Mechanical

Demining Equipment

Catalogue 2010

GICHD | CIDHG

The Geneva International Centre for Humanitarian Demining (GICHD) strives for a world free of anti-personnel mines and from the threat of other landmines and explosive remnants of war, and where the suffering and concerns of populations living in affected areas are addressed. The Centre is active in research, provides operational assistance and supports the implementation of the Anti-Personnel Mine Ban Convention.

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All photographs have been provided by the respective manufacturers.

MECHANICAL DEMINING EQUIPMENT | CATALOGUE 2010

JANUARY 2010

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FOREWORD

The *Mechanical Demining Equipment Catalogue 2010* is the eighth edition of this publication, produced by the Geneva International Centre for Humanitarian Demining (GICHD). The Catalogue provides an overview of the mechanical demining equipment that is currently available to the humanitarian mine action community. The publication has received positive feedback from readers to date.

All assets used for humanitarian demining must have proven reliability and the decision about which assets to employ is still a key element in planning a demining operation. A balanced use of both mechanical and manual assets leads to cost-effective demining and to the safe return of cleared land to communities. However, the past has shown that mechanical demining equipment only contributes to the efficiency and effectiveness of technical surveys and of mine clearance when combined with comprehensive training of staff.

This Catalogue describes three categories of machines: mine clearance machines, ground preparation machines and mine protected vehicles – as defined by the *International Mine Action Standards (IMAS) on Mechanical Demining 09.50* and referred to in the GICHD *Handbook of Mechanical Demining* (2008).

In addition, the Catalogue's introduction includes a checklist of guidelines for purchasing mechanical demining machines. Our newly published *'A Guide to Contracting in Mine Action'* (2009) is also relevant for those considering major procurement of equipment.

Further information on available tests and evaluations of machines can be found at www.itep.ws as well as on the GICHD website. From mid-2010, all ITEP-related material will be posted on the GICHD website.

All of our publications can be requested free of charge, or downloaded, from the GICHD website www.gichd.org

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Ambassador Stephan Husy
Director
Geneva International Centre for Humanitarian Demining

CATEGORISATION OF MECHANICAL DEMINING MACHINES AND A BUYER'S CHECKLIST

This chapter describes the categorisation of mechanical demining machines, and concludes with a "buyer's checklist" intended to help people considering the purchase or leasing of specific machines. The checklist is not exhaustive.

Categorisation of Mechanical Demining Machines

The International Mine Action Standards on Mechanical Demining 09.50 are available at the website: www.mineactionstandards.org.

The IMAS divide mechanical demining machines into three categories: mine clearance machines, ground preparation machines and mine protected vehicles. This categorisation is used as the structure for this edition of the Catalogue. Where a single machine could be assigned to either "mine clearance" or "ground preparation", it has been allocated to the "mine clearance machines" category. This category is further differentiated by type of machine (flails, tillers, flail and tiller combined, sifters, rollers) as well by weight in each category.

The GICHD *Mechanical Demining Handbook* (2008), clarifies the categorisation of demining machines described above, as well as showing the variety of applications in the field.

Demining machines in mine action are broadly used to do three things:

- destroy mines
- prepare ground[1] (and destroy mines but not in all cases)
- act as a platform for another application

Often an individual demining machine can be used to do all three things. For example, a consequence of using a ground engaging tool such as a flail may be the destruction of mines, the removal of vegetation and the loosening of soil. Also, if the prime mover is fitted with a magnet it would also be the platform for an additional application. More commonly when a machine is used as a platform it is understood that arrays of detectors or sensors are mounted.

Following these three broad purposes for use, demining machines are divided into three general design categories:

- mine clearance machines (light, medium and heavy systems)
- ground preparation machines (light, medium and heavy systems) including vegetation cutters (attachments to a tractor or excavator)
- mine protected vehicles (which are commonly adapted ex-military personnel carriers, but the category includes vehicles such a tractors with added armour)

The categories are thus derived from the design intent or use intent.

Machines can be further sub-categorised into:

- intrusive to the mined area – designed to work inside the mined area
- non-intrusive – designed to work from a safe area "reaching into" the mined area
- remote operated – designed to work remotely from the driver/operator position either intrusively or non-intrusively
- driver operated – designed to be controlled by a driver/operator in a cab either intrusively or non-intrusively

Machines in all categories are normally designed with armoured protection for both the operator and component parts/areas of the machine.

Common tasks

The table overleaf provides a general, non-definitive summary of the tasks normally associated with the three machine categories. There is a lot of task crossover, particularly between mine clearance and ground preparation machines.

Tasks slide into one another and the operator will know that area reduction, technical survey, verification, vegetation cutting, ground preparation and land release can be occurring concurrently when a machine is used in a specific area.

The table is presented to help thinking about what task or tasks a machine could or should be doing at a site.

Mine clearance machines (light, medium and heavy systems)

Mine clearance machines are those machines whose stated purpose is the detonation, destruction or removal of landmines.[2] For example, a front-end loader, armoured and adapted to excavate mined ground, can be designated as a mine clearance machine because the definition includes the removal of mines.

The use of a mine clearance machine may mean that follow-on processes can be reduced or eliminated. Not following up a mine clearance machine with a secondary process to finish the removal and destruction of all targets is unusual, but circumstances do exist where the machine used will have cleared all mines.

What these circumstances are will be derived from rigorous testing against target mine types in specific conditions. It may be established that a machine, for example a flail, engaging a specific mine type will detonate all functioning mines of this type without the machine being damaged or its capability degraded. If it is known that the contaminated site contains only the specific mine type which the machine is known to detonate, a case could be made for there being no requirement to follow on with a secondary clearance process. A simple visual inspection of the area may be sufficient.

The main mine clearance machine designs are:

- flails
- tillers
- combined tiller & flail systems
- dual capability of either a tiller or a flail
- rollers
- civil or military plant machinery that has been adapted for mine clearance or removal

Ground preparation machines (light, medium and heavy systems)

Ground preparation machines are primarily designed to improve the efficiency of demining operations by reducing or removing obstacles.

Ground preparation may or may not involve the detonation, destruction or removal of landmines. Ground preparation machine tasks include:

- vegetation cutting and clearing
- removal of tripwires
- loosening the soil
- removal of metal contamination
- removal of building debris, boulders, rubble, defensive wire obstacles
- sifting soil and debris

CATEGORISATION OF MECHANICAL DEMINING MACHINES AND A BUYER'S CHECKLIST

MECHANICAL DEMINING

Machine category	Common machine tasks
Mine clearance machines (light, medium and heavy systems) Specifically designed > Flails > Tillers > Combined systems flail & tiller > Dual capability flail or tiller > Rollers Adapted > Earth movers/front-end loaders > Rotary sifter systems	> Area reduction > Cancellation > Inspection > Land release > Mechanical mine clearance > Quality control procedures > Removal of metal contamination > Removal of buildings debris, boulders, rubble, defensive wire obstacles, etc. > Risk reduction > Road clearance > Road hazard (threat) reduction > Sifting of soil and debris > Soil loosening > Tripwire removal > Technical survey > Vegetation cutting > Vegetation clearance > Vegetation removal > Verification[3]
Ground preparation machines (light, medium and heavy systems) Multi-tools (attachments to a tractor or excavator): > Flail head > Tiller head > Magnet > Tree excavator > Soil disrupter > Rotary mine comb > Lift and grab > Rotary systems > Constructional engineering equipment tools > Adapted farming implements	
Ground preparation machines (light, medium and heavy systems) Vegetation cutters (attachments on a tractor or excavator): > Mower > Rotary mower > Reach mower > Brush cutter > Mulcher > Slasher > Flail > Tiller > Rock crushers > Sifters	
Mine protected vehicles	> Inspection > Mine clearance > Risk reduction > Road hazard (threat) reduction > Road clearance

Mine protected vehicles (MPV)

MPV are vehicles specifically designed to protect the occupants and equipment from the effects of a mine detonation.

In mine action, the designation MPV is associated with vehicles that may have been originally designed as armoured military personnel carriers.

MPV are commonly used during survey and detection operations (often on roads), where they may carry equipment such as detector arrays or vapour sampling devices, or they may push or pull a roller.

MPV equipped with steel wheels can be used for hazard reduction, technical survey and area reduction. MPV with steel wheels have also been used in the process of inspecting excavated soil.[4]

Further reading on the subject of armouring can be found in the GICHD 2004 study, *Mechanical Application in Mine Clearance*, Chapter 5: The protection of vehicles and plant equipment against mines and UXO.

A checklist for buying a demining machine

This checklist has been assembled from several sources, including the experiences of the GICHD mechanical demining team, and is offered to help those thinking about buying or leasing a demining machine.

Need

- What is the identified need for a machine?
- Is there a large number of potential target sites for the machine?
- Will the machine speed the achievement of national objectives?
- What difference will a machine make?

Capabilities

- Is there an existing machine (or several variations of type) in the market with the right capabilities for the task required?
- What is the productivity of the machine?
- Will the machine be used in support of manual deminers or mine detection dogs (MDD), or will manual deminers and MDD be in support of the machine?
- What are the differences between the various manual, animal and mechanical capabilities?
- How many personnel will be needed to support/follow-on the work of the machine?
- What are the annual costs of balanced supporting/follow-on assets – manual deminers, MDD or other?
- What is the working life of the machine – five years, ten years?
- What climatic factors will impact on the machine – heat, dust, rain, etc?

CATEGORISATION OF MECHANICAL DEMINING MACHINES AND A BUYER'S CHECKLIST

Capital cost

- What is the purchase cost of the machine(s)?
- Will the machine need to be armoured?
- What are the costs of armouring the machine?
- Does the machine need to be adapted?
- Has the adaptation been done before?
- What is the cost of the adaptation?

Establishment and running costs

- Will a specialised operator be required?
- How much operator training will be required?
- What is the cost of operator training?
- What is the maintenance regime for the machine?
- Will an internationally qualified mechanic be required?
- What is the annual cost of a qualified mechanic?
- How many other supporting mechanics will be needed?
- What is the training requirement?
- What will be the annual salary costs for mechanics?
- What are the annual costs of maintenance and spares parts?
- How easily are spares sourced – is the machine built with common parts?
- Are there parts suppliers or maintenance facilities in the country?
- What spares package and support is the machine supplier offering?
- What is the warranty period for the machine?
- What are the annual fuel costs?
- Will machine maintenance schedules need to be adjusted because of climatic factors?
- What will be the annual costs of maintenance adjustments?
- Does the frequency range of remote controlled units interfere with other operators (eg military forces) in the area?

Further support costs

- Can fuel be purchased easily in the country or region?
- Will a fuel truck need to be purchased to support the machine in some parts of the country?
- Will a low-loader or lorry be required to transport the machine between sites?
- What are the maintenance and running costs of the fuel truck and low-loader?
- Will a mobile workshop be required?
- What is the cost of a mobile workshop vehicle and tools?
- What are the main maintenance and running costs of the workshop?
- What maintenance and training package does the manufacturer provide?
- Is the infrastructure (rail, road and bridges) of the country good enough to enable the machine to be transported between sites?
- Will additional operations planners be required?
- Will additional operations planning vehicles be required?
- What are the costs of additional operational planning?

Importation

- What rules govern importation of the machine or in-country purchase? (For example, can a machine be imported if it is second hand?)
- What will be the costs of shipping the machine to the operational theatre?
- What country of origin/manufacture rules govern the export of the machine?
- What is the manufacture and delivery timeline?
- Will the delivery date coincide with the optimal season for machine use?

Quantity

- Will one machine be sufficient?
- Will two or more machines give measurable advantages and cost savings over the medium term?

Quality

- What test and evaluation needs to be done?[5]
- How much will the evaluation process cost?
- Can it be done safely in-country?
- Has it been done before?

Funding

- Are funds available to purchase the machine(s)?
- Are funds available for the running and support costs associated with the machine?
- Is funding likely to be sustainable for a number of years?
- When does the break-even point occur between machine use and the alternative of continued operations without a machine?

Other

- Is there a potential other use for the machine after its use in mine action?

CATEGORISATION OF MECHANICAL DEMINING MACHINES AND A BUYER'S CHECKLIST

If it is decided to obtain a machine, the following should be considered when negotiating the contract.

- What are the warranty conditions – and when does the period start?
- Can the machine be commissioned and delivered in-country (thus providing a guarantee from the manufacturer that the machine is working) and does the commissioning include a field trial?
- What spare parts package is included in the contract?
- Is delivery insurance for the machine included in the contract?
- Can the contract payment be in instalments (eg 30% on contract signature, 30% when the machine leaves the factory and 40% when commissioning/acceptance is completed)?
- Are technical manuals and operators handbook available in the desired language?
- Can a penalty agreement for late delivery of the machine be included?
- What factory/manufacturer support will be available?
- What service agreement on major services is available?
- Can a training package for both mechanics and operators be provided by the manufacturer?
- What are the competency standards of manufacturer's personnel giving support in-country?

ENDNOTES

1 Preparing ground includes vegetation cutting.

2 IMAS 09.50 First Edition, 12 October 2006.

3 Verification is the act of establishing that a suspected hazardous area is mined, thus this could also be described as technical survey.

4 RONCO Bagram Airfield, Afghanistan 2005.

5 The European Committee for Standardization (CEN) Workshop Agreement 15044 on "Test and evaluation of demining machines" sets out a mine action industry agreement on how machines could be tested and evaluated.

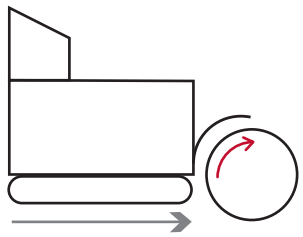
TECHNICAL NOTES

1. Equipment listed in the Catalogue is referred to as mechanical demining equipment. The Catalogue deals solely with demining by civilian organisations, although military forces also use some of the equipment featured.

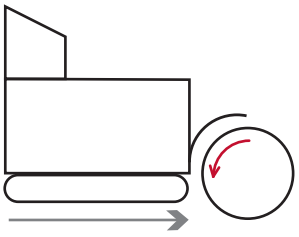
2. Systems using chains on a rotating drum or shaft are referred to as flails.

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 with one exception, the Mini MineWolf.

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:



DIRECTION OF TRAVEL | CLOCKWISE



DIRECTION OF TRAVEL | ANTI-CLOCKWISE

5. The varying weights of machines make it sensible to place them in three categories: light (up to 5 tonnes); medium (5-20 tonnes); and heavy (20 tonnes or more)[1]

6. "Anti-personnel" is abbreviated to AP throughout, while "anti-tank" and "anti-vehicle" are abbreviated to AT and AV. A full list of abbreviations is given in Appendix B.

7. The following abbreviations are used in the text and in data sheets:

cm	centimetres	kg	kilograms
cyl	cylinder	kg/cm^2	kilograms per square centimetre
ft	feet	km	kilometres
ha	hectares	km^2	square kilometres
hp	horsepower	kPa	kilo Pascal
km/h	kilometres per hour	kw	kilo watt
l	litres	mm	millimetres
l/h	litres per hour	mpg	miles per gallon
m^2	square metres	N	Newton (energy of ground strike)
m^2/h	square metres per hour	rpm	revolutions per minute
m^3	cubic metres	t	tonnes

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

ENDNOTES

[1] European Committee for Standardisation, CEN Workshop Agreement (CWA) 15044:2004 (E), Test evaluation of demining machines, Bruxelles, April 2004, p. 5.

MINE CLEARANCE MACHINES

WAY Industry J-s Co. | Slovak Republic

GENERAL DESCRIPTION

The *Bozena 4* is a remotely controlled mine clearance system using a light flail machine. It is manufactured by Way Industry which has invested significantly in R & D of the system since the Bozena 1 was introduced in 1995. (The company's Bozena 5 medium flail machine is described in the next sub-section.)

The Bozena 4 is designed for clearance of both AP and AT mines with up to 9 kg of TNT. It is also capable of removing tripwires, and vegetation up to about 4 m high.

The vehicle is controlled by an operator from either an air-conditioned cabin placed in line of sight or in the open air by means of a transmitter with a range of up to 5,000 m.

The chassis is primarily constructed as wheel-type, but manoeuvrability can be enhanced by easily mountable tyre tracks which can be supplied with each machine. Recent developments include a solution of fixed-track system (similar to dozer under-carriages).

The main protection against blast and flying debris is the armoured shield, attached behind the flail shaft. The hood (see picture) serves as the "dust cover" for the prime mover. The prime mover's internal parts are further protected by 4 mm ARMOX steel, additionally supported by LEXAN polycarbonate glass on the most vital parts.

The machine can process up to 2,500 m^2/h, depending on the ground and terrain conditions. Internal fire safety is improved with an automatic fire-extinguisher system.

The Bozena 4's versatile design allows it to go beyond mechanical demining for various engineering tasks and humanitarian support. A total of 19 various tool attachments – including blades, shovels, buckets, drilling machine, hydraulic hammer, concrete mixer, excavator – can be fitted to the prime mover. Detachment of the flail and attachment of another tool takes approximately five minutes.

BOZENA 4

CLEARANCE METHODOLOGY

Hammers at the end of 38 chains rotate clockwise at around 400 rpm and penetrate the ground down to 250 mm, depending on soil and terrain. The flail design ensures a dynamical overlap of the hammers. AP and AV mines may be destroyed either by their activation, or by direct mechanical destruction. The machine is capable of destroying dense vegetation, including tree trunks up to 20 cm diameter.

A hydraulic winch helps recovery when stuck in field situations.

MACHINES IN USE TO DATE

There are more than 80 units of the Bozena 4 and together more than 160 Bozena systems in service with humanitarian and military customers. The machine is integrated into the armed forces of several countries (including NATO) and is in use in following countries: Afghanistan, Albania, Angola, Azerbaijan, Bangladesh, Bosnia and Herzegovina, Cambodia, Canada, Colombia, Croatia, Czech Republic, Eritrea, Ethiopia, Iraq, Kenya, Kosovo, Lebanon, the Netherlands, Niger, Poland, Slovakia, Sri Lanka, Sudan and Thailand.

ENGINE, FUEL AND OIL

The latest version of the Bozena 4 contains the 157 hp Deutz diesel engine with direct fuel injection and air-cooling. The engine serves for both the prime mover and the flail unit and its energy is transferred hydrostatically. Fuel consumption is estimated at 13.1 litres per hour. Fuel tank capacity is 140 litres, which is enough for one full-working day of operation.

FACTORY SUPPORT

The Deutz engine and the Bosch-Rexroth hydraulic components are well-known brands with worldwide servicing networks so spares can be easily obtained.

In addition, Way Industry offers to supply customers with any kind of spare part, service or logistic support.

The following training packages are offered:

- initial operator's training (two weeks)
- initial mechanic's training (one to two weeks)
- advanced electrician's training (one to two weeks)
- on-the-job training/support (for desired period, usually four to 12 months)

Each machine is delivered with a full set of technical documentation, including the spare parts catalogue, operation/maintenance/diagnostic manuals.

Prices of particular support and spare parts packages depend on selected composition and location and can be obtained on request to the manufacturer.

MAINTENANCE AND SUPPORT

The producer recommends at least a two-man crew: ideally an operator and mechanic trained by the manufacturer. Procedures for preventive and corrective maintenance (daily, weekly, monthly) are fully covered in supplied documentation and can be easily done by trained crew. Any set of spare parts for any project type and duration can be supplied on request. The manufacturer can also provide specialised staff (from operators and mechanics to mechanical demining team leaders) with many years of mechanical demining experience worldwide.

On-site technical and logistic support, 24-hour call-out or e-mail support can be ordered.

