with a protection package for the operator and arm. A blast damping system protects the excavator arm from explosive blast. Quick release valves on the hydraulic system avoid hydraulic damage from heavy blast.

The prime mover has a purpose-built cab designed to withstand blast from anti-tank mines and ordnance up to 105mm artillery rounds.

The system provides the following general capabilities:¹

- Safety and security for the operator by working from the cleared area;
- Removes vegetation to make ground available for other clearance assets;
- Removes tripwire threat;
- Removes or reduces anti-personnel mine threat by neutralising mines.

Clearance and cutting methodology

The Pro Mac BDM 48 Brushcutter Deminer is a Rotary Drum (Arbor) System that removes brush and bamboo. It can grind anti-personnel mines to a depth of 200mm. The maximum reach radius at ground level is 9 metres.

The drum with its 23 cutter bits rotates with a speed of up to 2,300rpm and covers a working width of 1,220mm.

Machines in use to date

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

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.

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 (190l per minute and 282 bar) required for the BDM 48.
- In hotter regions it is necessary to increase the cooling system capacity of the excavator for the engine and hydraulic system. These modifications would be standard for Southeast 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.

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.



Example of a bite from the PRO MAC BDM 48

Tests and evaluations

- The BDM 48 system underwent evaluation by CCMAT (Canadian Centre for Mine Action Technologies), DRES (Defence Research Establishment Suffield) and TMAC (Thailand Mine Action Centre) in April-June 2001. During evaluation, Mechanical Reproduction Mines (MRM) and M14 anti-personnel mines were used.
- CIDC summarised its observations and analysis of the performance of BDM48 covering the period August 2001 to March 2002.
- Test report: www.itep.ws

Reported limitations and strengths

Limitations

- The BDM 48 head is not designed for clearance of anti-tank mines.¹
- Complete with armoured excavator, the system weighs 34 tonnes. For transport over longer distances, a low-loader is required.²
- The clearance depth is limited to approx. 20cm.
- A highly experienced operator is needed.²
- Productivity limited by requirement to operate from safe area.

Strengths

- A useful tool that combines bush cutting with the ability to spot clear anti-personnel mines.
- Works through root structure and rough ground.
- Works in and around obstacles.
- Capability to detonate or neutralise all mines to a depth of 200mm.¹

1. PROMAC manufacturer letter dated 8 October 2001.

2. Test report Thailand Mine Action Centre, *Standard Operating Procedures Mechanical Assistance to Demining — Promac Brush Deminer 48 (BDM 48)*, May 2001.

Digger 1

Digger Demining Technologies Research, Switzerland



General description

The **Digger 1** is a lightweight remotely-controlled vegetation cutter currently undergoing development by the Swiss NGO Digger Demining Technologies Research, which has a mine clearance background in Croatia and Cambodia. The system was deployed to Albania in July 2002.

The vehicle consists of an armoured, 'V' shaped hull with a vegetation cutter fixed to the front. This small vehicle is remotely controlled from behind a protection shield. The Swiss Army tested the vegetation cutter unit in May 2001.

Clearance and cutting methodology

The Digger 1 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.

Machines in use to date

- One prototype in existence.
- The first machine was tested by Swiss Federation for Mine Clearance (SFD) in Albania (July-September 2002).

Engine, fuel and oil

- The Digger 1 is equipped with a five-cylinder Kubota diesel engine (46kw/62hp).
- Fuel capacity is 50l with a maximum fuel consumption of 12l/h.

Factory support

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

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).
- System can be delivered in a 20ft container, equipped with a basic workshop.

Tests 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 of TNT with fragmentation between 0.04m to 1m were carried out against the cutter unit. Five detonations of 200g of TNT were fired beneath the vehicle tracks. In all cases no serious damage was reported.
- SFD tested the machine for two months in a live minefield. Detailed information is available on the manufacturer's website.



The cutting system undergoing trials

Reported limitations and strengths

Limitations

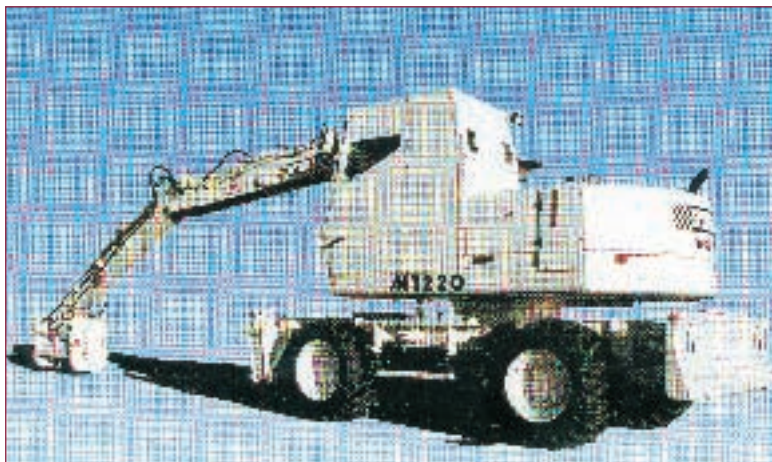
- The system is designed to operate in anti-personnel mined areas only.

Strengths

- Manoeuvrable and easy to transport.
- Above-average hill-climbing ability.

Hydrema M1220 Light Armoured and R1820

A/S Hydrema Danmark, Denmark



Hydrema M1220 Light Armoured with bush cutter

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 the excavator role, the machine can be fitted with three different excavator buckets. The operator is protected from blast and fragments and 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 x 4 wheel drive, with an optional gear allowing the machine to travel at up to 30km/h on paved roads.

The manufacturer has not provided further information.

The **Hydrema R 1820** is a powerful, high-capacity excavator (18-20 tonnes). It has a two-piece boom configuration for extended reach, height and low front turning radius. A neck cylinder provides safe stowage when travelling.

The unit can be fitted with various track types, depending on ground conditions.

A large armoured cab gives the operator protection against fragments and bullets to level C4 according to DIN 52290 (Deutsche Industrie Norm), part 2 (cal. 7.62x 51mm).

Computerised instrumentation provides information such as running time, maintenance scheduling etc., to the operator.

Working methodology

The main use of the M1220 Light Armoured is to cut vegetation. The working width of the bush cutter is 1,000mm, with 18 cutter bits mounted to the 100mm-diameter rotating drum. The arm of the Hydrema can reach the 392kg bush cutter out to 8,500mm. With a digger bucket, the boom can extend its reach to 9400mm. The M1220 has a maximum lift of 7 tonnes.

The R1820 is a multi-purpose construction machine which can also be used for vegetation cutting.

Machines in use to date

- M 1220 Light Armoured: One system sold to MgM in Namibia for use in Angola.
- R 1820: Four systems were purchased by the Swedish military and are currently employed in the Balkans.

Engine, fuel and oil

- M1220 Light Armoured: Perkins 1004-40 T turbo-diesel engine, four-cylinder 4.0l water-cooled with 75kw.

- R1820: Perkins 1004-4TW, turbocharged, intercooler, 91kw.
- 250l fuel tank capacity (for both machines).
- 180l hydraulic tank capacity (for both machines).