TESTS AND EVALUATIONS

The Bozena 4 has passed many survivability and performance tests which have proved its capabilities to effectively detonate or destroy all types of AP and AV mines up to 9 kg TNT charged in various types of soil and terrain conditions. See: www.way-industry.sk/eng/index.php?b=bozena4&c=test_reports

The following test reports are available at the ITEP website:

- G. C. Coley, D. J. Roseveare, P.G. Danielsson, T.T. Karlsson, S. M. Bowen, L. M. Wye, F. C. A. Borry, *Demonstration Trial of Bozena-4 and MV-4 Flails*, by Defence Research and Development Canada (DRDC), 2007; www.itep.ws/pdf/NairobiFinal.pdf
- C. Coley, F. Borry, *In-country trial of the Bozena-4 and MV-4 mini-flails*, by ITEP, 2007; www.itep.ws//pdf/NairobiTrialArticle.pdf
- Geoff Coley, Machine Demonstration Analysis and Preliminary Results, International Symposium "Humanitarian Demining 2007" 24 - 27 April 2007, Šibenik, Croatia, 2007; www.itep.ws//pdf/MachineDemoSibenik2007_Coley.pdf
- G.G. Coley and R.W. Fall Defence R&D Canada – Suffield, Maj P.G. Danielsson SWEDEC, P.W. Blatchford and L.M. Wye QinetiQ, Way Industries Bozena-4 Flail Test and Evaluation, Defence Research and Development Canada, Canada, 2005; www.suffield.drdc-rddc.gc.ca/reports/English/DRDC_Suffield_TR_2005-138.pdf
- C. Leach, BOZENA 4 *Mini Mineclearance System Assessment Phase 1*, by QinetiQ, 2004; www.itep.ws//pdf/Bozena_4_Phase1_Report.pdf

BOZENA 4 | Flailing

REPORTED LIMITATIONS AND STRENGTHS

Limitations

- Difficult to operate with precision from distances over 200 m. (This applies to all remotely controlled machines.)
- System creates huge dust clouds, as occurs with all flail systems in dry environments.

Strengths

- Resistance to AV mines (up to 9 kg TNT) without significant damage (20 min repair time)
- There is a variety of engineering working tools available.
- It has a well-designed cooling system (reducing breakdowns due to overheating).
- Well-designed armoured coating ensures good protection of vital parts, even against AV mine blasts.
- Winch for self recovery fitted.
- Transportation of the machine is simple. It is easy to handle with a light low-bed trailer.
- Good results are achieved in forested and space-limited areas due to small size.

BOZENA 4

DIMENSIONAL DATA

1. Length without attachment	3,305 mm
2. Length total	5,280 mm
3. Width without attachment	1,985 mm
4. Width total	2,840 mm
5. Clearing | Working width	2,225 mm
6. Height | Overall	2,270 mm
7. Mass | Basic vehicle	4,890 kg (with no tracks; with standard tyres)
8. Mass | Detachable unit(s)	1,407 kg
9. Mass | Overall	6,983 kg (with tracks, tyres and flail unit)

OPERATIONAL DATA

10. Wheels | Tracks (description)	Wheeled | tracked (tracks easily detachable by the crew, mounted on foam-filled tyres)
11. Ground Bearing Pressure (kPa)	
> Tracks	0.66 kg/cm^2
> Front Wheels	2.82 kg/cm^2
> Rear Wheels	1.46 kg/cm^2
12. Hill climbing ability (in degrees)	25°
13. Number of Chains | Chisels | Tools	38 hammers
14. Beat Pattern (hits per m^2) at different operating speeds	Not given
15. Length of Chains | Tools	Chain 400 mm; chain with hammer 470 mm
16. Diameter of drum	1,400 mm
17. Rotation Speed	300 - 400 rpm
18. Clearance | Working depth in varying terrain	Up to 25 cm, depending on speed and terrain
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	2,500 m^2
> Medium Soil | Medium Vegetation	1,100 m^2
> Heavy Soil | Dense Vegetation	520 m^2
20. Control of Clearance | Working depth	a. adjustable height of flail skids b. boom hydraulic control
21. Additional attachable working tools	Blades, shovels, buckets, drilling machine, hydraulic hammer, concrete mixer, excavator etc
22. Armour	a. 4 mm / 6 mm ARMOX steel plates strengthened by b. LEXAN polycarbonate plates (engine, remote control, hydraulic system)
23. Remote controlled	Yes
> +greatest distance	5,000 m
24. Transportation	
> Short distances	Self transportable (up to 9 km/h; harmless to tarmac surface)
> Long distances	Recommended to use the special BOZENA 4 trailer
> Sea transport	Whole BOZENA 4 system can be packed in one 40 ft container,
> Air transport	Transportable by cargo aircrafts (C130 or similar) transportable by helicopter (hooked up on steel ropes)

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	80 (over 160 of all models in use)
26. Other types	Bozena 1, Bozena 2, Bozena 3, Bozena 5
27. Location of use	Afghanistan, Albania, Angola, Azerbaijan, Bangladesh, Bosnia and Herzegovina, Cambodia, Canada, Colombia, Croatia, Czech Republic, Chile, Eritrea, Ethiopia, Iraq, Kenya, Kosovo, Lebanon, Niger, Poland, Slovakia, Sri Lanka, Sudan, Thailand, The Netherlands
28. Totally cleared so far (m^2)	More than 100,000,000 m^2

ENGINE | FUEL | OIL

29. Engine	DEUTZ, 4-Stroke, turbocharged diesel with direct fuel injection, air cooled, 6 cylinders
30. Engine power at the flywheel	110 kw (157 hp) at 2,500 rpm
31. Sufficient power supplied to working tool	Not given
32. Fuel capacity	140 l
33. Fuel consumption	13.1 l/h
34. Separate engine for working unit	No
35. Cooling system	Air cooled
36. Oil capacity of engine	18.0 l
37. Hydraulic oil capacity (both engines)	165 l

COSTS

38. Cost of system	On request
39. Other costs	
> training	On request (possible in country of operation or in Slovenia)
> spare part set chains | belts	a. basic set of spares included b. various sets of spare parts available - tailored for specific projects and environment
> repair costs for one year	Not given
40. Availability for hire	Yes

OTHER

41. Operator comfort	Protective, air-conditioned cabin with power generator provides safety and high comfort for the operator during demining operation
42. Air conditioning	Yes, (separated mine-protected monitoring cabin)

DOK-ING d.o.o. | Croatia

GENERAL DESCRIPTION

The DOK-ING *MV-4* is a remotely-controlled, tracked mine clearance system designed for the destruction of AP mines and unexploded ordnance. It is produced by DOK-ING in Croatia, a company with extensive humanitarian mine clearance field experience.

The MV-4 is remotely controlled within a range of 3,000 m and has a standard working width of 1,725 mm. The machine can be controlled by an operator using a portable control panel, or from a second armour-protected tracked vehicle. The machine is small and light, suited for mine clearance and vegetation cutting in built-up areas, forests or in other areas unsuitable for larger machines such as domestic gardens or woodland. The low ground pressure makes the machine suitable for operations on wet ground. The driving engine and other vital parts of the machine are protected by Swedish Hardox 400 armoured plates 8-10 mm thick.

The light weight of the machine ensures rapid deployment. The machine can be loaded onto an ordinary truck or trailer. For transport over large distances, the machine and all necessary spare parts and accessories can be packed into a standard 20 ft ISO shipping container. The MV-4 is fitted with four "eye-hook" lifting points for helicopter transport, and is certified for the Helicopter Sling Load (HSL) and for the Fixed Wing Airlift.

MV-4 | In action

CLEARANCE METHODOLOGY

The standard tool for clearance tasks is the flail unit. On request, the MV-4 can be also equipped with the tiller unit, roller unit, blade unit or the special gripper unit. The MV-4 flail unit rotates at up to 900 rpm, achieving a ground penetration depth from 240 mm to 320 mm, depending on soil conditions. Ground penetration is based on the impact force of the 34 flail hammers. The chains and hammers can quickly be replaced in case of damage or wear and tear. According to the manufacturer, a specially designed system keeps the clearing depth constant. The system is effective against vegetation and trees up to 50 mm in diameter. The action of the flail is intended to detonate or break up AP mines. A 10 mm steel shield hoods the flail unit to protect the chassis.

The flail unit can be rotated both clockwise and anti-clockwise. The machine can pass over ditches 0.5 m wide and 0.3 m deep. The MV-4 can operate in steeply inclined terrain both transversely and longitudinally. Flailing can be done on transverse slopes of 35° up and down, driving on transversal slopes of 45° up and down, flailing longitudinal slopes of 20°, and driving on longitudinal slopes of 35°.

The MV-4 tiller unit can be used as an alternative to the flail, depending on project requirements. The tiller has 52 specially designed steel teeth which can break up or detonate AP mines up to a depth of 25 cm.

The MV-4 blade unit is an exchangeable tool attachment that can be used for specific clearance-related tasks, such as: working soil containing explosives, removal or destruction of improvised explosive devices, clearing hazardous roadblocks, removal of vehicles.

The MV-4 roller unit provides less disturbance to soil and can be used for different mine-related tasks and missions, such as mine proofing, fast area reduction, and area or route clearance. The roller unit is mounted on the front of the MV-4 prime mover and is pushed through and over the designated area. It consists of a series of roller segments that individually "float" on uneven ground.

The MV-4 gripper unit is a special additional tool for the MV-4 designed to: penetrate walls and vehicles; cut barbed wire; move small devices, UXO, vehicles, fuel drums. It is especially designed for clearance of improvised explosive devices.

MACHINES IN USE TO DATE

To date, 92 MV-4 Mine Clearance Systems have been purchased by various organisations/demining companies, including:

Armed Forces

- US Army - 38 units operating in the USA, Afghanistan and Iraq
- Swedish Army – five units operating in Sweden
- Croatian Army – two units operating in Croatia
- Irish Army – two units operating in Ireland
- Sri Lankan Army – four units operating in Sri Lanka
- Greek Army – one unit operating in Greece
- Colombian Navy Marines - one unit operating in Colombia

National Mine Action Authorities

- Croatian Mine Action Centre (CROMAC) – four units operating in Croatia
- Iraqi National Mine Action Authority (NMAA) – four units operating in Iraq
- Azerbaijan National Agency for Mine Action (ANAMA) – one unit operating in Azerbaijan

Humanitarian Non-Governmental Organisations

- Norwegian People's Aid (NPA) – two units operating in Croatia and Sri Lanka
- Swiss Foundation for Mine Action (FSD) – one unit operating in Sri Lanka
- United Nations World Food Programme (UNWFP) – four units operating in Sudan

Commercial Demining Companies

- Mechem Consultants – four units operating in the Democratic Republic of Congo and South Korea
- REASeuro Worldwide – one unit operating in Croatia
- DIZ-EKO – two units operating in Croatia
- DOK-ING Demining – six units operating in Croatia and Bosnia and Herzegovina
- AVANGARD – one unit operating in Croatia
- ENIGMA – two units operating in Croatia and Bosnia and Herzegovina
- RGComercial – one unit operating in Colombia
- SEDITA – one unit operating in Angola
- TITAN – one unit operating in Croatia
- ISTRAŽIVA – two units operating in Croatia

ENGINE, FUEL AND OIL

The MV-4 can be equipped with the Perkins 1106 C-E60 TA modified diesel engine (129 kw/175 hp) or with the Perkins 1106D-E66 TA (186 kw/250 hp). No special fuel or oil is required. The fuel tank capacity is 70 litres, and the hydraulic oil capacity is 300 litres. Fuel consumption is from 15 to 25 litres per hour (depending on soil conditions and operating scenario).

FACTORY SUPPORT

The major components not produced by DOK-ING – such as the engine (Perkins) and hydraulics (Rexroth Bosch) – are from major international manufacturers and spare parts can be easily obtained worldwide.

DOK-ING has its own in-house service capabilities and can send a team at short notice to any location in the world.

DOK-ING maintains adequate stocks of spare parts – both those produced by DOK-ING and outsourced components.

Instruction manuals are available in Croatian, English and Spanish, and translation into the customer's language is possible. Manuals and documentation are part of the purchase package. Basic training of operators and mechanics is provided by the manufacturer and is free of charge. The warranty is provided for 12 months. General support service is provided by the manufacturer.

Additional equipment available includes additional tool attachments, up-armour kit, and video system.

MAINTENANCE AND SUPPORT

The manufacturer recommends daily inspections, monthly maintenance and a major annual inspection. One operator/mechanic is required for operation and maintenance.

TESTS AND EVALUATIONS

Croatian Mine Action Centre, *Testing of MV-4 Mine Clearing Machine*, Sisak, Croatia, May 2002.

Swedish Armed Forces, Swedish EOD and Demining Centre (SWEDEC), Defense Forces, Göta Engineer Regiment, *Final Report – Machine for removal of anti-personnel mines MV-4*, Eksjö, Sweden, November 2002.

Swedish Defence Materiel Administration (FMV), Combat Vehicles and Mobility Directorate, Test Centre, *Testing of the cooling capacity of the light vehicle for clearance of antipersonnel mines*, Skövde, Sweden, August 2003.

JämtTeknik, *System Safety Work for MV-4 MAPMCS*, Sweden, October 2003.

U.S. Army Aberdeen Proving Ground, *Detailed Test Report for the Production Qualification Test (PQT) for Electromagnetic Environmental Effects, Safety Release on the MV-4 Mini Flail*, Aberdeen, MD, USA, March 2004.

U.S. Army Yuma Proving Ground, *Final Test Report for the DOK-ING MV-4 Mechanical Anti-Personnel Mine Clearing System Assessment Test*, Yuma, Arizona, USA, April 2004.

Swedish Armed Forces, Swedish EOD and Demining Centre (SWEDEC), *MV-4 Test and Evaluation – Survivability Test*, Eksjö, Sweden, July 2004.

Department of the Air Force, Headquarters Aeronautical Systems Center (AFMC), Wright-Patterson Air Force Base, *Airlift Certification of the MV-4 Mine Clearing System (MAPMCS)*, Wright Patterson AFB, Ohio, USA, October 2004.

Department of the Army, US Army Research, Development and Engineering Command, Natick Soldier Center, *Helicopter Sling Load (HSL) Certification for the MV-4 Robotic Mine Flail*, Natick, MA, USA, June 2005.

Croatian Mine Action Centre, Centre for Testing, Development & Training (CROMAC-CTDT), *Testing of the MVR-1 – Roller Tool Attachment*, Sisak, Croatia, July 2005.

Department of the Army, Headquarters, US Army Developmental Test Command, *Safety Confirmation for DOK-ING MV-4 Mechanical Anti-Personnel Mine Clearing System (MAPMCS) in Support of Field Use*, Aberdeen Proving Ground, MD, USA, August 2005.

Croatian Mine Action Centre (CROMAC), Demining Machine Testing Committee: *Possible Effects of Tested Demining Machines, Appendix to CROMAC SOP 03.01: Efficiency Assessment of Technical Survey and Demining*, 2007.

Test reports are available at the websites:
www.itep.ws or www.hcr.hr or www.ctro.hr, or directly from the producer.

MV- 4

The following test reports are available at the ITEP website:

1. G. C. Coley, D. J. Roseveare, P.G. Danielsson, T.T. Karlsson, S. M. Bowen, L. M. Wye, F. C. A. Borry, *Demonstration Trial of Bozena-4 and MV-4 Flails*, by Defence Research and Development Canada (DRDC), 2007: www.itep.ws/pdf/NairobiFinal.pdf
2. C. Coley, F. Borry, *In-country trial of the Bozena-4 and MV-4 mini-flails*, by ITEP, 2007: www.itep.ws//pdf/NairobiTrialArticle.pdf
3. Geoff Coley, Machine Demonstration Analysis and Preliminary Results, International Symposium "Humanitarian Demining 2007" 24 - 27 April 2007, Šibenik, Croatia, 2007: www.itep.ws//pdf/MachineDemoSibenik2007_Coley.pdf
4. G. Danielsson, *Flail Hammer Head Test and Evaluation*, by SWEDEC, 2005: www.itep.ws//pdf/Flail_hammerhead_testreport.pdf
5. I. Steker, *Testing of the MVR-1 Roller Tool Attachment*, by Croatian Mine Action Centre - Centre for Testing, Development and Training (CTDT/CTRO), 2005: www.ctro.hr/eng/MVR-1%20Roller%20Tool%20Attachment%20Test%20Report.pdf
6. I. McLean, R. Sargisson, J. Dirscherl, H. Bach, *Throwing out mines: effects of a flail*, by GICHD, 2005: www.gichd.org/fileadmin/pdf/publications/Throwing_Out_Mines_Nov2005.pdf
7. Armed Forces Gota Engineer Regiment, *Final Report - Test and Evaluation of Machine for Removal of Anti-personnel Mines MV-4*, by SWEDEC, 2002: www.itep.ws//pdf/GotaEngineerALL.pdf

MV- 4 | With flail unit

REPORTED LIMITATIONS AND STRENGTHS

Limitations

- Difficult to operate with precision from long distance. (This applies to all remotely controlled machines.)
- System with attached flail creates huge dust clouds, as occurs with all flail systems in dry environments.

Strengths

- Easy to transport on a light trailer.
- The small size of the machine allows for flexible deployment.
- Maintenance and repair can easily be made in field conditions.
- Remote controls are simple to use.
- Powerful engine.
- Well-designed engine cooling system.
- High quality armour for vital parts of the machine.
- High quality steel for chains and hammers.

MV- 4

DIMENSIONAL DATA

1. Length without attachment	3,005 mm
2. Length total	4,455 mm
3. Width without attachment	1,530 mm
4. Width total	2,015 mm
5. Clearing | Working width	1,725 mm
6. Height | Overall	1,470 mm
7. Mass | Basic vehicle	4,110 kg
8. Mass | Detachable unit(s)	flail attachment: 1,200 kg gripper attachment: 900 kg roller attachment: 2,200 kg tiller attachment: 1,500 kg blade attachment: 500 kg
9. Mass | Overall	5,310 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Metal tracks, 300 mm width
11. Ground Bearing Pressure (kPa)	0.43 kg/cm^2
12. Hill climbing ability (in degree)	
> Longitudinal | Clearing	20°
> Longitudinal | Driving	35°
> Transversal | Clearing	35°
> Transversal | Driving	45°
13. Number of Chains | Chisels | Tools	34 chains; 10 or 12 roller segments; 58 tiller teeth
14. Beat Pattern (hits per m^2) at different operating speeds	Not given
15. Length of Chains | Tools	330 mm
16. Diameter of drum	900 mm
17. Rotation Speed	0 - 900 rpm
18. Clearance | Working depth in varying terrain	Up to 320 mm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	2,184 m^2
> Medium Soil | Medium Vegetation	1,896 m^2
> Heavy Soil | Dense Vegetation	944 m^2
20. Control of Clearance | Working depth	Automatically adjusted
21. Additional attachable working tools	Roller, blade, gripper
22. Armour	8, 10, 15 HARDOX 400 armour plates
23. Remote controlled	Yes
> greatest distance	3,000 m
24. Transportation	
> short distances	Road speed of 5 km/h
> long distances	6 t truck, 6 t trailer,
> sea transport	20 ft container,
> air transport	CH47 Helicopter

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	92
26. Other types	MV-4 MVR, MV-4 MVB, MV-4 MVG, MV-4 MVT
27. Location of use	Afghanistan, Angola, Azerbaijan, Bosnia and Herzegovina, Colombia, Croatia, DR Congo, Ireland, Iraq, Liberia, Serbia, Sri Lanka, Sudan, Sweden, USA
28. Totally cleared so far (m^2)	Approx. 40,000,000 m^2

ENGINE | FUEL | OIL

29. Engine	Perkins 1106C-E60 TA modified Optional: Perkins 1106D-E60 TA- 186 kw (250 hp)
30. Engine power at the flywheel	129 kw (175 hp)
31. Sufficient power supplied to working tool	140 hp
32. Fuel capacity	70 l
33. Fuel consumption	15 - 25 l per hour
34. Separate engine for working unit	No
35. Cooling system	Water cooled
36. Oil capacity of engine	15 l
37. Hydraulic oil capacity (both engines)	200 l

COSTS

38. Cost of system	On request
39. Other costs > training > spare part set chains | belts > repair costs for one year	
40. Availability for hire	Yes

OTHER

41. Operator comfort	N/A
42. Air conditioning	N/A

Digger DTR Demining Technologies | Switzerland

GENERAL DESCRIPTION

The *Digger D-2* is a light-weight, remotely-controlled multi-tool mine clearance vehicle developed by the Swiss NGO, Digger DTR. This organisation has 11 years of technical background in mechanical demining, acquired through the development of a vegetation cutter for mine clearance, (Digger D-1) and a multi-tool machine for mine clearance (Digger D-2). Digger DTR has five years of field experience, mainly acquired during tests and operational engagement in North and South Sudan and in Macedonia.

The vehicle consists of an armoured, V-shaped hull made of 10 mm hardened steel which minimises the damage caused by AP mines or UXO detonations. Both the tracks and all air intake latticing around the Digger D-2 are armoured, to make operation possible in vegetation clearance tasks where the ground was not previously touched by the flail. The flail can be used for both AP and tripwire mine clearance and vegetation cutting.

Through a Caterpillar Quick Coupler, every standard Caterpillar tool (such as a shovel) can be attached to the front of the D-2. This makes the vehicle highly versatile.

The system is remotely controlled from 50 m to 500 m range by an operator placed behind a shield in the line of sight. The remote control system is shock-, slash- and dust-proofed and displays data from the vehicle.

Despite its rugged design the machine should not operate in areas where many AV mines are expected.

DIGGER 2 | Operating along runway

CLEARANCE AND CUTTING METHODOLOGY

The rotor on the flail unit operates at approximately 800 rpm, using 26 chains with hardened steel hammers to remove AP mines and vegetation. Clearance depth can be mechanically adjusted from 0 to 200 mm. Depth control is achieved mechanically and hydraulically through an arms pressure regulation system, which guarantees the flail skids at a constant light pressure on the ground, which can be adjusted by the operator according to soil conditions.

Digger D-2 arms can be raised up to 4 m from the ground, allowing the flail to cut any kind of high and dense vegetation.

The Digger's forward speed can be adjusted between 0.03 km/h and 5 km/h, allowing working speeds from 300 to 2,000 m^2 per hour. A forward speed regulation allows the machine to work always at the most suitable speed.

MACHINES IN USE TO DATE

The Digger D-1 has been used in Switzerland by the Swiss Army to cut vegetation on a military training field with UXO contamination.

One Digger D-2 has been in use in Sudan since early 2006. After six months of testing in September the machine was integrated into a Swiss Foundation for Mine Clearance (FSD) demining team, which was accredited by the UN in October 2006. After accreditation, the Digger D-2 was operated in different areas in Northern Sudan, until the FSD programme ended in June 2007. Despite some unavoidable breakdowns due to extreme working conditions (dust, hard soil, heat), the prototype was never blocked for more than three days. After these tests, the machine was recommended by the UN in Sudan for other mine clearance programmes in Sudan.

This prototype continues to work with Mines Advisory Group in Northern Sudan in 2008.

Series production of the machine began in 2006. The first serial production unit was sold in summer 2007 to The Development Initiative (TDI), which works for the UN around Juba, South Sudan. The unit began working in October 2007 and stopped one year later after the unexpected termination of TDI's contract with the UN.

ENGINE, FUEL AND OIL

The Digger D-2 is equipped with a 4.5 litre, 140 hp John Deere turbo-diesel engine which is cooled by a double heat exchanger and uses a three-stage air filtration system. Fuel capacity is 115 litres with a maximal fuel consumption of 22 litres per hour. The engine oil capacity is 17 litres. Hydraulic fluid capacity is 160 litres. All lubricants can be changed easily through openings in the hull and quick-coupler connections, in order to simplify maintenance.

FACTORY SUPPORT

The Digger D-2 can be delivered with an initial spare parts kit, containing all most-used parts. The manufacturer also offers a "wearing parts kit", which is specifically adapted to each place of operation. Engine parts can also be provided through the international John Deere retailer network. If desired by the customer, Digger DTR provides basic drawings of some parts, such as track links, thus allowing the operator to make field repairs which can reduce breakdown time when supplies are restricted.

Initial training can be provided at the Digger DTR facility in Switzerland or at the client's operation base.

All technical manuals and training material are available in English and are included in the D-2 package.

Digger DTR's experienced technicians provide technical support throughout the world. If available, a Digger technician can be hired by the customer, paid by the user at standard international staff conditions.

DIGGER 2 | Operating from behind shield

MAINTENANCE AND SUPPORT

Daily/weekly servicing is required (30 min/two hours). Recommended crew: one operator (remote control), with basic mechanical skills. The machine can be delivered in a 20 ft container, with complete workshop equipment.

DIGGER 2 | Testing

TESTS AND EVALUATIONS

The D-2 prototype was tested by Digger in Sudan in 2006. After Digger's own tests, it was tested by FSD according to their specific performance trial. The D-2 met all requirements, with the exception of the track system, which had to be improved. With this improvement made, the prototype was accepted by the FSD for their programme in Sudan.

Two other test reports are available on the ITEP website:

1. Chris Leach and G.G. Coley, Pre-Trial Assessment of Digger D2, Defence Research Development Canada, Canada 2006: www.itep.ws//pdf/DiggerD2_PTAfinal.pdf
2. Patrik Blomander, DIGGER D-2 Test and Evaluation, Swedish EOD and Demining Centre, Sweden, 2009: www.itep.ws//pdf/DiggerD2_CWAfinal.pdf

REPORTED LIMITATIONS AND STRENGTHS

Extracts from the Swedish EOD and Demining Centre report include:

"The machine was tested with both flail and tiller. …The Digger D-2 with flail triggered or neutralised 447 out of 450 mines, 99 % of the targets. Of the 447 mines 416 were triggered and 31 mines neutralised with live fuzes. 3 mines were left live and intact.

"When the machine was using the tiller, it triggered or neutralised 429 out of 450 mines, 95% of the targets. Of the 429 mines 372 were triggered and 58 mines neutralised with live fuze. 20 mines were left live and intact.

"The variation of speed and problem with maintaining the right depth penetration are the main reasons for a low result of triggered mines. …It was almost the same penetration with flail or tiller. The machine has always been clearing to the required depth and deeper than strictly necessary. The tendency to clear deeper than necessary depends probably on a lack of depth control system.

"The survivability test was performed in two steps. At first the machine was tested with flail and after that with tiller. The target used during the test was the Swedish Anti-Tank Mine 41/47 boosted with 2.25 kg of plastic explosive, giving a total equivalent of 8 kg of TNT. The result was that both flail and tiller shafts were so damaged that further clearing was not possible, but the frame of the tool was not affected. The machine itself showed no damage."

Limitations

- The system is designed to operate in AP mine-affected areas only.
- Difficult to operate with precision from greater distances (which applies to all remotely controlled machines).
- The system creates huge dust clouds, as occurs with all flail systems in dry environments.

Strengths

- Manoeuvrable and easy to transport.
- Can be transported in a 20 ft container.
- Above-average hill-climbing ability.
- Light-weight and rugged design.
- Versatile.

DIMENSIONAL DATA

1. Length without attachment	3,730 mm
2. Length total	5,400 mm
3. Width without attachment	1,660 mm
4. Width total	2,250 mm
5. Clearing | Working width	1,800 mm
6. Height | Overall	1,920 mm
7. Mass | Basic vehicle	6,200 kg
8. Mass | Detachable unit(s)	1,000 kg
9. Mass | Overall	7,200 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Steel fabricated tracks | Mobile running wheels
11. Ground Bearing Pressure (kPa)	62 kPa
12. Hill climbing ability (in degrees)	30°
13. Number of Chains | Chisels | Tools	38 chains
14. Beat pattern (hits per m^2) at different operating speeds	8,400 hits per m^2 at 0.1 km/h 168 hits per m^2 at 5 km/h
15. Length of Chains | Tools	390 mm
16. Diameter of drum	Axle 170 mm Flail with chains 950 mm
17. Rotation Speed	700 rpm
18. Clearance | Working depth in varying terrain	Up to 200 mm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	2,000 m^2/h
> Medium Soil | Medium Vegetation	800 m^2/h
> Heavy Soil | Dense Vegetation	300 m^2/h
20. Control of Clearance | Working depth	Mechanically, arm pressure regulation
21. Additional attachable working tools	—
22. Armour	Hull 10 mm hardened steel R/C operator shield: shield with FB4 or FB6 ballistic protection norm
23. Remote controlled	Yes
> greatest distance	500 m
24. Transportation	
> short distances	
> long distances	International 20 ft container
> sea transport	Local: Ideally on a 6x6 truck, with palletized loading system
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	3
26. Other types	Digger D-1, Digger D-3
27. Location of use	North and South-Sudan, Macedonia
28. Totally cleared so far (m^2)	More than 200,000 m^2 (stated on June 2009)

ENGINE | FUEL | OIL

29. Engine	John Deere, Turbo Diesel, 4 cylinder
30. Engine power at the flywheel	104 kw / 140 hp
31. Sufficient power supplied to working tool	85 kw
32. Fuel capacity	115 l
33. Fuel consumption	22 l/h
34. Separate engine for working unit	No
35. Cooling system	Liquid cooling
36. Oil capacity (both engines)	17 l
37. Hydraulic oil capacity (both engines)	160 l

COSTS

38. Cost of system	On request
39. Other costs	On request
> training	
> spare part set chains | belts	On request
40. Availability for hire	Yes

OTHER

41. Operator comfort	N/A
42. Air conditioning	N/A

Aardvark Clear Mine Ltd | United Kingdom

GENERAL DESCRIPTION

The Aardvark was introduced in 1985, since when approximately 240 machines of all variants have been sold worldwide. The latest model is the *Aardvark Mk 4* which has been in production since 2001 as a medium mechanical flail.

The latest Aardvark Mk 4-H is a chain flail system designed to destroy AP and AV mines while cutting vegetation.

The machine uses a half-track platform giving it greater traction and stability in difficult terrain but can be operated on wheels in suitable terrain accessible to wheeled vehicles.

Wheels can replace the tracks if the machine is required to transport itselfover moderate distances. 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 substantial vehicle engine/hydrostatic transmission system. The Mk 4 is controlled by one or two operators seated in a fully air-conditioned and armoured cab. The joystick steering control (dual steering) can be switched from one operator to the other. Dual steering enables an operator to switch position if wind direction and dust obscures sight. A situational awareness system is fitted to aid operation and training. 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.

AARDVARK MK 4

CLEARANCE METHODOLOGY

During clearance operations, the vehicle moves rear-end-first into a suspect area. The flail component has an operational clearance width of 3 m, and to a maximum ground penetration depth of 600 mm. The ground penetration depth is adjusted by an automatic contouring and depth control system, with "lock-out" for hard surface clearance.

The system is designed to tackle 150 mm-diameter trees and dense vegetation.

The interchangeable flail/implement drum rotates at approximately 300 rpm. The manufacturer states that the flail unit will detonate or break up mines.

The flail can be rotated in either direction to aid in runway and other hard surface clearance operations. The flail is hydraulically driven.

AARDVARK MK 4

MACHINES IN USE TO DATE

The manufacturer says that 180 Mk III and 40 Mk 4 machines are currently in use worldwide. Most have been bought by national armed forces, including those of Angola, Bangladesh, Canada, Egypt, France, Italy, Iran, Ireland, Jordan, Korea, Libya, Morocco, Pakistan, Saudi Arabia, Sweden, the UK and the US (Air Force, Army and Marines).

ENGINE, FUEL AND OIL

The Aardvark Mk 4 has a single 350 hp turbocharged Caterpillar engine using standard diesel or JP8 fuel. Oil used in the engine and hydraulic systems is of a standard type used by agricultural/construction machines around 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 and other languages as required and are part of the sales package. Translation into the customer's language is possible if required.

A large parts inventory is maintained at the factory and spare parts can be shipped at short notice. The warranty covers one year from the date of delivery to final destination. Aardvark recommends a minimum of one-month's training for users and maintenance staff either in the UK or at a location chosen by the customer. The company also offers other support, including personnel for extended operations and long-term maintenance packages.

MAINTENANCE AND SUPPORT

Regular maintenance comprises 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 by Aardvark and/or CAT technicians.
The British Defence Evaluation and Research Agency (DERA) has stated that a lot of effort has gone into making the Mk 4 more maintenance-friendly.

Daily preventive maintenance checks and service takes a maximum of 45 minutes with two staff.

TESTS AND EVALUATIONS

Three test reports are available at www.itep.ws:

1. Aardvark Mark IV Joint Services Flail Unit (MKIV), Capabilities Demonstration, United States Army Communications-Electronic Command Research, Development & Engineering Center, Fort Belvoir, Virginia 22060-5806, Night Vision & Electronic Sensors Directorate DoD Humanitarian Demining Research & Development Programme, USA, 2002: www.itep.ws/pdf/aardvark.pdf
2. Area Mine Clearing System, Study Report, BRTRC Technology Research Cooperation, US Army, Project Manager for Close Combat Systems (PM - CCS), 2002: www.itep.ws//pdf/AMCSStudyReport.pdf
3. Evaluation of Aardvark Mk IV Flail, C.A Leach, Defence Evaluation and Research Agency (DERA), UK, 2001: www.itep.ws/pdf/aardvark_trial_report.pdf

REPORTED LIMITATIONS AND STRENGTHS

Limitations

- The system creates huge dust clouds, as occurs with all flail systems in dry environments.
- Visibility can become difficult for the operators.

Strengths

- The Aardvark Mk 4 is a mature product and incorporates all the lessons learnt from 24 years of safe operation.
- Simple mechanism.
- Spare parts readily available.
- Air transportable in a Hercules C-130 aircraft when the flail and the air filter are removed.
- High degree of operator safety.
- Good manoeuvrability.

DIMENSIONAL DATA

1. Length without attachment	5,969 mm
2. Length total	8,769 mm
3. Width without attachment	2,580 mm
4. Width total	3,556 mm
5. Clearing | Working width	3,000 mm
6. Height | Overall	3,632 mm (2,670 mm without air intake)
7. Mass | Basic vehicle	11,284 kg
8. Mass | Detachable unit(s)	4,140 kg
9. Mass | Overall	15,694 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Both (2 wheels/half-tracks, or 4 wheels)
11. Ground Bearing Pressure (kPa)	Not given
12. Hill climbing ability (in degrees)	35°
13. Number of Chains | Chisels | Tools	72
14. Beat pattern (hits per m^2) at different operating speeds	Every piece of ground will be struck at least twice
15. Length of Chains | Tools	100 cm
16. Diameter of drum	232 cm
17. Rotation Speed	Approx. 300 rpm
18. Clearance | Working depth in varying terrain	Up to 580 cm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	2,500 m^2/h
> Medium Soil | Medium Vegetation	1,200 m^2/h
> Heavy Soil | Dense Vegetation	300 m^2/h
20. Control of Clearance | Working depth	Automatic contouring, with 'LOCK-OUT' override
21. Additional attachable working tools	
22. Armour	60 mm protected glass and 10 mm armoured steel
23. Remote controlled	Optional
> greatest distance	5,000 m
24. Transportation	
> short distances	Flat bed/plant trailer/drops truck,
> long distances	USAF CERTIFIED, C130, C17, C5 aircraft,
> sea transport	own wheels (4)
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	220
26. Other types	No
27. Location of use	26 countries worldwide
28. Totally cleared so far (m^2)	Not given

ENGINE | FUEL | OIL

29. Engine	Caterpillar 6 cylinder in-line turbo diesel engine
30. Engine power at the flywheel	350 hp
31. Sufficient power supplied to working tool	Not given
32. Fuel capacity	500 l
33. Fuel consumption	42 - 62 l/h (circa 10 hours work)
34. Separate engine for working unit	No
35. Cooling system	Air and pressurised cooling system
36. Oil capacity (both engines)	25 l
37. Hydraulic oil capacity (both engines)	355 l (hydrostatic transmission and flail drive)

COSTS

38. Cost of system	On request
39. Other costs	
> training	Yes, operators and mechanics
> spare part set chains | belts	Not given
> repair costs for one year	Not given
40. Availability for hire	Yes with full support package

OTHER

41. Operator comfort	Blast attenuated seats, dust filtration, headphones, dual controls, situational awareness system
42. Air conditioning	Not given

Armtrac Ltd. | United Kingdom

GENERAL DESCRIPTION

The *Armtrac 75* is a multi-tool machine with both a demining and construction capability. The machine is lightweight, with compact four-wheel drive and crab steer which can optionally be used as a flail or a tiller for mine action. In construction mode the Armtrac 75 uses a four-in-one bucket to load trucks and to level or grade roads. Forklift tines can be fitted. This function is useful for site preparation and for unloading equipment without the need for additional machinery. The Armtrac 75t is the remote-controlled version (see page 46).

ARMTRAC 75 flail cleaning over ramp

The Armtrac 75 is designed for the destruction of AP and AV mines and the survivability has been tested against a 6 kg AV mine. No large damage occurred. This lightweight multi-purpose system has a capability, according to the manufacturer, of clearing from 530 m²/h in heavy soil up to 1,700 m²/h in light soil. It is particularly suitable for work in restricted and difficult sites as it can turn 360° without moving off its position. It can also operate on slopes up to 40°. The Armtrac 75 is operator driven or can be remote controlled within a range of 750 m. The cabin is air-conditioned, complete with four-point safety harness and sprung seat with neck restraints as standard. The cabin also has an escape hatch.

Vital parts of the machine are well protected, eg the cabin by 10 mm armour and 45 mm safety glass and the engine by 6 mm armour.

Fire suppression systems are fitted to all Armtracs, in the engine bay, hydraulic bay and cabin. The system operates automatically or manually.

The flail or tiller unit is attached to the machine's telescopic boom and can be dismounted and mounted via a quick release system within five minutes. This boom will extend up to 2.6 m allowing demining activities to take place at a safe distance from the operator's cab. With the boom extended and by using the tilt arm, Armtrac says that deep craters and riverbanks down to 2 m can be cleared of vegetation and UXO. A fork-lift bucket and a sifting bucket can be easily fixed to the telescopic boom making it useful for a variety of demining applications.

The machine can be transported by road on a standard truck or in a C-130 aircraft.

CLEARANCE METHODOLOGY

The Armtrac 75's flail and tiller system has a 2 m clearance path, but a 2.5 m flail system can be fitted. The flail's 36 chains or 54 chisels rotate at 350 rpm achieving a claimed clearance depth for the tiller of 30 cm and for the flail 28 cm in light soil. Cruise control and automatic depth control is fitted.

The achieved performance of vegetation cutting in low vegetation is 1,700 m²/h, 1,000 m²/h in medium vegetation and 750 m²/h in high vegetation. The flail attachment should be used in mined areas which are likely to contain AV mines. The tiller attachment is recommended when operating in AP-only minefields. Roller systems are also available. Performance speed using the roller system is 10 km/h.

MACHINES IN USE TO DATE

One machine has been in service in Lebanon for three years.

ENGINE, FUEL AND OIL

The machine is equipped with a 165 hp diesel engine. No special fuel or oil is required. The fuel capacity is 240 litres and the hydraulic oil capacity is 300 litres. According to the manufacturer the fuel consumption is from 25 to 37 litres per hour during operations (depending on soil conditions).

FACTORY SUPPORT

The manufacturer/supplier provides spare parts over a 12-month period. Most components are provided by companies operating worldwide which ensures the availability of spare parts. Armtrac also holds the whole range of spare parts in stock at any time.

The manufacturer recommends a two-week training course for mechanics and drivers. Training can be provided in the host country or at Armtrac's training school in the UK. With the purchase of two or more machines training is free of charge for six months.

Manuals and documentation are part of the purchase package and available in Arabic English and French. The system is covered by a 12-month or 1,000-hours warranty and factory follow-up.