Factory support

- Training of operators is part of the purchase package.
- Comprehensive manuals and documentation are part of the purchase package.

Maintenance and support

- The manufacturer has provided no further information.

Tests and evaluations

- Both systems have been on the market for several years and therefore well tested under operational conditions.



Hydrema R 1820

Reported limitations and strengths

Limitations

- No information available.

Strengths

- No information available.

Komatsu PC60 Vegetation Cutter

Komatsu, Japan



KOMATSU PC 60 vegetation cutter

General description

The **Komatsu PC 60 Vegetation Cutter** combines vegetation cutting and terrain levelling. The system features heavy armour protection for the driver's cab, fuel tank, hydraulic tank and engine.

The system is not capable of withstanding an anti-tank mine blast. Tests carried out using live mines such as OZM3 and M18A1 confirmed the survivability of the system against anti-personnel mine blasts.

With a total weight of around 10 tonnes, the machine is practical for deployment to countries where road infrastructure is poor. Low ground pressure allows for operation in wet and muddy ground conditions.

Low average fuel consumption and robust design are aimed at reducing operational costs of the machine.

Clearance methodology

The cutter unit cuts vegetation up to 100mm in diameter to a working width of 1,000mm. The cutter unit rotating drum is attached to a hydraulically-operated arm with a reach of 6.70m.

No further information is provided by the manufacturer.

Machines in use to date

- Two machines have been operated by CMAC since 2000.

Engine, fuel and oil

- The Komatsu 4D95 diesel engine powers both machines.
- The hydraulic brush cutter attachment is powered by the main engine.

Factory support

- Komatsu provides training both for operators and mechanics.
- Manuals are available in English or any language required by the purchaser.
- Worldwide servicing and spare parts network reduces machine down-time.

Maintenance and support

- The system features a water separator for poor quality fuel, a corrosion resistor for hard water treatment and a larger engine cooling system for tropical conditions.

Tests and evaluations

- The prototype of the PC 60 was tested in Cambodia. Operational performance and survivability fulfil CMAC requirements.
- The survivability test was carried out by using anti-personnel pressure mines (OZM3 and M18A1).



Komatsu vegetation cutter operating in Cambodia

Reported limitations and strengths

Limitations

- Machine is not capable of withstanding an anti-tank mine blast.
- The cutting performance is limited to 100mm in diameter.

Strengths

- Lightweight.
- Worldwide servicing network provides access to spares.

Tempest Mk III

Development Technology Workshops, Cambodia



Tempest Mk III cutting dense vegetation

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 and are working in Cambodia, Thailand, and Bosnia and Herzegovina. Nine Tempest machines were in operation with a further five in production as of October 2001. The Tempest Mk III is a remotely-controlled, lightweight vegetation cutter and tripwire clearance system.

The Mk III chassis is 'V' shaped with an 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 manoeuvrability. 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 anti-tank mine blast.

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

Operating methodology

Tempest Mk III is remotely driven into a suspect area. The front mounted flail has 36 chains that cut vegetation down to 25mm high and can deal with shrubs and small trees up to 20mm in diameter. The flail removes tripwires encountered during normal operation. A hydraulic motor operating at speeds of up to 1,300rpm powers the flail chain-driven shaft. The 330mm long chains of the flail unit have an effective clearance width of 1,200mm. The expected cutting rate of the system is from 200-800m²/h¹, depending on soil type and vegetation density.

Machines in use to date

- Currently nine machines are in use between Cambodia (MAG), Thailand (Thailand Mine Action Centre), and Bosnia and Herzegovina (Norwegian People's Aid).
- Approximately five machines were in production as of October 2001.

Engine, fuel and oil

- The vehicle is equipped with a Deutz four-cylinder diesel turbocharged engine BF4L1011F/T with 52kw (70hp).

- The fuel capacity is 42l with a fuel consumption of 7-10l per hour.
- A single hydraulic gear pump serves the individual wheel motors, flail lift arm ram and main hydraulic motor for the flail unit. In-line on return to tank filtration with magnetic mesh.
- Hydraulic tank capacity is 113l.
- The fuel tank is protected by 8mm steel plate.

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 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 different requirements.
- Manuals and documentation are in English. Other languages can be supplied but are part of the purchase package.
- One-year factory warranty from date of arrival on site.
- Additional services for Southeast Asian markets, e.g. 48-hour call-out, regular checks for operational performance monitoring, factory rebuilds or major repairs are provided.



Tempest bush cutting flail system

Maintenance and support

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

Tests and evaluations

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

Reported limitations and strengths

Limitations

- The first Tempest machines had overheating problems above 38°C. This problem should be solved with slight design changes to the Mk III.¹
- The Tempest is designed for heavy tropical vegetation where it works best. It is not suitable for very thin or limited vegetation.¹
- The machine is not intended to be used in areas where anti-tank mines are present.²
- The steel wheels provide limited traction in muddy conditions, but increase the system survivability.²

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. 4 x4 with trailer or 5-tonne flat-bed truck can transport it.
- The blast of live mines of 0.25kg under the flail, skids, and wheels did not affect the operational capability of the system and repairs took only minutes to perform.²

1. According to the manufacturer.

2. U.S. Department of Defence, *Humanitarian Demining Developmental Technologies 2000-2001*, p. 33.

Rotary Cutter BM 307

Yamanashi Hitachi Construction Machinery Ltd., Japan



BM 307 model V21 W

General description

The **Rotary Cutter BM 307** is mounted on a hydraulic arm on an excavator vehicle designed by Hitachi Construction Machinery Ltd. Hitachi produce some of the most commonly-used machines in the world.

The BM307 combines a vegetation cutter and tiller system. The cutter unit consists of steel cutter bits mounted to a rotating drum. The cutter can destroy anti-personnel mines, fragment rocks, and cut vegetation. It has a ground penetration depth of up to 300mm.¹

The machine can be used for construction or agricultural purposes with the application of other attachments.

One operator controls the machine from a cab protected by special bulletproof glass (Rexguard) and high tension steel plates.

Critical parts such as the hydraulic cylinder, fuel tank and hydraulic oil tank are protected from anti-personnel mine blast.

Clearance methodology

The drum rotates with a speed of up to 500rpm. The working width is 1,000mm. Up to 44 cutter bits can cut vegetation and fragment stones of up to a maximum of 300mm in diameter. The cutter head can destroy anti-personnel mines in the ground down to a depth of 300mm.

The hydraulic arm can reach out to 10 metres in height with a working radius of 8,760mm.

Machines in use to date

- Two BM 307 (version S16) are in service in Cambodia since March 2000.
- One BM 307 (version V20) operated by UNOCHA in Afghanistan since June 2000.
- Two BM 307 (version V20) operating in Nicaragua since September 2001.

Engine, fuel and oil

- Direct injection diesel engine with turbocharger. No further information is given by the manufacturer.
- The prime mover runs on ordinary diesel fuel.
- The hydraulic oil capacity is 170l.