With the purchase of two or more machines Armtrac offers the services of an engineer and a service vehicle in-country for an initial 12 months free of charge. The cost of a set of working tools is based on the customer requirements. The spare parts catalogue is available on memory stick or paper hard copy

MAINTENANCE AND SUPPORT

The level of maintenance is as per manufacturer's recommendation. Maintenance schedules as found in the manual can vary according to working conditions. A one-hour daily check and a two-hour weekly service are recommended.

Initial 50 hour and 300 hour services will be carried out by a qualified Armtrac service engineer. A basic workshop complete with welder, generator and tools is adequate for on-site maintenance. Armtrac recommends that the system is operated and maintained by two operator/mechanics.

TESTS AND EVALUATIONS

One test report is available at www.itep.ws:

1. Peter Blatchford & Chris Leach, Armtrac 75 Assessment Phase 1, QinetiQ, UK, 2004: www.itep.ws/pdf/Armtrac75_phase1_final.pdf

The Armtrac 75 has undergone trials carried out by the Lebanon Army, which keeps reports on the performance of the machine. These reports are available from Armtrac.

REPORTED LIMITATIONS AND STRENGTHS

Limitations

- Difficult to operate with precision from greater distances in remote-controlled mode. (This applies to all remotely controlled machines.)
- The flail system creates huge dust clouds, as occurs with all flail systems in dry environments.

Strengths

- High manoeuvrability.
- Combines flail and tiller systems.
- The machine is lightweight.
- Versatility.
- The machine is air transportable.

DIMENSIONAL DATA

1. Length without attachment	3,200 mm
2. Length total	4,700 mm
3. Width without attachment	1,960 mm
4. Width total	2,580 mm
5. Clearing | Working width	2,200 mm
6. Height | Overall	1,970 mm
7. Mass | Basic vehicle	6,720 kg
8. Mass | Detachable unit(s)	1,500 kg
9. Mass | Overall	8,220 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Wheels with foam filled tyres
11. Ground Bearing Pressure (kPa)	Not given
12. Hill climbing ability (in degrees)	45°
13. Number of Chains | Chisels | Tools	36 chains | 54 chisels
14. Beat pattern (hits per m^2) at different operating speeds	Not given
15. Length of Chains	Chains 1,000 mm
16. Diameter of drum	(tiller 1,200 mm) (flail 2,200 mm)
17. Rotation Speed	350 rpm
18. Clearance | Working depth in varying terrain	Maximum 40 cm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	1,700 m^2/h
> Medium Soil | Medium Vegetation	1,000 m^2/h
> Heavy Soil | Dense Vegetation	750 m^2/h
20. Control of Clearance | Working depth	Not given
21. Additional attachable working tools	Multi purpose bucket/blade, forklift tines, back hoe, standard bucket
22. Armour	10 mm ARMOX and 37 mm glass to 7.6 (NATO Ball)
23. Remote controlled	Remote controlled up to 750 m
> greatest distance	
24. Transportation	
> short distances	By low bed trailer or in a container
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	3
26. Other types	Armtrac 75T, Armtrac 100, Armtrac 200, Armtrac 400, Armtrac sifter, Armtrac strimmer
27. Location of use	Lebanon
28. Totally cleared so far (m^2)	Not given

ENGINE | FUEL | OIL

29. Engine	DEUTZ engine
30. Engine power at the flywheel	165 hp
31. Sufficient power supplied to working tool	Not given
32. Fuel capacity	240 l
33. Fuel consumption	25 - 37 l/h
34. Separate engine for working unit	No
35. Cooling system	Water cooled
36. Oil capacity (both engines)	7 l
37. Hydraulic oil capacity (both engines)	300 l

COSTS

38. Cost of system	On request
39. Other costs	
> training	On request
> spare part set chains | belts	On request
40. Availability for hire	On request

OTHER

41. Operator comfort	Suspension seat, four point safety harness
42. Air conditioning	Yes

Armtrac Ltd. | United Kingdom

GENERAL DESCRIPTION

The *Armtrac 75t* is a multi-tool machine with both demining and construction capabilities. It is operated by remote control and has the same specifications as the Armtrac 75, except that it is a tracked vehicle. Frame and chassis is fully welded, frame-type section utilising off-the-shelf JCB components with bolted on tracks. Survivability was tested against the Belgium PRB M3 AV-mine containing 6 kg of explosive and no serious damage occurred.

The Armtrac 75t is able to operate in heavy/wet ground conditions due to its high ground clearance. Track cruise control and automatic depth control are fitted.

The Armtrac 75t remote control has a range of 750 m. A remote cabin can be provided for the operator. The cabin can be moved by using the Armtrac 75t quick pick-up hitch system. Fork lift tines and bucket can be supplied as optional extras.

The machine can be transported by road on a standard truck or in a C-130 aircraft.

ARMTRAC 75 tiller

WORKING METHODOLOGY

The Armtrac 75t comes with a flail or tiller system. The flail or tiller unit is attached to the machine's telescopic boom. This telescopic arm can extend to 2.6 m and pick up a weight of 1,000 kg, or 2,000 kg when retracted. The end of the telescopic arm has a crowd-and-tilt assembly with a quick-hitch system – allowing a flail, tiller or rollers to be changed within five minutes.

The Armtrac 75t's flail and tiller system has a 2 m clearance path, but a 2.5 m flail system can be fitted. The flail's rotors are designed to withstand bounding fragmentation AP and AV mines and the flail/tiller tools have a rotation speed up to 350 rpm. Clearance depth in light and heavy soil conditions are set at 30 cm during operations. The tiller tool has 48 chisels and the flail system 48 chains. The manufacture recommends using the flail system for rocky conditions and the tiller tool for vegetation cutting and in sandy conditions. The achieved performance of vegetation cutting in low vegetation is 1,700 m²/h, 1,000 m²/h in medium vegetation, and 750 m²/h in high vegetation.

The Armtrac 75t can clear areas up to a rate of 1,700 m²/h in light soil and can operate on slopes longitudinal up 45° and transversal up 22°.

The system is lightweight and the control box is simple to use. An automatic depth control is incorporated which allows the operator to concentrate on the machine's direction.

MACHINES IN USE TO DATE

The Armtrac 75t is under full production and four machines have been in service for one year.

ENGINE, FUEL AND OIL

The machine is equipped with a Deutz BF4M1013FC 125 hp diesel engine. No special fuel or oil is required.

The fuel capacity is 376 litres and the hydraulic oil capacity is 400 litres. According to the manufacturer, fuel consumption is from 25 to 35 litres per hour during operations (depending on soil conditions).

OTHER CATEGORIES

Factory support and maintenance are comparable with the Armtrac 75.

No test reports are yet available for the 75t. Performance reports are available from the manufacturer.

TECHNICAL SPECIFICATIONS	ARMTRAC 75 T

DIMENSIONAL DATA

1. Length without attachment	3,700 mm
2. Length total	5,200 mm
3. Width without attachment	1,800 mm
4. Width total	2,580 mm
5. Clearing | Working width	2,200 mm
6. Height | Overall	2,400 mm
7. Mass | Basic vehicle	7,000 kg
8. Mass | Detachable unit(s)	1,500 kg
9. Mass | Overall	8,500 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Tracked
11. Ground Bearing Pressure (kPa)	N/A
12. Hill climbing ability (in degrees)	45°
13. Number of Chains | Chisels | Tools	48 chains | 48 chisels
14. Beat pattern (hits per m^2) at different operating speeds	
15. Length of Chains	Chains 100 cm
16. Diameter of drum	(tiller 1,200 mm) (flail 2,200 mm)
17. Rotation Speed	350 rpm
18. Clearance | Working depth in varying terrain	Maximum 40 cm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	1,700 m^2/h
> Medium Soil | Medium Vegetation	1,000 m^2/h
> Heavy Soil | Dense Vegetation	750 m^2/h
20. Control of Clearance | Working depth	40 cm
21. Additional attachable working tools	Multi purpose bucket/blade, forklift tines, back hoe, standard bucket
22. Armour	6 mm ARMOX
23. Remote controlled	Remote controlled up to 750 m
> greatest distance	
24. Transportation	
> short distances	By low bed trailer or by sea in a container
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	3
26. Other types	Armtrac 100, Armtrac 200, Armtrac 400
27. Location of use	Lebanon, UK and for demonstration
28. Totally cleared so far (m^2)	Not given

ENGINE | FUEL | OIL

29. Engine	DEUTZ engine
30. Engine power at the flywheel	125 hp
31. Sufficient power supplied to working tool	Not given
32. Fuel capacity	376 l
33. Fuel consumption	25 - 35 l/h
34. Separate engine for working unit	N/A
35. Cooling system	Water cooled
36. Oil capacity (both engines)	7 l
37. Hydraulic oil capacity (both engines)	400 l

COSTS

38. Cost of system	On request
39. Other costs	On request
> training	
> spare part set chains | belts	
40. Availability for hire	On request

OTHER

41. Operator comfort	N/A
42. Air conditioning	No cabin

WAY Industry J-s Co | Slovak Republic

GENERAL DESCRIPTION

The *Bozena 5* is a remotely controlled mine clearance system using a medium flail machine to clear AP and AV mines (up to 9 kg of TNT). It is produced by Way Industry which has invested in considerable R & D for the Bozena range since it was first introduced in 1995. (The Bozena 4 light flail has been described earlier.) Latest improvements to the Bozena 5 include the tiller – which can be used instead of the flail where preferable. The Bozena 5 can also remove tripwires and dense, high vegetation.

The vehicle is controlled by an operator in an air-conditioned cabin placed in line of sight or in the open air using a transmitter with a range up to 5,000 m. The normal chassis is wheel-type, but for field operation it is recommended to use the easily mountable tyre tracks supplied with each machine.

The main protection against blast and flying debris is the armoured shield, attached behind the flail shaft. The hood (see picture) serves as the "dust cover" for the prime mover. The prime mover's internal parts are further protected by 4 mm/6 mm Armox steel plates.

The manufacturers say the machine is capable of processing from 1,050 to 4,900 m^2 per hour, depending on ground and terrain conditions. Internal fire safety is improved with an automatic fire-extinguisher system.

The Bozena 5 has been designed (like the Bozena 4) to go beyond mechanical demining: 15 additional tool attachments can be fitted to the prime mover to replace the flail head. These include blades, shovels, buckets, drilling machine, hydraulic hammer, concrete mixer and excavating equipment. Changing attachments takes about five minutes.

For daily operations the Bozena 5 is self-transportable (up to 9 km/h). For long-distances it should be transported on a low-bed trailer. The whole system (excluding the trailer) can be shipped in one 40 ft container.

BOZENA 5

CLEARANCE METHODOLOGY

Hammers at the end of 48 chains rotate clockwise at up to 500 rpm and process the ground up to 30 cm deep, depending on conditions. The flail design ensures a dynamic overlap of the hammers. AP and AV mines can be destroyed either by activation or by direct mechanical destruction. The Bozena 5 can destroy dense vegetation, including trees up to 20 cm diameter.

A hydraulic winch helps recovery when stuck in field situations.

MACHINES IN USE TO DATE

Some 30 Bozena 5 systems have been sold to military and humanitarian customers in several countries, including Afghanistan, Albania, Angola, Azerbaijan, Bangladesh, Bosnia and Herzegovina, Cambodia, Canada, Colombia, Croatia, Czech Republic, Chile, Eritrea, Ethiopia, Iraq, Kenya, Kosovo, Lebanon, the Netherlands, Niger, Poland, Slovakia, Sri Lanka, Sudan and Thailand.

ENGINE, FUEL AND OIL

The Bozena 5 is powered by a Tatra diesel engine, with direct fuel injection and an air-cooling system. The engine serves both prime mover and flail unit by hydrostatic transmission. The standard version contains the 170 kw, eight-cylinder power unit, but a 270 kw output, ten-cylinder, turbocharged engine can be provided as an option.

FACTORY SUPPORT

The Tatra engine and Bosch-Rexroth hydraulic components are well-known brands with worldwide servicing networks so most spares can be easily obtained. Way Industry can also supply spares and service support tailored to specific customer requirements.

The following training packages are offered:

- initial operator's training (two weeks)
- initial mechanic's training (one to two weeks)
- advanced electrician's training (one to two weeks)
- on-the-job training/support (for desired period, usually four to 12 months)

Each machine is delivered with full technical documentation, including spare parts catalogue and operation/maintenance/diagnostic manuals. Prices of particular support and spare parts packages can be obtained on request.

MAINTENANCE AND SUPPORT

The producer recommends at least a two-man crew: ideally an operator and mechanic trained by Way Industry. Procedures for preventive and corrective maintenance (daily, weekly, monthly) are fully covered in supplied documentation and can be easily done by the trained crew. Any set of spare parts for any project type and duration can be supplied on request. The manufacturer can also provide specialised staff – from operators and mechanics to mechanical demining team leaders – with many years of mechanical demining experience worldwide.

On-site technical and logistic support, 24-hour call-out or e-mail support can be ordered.

BOZENA 5

TESTS AND EVALUATIONS

The Bozena 5 has undergone several tests at the Testing Institute in Slovakia. By June 2009 these included tests on about 40 AV mines and 200 AP mines.

From 2005 to 2007, it underwent the CEN WS12 test, passing it with good results. The tests proved the Bozena 5's capabilities to effectively detonate or destroy all types of AP and AV mines (up to 9kg TNT) in various soil and terrain conditions.
See: www.way-industry.sk/eng/index.php?b=bozena5&c=test_reports

Two test reports are available at www.itep.ws:

1. W.C. Roberts, R.W. Fall, and J.L. Eagles, Way Industry Bozena-5 Flail Test and Evaluation, Defence Research and Development Canada, 2007: www.itep.ws//pdf/Bozena5_DRDC_2007.pdf

2. Geoff Coley, Machine Demonstration Analysis and Preliminary Results, International Symposium "Humanitarian Demining 2007" 24 - 27 April 2007, Šibenik, Croatia, 2007: www.itep.ws//pdf/MachineDemoSibenik2007_Coley.pdf

REPORTED LIMITATIONS AND STRENGTHS

The Canadian test report cited above said the Bozena 5 is well-built and easy to operate and maintain. It had adequate power for both ground penetration and vegetation cutting. Mine neutralisation performance ranged from a low of 42/50 to a high of 50/50 targets. It had good survivability against several AP and one AV mine detonated by the flail. Damage from the AP mines was primarily cosmetic. Damage from the TMM-1 AV mine would have required approximately 15 minutes to repair.

No major issues were noted with the design or performance of the Bozena 5. Although a potential debris-trap may exist on the skids of the flail, this would be easily corrected through the use of a thin angular shield.

As with all flails, the Bozena-5 did scatter some debris outside the test area.

BOZENA 5

Limitations

- Difficult to operate with precision from distances over 200 m. (This applies to all remotely controlled machines.)
- The system creates huge dust clouds, as occurs with all flail systems in dry environments.

Strengths

- Resistance against AV mines (up to 9 kg TNT) without significant damage (20 min repair time).
- A variety of engineering working tools available.
- Well-designed and proven technique.
- Winch for self recovery fitted.
- Can handle dense vegetation, AP and AV mines.
- Transportation is simple. Easy to handle with a light low-bed trailer.

DIMENSIONAL DATA

1.	Length without attachment	4,170 mm
2.	Length total	7,320 mm
3.	Width without attachment	2,400 mm Without tracks 2,240 mm
4.	Width total	3,350 mm
5.	Clearing | Working width	2,655 mm
6.	Height | Overall	2,255 mm
7.	Mass | Basic vehicle	9,920 kg
8.	Mass | Detachable unit(s)	2,100 kg
9.	Mass | Overall	12,020 kg

OPERATIONAL DATA

10.	Wheels | Tracks (description)	Wheeled | tracked (tracks easily detachable by the crew, mounted on foam-filled tyres)
11.	Ground Bearing Pressure (kPa)	
	> Tracks	0.56 kg/cm² (with tyre tracks mounted)
	> Front Wheels	—
	> Rear Wheels	—
12.	Hill climbing ability (in degrees)	30°
13.	Number of Chains | Chisels | Tools	48 hammers
14.	Beat Pattern (hits per m²) at different operating speeds	Not given
15.	Length of Chains | Tools	Chain: 540 mm | Chain with hammer: 570 mm
16.	Diameter of drum	1,780 mm
17.	Rotation Speed	Up to 500 rpm (exactly displayed on control panel)
18.	Clearance | Working depth in varying terrain	Up to 30 cm, depending on speed and terrain
19.	Working Speed (m²/h)	
	> Light Soil | Medium Vegetation	4,900 m²/h
	> Medium Soil | Medium Vegetation	2,400 m²/h
	> Heavy Soil | Dense Vegetation	1,050 m²/h
20.	Control of Clearance | Working depth	a. Adjustable height of flail skids b. Boom hydraulic control
21.	Additional attachable working tools	
22.	Armour	4 mm / 6 mm ARMOX steel plates
23.	Remote controlled	Yes
	> greatest distance	5,000 m
24.	Transportation	
	> short distances	Self transportable (up to 9 km/h, harmless to tarmac surface)
	> long distances	Recommended to use the special Bozena 5 trailer PM-180
	> sea transport	Whole Bozena 5 system can be packed in one 40 ft container
	> air transport	Transportable by cargo aircrafts (C130 or similar) Transportable by helicopter

SYSTEM STATUS AND DEPLOYMENT	
25. Machines in use	30 units (160 of all models in use, line No. 22)
26. Other types	Bozena 1, Bozena 2, Bozena 3, Bozena 4
27. Location of use	Afghanistan, Albania, Angola, Azerbaijan, Bangladesh, Bosnia and Herzegovina, Cambodia, Canada, Colombia, Croatia, Chile, Czech Republic, Eritrea, Ethiopia, Iraq, Kenya, Kosovo, Lebanon, Niger, Poland, Slovakia, Sri Lanka, Sudan, Thailand, The Netherlands
28. Totally cleared so far (m^2)	More than 10,000,000 m^2 (estimation)
ENGINE | FUEL | OIL	
29. Engine	TATRA, 4 stroke, diesel with direct fuel injection, air cooled, 8 cylinders **or** TATRA, 4 stroke, turbocharged diesel with direct fuel injection, air cooled, 8 cylinders
30. Engine power at the flywheel	170 kw (228 hp) at 2,500 rpm **or** 270 kw (362 hp) at 1,800 rpm
31. Sufficient power supplied to working tool	100 kw **or** 200 kw (version with turbocharged engine)
32. Fuel capacity	160 l **or** 300 l (version with turbocharged engine)
33. Fuel consumption	30 l/h **or** 59 l/h (version with turbocharged engine)
34. Separate engine for working unit	No
35. Cooling system	Air cooled
36. Oil capacity of engine	30 l
37. Hydraulic oil capacity (both engines)	160 l
COSTS	
38. Cost of system	On request
39. Other costs	
> training	On request (possible in country of operation or in Slovakia)
> spare part set chains | belts	a. basic set of spares included b. various sets of spare parts available - tailored for specific projects and environment
> repair costs for one year	Not given
40. Availability for hire	Yes
OTHER	
41. Operator comfort	Protective air-conditioned cabin with power generator provides safety and high comfort for the operator during demining operation
42. Air conditioning	Yes (separated mine-protected monitoring cabin)

MDR Complete Demining AB | Sweden

GENERAL DESCRIPTION

The *Freeland 3000* flail machine is built on the best of existing technologies in the field of mechanical mine clearing. It introduces new concepts to deliver a clearance capacity exceeding that of much heavier machines.

The Freeland 3000 is based on a forestry machine developed by the renowned Swedish company Rottne Industri AB. It is an eight-wheel-drive machine with removable steel tracks. The cabin is armoured with 22 mm Armox and 60 mm glass. There is an extra door in the roof if the machine should roll over. An automatic sprinkler is activated in case of fire.

The revolutionary design of the flail unit – with its heavy, specially-designed hammer tools and short chain links – permits a performance equivalent to that of a tiller-equipped machine but without the inherent susceptibility to damage the tools.

Cruise control maintains the desired speed and a GPS maintains course with the chosen overlap. Clearance depth is manually controlled with the help of two indicators. The machine is designed to clear AP and AV mines. In tests so far the flail has been unharmed when exploding an AV mine.

Fully armoured and fitted with a 300 cm wide flail unit, the machine weighs about 19.6 tons, and is therefore classified as a medium-sized flail machine. The machine can process 1,000-3,500 m^2/h. It can be transported by air in a C-130 Hercules aircraft. (This demands that the cabin is dismounted to lower the height of the machine). For moving on roads an ordinary trailer is sufficient.

FREELAND 3000

CLEARANCE AND CUTTING METHODOLOGY

The 42 hammer-shaped tools on the 3 m wide flail unit are 700 mm long and weigh approximately 10 kg each. They are made from tempered Swedish steel. The heavy weight of the tools and a flail rotation speed of 420 rpm result not only in an exceptional flail performance but also ground penetration characteristics similar to those of a tiller system. The maximum depth is 400 mm while 300 mm is possible in all soil conditions. The tools have a life of up to 500 hours and are easily replaced in the field, resulting in high operational efficiency. The capacity for vegetation cutting varies between 1,000-3,000 m^2/h.

MACHINES IN USE TO DATE

The Freeland 3000 is a totally new machine built according to well-known and proven concepts, with a unique flailing tool. It is now ready to enter the world market after having been thoroughly tested with very good results.

ENGINE, FUEL AND OIL

The base unit is driven by a John Deere 140 hp diesel engine. The mine-clearing unit consists of an air-cooled Deutz 480 hp diesel engine which runs the flail via a mechanical transmission. Less than 10% of the engine power is lost in the transmission. Fuel consumption is typically 55 litres per hour. (The machine is designed to operate a full day without refuelling.)

FACTORY SUPPORT

Spare parts, consumables, training, a fully equipped workshop and a quality assurance programme are offered and vary from case to case. Basic training for drivers is three weeks and the quality assurance program is one year on site. Manuals are in English but can be translated into any desired language. Warranty period is one year covering design and fabrication errors.

MAINTENANCE AND SUPPORT

The Freeland 3000 operates six hours without any maintenance. About two hours is needed for refuelling, cleaning and changing filters, after which the machine is ready to operate. There are also schedules for weekly, monthly and yearly maintenance. Everything needed for maintenance is included in the container-based workshop.

FREELAND 3000 | Ready to go

TESTS AND EVALUATIONS

The Freeland 3000 was tested in August 2008 at the Swedish Army EOD and Demining Centre, in accordance with standards set by the International Test and Evaluation Program for Humanitarian Demining.

Two test reports are available at the ITEP website:

1. Capt Patrik Blomander, Pre-Test Assessment of Freeland 3000, SWEDEC, Sweden, 2008: www.itep.ws//pdf/SwedecFreeland3000_2008.pdf
2. Capt Patrik Blomander, Freeland 3000 Test and Evaluation, SWEDEC, Sweden, 2008: www.itep.ws/pdf/SwedecFreeland3000CWA_2008.pdf

REPORTED LIMITATIONS AND STRENGTHS

Comments from the SWEDEC Test and Evaluation report include:

"The Freeland 3000 triggered or neutralised 450 mines of 450 mines - 100 % of the target mines used in these trials.

"The results in each lane were varying between 44 up to 50 broken or triggered mines. The machine demonstrated the ability to penetrate well beyond the depth required to reach the deepest targets. In all but the most difficult soil, a smooth uniform cut across the whole width of the machine was observed.

"The survivability test went well. The machine was not driven across the anti-tank mine (the Swedish M/41-47) placed at the surface …because the machine had not done the operator survivability test. The mine was placed in front of the flail and was remotely detonated. The machine suffered no damage from the mine. No tools were missing. The machine could operate again after five minutes."

Limitations

- The system requires transportation on a trailer over longer distances.
- Creates huge dust clouds, as with all flail systems in dry environments.

Strengths

- High clearance rate.
- Easy maintenance.
- Low ground pressure gives outstanding terrain mobility.
- The working tool unit separates from the machine to give easy transportation
- RTK GPS guidance system width accuracy of 2.5 cm autoguide allows minimal overlap capability.
- Working tools have an outstanding lifespan.

DIMENSIONAL DATA

1. Length without attachment	9,150 mm
2. Length total	10,210 mm
3. Width without attachment	2,400 mm
4. Width total	3,850 mm
5. Clearing | Working width	3,000 mm
6. Height | Overall	3,300 mm
7. Mass | Basic vehicle	14,950 kg
8. Mass | Detachable unit(s)	4,700 kg
9. Mass | Overall	19,650 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	8 tyres 500/60-22.5 and 4 tracks 600 mm wide
11. Ground Bearing Pressure (kPa)	0.15 - 0.20 kg/cm^2
> Tracks	—
> Front Wheels	—
> Rear Wheels	
12. Hill climbing ability (in degrees)	27°
13. Number of Chains | Chisels | Tools	42
14. Beat Pattern (hits per m^2) at different operating speeds	390 at speed 1 km/h
15. Length of Chains | Tools	589 mm
16. Diameter of drum	222 mm
17. Rotation Speed	420 rpm
18. Clearance | Working depth in varying terrain	200 - 350 mm, maximum 400 mm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	3,500 m^2/h
> Medium Soil | Medium Vegetation	2,000 m^2/h
> Heavy Soil | Dense Vegetation	1,000 m^2/h
20. Control of Clearance | Working depth	Mechanical control, digital indicator in the cabin
21. Additional attachable working tools	N/A
22. Armour	22 mm ARMOX 440T 60 mm glass (tested for AP 762*8)
23. Remote controlled	No
> greatest distance	
24. Transportation	
> short distances	With tracks 7 km/h, dismounted tracks 25 km/h
> long distances	Can be transported with normal trailer without any special permissions
> sea transport	—
> air transport	Can be modified to fit into a Hercules C130

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	New on market
26. Other types	No
27. Location of use	—
28. Totally cleared so far (m^2)	—

ENGINE | FUEL | OIL

29. Engine	John Deere 140 hp
30. Engine power at the flywheel	N/A
31. Sufficient power supplied to working tool	N/A
32. Fuel capacity	120 l John Deere, 460 l Deutz
33. Fuel consumption	55-60 l/h in total for both engines
34. Separate engine for working unit	Yes, Deutz BF12513L, 353 kw, 19.7 l
35. Cooling system	Air cooled
36. Oil capacity of engine	
37. Hydraulic oil capacity (both engines)	

COSTS

38. Cost of system	On request
39. Other costs > training > spare part set chains | belts > repair costs for one year	
40. Availability for hire	Yes

OTHER

41. Operator comfort	Ergonomic chair and controls, radio, GPS guiding and documentation
42. Air conditioning	Yes

A/S Hydrema Denmark | Denmark

GENERAL DESCRIPTION

The *Hydrema 910 MCV-2* is a flail system designed for clearing surface or buried AP or AV mines containing up to 10 kg 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 136 kw diesel engines. After thorough modifications, the flail can now be powered by both engines at the same time. In this case, 272 kw can be brought to bear for flailing operations. During transportation, the flail unit is mounted on the platform to the rear of the cab.

HYDREMA | Flail in action

The driving speed on paved roads is up to 35 km/h. The system can be transported by loader vehicle, by rail or airlifted in a Hercules C-130. The vehicle requires one operator or can be optionally operated by a remote control system. 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.

The cabin of the Series 2 was modified and is now protected by 14 mm Armox thus it can withstand an AV mine detonating underneath of one of the front wheels.

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. The vehicle moves in reverse when working. Pivot steering is designed to ensure that the front and rear wheels move in the same track. The 72 chains of the 3.5 m-wide flail shaft rotate clockwise at up to 440 rpm. The flail action should detonate or break up AP and AV mines. Direction of rotation can be reversed. Effective ground penetration depth is up to 250 mm (up to 400 mm in sandy soil) 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, according to the manufacturer. The power on the flail unit has been increased significantly (by 30-40%).

HYDREMA | View of the front

MACHINES IN USE TO DATE

Hydrema says there are 54 machines in service with armed forces or mine clearance organisations.

Three systems were in service with the US military clearing Bagram airfield in Afghanistan.

A Danish platoon equipped with two 910 MCV-2 machines is involved in clearance operations at Kabul airport.

Since 2003, 24 machines have been in service to clear the majority of the minefields in a broad zone in Kashmir.

ENGINE, FUEL AND OIL

Average fuel consumption is 60 litres per hour, according to the manufacturer. 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 the 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

The recommended level of maintenance required is similar to standard commercial engineering construction machines. Since 2005, a team of specially trained Hydrema technicians has been available for worldwide service on request.

HYDREMA | Moving flail unit from transport to clearance position

HYDREMA | Flail unit ready to clear

TESTS AND EVALUATIONS

- G. Danielsson, *Hydrema 910 MCV*, by SWEDEC, 2004.
  The machine was tested on its performance, or effectiveness against AP surrogates targets with live mine fuzes and AT mine surrogate targets with live mine igniters. One test report is available at the website: www.itep.ws.
- Croation Mine Action Centre (CROMAC), Demining Machine Testing Committee: *Possible Effects of Tested Demining Machines, Appendix to CROMAC SOP 03.01: Efficiency Assessment of Technical Survey and Demining, 2007*. Test report is available at the website: www.hcr.hr.

REPORTED LIMITATIONS AND STRENGTHS

Limitations

- As with all flail systems, the Hydrema tends to create lots of dust during operations.

Strengths

- Easily deployed to the area of operations and ready to operate in around five minutes.
- Changing flail rotation direction permits clearance of roads and areas with hard surfaces.
- Equipped with two engines for driving and flailing.
- Pivot steering enables the vehicle to drive with front and rear wheels in the same track.
- Can be transported by trailer, train or plane.

DIMENSIONAL DATA

1. Length without attachment	9,200 mm
2. Length total	10,000 mm
3. Width without attachment	Transportation position 2,780 mm
4. Width total	2,420 mm
5. Clearing | Working width	4,830 mm
6. Height | Overall	3,600 mm
7. Mass | Basic vehicle	Not given
8. Mass | Detachable unit(s)	Not given
9. Mass | Overall	18,000 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	4 standard tyres Goodyear RL-2+17.5R25 foam filled
11. Ground Bearing Pressure (kPa)	Not given
12. Hill climbing ability (in degrees)	34°
13. Number of Chains | Chisels | Tools	72
14. Beat pattern (hits per m^2) at different operating speeds	Not given
15. Length of Chains | Tools	900 mm
16. Diameter of drum	Not given
17. Rotation Speed	440 rpm
18. Clearance | Working depth in varying terrain	Up to 40 cm in sandy soil
19. Working Speed (m^2/h)	400-800 m^2/h
> Light Soil | Medium Vegetation	
> Medium Soil | Medium Vegetation	
> Heavy Soil | Dense Vegetation	
20. Control of Clearance | Working depth	Computer controlled
21. Additional attachable working tools	
22. Armour	Not given
23. Remote controlled	Yes optional
> greatest distance	Not given
24. Transportation	
> short distances	Maximum 40 km/h on own wheels
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	80
26. Other types	Series 1
27. Location of use	Afghanistan, Angola, Bosnia and Herzegovina, Croatia, boarder area between Pakistan and India, Denmark (army), India, Kosovo, Mozambique, Norway, United Arab Emirates
28. Totally cleared so far (m^2)	Not given

ENGINE | FUEL | OIL

29. Engine	Perkins 1006-6TW, 6 cylinder diesel with turbocharger
30. Engine power at the flywheel	Not given
31. Sufficient power supplied to working tool	Hydrostatic transmission
32. Fuel capacity	600 l
33. Fuel consumption	60 l/h
34. Separate engine for working unit	Yes, the same engine as for driving
35. Cooling system	Driving engine is mounted with reversible propellers and increased cooling capacity and is additionally used as power pack increasing the power of the flail unit
36. Oil capacity (both engines)	Not given
37. Hydraulic oil capacity (both engines)	Not given

COSTS

38. Cost of system	On request and depending on the configuration
39. Other costs	
> training	Negotiable
> spare part set chains | belts	Not given
> repair costs for one year	Not given
36. Availability for hire	Negotiable

OTHER

41. Operator comfort	Not given
42. Air conditioning	Yes

FLAIL SYSTEMS | MEDIUM FLAIL | KZC

Khabat Zanganga Company | Sulaimaniyah, Iraq

GENERAL DESCRIPTION

Founded in 1998, the Khabat Zangana Company (KZC) produced the first flail in Iraq and the Middle East, excluding Israel. The *KZC Medium Flail* consists of a tracked crawler shovel, the Komatsu D65 with a flail unit mounted in front. The flail unit is driven by a second engine mounted at the back of the machine. The overall width of the vehicle is 2.5 m, with a working width of 2.9 m. The flail has 72 hammers, T- shaped and connected with chains. The driver is protected by an armoured cab.

CLEARANCE METHODOLOGY

The flail prepares the mine-affected area for further demining operations. The system achieves an average ground penetration of up to 200 mm, depending on soil conditions. The 72 chains rotate on the 2.9 m-wide flail shaft. The flail action should detonate or break up AP and AV mines. The daily clearing rate achieved, according to the manufacturer, is up to 3,000 m^2. The machine can operate on slopes up to 35°. No more information was provided by the manufacturer.

KZC

MACHINES IN USE TO DATE

Three machines are in operation in Southern and Northern Iraq.

ENGINE, FUEL AND OIL

No information was provided by the manufacturer.

FACTORY SUPPORT

No information provided

MAINTENANCE AND SUPPORT

No information provided.

TESTS AND EVALUATIONS

No information is available.

REPORTED LIMITATIONS AND STRENGTHS

Limitations

- No automatic depth control or terrain following mechanism.
- System creates huge dust clouds, as occurs with all flail systems in dry environments.

Strengths

- Simple and rugged design.

DIMENSIONAL DATA

1. Length without attachment	5,000 mm
2. Length total	7,500 mm
3. Width without attachment	2,500 mm
4. Width total	3,500 mm
5. Clearing | Working width	2,900 mm
6. Height | Overall	3,200 mm
7. Mass | Basic vehicle	16,000 kg
8. Mass | Detachable unit(s)	4,000 kg
9. Mass | Overall	20,000 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Track
11. Ground Bearing Pressure (kPa)	Not given
12. Hill climbing ability (in degrees)	40°
13. Number of Chains | Chisels | Tools	72
14. Beat pattern (hits per m^2) at different operating speeds	Not given
15. Length of Chains | Tools	89 cm
16. Diameter of drum	16 cm
17. Rotation Speed	250 rpm
18. Clearance | Working depth in varying terrain	Up to 20 cm
19. Working Speed (m^2/h)	3,000 m^2/day
> Light Soil | Medium Vegetation	Not given
> Medium Soil | Medium Vegetation	Not given
> Heavy Soil | Dense Vegetation	Not given
20. Control of Clearance | Working depth	Not given
21. Additional attachable working tools	No
22. Armour	Yes
23. Remote controlled	No
> greatest distance	
24. Transportation	Low loader
> short distances	
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	3
26. Other types	No
27. Location of use	Northern and Southern Iraq
28. Totally cleared so far (m^2)	More than 1,500,000 m^2

ENGINE | FUEL | OIL

29. Engine	Cummense / Komatsu D 65
30. Engine power at the flywheel	Not given
31. Sufficient power supplied to working tool	Not given
32. Fuel capacity	250 l
33. Fuel consumption	Not given
34. Separate engine for working unit	DEUTZ
35. Cooling system	Aircooled for DEUTZ and water cooled for Komatsu
36. Oil capacity (both engines)	52 l
37. Hydraulic oil capacity (both engines)	190 l

COSTS

38. Cost of system	On negotiation
39. Other costs	
> training	On negotiation
> spare part set chains | belts	On negotiation
> repair costs for one year	On negotiation
40. Availability for hire	No

OTHER

41. Operator comfort	Not given
42. Air conditioning	Not given

Trademill Mejac & Co. | Slovenia

GENERAL DESCRIPTION

The *Minemill MC 2004* is a chain-flail system produced in Slovenia. The machine is based on the chassis of a commercial track-driven prime mover, propelled by a 66 kw diesel engine. Ground penetration depth control is automatic (mechanical) or manual. The machine is designed for AP and AV mine clearance.

The flail unit has 67 chains and is powered by a 165 kw diesel engine. The system is a medium- class flail system (a relatively light weight 9,800 kg), enabling it to work in difficult-to-access areas where larger systems cannot operate. One operator drives the system from a fully armoured cabin. The cabin and engine compartments are protected by a double layer sandwich of 5+5 mm ballistic steel armour and 52 mm bullet-proof glass.

A self-recovery winch is attached to the prime mover. A fire suppression system and an additional emergency exit from the cabin ensure the safety of the operator in case of an accident. According to the manufacturer, the machine can keep to the set working depth and follow the contours of the ground.

On request, the system can be equipped with a video control system enabling the operator to monitor the ground in front of and behind the machine. Optionally the system can be prepared for remote-controlled operation. With its special air filtration system the machine can be used in heavy dust environments.

The manufacturer states that the Minemill is best used for ground preparation and technical survey operations.

MINEMILL MC 2004

CLEARANCE METHODOLOGY

The total width of the vehicle with attached flail unit is 2.7 m. The clearance width is 2 m. The 67 chains of the flail rotate clockwise at up to 500 rpm. The machine works at up to 5 km/h. The hammers attached to each chain are intended to either detonate or break up AP or AV mines. The ground penetration depth achieved is up to 250 mm processing up to 2,500 m^2/h, depending on soil conditions. The Minemill can cut vegetation up to 10 cm in diameter.

MACHINES IN USE TO DATE

Seven machines have been in service since 1999, five of them in South-Eastern Europe (Bosnia and Herzegovina, Serbia and Montenegro), one in Africa and one in Lebanon.

ENGINE, FUEL AND OIL

The Minemill MC 2004 has two diesel engines: one for the prime mover (66 kw) and the other for the flail unit (165 kw). Fuel capacity is 150 litres. Fuel consumption is 10-15 litres per hour. Hydraulic oil capacity is 600 litres.

MINEMILL MC 2004

FACTORY SUPPORT

Manuals are available in English, Slovenian, Croatian and Serbian. The manufacturer provides a six-month warranty. Specific spares for both the flail unit and the prime mover and their engines are provided worldwide by the manufacturer or through the Iveco and Deutz-Fahr Group service network. Factory training of operators and mechanics is part of the purchase package. Field training of operators and mechanics is negotiable.

MAINTENANCE AND SUPPORT

Daily and weekly checks and maintenance are performed by the operators. 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 has been tested by the Bosnia-Herzegovina Mine Action Centre and the National Demining Office of Lebanon.

REPORTED LIMITATIONS AND STRENGTHS

Limitations

> No information available

Strengths

> The system is simple and robust.
> It is relatively lightweight.
> Capable of clearing AP and AV mines.