Factory support

- Spare parts, including consumable parts such as bits, bearings, seals, etc. are included in the purchase package.
- Due to worldwide servicing network the availability of spares is good.
- Warranty period is one year or 1,000 hours, whichever comes first.
- Training courses for operators and maintenance staff is included in the purchase package.
- Manuals are supplied in language required by the purchaser.

Maintenance and support

- BM307 combines simplicity of design with robust materials.
- Regular maintenance comprising daily, weekly, monthly and annual checks required as per the operating instructions

Tests and evaluations

- CMAC carried out safety tests for two versions of the machine, BM 307 S16 and BM 307 V20, in June-September 1999. Both met CMAC requirements.
- The system demonstrated operation in a live minefield during the Meeting of States Parties to the Anti-Personnel Mine Ban Convention in Nicaragua in 2001.



Rotary cutter BM 307

Reported limitations and strengths

Limitations

- System is designed for anti-personnel mine clearance only.

Strengths

- Combines vegetation cutting with the ability to “spot clear” anti-personnel mines.
- Robust design with worldwide servicing network.

1. According to the manufacturer.

Technical data sheet BDM 48 Brusher Deminer

a. Dimensional data

1.	Total length:	9,880mm
2.	Maximum reach radius:	9,000mm
3.	Width total:	3,380mm
4.	Working width:	1,220mm
5.	Height, minimum:	3,070mm
6.	Height, overall:	As per boom position
7.	Mass, basic vehicle:	32,000kg
8.	Mass, working tool:	1,820kg
9.	Mass, total:	34,000kg

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 cutting tools:	23 cutter bits
14.	Gap between drums/ chisels/chains:	Overlapping bits
15.	Rotation speed:	1,900-2,300rpm
16.	Working depth, max.:	Up to 200mm
17.	Working speed:	
	• in thick underbrush and bamboo:	4-8m ² /min ^{a)}
18.	Control of working depth:	Manual
19.	Machines in use:	1
20.	Other types:	Not given
21.	Location of use:	Thailand
22.	Total area cleared so far:	Not given

d. System specifications

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

e. Comfort and security

30.	Air conditioning:	Not given
31.	Operator comfort:	Not given
32.	Armour:	Not given
33.	Remote control:	No

f. Costs

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

a) According to the manufacturer.

Technical data sheet Digger 1

a. Dimensional data

1.	Total length:	3,500mm
2.	Maximum reach radius:	-
3.	Width total:	1,400mm
4.	Working width:	200mm
5.	Height, minimum:	1,500mm
6.	Height, overall:	1,700mm
7.	Mass, basic vehicle:	2,200kg
8.	Mass, working tool:	500kg
9.	Mass, total:	2,700kg

b. Driving specifications

10.	Wheels/ tracks:	2 tracks
11.	Ground pressure:	Approx. 0.7kg/cm ²
12.	Hill climbing ability:	35°

c. Working performance

13.	Number of cutting tools:	44
14.	Gap between drums/ chisels/chains:	Overlap
15.	Rotation speed:	500rpm
16.	Working depth, max:	Only vegetation cutting above the ground
17.	Working speed ^{a)}	
	• light soil/ small vegetation:	3,000m/h
	• medium soil/medium vegetation:	2,000m/h
	• heavy soil/ dense vegetation:	600-1,000m/h
18.	Control of working depth:	Mechanic
19.	Machines in use:	1
20.	Other types:	No
21.	Location of use:	Albania
22.	Total area cleared so far:	Not given

d. System specifications

23.	Engine:	Kubota five-cylinder diesel engine, 2700cc, 46kw
24.	Fuel capacity:	Not given
25.	Fuel consumption:	12l
26.	Separate engine for tilling unit:	No
27.	Transition:	Not given
28.	Cooling system engine:	Not given
29.	Hydraulic oil capacity:	120l

e. Comfort and security

30.	Air conditioning:	—
31.	Operator comfort:	—
32.	Armour:	10mm hardened steel
33.	Remote control:	Yes
	• greatest distance:	Not given

f. Costs

34.	Cost of system:	CHF70,000
35.	Other costs:	
	• spare parts set:	CHF10,000
36.	Transport limitation:	Transportation on a trailer is required
37.	Availability for hire:	Yes

a) According to the manufacturer.

Technical data sheet Hydrema M1220/R1820

a. Dimensional data

1.	Length total:	6,610mm/8,340mm
2.	Maximum reach radius:	1,000mm
3.	Width total:	2,486 mm/2,880mm
4.	Working width:	Not given
5.	Height, minimum:	Not given
6.	Height, overall:	3,920mm/2,959mm (in transportation mode)
7.	Mass, basic vehicle:	Not given/18,000-20,000kg
8.	Mass, attachments:	392kg (for bush cutter head)
9.	Mass, total:	Max. 13,500kg

b. Driving specifications

10.	Wheels/ tracks:	4 wheels 8 x 9 – 20 EM (with twin tyres 4 x 600/40 – 22,5/tracks)
11.	Ground pressure, max weight:	Not given/0,32-0,57kg/cm ²
12.	Hill climbing ability:	Not given

c. Working performance

13.	Number of cutting tools:	Not given
14.	Gap between drums, chisels, chains:	Not given
15.	Rotation speed:	Not given
16.	Working depth, max:	5,700 mm/6,600mm (max. digging depth)
17.	Working speed brush cutter:	Not given
18.	Control of working depth:	Not given
19.	Machines in use:	1/4
20.	Other types:	Not given
21.	Location of use:	Angola, Balkans
22.	Total area cleared so far:	Not given

d. System specifications

23.	Engine:	Perkins 1004 – 40 T turbo-diesel engine, four-cylinder, 4.0l, with 75kw/ turbocharged intercooler, 91kw
24.	Fuel capacity:	250l
25.	Fuel consumption:	Not given
26.	Separate engine for tilling unit:	Not given
27.	Transition:	Not given
28.	Cooling system engine:	Water cooled
29.	Hydraulic oil capacity:	180l

e. Comfort and security

30.	Air conditioning:	Optional
31.	Operator comfort:	Comfort drivers seat damped against shock wave from mine explosions, vibration damped cab, heating system, other equipment is available as an option
32.	Armour:	DIN 52290-2/DIN 52290-2 class C5
33.	Remote control:	Not given

f. Costs

34.	Cost of system:	Not given
35.	Other costs:	Not given
36.	Transport limitation:	For long distances transportation on a low-bed trailer is required
37.	Availability for hire:	Not given

a) According to the manufacturer.