DIMENSIONAL DATA

1. Length without attachment	5,500 mm
2. Length total	6,800 mm
3. Width without attachment	2,300 mm
4. Width total	2,700 mm
5. Clearing | Working width	2,000 mm
6. Height | Overall	2,400 mm
7. Mass | Basic vehicle	7,400 kg
8. Mass | Detachable unit(s)	2,400 kg
9. Mass | Overall	9,800 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Tracks (2,300 x 400/450 mm)
11. Ground Bearing Pressure (kPa)	0.45 kg/cm^2
12. Hill climbing ability (in degrees)	30°
13. Number of Chains | Chisels | Tools	67
14. Beat pattern (hits per m^2) at different operating speeds	2,020 hits/m^2
15. Length of Chains | Tools	700 mm
16. Diameter of drum	Not given
17. Rotation Speed	Up to 500 rpm
18. Clearance | Working depth in varying terrain	Up to 250 mm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	2,500 m^2/h
> Medium Soil | Medium Vegetation	1,700 m^2/h
> Heavy Soil | Dense Vegetation	1,000 m^2/h
20. Control of Clearance | Working depth	Automatic (mechanical) or manual
21. Additional attachable working tools	None
22. Armour	Double layer, sandwich construction 5+5 mm, ballistic steel
23. Remote controlled	Optionally
> greatest distance	1,000 m
24. Transportation	
> short distances	Ordinary truck trailer, 40 ft container, air-lift is possible
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	7
26. Other types	No
27. Location of use	Africa, Bosnia and Herzegovina, Serbia and Montenegro, South Lebanon
28. Totally cleared so far (m^2)	Over 7,000,000 m^2

ENGINE | FUEL | OIL

29. Engine	2 x diesel
30. Engine power at the flywheel	66 kw-prime mover, 165 kw-working unit
31. Sufficient power supplied to working tool	127 kw
32. Fuel capacity	150 l
33. Fuel consumption	10-15 l/h
34. Separate engine for working unit	Yes, turbo diesel 165 kw
35. Cooling system	Water / water
36. Oil capacity (both engines)	39 l
37. Hydraulic oil capacity (both engines)	600 l

COSTS

38. Cost of system	On request
39. Other costs	On request
> training	
> spare part set chains | belts	
> repair costs for one year	
40. Availability for hire	Yes

OTHER

41. Operator comfort	Self-recovery winch, fire suppression system, seat-belts
42. Air conditioning	Yes

Duro Dakovic Speciajalna Vozila (DD Special Vehicles Inc.) | Croatia

GENERAL DESCRIPTION

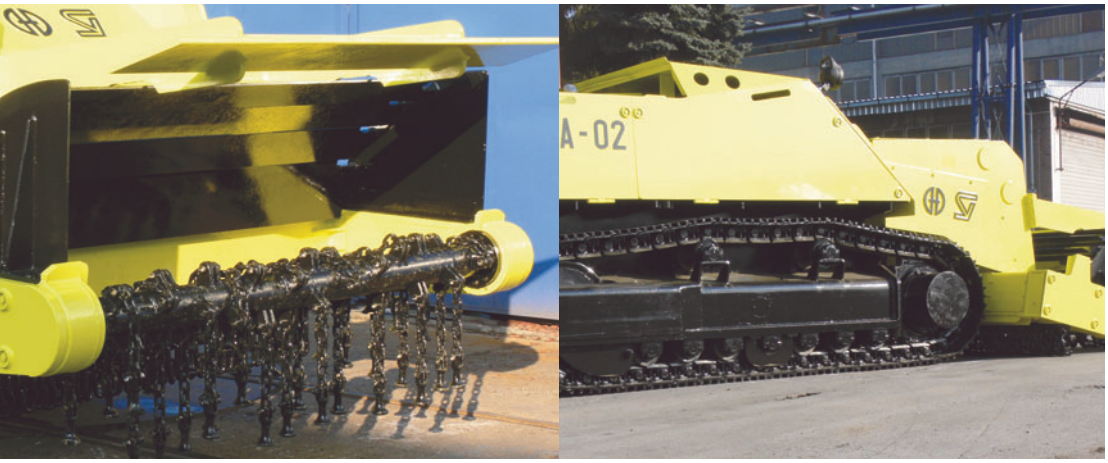
The *RM-KA-02* is a tracked demining machine with total weight of 14.5 tons. The remote-controlled medium flail is produced by the Duro Dakovic Specijalna Vozila company. The machine destroys all types of AV and AP mines as well as removing low, medium and high vegetation.

An operator using a joystick attached to a portable control panel remotely controls the system. The chassis is made of 20 mm steel plates. Vital parts of the machine are additionally protected from explosive blast by 10 mm Armox armoured steel plates. 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, the blast passes between the pipes.

The remote control system is electric magnetic interference and radio frequency interference compliant and resistant to jamming. The machine is fitted with an automatic fire-extinguishing system.

Additional GPS, a video control system, a cable winch, a tiller unit and an escort vehicle are available as options.

Because of its small dimensions, the RM-KA-02 can be easily transported by ordinary trailer and by plane as well as in a 20 ft container.



RM-KA-02 | Detailed view of the flail

CLEARANCE METHODOLOGY

The rotor turns the 36 chains of the flail unit at 600 rpm in both directions. A mushroom-shaped, strengthened steel hammer is attached at the end of each 30 cm long chain. As the machine works through a suspect area at between 0.3-1.2 km/h (depending on soil conditions) the chains will detonate or break up AP and AV mines. The system achieves an average ground penetration of up to 200 mm, measured on the whole cleaning width of 2,000 mm.

MACHINES IN USE TO DATE

An earlier version of the machine, RM-KA-01, has been in use by the Croatian Demin-ka company since 2001. Three RM-KA-02 machines are operating in Croatia with Croatian demining companies.

ENGINE, FUEL AND OIL

The RM-KA-02 is equipped with a Cummins 6CTA8.3-C diesel engine with 260 hp. The fuel tank capacity is 380 litres. Fuel consumption is 30 to 40 litres per hour (depending on working conditions). Hydraulic oil capacity is 260 litres. Oil capacity is 16 litres.

FACTORY SUPPORT

The manufacturer gives full after-sales support which includes: warranties, spare parts, servicing, training, technical documentation and integral logistical support (on request). User manual and spare parts catalogue are available in Croatian, English and any other language on request.

Two weeks training for operators and mechanics can be organised, on the manufacturer's own proving ground as well as on site.

The warranty covers the whole machine, except for consumables or wearing parts, as well as parts damaged in explosions. Subject to agreement, the manufacturer can organise local service support to assure full and effective maintenance.

MAINTENANCE AND SUPPORT

The manufacturer recommends a two-man team for operations. The RM-KA-02 needs daily and weekly checks, performed by the operators. The manufacturer recommends proper maintenance activities at defined intervals. The first three services in the warranty period are free of charge.

TESTS AND EVALUATIONS

The machine was tested by CROMAC and accredited in 2003 for both AV and AP mine clearance under all ground conditions. See also Croation Mine Action Centre (CROMAC), *Demining Machine Testing Committee: Possible Effects of Tested Demining Machines, Appendixes to CROMAC SOP 03.01: Efficiency Assessment of Technical Survey and Demining, 2007*. Test report available at the website: www.hcr.hr

The machine was tested against the criteria in the CEN Workshop Agreement (CWA) 15044 on Test and Evaluation of Mechanical Demining Machines by QinetiQ in June 2004 and by Defence Research and Development Canada in October 2004.

1. Leach C.A., Duro Dakovic RM-KA-02 Mine Flail assessment Phase 1. Farnborough, Hampshire:QinetiQ/FST/LDS/CR0461150/1.0, 2004 and
2. Coley G., Fall R., Danielsson G., Blatch P. and Wye L.. Duro Dakovic RM-KA-02 Flail Test and Evaluation. Suffield: Defence R&D Canada, 2005.

These reports and the CEN Workshop Agreement 15044 are available at www.itep.ws.

REPORTED LIMITATIONS AND STRENGTHS

Limitations

- Difficult to operate with precision from greater distances. (This applies to all remotely controlled machines).
- No automatic depth control or terrain following mechanism.
- System creates huge dust clouds, as occurs with all flail systems in dry environments.

Strengths

- Simple and rugged design.
- For AV and AP mine clearance.
- Good capability of the flail head "to dig… beyond the 15 cm depth of burial without any difficulty or evidence of skip zones in all but the most difficult soil conditions." (QinetiQ report.)
- Good remote-control system.
- Small and easy to transport.

DIMENSIONAL DATA

1. Length without attachment	3,980 mm
2. Length total	5,415 mm
3. Width without attachment	2,000 mm
4. Width total	2,500 mm
5. Clearing | Working width	2,000 mm
6. Height | Overall	1,900 mm
7. Mass | Basic vehicle	13,000 kg
8. Mass | Detachable unit(s)	1,500 kg
9. Mass | Overall	14,500 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Tracks 400 mm width
11. Ground Bearing Pressure (kPa)	0.58 kg/cm^2
12. Hill climbing ability (in degrees)	Max gradient 35° | Max grade slope 25°
13. Number of Chains | Chisels | Tools	36
14. Beat pattern (hits per m^2) at different operating speeds	Hammers overlay width 7 mm
15. Length of Chains | Tools	350 to 450 mm
16. Diameter of drum	900 mm
17. Rotation Speed	Up to 600 rpm
18. Clearance | Working depth in varying terrain	More than 250 mm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	2,000 m^2/h
> Medium Soil | Medium Vegetation	Not given
> Heavy Soil | Dense Vegetation	500 m^2/h
20. Control of Clearance | Working depth	Manually
21. Additional attachable working tools	
22. Armour	Chassis plates 20 mm and armour plates 10 mm, ARMOX
23. Remote controlled	Yes
> greatest distance	Up to 800 m
24. Transportation	
> short distances	Easily transportable on a 15 tonne trailer
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	3
26. Other types	No
27. Location of use	Croatia
28. Totally cleared so far (m^2)	Not given

ENGINE | FUEL | OIL

29. Engine	Cummins 6CTA8.3-C with 194 kw (264 hp)
30. Engine power at the flywheel	Not given
31. Sufficient power supplied to working tool	Not given
32. Fuel capacity	360 l
33. Fuel consumption	35 to 40 l/h
34. Separate engine for working unit	No
35. Cooling system	Water
36. Oil capacity (both engines)	—
37. Hydraulic oil capacity (both engines)	220 l

COSTS

38. Cost of system	Not given
39. Other costs	
> training	Included
> spare part set chains | belts	Negotiable
> repair costs for one year	Negotiable
40. Availability for hire	Yes

OTHER

41. Operator comfort	N/A
42. Air conditioning	N/A

Vilpo d.o.o. | Slovenia

GENERAL DESCRIPTION

Samson was developed by the Slovenian manufacturer Vilpo and the third version, the Samson 300 (420), is quite new to the market and replaces the 200 and 260 models. The machine is designed for clearance of AP and AV mines.

The Samson 300 (420) weighs up to 11,800 kg and has a working clearance width of 2.54 m. 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 or tiller is mounted in an armoured casing, ensuring the protection of all vital elements of the system (engine, hydraulics and transmission). An additional rotor flail unit of 900 mm width on a 9 m long crane arm can be mounted. It allows mine clearing work in difficult terrains.

The clearance operation is controlled manually or by remote control. The rotor housing and driver's cabin are made of armoured steel. The road speed of the vehicle is 25 km/h on most surfaces. One operator controls the vehicle. It is light weight, 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.

According to the manufacturer, operations in live minefields have lead to significant improvements of the system and the variety is improved by the additional rotor attachment.

SAMSON 300 (420)

CLEARANCE METHODOLOGY

The flail unit attached to the front of the Samson machine rotates 32 chains with hammers attached, at up to 600 rpm with a stated clearance depth of at least 200 mm, depending on soil conditions.

The hammers weigh 800 g each and have a T-shape or disk profile connected to 425 mm long chains. Depending on soil conditions and the clearance depth selected, the machine operates by demining speed at up to 3 km/h.

The Samson 300 (420) can also be equipped with a tiller. Changing the flail unit and tiller is possible in less than ten minutes. The Samson 300 (420) is very operator-friendly as both the vehicle and flails (or tiller) are hydrostatically driven by a computer-controlled system, so that the operator can focus on steering the machine by a joystick integrated in the arm rest. The built-in computer steering hydrostatic prevents over-loading of mechanical parts of the vehicle, rotor and diesel engine, controls the engine and optimises its work to achieve minimum fuel consumption. The power of the engine can be divided between rotor and vehicle automatically: more power can be applied to the rotor by reducing the speed of the vehicle.

These automatic functions ensure the ability of Samson 300 (420) to operate in difficult conditions (eg hot and dry climate, as in Sudan).

MACHINES IN USE TO DATE

Samson machines operate in Afghanistan, Croatia, Bosnia and Herzegovina, Namibia and Sudan where they have cleared approximately 12 million square metres. In Sudan the two machines had exceptional achievement and, to date, have suffered neither major damage nor required support from the manufacturer.

ENGINE, FUEL AND OIL

The Samson 300 has a Deutz BF6M 1013 FC diesel engine with 212 kw. Average fuel consumption is around 30 litres per hour. On request, it can also be equipped with a more powerful Caterpillar or Cummins engine giving 310 kw (420 hp). Engine and hydraulic oils are of general standard.

MAINTENANCE AND SUPPORT

Regular cleaning is required weekly and monthly; annual maintenance checks have to be done as per the operating instructions. The Samson can be supported by a mobile maintenance vehicle on the worksite. For missions outside Slovenia maintenance staff and operators are trained before deployment. The manufacturer offers a spare parts kit sufficient for one year of field work for 15,000 euros.

TESTS AND EVALUATIONS

The Samson 300 was tested by CROMAC in 2005 by following its work on a project covering 50,000 m^2. The trials included AP and AV mines and the efficiency of the machine. The test report is available in English at the website: www.vilpo.si. Also see: Croatian Mine Action Centre (CROMAC), Demining Machine Testing Committee: Possible Effects of Tested Demining Machines, Appendixes to CROMAC SOP 03.01: Efficiency Assessment of Technical Survey and Demining, 2007. Test report is available at the website: www.hcr.hr.

Two test reports are available at the ITEP website:

1. Republic of Croatia Croatian Mine Action Centre - Centre for Testing, Development and Training, "Samson 300 Demining Machine Testing Report," Croatia, 2005:
   www.vilpo.si/images/stories/proizvodi/Samson/Samson_testing_report.pdf

2. Geoff Coley, Machine Demonstration Analysis and Preliminary Results, International Symposium "Humanitarian Demining 2007" 24 - 27 April 2007, Šibenik, Croatia, 2007:
   www.itep.ws//pdf/MachineDemoSibenik2007_Coley.pdf

REPORTED LIMITATIONS AND STRENGTHS

Limitations

- As with all flail systems, the machine tends to create lots of dust during operations.

Strengths

- The system offers a variety of uses because of the additional flail unit on a crane arm.
- Combined system, flail or tiller can be attached.
- Variety of uses because of the additional flail unit on a crane arm.
- Good manoeuvrability.
- Effective cooling system, which helps work in hot conditions.
- A roller behind the flail reduces the risk of missed mines.
- Small, therefore reducing transport problems.
- Operator friendly.

SAMSON 300 (420) in Sudan

DIMENSIONAL DATA

1. Length without attachment	6,100 mm | 6,400 mm
2. Length total	7,800 mm | 8,100 mm Transport length: 9,100 mm | 9,400 mm
3. Width without attachment	2,300 mm | Transport width 2,300 mm
4. Width total	3,400 mm
5. Clearing | Working width	2,530 mm Additional flail unit on crane-arm 900 mm
6. Height | Overall	2,900 mm
7. Mass | Basic vehicle	8,100 kg | 8,600 kg
8. Mass | Detachable unit(s)	2,700 kg
9. Mass | Overall	10,800 kg | 11,300 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	4 standard tyres Nokia TRS-LS 16 PR-steel foam filled
11. Ground Bearing Pressure (kPa)	0.62 kg/cm^2
12. Hill climbing ability (in degrees)	45°
13. Number of Chains | Chisels | Tools	32
14. Beat pattern (hits per m^2) at different operating speeds	Vehicle speed 0.8 km/h and 650 rpm of flail unit is 5 x 8.6 mm
15. Length of Chains | Tools	425 mm
16. Diameter of drum	1,300 mm
17. Rotation Speed	Up to 650 rpm
18. Clearance | Working depth in varying terrain	Min. 200 mm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	2,600 m^2/h | 3,800 m^2/h
> Medium Soil | Medium Vegetation	Not given
> Heavy Soil | Dense Vegetation	1,200 m^2 | 2,200 m^2/h
20. Control of Clearance | Working depth	Automatically
21. Additional attachable working tools	Additional flail unit on crane-arm
22. Armour	6 mm ARMOX, bullet proofed glass
23. Remote controlled	Yes
> greatest distance	1,000 m
24. Transportation	Self driven up to 25 km/h or on a ordinary truck
> short distances	
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	Not given
26. Other types	Samson 420
27. Location of use	Afghanistan, Bosnia and Herzegovina, Croatia, Namibia, Sudan
28. Totally cleared so far (m^2)	More than 12,000,000 m^2

ENGINE | FUEL | OIL

29. Engine	DEUTZ diesel engine with 212 kw **or** Cumings with 420 hp (Samson 420)
30. Engine power at the flywheel	Hydrostatic drive
31. Sufficient power supplied to working tool	Computer steered
32. Fuel capacity	240 l
33. Fuel consumption	30 l/h | 50 l/h
34. Separate engine for working unit	No
35. Cooling system	Water Cooling
36. Oil capacity (both engines)	Not given
37. Hydraulic oil capacity (both engines)	130 l

COSTS

38. Cost of system	350,000 - 430,000 euros depending on the configuration
39. Other costs	
> training	10 days training is included
> spare part set chains | belts	
> repair costs for one year	The manufacture offers a spare part kit sufficient for one year field work for 15,000 euros
40. Availability for hire	Yes

OTHER

41. Operator comfort	Upholstered cabin, air conditioning, seat with pneumatic springs-control, drive and flail control with joy-stick on arm rest
42. Air conditioning	Yes

Corus Northern Engineering Services | United Kingdom

GENERAL DESCRIPTION

The *Minelifta* flail unit is attached to a Komatsu D65EX bulldozer. It is an anti-personnel mine clearance system. It is not designed to clear AV mines. The first trials were undertaken in February 2001. Recommendations to improve performance 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. The bulldozer with the mounted flail weighs approximately 3.5 tons.

The armoured, bucket-shaped cowling prevents the flail throwing soil out of the cleared area. The operator's cab and the new fitted hydraulic unit are fully armour protected. On completion of mine clearance, the system can be employed as a standard bulldozer.

MINELIFTA chertsey blast | MINELIFTA on low loader

CLEARANCE METHODOLOGY

The manufacturer recommends that the Minelifta sweeps a mined area up to three times to ensure the best possible clearance performance. The scalping blade scoops soil to a depth of 20 cm into the cowling where it is pulverised 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 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 AP mine without interrupting 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 75 mm in diameter.

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 was in service with Norwegian People's Aid (NPA) in Bosnia in 2003 and 2004. According to the manufacturer, in 2003 it cleared 150,000 m^2 and in 2004 it cleared 400,000 m^2 at a cost per square metre of between 0.17 and 0.11 euros.

The Corus company says it is currently open to offers to purchase the complete Minelifta machine and system from those who may wish to market this product.

ENGINE, FUEL AND OIL

- The primary mover is a Komatsu D65EX-12 powered by a 142 kw diesel engine with a 406 litre fuel capacity.
- The hydraulic auxiliary power unit is driven by an air-cooled 200 kw Deutz diesel engine.
- The hydraulic reservoir capacity is 250 litres.
- The cooling system of the Komatsu contains 50 litres of coolant.
- Estimated average fuel consumption is 50 litres per hour.

FACTORY SUPPORT

The Minelifta is supplied with a comprehensive recommended spares package negotiable with the purchaser. Corus Northern Engineering Services can provide full field support.

MAINTENANCE SUPPORT

The manufacturer says that personnel with basic mechanical skills should be able to deal with damage and wear and tear on the component parts. Full workshop manuals for the bulldozer and repair procedures are 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 had "merit".

Cranfield University reviewed Minelifta operator cab protection in February 2002 and recommended materials/thicknesses, etc., which have since 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 AP mines of up to 200 g of TNT. Minor damage was reported. For further information contact Corus Northern Engineering Services.