Technical data sheet Komatsu PC 60

a. Dimensional data

1.	Total length:	6,320mm
2.	Maximum reach radius:	6,705mm
3.	Width total:	2,605mm
4.	Working width:	1,000 mm
5.	Height, minimum:	2,890 mm
6.	Height, overall:	6,715mm
7.	Mass, basic vehicle:	10,400kg
8.	Mass, working unit:	500kg
9.	Mass, total:	10,900kg

b. Driving specifications

10.	Wheels/ tracks:	Tracks
11.	Ground pressure, max weight:	0.4kg/cm ²
12.	Hill climbing ability:	15°

c. Clearance performance

13.	Number of cutting tools:	40
14.	Gap between tools:	6 lines on the circumference
15.	Rotation speed:	2,500rpm
16.	Working depth max.:	Not given
17.	Working speed:	Not given
18.	Control of working depth:	Manual
19.	Machines in use:	2
20.	Other types:	Bigger and more powerful model is available as well
21.	Location of use:	Cambodia
22.	Total area cleared so far:	Not given

d. System specifications

23.	Engine:	Komatsu 4D95
24.	Fuel capacity:	130l
25.	Fuel consumption:	6l per hour
26.	Separate engine for tilling unit:	No
27.	Transition:	Not given
28.	Cooling system engine:	Water cooled
29.	Hydraulic oil capacity:	57l

e. Comfort and security

30.	Air conditioning:	Yes
31.	Operator comfort:	Not given
32.	Armour:	See general description
33.	Remote control:	No

f. Costs

34.	Cost of system:	Not given
35.	Other costs:	Not given
36.	Transport limitation:	For long distances transportation on a low-bed trailer is required
37.	Availability for hire:	Not given

Technical data sheet Tempest Mk III

a. Dimensional data

1.	Total length:	3,500mm
2.	Maximum reach radius:	1,200mm
3.	Width total:	1,500mm
4.	Working width:	Not given
5.	Height minimum:	Not given
6.	Height, overall:	1,500mm
7.	Mass, basic vehicle:	Not given
8.	Mass, working tool:	Not given
9.	Mass, total:	2,700kg

b. Driving specifications

10.	Wheels/ tracks:	Steel fabricated wheels
11.	Ground pressure, max. weight:	Not given
12.	Hill climbing ability:	No tests carried out

c. Clearance performance

13.	Number of cutting tools:	36
14.	Gap between drums/ chisels:	30mm
15.	Rotation speed:	1300rpm
16.	Working depth, max.:	Only vegetation cutting 25mm from the ground
17.	Working speed: ^{a)}	
	• light soil/ small vegetation:	600-800m ² /h
	• medium soil/medium vegetation:	350-600m ² /h
	• heavy soil/ dense vegetation:	200-350m ² /h
18.	Control of working depth:	Automatic by skids attached to the flail hood
19.	Machines in use:	9
20.	Other types:	Not given
21.	Location of use:	Bosnia and Herzegovina, Cambodia, Thailand
22.	Total area cleared so far:	Not given

d. System specifications

23.	Engine:	Deutz four-cylinder diesel turbocharged engine BF4L1011F/T with 52kw (70hp)
24.	Fuel capacity:	42l
25.	Fuel consumption:	7-10l/h
26.	Separate engine for tilling unit:	No
27.	Transition:	Not given
28.	Cooling system engine:	Integrated oil cooling
29.	Hydraulic oil capacity:	113l

e. Comfort and security

30.	Air conditioning:	—
31.	Operator comfort:	Remote control
32.	Armour:	8mm steel plates
33.	Remote control:	Yes
	• greatest distance:	400m

f. Costs

34.	Cost of system:	US\$85,000
35.	Other costs:	
	• training:	Approx. US\$10,000 subject to country
	• duration of training:	Five weeks
	• spare parts set:	US\$11,500 (for approx. one year)
	• repair costs:	Included in spares subject to the operations, anti-personnel and anti-tank replacement components are included in the spare parts set
36.	Transport limitation:	20ft container
37.	Availability for hire:	Only in Southeast Asia

a) According to the manufacturer.

Technical data sheet Yamanashi BM 307-V 20

a. Dimensional data

1.	Length total:	9,500mm
2.	Maximum reach radius:	8,700mm/1000mm
3.	Width total:	290mm
4.	Working width:	Not given
5.	Height, minimum:	2,970mm
6.	Height, overall:	2,970mm
7.	Mass, basic vehicle:	Not given
8.	Mass, working tool: ^{a)}	Not given
9.	Mass, total:	23,500kg (depending on attachment)

b. Driving specifications

10.	Wheels/ tracks:	Grouser shoe (standard 600mm, optional 700mm)
11.	Ground pressure, max weight:	0.42kg/cm ²
12.	Hill climbing ability:	35°

c. Clearance performance

13.	Number of cutting tools:	40/44
14.	Gap between tools:	Overlapping
15.	Rotation speed:	500rpm
16.	Working depth, max:	300mm
17.	Working speed:	Not given
18.	Control of working depth:	Manual
19.	Machines in use:	3
20.	Other types:	BM 307-S16, BM 307- V2 1W
21.	Location of use:	Afghanistan, Nicaragua
22.	Total area cleared so far:	Not given

d. System specifications

23.	Engine:	Four-cycle water cooled, direct injection
24.	Fuel capacity:	360l
25.	Fuel consumption:	Not given
26.	Separate engine for tilling unit:	No
27.	Transition:	Not given
28.	Cooling system engine:	Water
29.	Hydraulic oil capacity:	170l

e. Comfort and security

30.	Air conditioning:	Yes
31.	Operator comfort:	Suspension seat, radio
32.	Armour:	See general description
33.	Remote control:	No

f. Costs

34.	Cost of system:	Not given
35.	Other costs:	Not given
36.	Transport limitation:	For long distances a low-bed trailer is required
37.	Availability for hire:	Not given

a) According to the manufacturer.

COMPARATIVE ANALYSIS

	BDM 48	Digger 1
a. Dimensional data		
1. Total length:	9,880mm	3,500mm
2. Maximum reach radius:	9,000mm	—
3. Width total:	3,380mm	1,400mm
4. Working width:	1,220mm	200mm
5. Height, minimum:	3,070mm	1,500mm
6. Height, overall:	As per boom position	1,700mm
7. Mass, basic vehicle:	32,000kg	2,200kg
8. Mass, working tool:	1,820kg	500kg
9. Mass, total:	34,000kg	2,700kg
b. Driving specifications		
10. Wheels/ tracks:	Tracks	2 tracks
11. Ground pressure, max weight:	Not given	Approx. 0.7kg/cm ²
12. Hill climbing ability:	35°	35°
c. Clearance performance		
13. Number of cutting tools:	23 cutter bits	44
14. Gap between drums/ chisels/chains:	Overlapping bits	Overlap
15. Rotation speed:	1,900-2,300rpm	500rpm
16. Working depth, max.:	Up to 200mm	Only vegetation cutting above the ground
17. Working speed:		
• light soil/ small vegetation:		3,000m/h ⁽²⁾
• medium soil/medium vegetation:		2,000m/h ⁽²⁾
• heavy soil/ dense vegetation:		600-1,000m/h ⁽²⁾
• in thick underbrush and bamboo:	4-8m ² /min ⁽²⁾	
18. Control of working depth:	Manual	Mechanic
19. Machines in use:	1	1
20. Other types:	Not given	—
21. Location of use:	Thailand	Albania
22. Total area cleared so far:	Not given	Not given
d. System specifications		
23. Engine:	Cummins GT830 (CASE 9040B)	Kubota five-cyl. diesel engine, 2700cc, 46kw
24. Fuel capacity:	310l	Not given
25. Fuel consumption:	Not given	12l
26. Separate engine for tilling unit:	No	No
27. Transition:	—	Not given
28. Cooling system engine:	35l	Not given
29. Hydraulic oil capacity:	216l	120l
e. Comfort and security		
30. Air conditioning:	Not given	—
31. Operator comfort:	Not given	—

Vegetation cutter

M1220/R1820	Komatsu PC 60	Tempest Mk III	BM 307-V 20
6,610mm/8,340mm	6,320mm	3,500mm	9,500mm
1,000mm	6,705mm	1,200mm	8,700mm/1000mm
2,486 mm/2,880mm	2,605mm	1,500mm	290mm
Not given	1,000 mm	Not given	Not given
Not given	2,890 mm	Not given	2,970mm
3,920mm/2,959mm (in transportation mode)	6,715mm	1,500mm	2,970mm
Not given/18,000-20,000kg	10,400kg	Not given	Not given
392kg (for bush cutter head)	500kg	Not given	Not given ^{o)}
Max. 13,500kg	10,900kg	2,700kg	23,500kg (depending on attachment)
4 wheels 8 x 9 – 20 EM (with twin tyres 4 x 600/40 – 22,5/tracks)	Tracks	Steel fabricated wheels	Grouser shoe (standard 600mm, optional 700mm)
Not given/0,32-0,57kg/cm ²	0.4kg/cm ²	Not given	0.42kg/cm ²
Not given	15°	No tests carried out	35°
Not given	40	36	40/44
Not given	6 lines on the circumference	30mm	Overlapping
Not given	2,500rpm	1300rpm	500rpm
5,700 mm/6,600mm (max. digging depth)	Not given	Only vegetation cutting 25mm from the ground	300mm
Not given	Not given		Not given
		600-800m ² /h	
		350-600m ² /h	
		200-350m ² /h	
Not given	Manual	Automatic by skids attached to the flail hood	Manual
1/4	2	9	3
Not given	Bigger and more powerful model is available as well	Not given	BM 307-S16, BM 307-V2 1W
Angola, Balkans	Cambodia	Bosnia and Herzegovina, Cambodia, Thailand	Afghanistan, Nicaragua
Not given	Not given	Not given	Not given
Perkins 1004 – 40 T turbo-diesel engine, four-cyl, 4l, with 75kw/ turbocharged intercooler, 91kw	Komatsu 4D95	Deutz four-cyl. diesel turbocharged engine BF4L1011F/T with 52kw (70hp)	Four-cycle water cooled, direct injection
250l	130l	42l	360l
Not given	6l per hour	7-10l/h	Not given
Not given	No	No	No
Not given	Not given	Not given	Not given
Water cooled	Water cooled	Integrated oil cooling	Water
180l	57l	113l	170l
Optional	Yes	—	Yes
Comfort drivers seat damped against shock wave from mine explosions, vibration damped cab, heating system, other equipment is available as an option	Not given	Remote control	Suspension seat, radio

COMPARATIVE ANALYSIS

	BDM 48	Digger 1
32. Armour:	Not given	10mm hardened steel
33. Remote control:	No	Yes
• greatest distance:		Not given
f. Costs		
34. Cost of system:	Not given	CHF70,000
35. Other costs:	Not given	
• training:		
• duration of training:		
• spare parts set:		CHF10,000
• repair costs:		
36. Transport limitation:	Max. speed on tracks 5km/h. Normally on trailer	Transportation on a trailer is required
37. Availability for hire:	Not given	Yes

a) According to the manufacturer.

Vegetation cutter

M1220/R1820	Komatsu PC 60	Tempest Mk III	BM 307-V 20
DIN 52290-2/DIN 52290-2 class C5 Not given	See general description	8mm steel plates Yes 400m	See general description No
Not given Not given	Not given Not given	US\$85,000 Approx. US\$10,000 subject to country Five weeks US\$11,500 (for approx. one year) Included in spares subject to the operations, anti-personnel and anti-tank replacement components are included in the spare parts set 20ft container	Not given Not given For long distances a low-bed trailer is required
For long distances transportation on a low-bed trailer is required Not given	For long distances transportation on a low-bed trailer is required Not given	Only in Southeast Asia	Not given



Section 6

Sifter

Armtrac Sifter

Armtrac Ltd., United Kingdom



Armtrac Sift & Separation System towed behind an Armtrac 100

General description

The **Armtrac Sifter** is designed for towing behind the Armtrac 100 or other prime movers.

The Armtrac Sifter employs a hydraulically-driven separation system with a low-voltage, high-power magnet to remove metallic objects. The separator has a hydraulic drawbar, fully adjustable to fit on to the Armtrac 100 or other vehicles.

Multi-shares or a single share can be selected to suit different soil conditions. Plough boards are attached to the outer sides to save 60cm in order to limit the sifter transport width.

Working methodology

The hydraulic system has various adjustments for the rotating components to achieve separation in all conditions. Independent pressure relief valves for the star unit and web section prevent stress on the drive-line if the machine is overloaded or becomes jammed.

A combination of steel spiral roller and 5 x 25-40mm-pitch polyurethane star wheels ensure high output whilst maintaining separation. The operating angle of the long separation web can be altered to improve separation and compensate for uneven ground conditions without affecting operating depth or share angle. An upper scrub web improves separation and breaks up clods. Both the web speed and scrubber web pressure pads are hydraulically adjustable.

Wheel track has automatic, self-centering, hydraulically-steered wheels and a steering lock, which enables easy in-file operation.

The speed of the hydraulically-driven 550mm wide cross conveyor is variable to match field conditions. The side traverse ram enables the conveyor to deliver debris and mines into a row for inspection. The system folds hydraulically for transport.

Machines in use to date

- One machine in Bosnia and Herzegovina.

Engine, fuel and oil

- No information provided.

Factory support

- No information provided.

Maintenance and support

- No information provided.

Tests and evaluations

- Not yet tested.



Arntrac sifter in operation

Reported limitations and strengths

Limitations

- No information provided.

Strengths

- No information provided.

MgM Rotar Mk-I

Menschen gegen Minen e.V. MgM, Namibia



MgM Rotar Mk-I sifting suspect soil

General description

The **MgM Rotar Mk-I** is a commercial, off-the-shelf attachment used primarily to separate different sizes of rubble on construction sites. The modified/armoured MgM Rotar is attached to an armoured CAT 916, wheeled front-end loader.

The model chosen by MgM is HPL 1500S with special fittings and customised armour. The Rotar is a cylindrical grid encased by an opening/closing bucket. Ten 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 its Rotar System is able to process approximately 0.3m³ of sandy soil in three to five minutes.

Armour is fitted between the machine and the Rotar. The operator's cab and other vital areas of the vehicle are fully protected with 6mm armour plate and bullet/fragmentation-proof windows. The grid spacing has been modified to 4.5cm x 4.5cm (smaller than the R2M2, a small South African anti-personnel mine). For sandy conditions, solid plate covers around a third of the bucket to prevent the sifting process during movement from the suspect area to the inspection area. 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 machine operates in anti-personnel minefields only.