In 2003, the machine was tested by QinetiQ in a field trial in Bosnia and Herzegovina (Leach, C.A. Field Trials for Minelifta, Bosnia, June 2003 to Sep 2003. Farnborough: QinetiQ, 2003). Approximately 130,000 m^2 was cleared under the supervision of NPA. The rate of clearance during tests was approximately 2,300 m^2/h for one run in light terrain with light vegetation with 10 cm flailing depth. The report is available at www.itep.ws

REPORTED LIMITATIONS AND STRENGTHS

Limitations

- Minelifta is for clearance of anti-personnel mines and small ERW – not AV mines.
- System creates huge dust clouds, as occurs with all flail systems in dry environments.
- The system requires transportation by low-loader over longer distances.

Strengths

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

DIMENSIONAL DATA

1. Length without attachment	5,550 mm
2. Length total	9,030 mm
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 (removable)
5. Clearing | Working width	2,740 mm
6. Height | Overall	3,580 mm
7. Mass | Basic vehicle	15,255 kg
8. Mass | Detachable unit(s)	18,545 kg
9. Mass | Overall	33,800 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Tracks 660 mm width
11. Ground Bearing Pressure (kPa)	0.82 kg/cm^2
12. Hill climbing ability (in degrees)	30°
13. Number of Chains | Chisels | Tools	72
14. Beat pattern (hits per m^2) at different operating speeds	Gap between chains 155 mm (static centred)
15. Length of Chains | Tools	Not given
16. Diameter of drum	Not given
17. Rotation Speed	150 rpm
18. Clearance | Working depth in varying terrain	Up to 200 mm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	2,740 m^2/h
> Medium Soil | Medium Vegetation	1,800 m^2/h
> Heavy Soil | Dense Vegetation	800 m^2/h
20. Control of Clearance | Working depth	Manual from 0 to 20 cm, depth controlled by angle of bucket set by driver
21. Additional attachable working tools	
22. Armour	6 mm of CP 50 armour
23. Remote controlled	No
> greatest distance	N/A
24. Transportation	
> short distances	Needs low-loader for overland transport
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	1
26. Other types	No
27. Location of use	Bosnia and Herzegovina
28. Totally cleared so far (m^2)	450,000 m^2

ENGINE | FUEL | OIL

29. Engine	Komatsu D65 EX-12
30. Engine power at the flywheel	142 kw
31. Sufficient power supplied to working tool	200 kw
32. Fuel capacity	406 l Komatsu Dozer
33. Fuel consumption	Depends on the ground conditions
34. Separate engine for working unit	Yes Komatsu D65 EX with 200 kw
35. Cooling system	Flail engine is air cooled
36. Oil capacity (both engines)	Not given
37. Hydraulic oil capacity (both engines)	50 l for Komatsu Dozer

COSTS

38. Cost of system	On request
39. Other costs	On request
> training	—
> spare part set chains | belts	—
40. Availability for hire	Yes

OTHER

41. Operator comfort	Not given
42. Air conditioning	Yes

Scanjack AB | Sweden

GENERAL DESCRIPTION

The *Scanjack 3500* is a heavy flail based on a Finnish deforestation machine that has been on the market for several years. The first modified demining version was built in 1999.

The Scanjack 3500 employs a unique, front-mounted double flail system. Since 1999, the system has undergone several evaluations and tests, with good results. Since the first model, the Scanjack 3500 has been improved in more than 600 engineering tasks, including improvements to protection of the cabin, remote control and cooling capacity. The manufacturer says that most of the changes have resulted from experience in various operating theatres, as well as customer requirements for quality assurance and operator safety.

The Scanjack 3500 is designed to clear AP and AV mines. The machine is operated from an armoured cab. The level of armour can be varied at customer request. However, the most common level of protection corresponds, says the manufacturer, to the NATO STANAG 4569, (level 3 for ballistic protection). The machine can be optionally operated by a remote control system and the operating range is from 300 m to 700 m, depending on customer request. (For longer remote control distances a camera system must be added.) The stated clearance width is 3,500 mm.

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

SCANJACK 3500 | Operating in Bosnia

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 100 mm shorter that those of the second. The front flail cuts vegetation and clears the ground to a depth of 150 mm. The second flail is designed to clear down to 300 mm. The total clearance depth of the system claimed by the manufacturer is 300 mm. With a rotation speed of 300-400 rpm, the flail unit hits the ground approximately six times per second.

Both flails have 76 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

- Two machines have been operational in Croatia since 2000.
- Five machines were delivered in 2003 to the Swedish Army.
- One machine was delivered to Piper d.o.o. in August 2003 for use in Croatia.
- One machine was delivered to the Swiss Foundation for Mine Action in October 2003 and is now operational in Sudan under WFP.
- Two machines have been operational in Iraq since 2005.
- One machine was bought by the Netherlands military.
- The Swedish Army operated two machines in Bosnia and Herzegovina during 2007.

ENGINE, FUEL AND OIL

- The Scanjack has a six-cylinder John Deere 6081HTJ02 diesel engine with 220 hp for the base unit. The hydraulic oil capacity is 190 litres.
- The flail unit has a Scania DSI 14 turbocharged V8 diesel engine with 570 hp. The hydraulic oil capacity for this unit is 390 litres.
- Mineral hydraulic oil is included in the standard equipment package.
- The machine uses the same fuel tank for both engines.
- The fuel capacity is 300 litres and the consumption is 60-80 litres per hour 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, stability brake, hydraulic steps and mineral hydraulic oil.

Training of operators and mechanics is offered during manufacturing until the end of the second month after delivery. Training costs are part of the purchasing package.

A one-year warranty for manufacturing faults in the complete system is included but there is no warranty on the flail unit itself, except a 100 % guarantee that the unit works at the time of delivery.

Service contracts ranging from one annual check-up to a full service are available.

MAINTENANCE SUPPORT

A one-year full service support includes non-consumable spares and on-site technical support once a month. Technician call-out can be ordered. The machine must be refueled every four hours and must be cleaned of dust and dirt at the same interval.

The manufacturer recommends daily and weekly preventive maintenance and cleaning as well as a service contract for monthly check-ups by the supplier.

The manufacturer recommends a three-man crew, preferably with all three trained as operators and one as a skilled mechanic. Non-specialist, mechanical workshop tools and crane support on-site are required.

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 5.5 kg AV metal-covered mine and one 10 kg non-metallic AV 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. The test reports are available at SWEDEC.

During 2003 the Swedish Army ordered and verified one pre-series machine. All technical requirements were met. The detonation of 10 kg of TNT under the front wheel did not cause any injuries to the driver (dummy). Four additional vehicles were ordered by the Swedish Army and delivered in November 2003.

See Croatian Mine Action Centre (CROMAC), Demining Machine Testing Committee: Possible Effects of Tested Demining Machines, Appendixes A1 and A2 to CROMAC SOP 03.06-1: Efficiency Assessment Of Technical Survey and Demining, 2005. It was tested by US Army Night Vision and Electronic Sensors Directorate during 2005. Reports are available at the website: www.itep.ws and www.hcr.hr or www.ctro.hr.

Five test reports are available at the website www.itep.ws:

1. G. Danielsson, *Flail Hammer Head Test and Evaluation*, by SWEDEC, 2005.
2. U.S. Army Research, Development and Engineering Command, Communications, Electronics Research, Development and Engineering Command, Countermine Division, *Scanjack 3500 System Technical Test Report*, 2005.
3. FMV, *Verification of Mine Clearance Vehicle 1/T Deep Mine Clearance Machine*, by Scandinavian Demining Group (SDG), 2003.
4. BRTRC Technology Research Cooperation, *Area Mine Clearing System (AMCS), Study Report*, by US Army, Project Manager for Close Combat Systems (PM - CCS), 2002.
5. SWEDEC, *Performance Test of Demining Machines Performed by SWEDEC*, by Scandinavian Demining Group (SDG), 2001.

SCANJACK 3500 | Operating in Sudan

REPORTED LIMITATIONS AND STRENGTHS

Limitations

- Vegetation cutting is limited to trees with trunks of approximately 15 cm diameter.
- It is a large machine that requires transporting over long distances on a trailer.
- The flail unit is detachable and can be transported on a separate truck or lorry.
- The system creates huge dust clouds as occurs with all flail systems in dry environments.

Strengths

- The unique double flail system ensures a high clearance rate (test reports are available from SWEDEC) of AP and AV mines.
- The experience of 40 years with the base machine under hard conditions means that many problems have been rectified.
- Operator safety.
- Technical reliability.

DIMENSIONAL DATA

1. Length without attachment	10,300 mm
2. Length total	14,000 mm
3. Width without attachment	3,000 mm
4. Width total	4,440 mm
5. Clearing | Working width	3,500 mm
6. Height | Overall	3,700 mm
7. Mass | Basic vehicle	29,000 kg
8. Mass | Detachable unit(s)	8,500 kg
9. Mass | Overall	36,480 kg 37,500 kg with tracks

OPERATIONAL DATA

10. Wheels | Tracks (description)	8 tyres 650/65-26.5 and 4 tracks 750 mm wide
11. Ground Bearing Pressure (kPa)	Front 0.96 kg/cm^2 | Rear 0.6 kg/cm^2
12. Hill climbing ability (in degrees)	35°
13. Number of Chains | Chisels | Tools	76 on each rotor
14. Beat pattern (hits per m^2) at different operating speeds	Not given
15. Length of Chains | Tools	First rotor: 697 mm | Second rotor: 793 mm
16. Diameter of drum	Not given
17. Rotation Speed	300 - 400 rpm
18. Clearance | Working depth in varying terrain	First rotor: up to 15 mm Second rotor: up to 30 mm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	1,500 m^2/h
> Medium Soil | Medium Vegetation	1,200 m^2/h
> Heavy Soil | Dense Vegetation	900 m^2/h
20. Control of Clearance | Working depth	Manual by hydraulic pressure and ultrasonic sensor
21. Additional attachable working tools	
22. Armour	12 mm ARMOX 500S toughened plate for the cabin and 41 mm protection glass windows. 10 mm ARMOX 500S for hydraulic system and the rest of the machine
23. Remote controlled	Optional remote control 300 m in line of sight
> greatest distance	700 m
24. Transportation	
> short distances	Limitation 3.03 m wide and 4.2 m high on low bed trailer
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	15
26. Other types	No
27. Location of use	Bosnia and Herzogovina, Croatia, Iraq, Sweden, Sudan, USA, The Netherlands
28. Totally cleared so far (m^2)	Not given

ENGINE | FUEL | OIL

29. Engine	John Deere, 6 cylinder diesel engine with 220 hp
30. Engine power at the flywheel	Not given
31. Sufficient power supplied to working tool	Not given
32. Fuel capacity	300 l
33. Fuel consumption	Max 60 - 80 l/h in operation
34. Separate engine for working unit	Yes, Scania V8 diesel engine with 570 hp
35. Cooling system	Water cooled
36. Oil capacity (both engines)	Not given
37. Hydraulic oil capacity (both engines)	390 l for both engines

COSTS

38. Cost of system	On request
39. Other costs	Not given
> training	—
> spare part set chains | belts	—
40. Availability for hire	Yes

OTHER

41. Operator comfort	Ergonomic chair and controls, radio
42. Air conditioning	Yes

Yamanashi Hitachi | Japan

GENERAL DESCRIPTION

The new *FV30* model has been developed to add a robust flail machine to the BM307 series of Hitachi Demining. It is based on a 30-ton class hydraulic shovel dozer with the engine and hydraulic system of a 45-ton class machine. It is capable of bush cutting and mine clearance with 3 m wide drum.

A 2006 survivability test in Cambodia proved that the system can withstand an AV mine blast with only minor repair – and with an operator in the cabin using only ear protectors. The drum is mounted at the rear of the machine and makes final inspection by deminers or dogs easier by ploughing the ground processed by the flail. The 600 mm track shoe makes it reliable on muddy and sticky ground. It can also be used for agricultural work. The base machine is compact and easy to transport, minus the attachments.

One operator controls the machine from a cab protected by special bullet-proof glass (Rexguard) and high-tension steel plates. Critical parts – such as the hydraulic cylinder, fuel tank and hydraulic oil tank – are protected against mine blasts. Consumable parts, such as the hammer, chain and joints, are recyclable.

BM307 FV30 | Flail system

CLEARANCE METHODOLOGY

The drum rotates up to 400 rpm powered by a hydraulic motor. With a working width of 3,000 mm, the 90 hammers can cut vegetation, fragment stones (maximum diameter 300 mm) and destroy AP mines to a depth of 300 mm. The FV30 has a level plate system and an angle sensor to keep constant excavation depth so that the operator can easily control the machine from the cab.

MACHINES IN USE TO DATE

Rotary cutter

- Two BM307s (version S16) in Cambodia since 2000.
- One BM307 (v V20) in Afghanistan since June 2000 (with UNOCHA).
- Two BM307s (v V20) in Nicaragua since September 2001.
- One BM307 (v V27) in Vietnam since June 2003.
- Eight BM307s (v SG16) in Cambodia since July 2003.

- Fourteen BM307s (v SG16) in Cambodia since June 2005.
- Two BM307s (v V33) in Angola since August 2007.
- Two BM307s (one v V23 and one V35) in Afghanistan since September 2007.

Flail hammer

- Two BM307s (v V33) in Angola since August 2007.
- One BM307 (v V35) in Afghanistan since September 2007.

ENGINE, FUEL AND OIL

- The BM307 is powered by a 235 kw Isuzu 6WG1 diesel engine.
- Standard oil types are used for engine, gearbox and hydraulics.
- Fuel consumption varies from 30 to 45 litres per hour.

BM307 FV30 | Ready for transport

FACTORY SUPPORT

- Spare parts – including consumable parts such as cutter bits, bearings, seals, etc. – are included in the purchase package.
- Availability of spares is good due to a worldwide servicing network.
- One month training is conducted in the buyer's country and training for operators and maintenance staff is included in the purchase package.
- Manuals are supplied in the language required by the purchaser and included in the purchasing package. A spare part catalogue is available.
- Warranty period is one year or 1,000 hours, whichever comes first.

MAINTENANCE SUPPORT

Regular maintenance – daily, monthly and other periodic checks – is required as per the operating instructions. Daily servicing takes 30 minutes, monthly servicing takes one hour.

TESTS AND EVALUATIONS

No information provided.

REPORTED LIMITATIONS AND STRENGTHS

No information provided.

DIMENSIONAL DATA

1. Length without attachment	6,100 mm
2. Length total	10,880 mm
3. Width without attachment	2,750 mm
4. Width total	4,260 mm
5. Clearing | Working width	2,900 mm
6. Height | Overall	3,460 mm
7. Mass | Basic vehicle	23,200 kg
8. Mass | Detachable unit(s)	Flail hammer: 6,150 kg | Rake: 2,750 kg
9. Mass | Overall	32,500 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Tracks | Grouser - shoe Std. 600 mm
11. Ground Bearing Pressure (kPa)	71 kPa
12. Hill climbing ability (in degrees)	35°
13. Number of Chains | Chisels | Tools	86
14. Beat pattern (hits per m^2) at different operating speeds	Not given
15. Length of Chains | Tools	860 mm
16. Diameter of drum	267 mm
17. Rotation Speed	400 rpm
18. Clearance | Working depth in varying terrain	250 mm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	1,000 m^2/h
> Medium Soil | Medium Vegetation	700 m^2/h
> Heavy Soil | Dense Vegetation	300 m^2/h
20. Control of Clearance | Working depth	Level plate system
21. Additional attachable working tools	
22. Armour	Armoured cabin, protection cover on fuel tank, hydraulic tank, cylinders and hoses of front devices
23. Remote controlled	Option
> greatest distance	100 m
24. Transportation	
> short distances	By trailer or own trip for short distance
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	11
26. Other types	Not given
27. Location of use	Cambodia, Angola
28. Totally cleared so far (m^2)	Not given

ENGINE | FUEL | OIL

29. Engine	ISUZU 6WG1
30. Engine power at the flywheel	235 kw
31. Sufficient power supplied to working tool	Not given
32. Fuel capacity	650 l
33. Fuel consumption	30 - 45 l/h
34. Separate engine for working unit	No
35. Cooling system	Water cooled
36. Oil capacity (both engines)	55 l
37. Hydraulic oil capacity (both engines)	280 l

COSTS

38. Cost of system	Not given
39. Other costs	
> training	—
> spare part set chains | belts	—
40. Availability for hire	Yes

OTHER

41. Operator comfort	Suspension seat, radio, hot and cool box
42. Air conditioning	Full auto air conditioner

Ararat Company | Iraq

GENERAL DESCRIPTION

The *NOMA Crusher* is manufactured by the Ararat company, a regional producer of mechanical demining equipment in Northern Iraq. The medium-size tiller system is designed for mine clearance task as well as ground preparation tasks by crushing the topsoil and simultaneously clearing the mines.

The machine can operate in all ground conditions, even in difficult terrain.

The NOMA Crusher and the methodology have been accredited by the General Directorate for Mine Action in Iraq.

The machine is remotely controlled by an operator from a safe distance. It is described as an economic, simple machine and easy to maintain.

NOMA CRUSHER

CLEARANCE METHODOLOGY

The crushing action is created by a rotational axle which is surrounded by the 99 carbon teeth. Rotation speed is up to 500 rpm. The machine can penetrate the ground and achieve a clearance depth of up to 30 cm. There is no gap between the carbon teeth.

The Crusher is designed to detonate or destroy all AP and AV mines. The area production rate is approximately 2,000 - 3,000 m^2 per day depending on ground conditions.

MACHINES IN USE TO DATE

Two machines are operated by the Ararat company for the Iraqi Government in the Kurdistan region.

ENGINE, FUEL AND OIL

- The Crusher is equipped with a 300 hp Deutz diesel engine.
- Fuel consumption is 15 litres per hour under normal conditions.

FACTORY SUPPORT

- A basic spare parts set is included in the purchase package.
- Heavy maintenance for the machine can be provided on request.
- Mechanic and operator training as well as refresher training can be provided.
- The manufacturer can send their own technicians with a mobile workshop for on-site maintenance.

MAINTENANCE SUPPORT

Ararat have a special team to perform maintenance and other services, depending on the contract and customer request.

NOMA CRUSHER

TESTS AND EVALUATIONS

This is a new product and no reports are yet available.

REPORTED LIMITATIONS AND STRENGTHS

No information available. It is likely that it will be difficult to operate with precision at greater distances, as with all remotely controlled machines.

TECHNICAL SPECIFICATIONS	NOMA CRUSHER

DIMENSIONAL DATA

1. Length without attachment	4,000 mm
2. Length total	5,500 mm
3. Width without attachment	2,100 mm
4. Width total	2,300 mm
5. Clearing | Working width	2,100 mm
6. Height | Overall	2,600 mm
7. Mass | Basic vehicle	6,500 kg
8. Mass | Detachable unit(s)	2,500 kg
9. Mass | Overall	9,000 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Wheels
11. Ground Bearing Pressure (kPa)	Not given
12. Hill climbing ability (in degrees)	Not given
13. Number of Chains | Chisels | Tools	99 teeth
14. Beat pattern (hits per m^2) at different operating speeds	Not given
15. Length of Chains | Tools	250 mm
16. Diameter of drum	Not given
17. Rotation Speed	500 rpm
18. Clearance | Working depth in varying terrain	30 cm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	500 m^2/h
> Medium Soil | Medium Vegetation	Not given
> Heavy Soil | Dense Vegetation	400 m^2/h
20. Control of Clearance | Working depth	Manual
21. Additional attachable working tools	
22. Armour	10 mm
23. Remote controlled	Yes
> greatest distance	400 m
24. Transportation	
> short distances	From site to site by a low bed trailer
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	2
26. Other types	No
27. Location of use	Northern Iraq
28. Totally cleared so far (m^2)	Not given

ENGINE | FUEL | OIL

29. Engine	DEUTZ diesel engine with 300 hp
30. Engine power at the flywheel	Not given
31. Sufficient power supplied to working tool	Not given
32. Fuel capacity	Not given
33. Fuel consumption	14 - 15 l/h
34. Separate engine for working unit	No
35. Cooling system	Air cooled
36. Oil capacity (both engines)	18 l
37. Hydraulic oil capacity (both engines)	120 l

COSTS

38. Cost of system	Not given
39. Other costs	Not given
> training	—
> spare part set chains | belts	—
40. Availability for hire	Not given

OTHER

41. Operator comfort	N/A
42. Air conditioning	N/A

ASA company | Iraq

GENERAL DESCRIPTION

The new *ASA Heavy Crusher* was designed in 2007 by ASA, a company based in Iraq/Suleimanyah. The medium-sized machine is used to break and crush the topsoil of mine-affected areas. The basic vehicle used is a Fiat ALS14 bulldozer. The speed of the vehicle is reduced by changing the gearbox ratio. The crushing rotor consists of a heavy cylinder mounted with armoured teeth. Each tooth contains a carbon point for more friction resistance.