Due to the armouring and sealing of the operator's cab, an air conditioner is fitted. The MgM Rotar can be separated at the same points as a standard bucket attachment so that other working modules can be fitted.

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 jaw remains closed. As the bucket drops, the spoil within it passes through the grid. Pieces smaller than 4.5cm x 4.5cm sift through it while larger pieces remain within the Rotar. The remaining 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. When the observer sees an item requiring further investigation, tipping is suspended and a visual check is carried out. If a mine or UXO is found in the bed of the tipper, EOD personnel

are notified. The suspect item is then either removed to the demolition pit manually or by the Rotar if the item is considered volatile.

Machines in use to date

- One machine in Namibia.

Engine, fuel and oil

- No information provided by MgM.

Factory support

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

Maintenance and support

- No information provided by MgM.

Tests and Evaluations

The Rotar Mk-I was tested by MgM's own development organisation in Namibia in August-September 1999. The following statements by observers were given:

- "At the end of the clearance by the Rotar, the actual area that had been processed equated to approximately 250 to 300m² against the original mined area of 50m²."²
- "The machine cleared 99 out of 100 mines in four hours and 16 minutes. This time spent for the clearance of 50 square metres is far from satisfactory. The problem of berm creation is the greatest obstacle to effective use of the machine."³
- "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."⁴



The Rotar sifting dry soil

Reported limitations and strengths

Limitations

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

Strengths

- Most of the tools and the vehicle are produced commercially.
- The Rotar performed well against detonation of anti-personnel mines within the bucket.

1. According to the manufacturer.

2. G. T. R. Pritchard, EOD & Mines Consultant, Coral Stand Consultants.

3. Håvard Bach, Head of Operational Methods Section, GICHD.

4. Hans Hashagen, Price Waterhouse Coopers.

Technical data sheet Armtrac Sifter

a. Dimensional data

1.	Length without attachment:	6,700mm
2.	Length total:	1,2000mm
3.	Width without attachment:	2,100mm
4.	Width total:	2,100mm
5.	Working width:	2,100mm
6.	Height, overall:	2,500mm
7.	Mass:	3,600kg

b. Driving specifications

8.	Hill climbing ability:	45°
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c. Working performance

9.	Gab between webs:	10mm
10.	Rotation speed (web):	350rpm
11.	Working depth, max:	400mm
12.	Working speed ^{a)}	
	• light soil/ small vegetation:	1,600m ² /h
	• medium soil/medium vegetation:	1,200m ² /h
	• heavy soil/ dense vegetation:	1,000m ² /h
13.	Machines in use:	1
14.	Location of use:	Bosnia and Herzegovina
15.	Total area cleared so far:	150,000m ²

d. System specifications

16.	Power:	Armtrac/ prime mover PTO
17.	Fuel capacity:	Not given
18.	Fuel consumption:	Not given
19.	Separate engine for sifting unit:	No
20.	Transition:	Not given
21.	Cooling system engine:	Not given
22.	Oil capacity:	Not given
23.	Hydraulic oil capacity:	Not given

e. Comfort and security

16.	Armour:	6mm plates
17.	Remote control:	No

f. Costs

18.	Cost of system:	£52,000
19.	Other costs:	£3,200 (training)
20.	Transport limitation:	Towed or low-loader
21.	Availability for hire:	Yes

a) According to the manufacturer.

Technical data sheet MgM Rotar Mk-I

a. Dimensional data

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

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:	1500l
14.	Rotation speed:	variable
15.	Working depth, max.:	Not given
16.	Working speed:	
	• light soil/ small vegetation:	Approx. 20m ² /h ^{a)}
	• 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.	Total area 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 conditioning:	Yes
30.	Operator comfort:	HF, VHF and HF PGS radio communication equipment
31.	Armour:	6mm plates
32.	Remote control:	No

f. Costs

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

a) Håvard Bach, Head of Operational Methods Section, GICHD.

COMPARATIVE ANALYSIS

	Armtrac Sifter	MgM Rotar Mk-I
a. Dimensional data		
1. Length without attachment:	6,700mm	Not given
2. Length total:	1,200mm	7,380mm
3. Width without attachment:	2,100mm	Not given
4. Width total:	2,100mm	2,904mm
5. Working width:	2,100mm	2,224mm (drum width)
6. Height, overall:	2,500mm	3,400mm
7. Weight, basic vehicle:		7,900kg
8. Weight, attachments:		1,700kg (without screen/hinge plate)
9. Weight, total:	3,600kg	9,600kg
b. Driving specifications		
10. Wheels/ tracks:		4 wheels
11. Ground pressure, max weight:		Not given
12. Hill climbing ability:	45°	
c. Working performance		
13. Gab between webs:	10mm	
14. Capacity of the Rotar:		1500l
15. Rotation speed :	(web) 350rpm	variable
16. Working depth, max:	400mm	Not given
17. Working speed ^{a)}		
• light soil/ small vegetation:	1,600m ² /h	Approx. 20m ² /h ^{b)}
• medium soil/medium vegetation:	1,200m ² /h	Not given
• heavy soil/ dense vegetation:	1,000m ² /h	Not given
18. Machines in use:	1	1
19. Other types		Rotar-II (smaller machine, listed as multi-tool)
20. Location of use:	Bosnia and Herzegovina	Namibia
21. Total area cleared so far:	150,000m ²	
d. System specifications		
22. Power:	Armtrac/ prime mover PTO	Not given
23. Fuel capacity:	Not given	Not given
24. Fuel consumption:	Not given	Not given
25. Separate engine for sifting unit:	No	No
26. Transition:	Not given	Not given
27. Cooling system engine:	Not given	Not given
28. Oil capacity:	Not given	Not given
29. Hydraulic oil capacity:	Not given	Not given
e. Comfort and security		
30. Air conditioning:		Yes
31. Operator comfort:		HF, VHF and HF PGS radio communication equipment
32. Armour:	6mm plates	6mm plates
33. Remote control:	No	No
f. Costs		
34. Cost of system:	£52,000	€192,500
19. Other costs:	£3,200 (training)	Not given
20. Transport limitation:	Towed or low-loader	For long distances a low-bed trailer is required
21. Availability for hire:	Yes	No

a) According to the manufacturer.

b) Håvard Bach, Head of Operational Methods Section, GICHD.

Section 7

Mine-protected vehicles

Casspir MPV with VAMIDS

Mechem, South Africa



Casspir Mine-Protected Vehicle with steel wheels

General description

The **Casspir Mine-Protected Vehicle** has been in service with a number of military forces for 20 years. It is currently in use with South African-based Mechem for mine action.

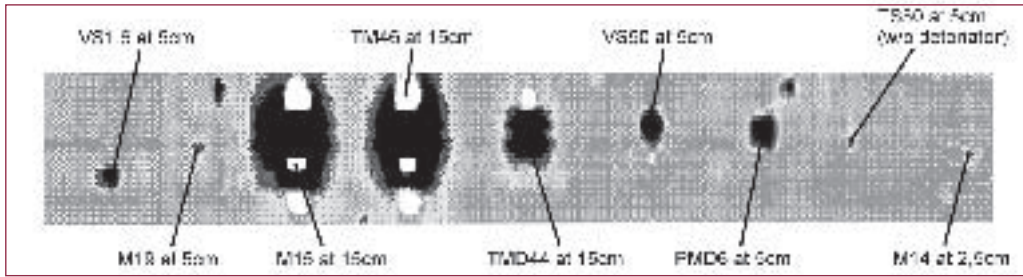
Casspir is a versatile Mine-Protected Vehicle (MPV) successfully adapted to support mine action. Casspir is able to integrate with technical attachments such as the Vehicular Array Mine Detection System (VAMIDS). VAMIDS is used to detect the metal content of sub-surface landmines and UXO. VAMIDS can 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 road wheels for special steel wheels. The steel wheels are specifically designed to withstand detonation of most types of anti-personnel mines, but are not adequate protection against anti-tank mines. Tests have shown the steel wheels to be unaffected by an anti-personnel mine blast.¹ The steel wheels are attachable to Casspir and Tapir MPVs.

Specifications

- Casspir can be employed in multiple roles, e.g. 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 anti-tank mines (up to 21kg of TNT).¹ There is effective ballistic protection up to 7.62mm, as well as shrapnel.¹
- Casspir can be equipped with VAMIDS.
- VAMIDS can detect zones of ground of 2-6 metres in diameter. Paint spray nozzles mark mines or UXO (or areas of interest) while moving up to 10km/h. 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/h.¹
- 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.



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 UXO and mines with a large metal content such as TM 46 and TM 47 (down to approx. 1m in depth). With user experience, false alarms can be reduced.¹

Technical data for VAMIDS system:

One-Meter Flexible Array Segment

Effective detection width:	1,000mm (39.40")
Dimensions:	1,168mm (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 1,000mm (39.40") in width and 27kg (59lbs) for each additional metre of segmented detector head.



Casspir with road wheels

Machines in use to date

- Mechem has 8 Casspir/Tapir vehicles fitted with steel wheels between Croatia and Mozambique.
- More than 10 million square metres of ground covered by steel-wheeled Casspir. Over 10 years, more than 10,000 anti-personnel mines have been detonated by steel wheels without crew injury.

-
- Mechem have employed one Casspir and one Tapir equipped with VAMIDS in Mozambique as well as trials in South Africa since 1997.
 - NPA is using the Casspir with steel wheels in Angola.

Engine, fuel and oil

- Casspir is equipped with a six-cylinder in-line 124kw turbocharged diesel engine.
- 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 220l.

Factory support

For the VAMIDS system:

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

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.

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 repairable 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.

Tests and evaluations

VAMIDS:

- Mechem carried out significant evaluations of the system over a four-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 Mozambique and Croatia.
- Technical tests have been conducted. Results available from Mechem on request. Manufacturer has not provided further information.



Early version of Casspir mounting steel wheels

Reported limitations and strengths

Limitations

Steel wheels:

- Very heavy system requiring special equipment to fit 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.

Strengths

Steel wheels:

- Robust.
- Good for most terrain.
- Claimed to detonate more than 80 per cent 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 directional fragmentation mines.

1. According to the manufacturer.

Wer'wolf MkII MPV

Windhoek Maschinenfabrik (WMF), Namibia



The Wer'wolf MkII Modular Mine Protected Vehicle personnel carrier

General description

The **Wer'wolf MkII Modular Mine and Ballistic Protected Vehicle** (MPV) is the product of collaboration between Military International Ltd. (MIL) of Canada and Windhoek 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 manufacturer with worldwide logistic 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.

Specifications

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

The driver can select tractive effort through four 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 960km on a full tank. Wer'wolf can be driven up gradients of 70% and for its size, has a tight turning circle of 16 metres.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 of TNT) under any wheel and double anti-tank mine blasts (14 kg of TNT) under the hull.

The vehicle defends against IED detonations of 14 kg of TNT, with a stand-off 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).

Machines in use to date

- Approx. 400 vehicles are in service with the Namibian Defence Force.

Engine, fuel and oil

- Wer'wolf MkII is powered by a MAN straight six, turbocharged 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.

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).

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.
- Air pressure point provided inside the engine compartment linked to the vehicle's air pressure system for checking and adjusting tyre pressures and cleaning air filters.

Tests and evaluations

- The Wer'wolf MkII has undergone blast and ballistic tests by the manufacturer in Namibia. Test results are available from MIL Canada and the GICHD.



Wer'wolf after detonation of 14kg of TNT under the front axle

Reported limitations and strengths

Limitations

- Heavy due to extensive protection.

Strengths

- Based on widely-available MAN commercial automotive parts.
- Reliable defence against mine blasts.

1. According to the manufacturer.

Technical data sheet **Casspir as standard personal carrier**

a. Dimensional data

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

b. Driving specifications

7.	Wheels/ tracks:	4 wheels 1,400x20
8.	Ground pressure, max weight:	Not given
9.	Hill climbing ability:	Up to 60% ^{a)}
10.	Maximal speed:	98 km/h
11.	Turning circle diameter:	18,360mm

c. System specifications

12.	Engine:	Six-cylinder in-line 124kw turbocharged diesel engine
13.	Fuel capacity:	220l
14.	Fuel consumption:	25l/h
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
20.	Location of use	Croatia, Mozambique

d. Comfort and security

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

e. Costs

25.	Cost of system:	Not given
26.	Other costs:	Not given
27.	Availability for hire:	Not given

a) According to the manufacturer.

Technical data sheet Wer'wolf MkII

a. Dimensional data

1.	Length total:	6,360mm
2.	Width total:	2,500mm
3.	Height, overall:	2,650mm
4.	Weight, basic vehicle:	9,860kg
5.	Payload:	1,500kg
6.	Gross vehicle mass:	11,360kg

b. Driving specifications

7.	Wheels/ tracks:	Four wheels and one spare, Michelin 365/80R20
8.	Ground pressure, max. weight:	Not given
9.	Hill climbing ability:	Up to 70% on paved roads ^{a)}
10.	Maximal speed:	<ul style="list-style-type: none"> • 125 km/h on paved roads • 90 km/h on hard, even dirt road
11.	Turning circle diameter:	16m

c. System specifications

12.	Engine:	MAN D0826 LF – Euro 2 turbocharged, intercooled diesel engine with 224hp, 6.87l, six-cylinder in-line
13.	Fuel capacity:	240l
14.	Fuel consumption:	25l/h
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:	Six-speed manual – optional automatic transmission, synchronized on all forward gears, six forward and one reverse
	• power take off:	Optional
11.	Vehicles in use:	Approx. 400
12.	Location of use:	Namibia

d. Comfort and security

13.	Air conditioning:	Not given
14.	Operator comfort:	Not given
15.	Armour:	Not given
16.	Remote control:	Optional

e. Costs

17.	Cost of system:	Not given
18.	Other costs:	Not given
19.	Availability for hire:	Not given

a) According to the manufacturer.

COMPARATIVE ANALYSIS

	Casspir	Wer'wolf MkII
a. Dimensional data		
1. Length total:	6,900mm	6,360mm
2. Width total:	2,450mm	2,500mm
3. Height, overall:	2,850mm	2,650mm
4. Weight, basic vehicle:	Not given	9,860kg
5. Payload:	Not given	1,500kg
6. Gross vehicle mass:	10,800kg	11,360kg
b. Driving specifications		
7. Wheels/ tracks:	4 wheels 1,400x20	4 wheels and one spare, Michelin 365/80R20
8. Ground pressure, max weight:	Not given	Not given
9. Hill climbing ability:	Up to 60% ⁽³⁾	Up to 70% on paved roads ⁽³⁾
10. Maximal speed:	98 km/h	• 125 km/h on paved roads • 90 km/h on hard, even dirt road
11. Turning circle diameter:	18,360mm	16m
c. System specifications		
12. Engine:	Six-cylinder in-line 124kw turbo-charged diesel engine	MAN D0826 LF – Euro 2 turbo-charged, intercooled diesel engine with 224hp, 6.87l, six-cylinder in-line
13. Fuel capacity:	220l	240l
14. Fuel consumption:	25l/h	25l/h
15. Tracking/transition:	4x4	Not given
16. Cooling system engine:	Pressurized liquid cooling	Water & ethylene glycol mixture 1:1
17. Oil capacity:	Not given	Not given
18. Hydraulic oil capacity:	Not given	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:		Six-speed manual – optional automatic transmission, synchronized on all forward gears, six forward and one reverse
• power take off		Optional
19. Vehicles in use:	1 (with VAMIDS), 8 Casspir/Tapir with steel wheels	Approx. 400
20. Location of use	Croatia, Mozambique	Namibia
d. Comfort and security		
21. Air conditioning:	Only dual expeller fans	Not given
22. Operator comfort:	Not given	Not given
23. Armour:	Not given	Not given
24. Remote control:	Not given	Optional
e. Costs		
25. Cost of system:	Not given	Not given
26. Other costs:	Not given	Not given
27. Availability for hire:	Not given	Not given

Appendixes



List of manufacturers

Aardvark Clear Mine Ltd

• Aardvark Mk IV, p. 16

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• Viking VMCS, p. 48

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Website: www.haggmo.no

Armtrac Limited

- Armtrac 100, p. 18
- Armtrac 325, p. 92
- Armtrac Siffer, p. 142

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Bofors Defence AB

• Mine-Guzzler, p. 60

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• Oracle, p. 64

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DEMIN – KA d.o.o.

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Demco System, p. 94

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Development Technology Workshops

• **Tempest Mk III, p. 126**

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Fax: +855 23 43 02 38
E-mail: dtw@bigpond.com.kh
Website: www.dtwuk.fsnet.co.uk

Digger DTR

• **Digger 1, p. 120**

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DOK-ING d.o.o.

• **MV-4, p. 10**

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FFG Flensburger Fahrzeugbau GmbH

• **Minebreaker 2000/2, p. 62**

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Website: www.ffg-flensburg.de

FURUKAWA Co. Ltd

• **Furukawa Land Sweeper, p. 96**

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Website : www.furukawakk.co.jp

HADI Maschinenbau GmbH

• **FMR 2000, p. 58**

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Website: www.hadi.at

Hitachi-Furukawa Loaders Europe

S.A.S.

• **Hitachi- Furukawa Mine Clearance Equipment & System**

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France

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Fax: + 33 478 90 09 56
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A/S Hydrema Danmark

• **Hydrema 910 MCV, p. 20**

• **Hydrema M1220 Light armoured and R 1820, p. 122**

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Website: www.hydrema.com

Komatsu Trading, Inc.

• **Komatsu PC 60 Vegetation Cutter, p. 124**

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Tokyo 107-8414
Japan

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Fax: +81 33 587 29 28
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Mechem

• **Casspir MPV, p. 150**

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Fax: + 27 12 803 7189
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MgM Menschen gegen Minen e.V.

•MgM Rotar Mk-I, p. 144

•MgM Rotar Mk-II, p. 98

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Military International Limited

•Wer'wolf, p. 154

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Norwegian Demining Consortium AS -

NoDeCo

•Minecat 230, p. 22

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E-mail: LK_minecat@hotmail.com
Website: www.nodeco.nu

Patria Vehicles Oy

•Patria RA-140 DS, p. 26

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Pearson Engineering

•Pearson Survivable

Demining Tractor and Tools, p. 100

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PRO MAC Manufacturing Ltd.

•BDM 48 Brusher Deminer, p. 118

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Redbus LMDS Limited

•Redbus LMDS, p. 82

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•Rhino, p. 66

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Scandinavian Demining Group AB

•Scanjack 3500, p. 46

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Trademill Mejac & Co.d.n.o.

•Minemill MC 2002, p. 24

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Vilpo d.o.o.

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WAY Industry, a.s.

•Bozena 4, p. 8

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E-mail: sales@way-industry.sk
Website: way-industry.sk

Yamanashi Hitachi Construction

Machinery Co., Ltd

•Rotary Cutter BM 307, p. 128

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Glossary of terms

AMVC	Armoured Mine Clearing Vehicle
APC	Armoured Personnel Carrier
BWB	Federal Office for Defence – Technology and Procurement (Bundesamt für Wehrtechnik und Beschaffung)
CARE	Cooperative 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
DERA	Defence Evaluation and Research Agency (U.K.)
DIN	Deutsche Industrie Norm
DoD	Department of Defense (U.S.)
DRES	Defense Research Establishment Suffield
EEP	External Power Pack
EOD	Explosive Ordnance Disposal
e.V.	registered society (eingetragener Verein)
FACS	Flail Assembly Control System
FFG	Flensburger Fahrzeugbau Gesellschaft
GICHD	Geneva International Centre for Humanitarian Demining
GmbH	Gesellschaft mit beschränkter Haftung
GSCS	Ground, Sift & Clear Systems
HALO	Hazardous Area Life Support Organisation
HPU	Hydraulic Power Unit
IED	Improvised Explosive Device
ISO	International Standards Organization
ITEP	International Test and Evaluation Program
KMMCS	Krohn Mechanical Mine Clearance System
LCD	Liquid Crystal Display
LMDS	Land Mine Disposal System
MAG	Mines Advisory Group (NGO)
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
OCU	Operator's Control Unit
PTO	Power Take-Off
RF	Radio Frequency
RUAG	Rüstungsunternehmen Aktiengesellschaft
SDTT	Survivable Demining Tractor and Tools
SFD	Swiss Federation for Mine Clearance
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
TNT	Trinitrotoluene
UN	United Nations
UNOCHA	United Nations Office for the Coordination of Humanitarian Assistance to Afghanistan
UNMAS	United Nations Mine Action Service
UXO	Unexploded Ordnance
VAMIDS	Vehicular Array Mine Detection System
VCU	Vehicle Control Unit
VHF	Very High Frequency
WMF	Windhoeker Maschinenfabrik
WTD	Defence Technology Agency (Wehrtechnische Dienststelle)



Geneva International Centre for
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