The crusher attachment is powered hydraulically from the second engine. The Crusher is operated manually but it can also be operated remotely.

This machine is a prototype, currently operating in Northern Iraq/Suleimanyah. It is claimed that it works very well in steep areas. Normal operational speed is 10 m per minute. Most parts of the machine are armour plated, including the operator cabin and crusher attachment.

ASA

CLEARANCE METHODOLOGY

Recommended operating procedure for the machine is to work in lines taking care to maintain an overlap. The working depth is between 20 cm and 40 cm depending on local conditions. The claimed daily area production in medium soil is 4,000 - 5,000 m^2. The cylinder, with its 180 carbon teeth, rotates at up to 200 rpm.

MACHINES IN USE TO DATE

The prototype machine is owned and operated by the ASA company in Northern Iraq/Suleimanyah.

ENGINE, FUEL AND OIL

The original Fiat bulldozer engine powers movement of the vehicle. The second (Perkins) engine at the back of the bulldozer generates hydraulic power for the crusher unit. Both engines are six-cylinder diesels.

FACTORY SUPPORT

Assuming the machine goes into production, ASA is likely to offer:

- technical support
- basic spare parts
- heavy maintenance for the machine where possible
- mechanic and operator training, if ordered
- possible on-site visits by company technicians with a mobile workshop

ASA | In action

MAINTENANCE SUPPORT

In case of breakdown, qualified staff with a mobile workshop are available.

TESTS AND EVALUATIONS

No reports yet available.

REPORTED LIMITATIONS AND STRENGTHS

No information available.

DIMENSIONAL DATA

1. Length without attachment	4,000 mm
2. Length total	8,000 mm
3. Width without attachment	2,500 mm
4. Width total	2,900 mm
5. Clearing | Working width	2,500 mm
6. Height | Overall	4,000 mm
7. Mass | Basic vehicle	14,000 kg
8. Mass | Detachable unit(s)	7,000 kg
9. Mass | Overall	21,000 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Tracks
11. Ground Bearing Pressure (kPa)	Not given
12. Hill climbing ability (in degrees)	40°
13. Number of Chains | Chisels | Tools	180
14. Beat pattern (hits per m^2) at different operating speeds	Not given
15. Length of Chains | Tools	300 mm
16. Diameter of drum	Not given
17. Rotation Speed	150-200 rpm
18. Clearance | Working depth in varying terrain	20-40 cm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	600 m^2/h
> Medium Soil | Medium Vegetation	Not given
> Heavy Soil | Dense Vegetation	500 m^2/h
20. Control of Clearance | Working depth	Manually
21. Additional attachable working tools	
22. Armour	8 mm
23. Remote controlled	N/A
> greatest distance	
24. Transportation	
> short distances	Not given
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	1
26. Other types	No
27. Location of use	Northern Iraq
28. Totally cleared so far (m^2)	Not given

ENGINE | FUEL | OIL

29. Engine	Fiat
30. Engine power at the flywheel	Not given
31. Sufficient power supplied to working tool	Not given
32. Fuel capacity	400 l
33. Fuel consumption	15 - 17 l/h
34. Separate engine for working unit	Perkins
35. Cooling system	Water cooled
36. Oil capacity (both engines)	25 l
37. Hydraulic oil capacity (both engines)	300 l

COSTS

38. Cost of system	Not given
39. Other costs	Not given
> training	—
> spare part set chains | belts	—
40. Availability for hire	Not given

OTHER

41. Operator comfort
42. Air conditioning

TILLER SYSTEMS | HEAVY TILLER | KOMATSU D85MS-15

Komatsu Ltd. | Japan

GENERAL DESCRIPTION

The Komatsu company has been in business for more than 85 years and started to develop humanitarian anti-personnel demining equipment in 2003 with the aid of the Japanese Government.

The standard middle-size Komatsu Bulldozer D85EX-15 on tracks is used as the prime mover of the tiller system, and is partnered with Komatsu's CS210 soil-digging stabilising system. The CS210 and engine, transmission and controllers are all Komatsu-designed technology. The machine is suitable for operating in all kinds of terrain. The track system is equipped with an oscillation system to enable more ground contact on hard slopes or uneven terrain.

The machine can be driven by an operator or remotely controlled. With the specially developed filter and cooling system, the machine can operate in a broad range of climatic conditions. The operator cabin, engine and tanks for fuel and hydraulic oil are all protected by bullet-proofed material.

For longer journeys between worksites a flatbed trailer is required. It can be made lighter for transportation by separating the front attachment and rear counterweight. The overall weight of the system is 35,000 kg: separating the attachments reduces the weight to 27,400 kg or 22,300 kg.

KOMATSU | In action in different vegetation

CLEARANCE METHODOLOGY

The tiller system penetrates the ground to a depth of 300 mm and performs well on vegetation cutting. The working tool rotates at about 200 rpm. It can be tilted, as well as raised and lowered. The machine's claimed maximum clearance rate is 1,000 m^2/h. In Afghanistan and Cambodia, actual average clearance rates were between 400 and 600 m^2/h. A blade can be attached to the bulldozer for dozing operations after clearing operations.

MACHINES IN USE TO DATE

The first machine is in service with the Mine Dog and Detection Center in Afghanistan. The second machine belongs to the Cambodian Mine Action Center (CMAC). The third machine has been operated as a joint project by Japan Mine Action Service (JMAS) and CMAC in Cambodia. The fourth machine has been used as a joint project by JMAS and the National Institute for Demining in Angola.

ENGINE, FUEL AND OIL

The diesel engine is Komatsu's own SA6D125E generating 179 kw (240 hp). Normal fuel consumption is around 40 litres per hour.

FACTORY SUPPORT

- Spare parts are available from the manufacturer.
- Komatsu also offers two- or three-week factory training for operators and mechanics.
- Operation manuals and field assembly manuals are available in English.

MAINTENANCE SUPPORT

Daily maintenance and periodic changes for consumable parts are recommended.

KOMATSU | In action and ready for transport

TESTS AND EVALUATIONS

Two test reports are available:

1. Project for Research and Development of Demining Related Equipment in Cambodia. Final Report of Komatsu - D-85EX (Komatsu) – 2007: www.cmac.org.kh/menu_rd.asp
2. Japan International Cooperation System (JICS), Final report (summary) for humanitarian mine clearance equipment in Afghanistan under the research project for developing mine clearance related equipment in Afghanistan, 2004-2005: www.mineaction.org/downloads/1/Final%20Report%20(Summary).pdf

They can also be found at www.itep.ws

REPORTED LIMITATIONS AND STRENGTHS

Limitations

- The tiller system is not designed for clearance of AV mines.
- Complete with the tiller attachment, the system weighs 35 tons. For transport over longer distances, a low loader is required.

Strengths

- The system can operate various terrains, including steep slopes, uneven ground, dry riverbeds and canal sides, and rocky sites.
- Capacity to detonate or neutralise all AP mines.

DIMENSIONAL DATA

1. Length without attachment	6,625 mm
2. Length total	8,620 to 9,000 mm
3. Width without attachment	2,510 mm
4. Width total	3,470 mm
5. Clearing | Working width	2,550 mm
6. Height | Overall	3,620 mm
7. Mass | Basic vehicle	28,000 kg
8. Mass | Detachable unit(s)	Not given
9. Mass | Overall	35,000 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Tracks
11. Ground Bearing Pressure (kPa)	1.1 kP/cm^2
12. Hill climbing ability (in degrees)	30°
13. Number of Chains | Chisels | Tools	152
14. Beat pattern (hits per m^2) at different operating speeds	Not given
15. Length of Chains | Tools	Not given
16. Diameter of drum	Not given
17. Rotation Speed	200 rpm
18. Clearance | Working depth in varying terrain	300 rpm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	
> Medium Soil | Medium Vegetation	
> Heavy Soil | Dense Vegetation	Max 1,000 m^2/h
20. Control of Clearance | Working depth	Not given
21. Additional attachable working tools	Blade
22. Armour	Yes
23. Remote controlled	Yes
> greatest distance	100 m
24. Transportation	
> short distances	Over long distances on a flat bed trailer
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	4
26. Other types	No
27. Location of use	Afghanistan, Cambodia, Angola
28. Totally cleared so far (m^2)	Not given

ENGINE | FUEL | OIL

29. Engine	Komatsu SA6D 125E-3
30. Engine power at the flywheel	(SAEJ1349) 179 kw (240 hp)/1900 rpm
31. Sufficient power supplied to working tool	Not given
32. Fuel capacity	490 l
33. Fuel consumption	About 40 l/h
34. Separate engine for working unit	No
35. Cooling system	Water
36. Oil capacity (both engines)	Not given
37. Hydraulic oil capacity (both engines)	Not given

COSTS

38. Cost of system	On request
39. Other costs	On request
> training	On request (2-3 weeks)
> spare part set chains | belts	On request
> repair costs for one year	On request
40. Availability for hire	Not given

OTHER

41. Operator comfort	Not given
42. Air conditioning	Yes

Kawasaki Heavy Industries Ltd. | Japan

GENERAL DESCRIPTION

Minebull is produced by Kawasaki and belongs to the Bulldog family, Kawasaki's humanitarian mine detection and demining system. The components are the Minedog, a mine detection system, and the Minebull, a mechanical demining machine.

The Minebull is a four-wheel drive, heavy demining machine equipped with a high-speed digging drum (tiller) at its front. The Minedog electronically detects and marks the AP mines detected; the Minebull detonates the mines by smashing them against the digging drum and drum covers. At the same time, buried metal fragments are automatically collected with permanent magnetic pulleys.

The digging drum is made of 30 mm steel plates. The number of digging bits and their arrangement are designed to prevent unexploded AP mines being carried away with the dirt. The design is based on studies of how AP mines and surrounding dirt move when they encounter the digging drum. The drum takes a 2.23 m-wide swath and can penetrate the ground to a depth of 35 cm. A clearance rate of 3,345 m^2/h (at 1.5 km/h) is claimed, but depends on ground conditions.

THE MINEBULL

The vehicle body is protected from AV mine shrapnel as follows:

- the cabin window is 67 mm, bullet- and dust-proof glass
- the cabin is armoured with a 16 mm steel plate on the front and a 12 mm steel plate on the side
- the engine room access door is a composite plate made of iron and Zylon, a synthetic fibre with outstanding thermal properties that is ten times stronger (static strength) than iron
- the engine room, fuel tank, tyres and joints are armoured with 12 mm steel plating protection.

The Minebull's metal fragment collection system uses strong magnetic pulleys to collect metal fragments into a bucket while the dirt mixed with the metal fragments is removed via a conveyer belt after detonation. The system sweeps up nearly 100% of all exploded shrapnel including small metal fragments in the soil. The machine is normally remotely controlled but also allows for manned operation. It is equipped with two rescue winches at the rear of its chassis capable of towing 12 tons each (total 24 tons) in case of sticking or mechanical failure of the driving system. For long-distances, the Minebull can be transported on a low-bed trailer, but it can be self-driven for site changes over short and medium distances with a speed up to 20 km/h.

THE MINEBULL | Detail of the tiller system

CLEARANCE METHODOLOGY

Minebull's digging drum rotates anti-clockwise to dig up AP mines and the intercepting bits (chisels) implanted inside the drum cover destroy those mines uncrushed by drum. The drum's rotation speed can be varied depending on the minefield's soil characteristics from 60 rpm (Low First) to 200 rpm (High Third).

Maximum clearing depth is 35 cm but usually the depth is set at 30 cm or 20 cm and such depths are maintained automatically by digging depth sensors. The digging drum is made of 30 mm steel plate and has 249 bits, while the drum cover has 81 intercepting bits.

MACHINES IN USE TO DATE

The first Minebull was delivered to Afghanistan in August 2007 and started operation in September 2007.

ENGINE, FUEL AND OIL

- The engine is a 243 kw (330 hp) Nissan diesel and the driving system has hydrostatic transmission for ultra-low speed traction.
- Fuel capacity is 420 litres.
- Fuel consumption depends on the particular site conditions but during the test trials mentioned below the fuel consumption varied from 21.3 to 47.3 litres per hour.

FACTORY SUPPORT

- Two months of training for two operators and one mechanic are provided at the construction factory in Japan.
- Training courses and manuals (operation and maintenance) are provided in English and are included in the purchase agreement.

MAINTENANCE SUPPORT

Kawasaki recommend employing at least two operators and one engineer (with some technicians in support) to operate the Minebull. It is also recommended to have access to heavy construction machinery maintenance shop.

Federal Trading Corp., with its main factory in Karachi, Pakistan and branches elsewhere in Pakistan and Kabul, Afghanistan, has been appointed as a service centre for maintenance and operation support to Minebull.

MINEBULL | With support vehicles

TESTS AND EVALUATIONS

One test report is available at the website www.itep.ws Japan International Cooperation System (JICS), *Final report (summary) for humanitarian mine clearance equipment in Afghanistan under the research project for developing mine clearance related equipment in Afghanistan*, 2004-2005. At a minefield near Kabul airport the Minebull destroyed 32 mines in 50 minutes.

REPORTED LIMITATIONS AND STRENGTHS

Limitations

- The system is not designed for clearance of AV mines.
- Complete with the tiller attachment, the system weighs 34 tonnes. For transport over longer distances, a low loader is required.

Strengths

- The additional collection system for metal fragments.
- GPS available for mapping.
- Suitable for various terrains.
- Able to detonate or neutralise all AP mines.

DIMENSIONAL DATA

1. Length without attachment	N/A
2. Length total	9,293 mm
3. Width without attachment	N/A
4. Width total	3,240 mm
5. Clearing | Working width	2,388 mm
6. Height | Overall	3,820 mm (without antenna) 4,420 mm (with antenna)
7. Mass | Basic vehicle	N/A
8. Mass | Detachable unit(s)	N/A
9. Mass | Overall	34,000 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Four wheel drive Wheel base: 2,798 mm | Wheel track: 1,715 mm
11. Ground Bearing Pressure (kPa)	Normal tyre 706 kPa (front) / 373 kPa (rear) Wide tyre (optional) 490 kPa (front) / 255 kPa (rear)
12. Hill climbing ability (in degrees)	10° (in operation) / 20° (travelling)
13. Number of Chains | Chisels | Tools	Cutting bits: 249 (drum)| 81 (drum cover)
14. Beat pattern (hits per m^2) at different operating speeds	N/A
15. Length of Chains | Tools	N/A
16. Diameter of drum	1,005 mm (tip of cutting bit)
17. Rotation Speed	From 60 rpm at low 1st to 200 rpm at high 3rd
18. Clearance | Working depth in varying terrain	Digging depth maximum 35 cm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	3,345 m^2/h at 1.5 km/h
> Medium Soil | Medium Vegetation	Depending on specific condition
> Heavy Soil | Dense Vegetation	Depending on specific condition
20. Control of Clearance | Working depth	Automatic (can be set at 20 and 30 cm depth)
21. Additional attachable working tools	
22. Armour	Armoured with 12 - 16 mm thick steel plate and 60 mm anti-bullet glass
23. Remote controlled	Yes
> greatest distance	Max 900 m
24. Transportation	
> short distances	Sea and land Self deployable for short/medium distance
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	1
26. Other types	No
27. Location of use	Afghanistan
28. Totally cleared so far (m^2)	Not given

ENGINE | FUEL | OIL

29. Engine	Nissan Pe6t diesel engine
30. Engine power at the flywheel	243 kw (330 ps)/2,000 rpm
31. Sufficient power supplied to working tool	N/A
32. Fuel capacity	420 l
33. Fuel consumption	Depending on specific condition
34. Separate engine for working unit	N/A (power for working unit is extracted from main engine with hydraulic pump and motor)
35. Cooling system	Conventional radiators
36. Oil capacity (both engines)	Approx. 30 l
37. Hydraulic oil capacity (both engines)	120 l for HST 120 l for loading system

COSTS

38. Cost of system	Approx. 800,000 US$ including training and initial spare parts
39. Other costs	
> training	Included in purchase agreement for two operators and one engineer
> spare part set chains | belts	Included in purchase agreement for initial spare parts set
> repair costs for one year	Depends on the operation
40. Availability for hire	One machine is available

OTHER

41. Operator comfort	Operator can remotely operate the Minebull in the remote operation vehicle equipped with air conditioner (two passenger car type operators seat with noise insulation interior and air conditioning in case of manual driving for short transportation)
42. Air conditioning	Provided for cabin cooling

Rybro International Ltd. | United Kingdom

GENERAL DESCRIPTION

The *Mine-Guzzler* was developed by Bofors Defence in Sweden. Under the new owner, Rybro International Ltd., it has been redesigned and is now based completely on commercial components for easy maintenance, repair and accessibility of spare parts.

The Mine-Guzzler is based on a double track arrangement of Caterpillar. A demining tiller is located on hydraulic supports at the front of the vehicle and powered by a 640 kw 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 to continue while a tiller is being repaired. A complete tiller change takes less than 30 minutes using the hydraulic supports to lift the tiller for access or to load/unload the roller onto a vehicle.

The 45-tonne 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 12 kg of TNT.

The machine has 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 roads. The rotator can be replaced by a blade to allow the machine to be used as an armoured bulldozer.

MINE-GUZZLER | Left, back and front view

CLEARANCE METHODOLOGY

The vehicle drives forward into the suspect area by revolving the tiller unit. It rotates clockwise at up to 190 rpm. 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 at their edges, which either causes the mines (AP and AV) to detonate or breaks them into small pieces.

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

The machine can be equipped, as an option, with a GPS system allowing navigation and documentation of the cleared area. The system will record the area covered including the preset depth that is set for the area.

MACHINES IN USE TO DATE

One machine is in use in the Basra area in Iraq, operated by NMAA.
Two prototypes were previously made on a Leopard 1 chassis.

ENGINE, FUEL AND OIL

A Caterpillar 3412E, TTA 641 kw (860 hp) diesel engine powers the Mine-Guzzler. The tiller unit does not have a separate engine. Fuel capacity is 800 litres. The hydraulic oil capacity for the tracks is 235 litres, while the lift and tilt system requires 70 litres. During two tests in Germany in October 2000, the average fuel consumption was 70 to 90 litres per hour.

FACTORY SUPPORT

Rybro International has signed distribution agreements with Caterpillar dealers in Egypt, Ghana, Iraq, Kenya, Nigeria, Russia, Sierra Leone, Tanzania and Uganda to secure local support for spare parts, repair and maintenance and training. More countries will be added if requested by any customer/user.

The main components (engine, tracks, filters, etc.) are from Caterpillar. Special parts can be ordered either from Caterpillar agents or directly from Rybro International.

Training, spare parts catalogue and comprehensive manuals in English are part of the delivery package. Training can be provided locally or in the UK prior to shipment.

MAINTENANCE AND SUPPORT

Daily maintenance is performed by the machine operator. Repairs can be done in the field, assuming oxyacetylene cutting and welding equipment.

Recommended operators for the machine are one trained and experienced heavy machine operator and one manual deminer.

TESTS AND EVALUATIONS

In May-June 2000, the Mine-Guzzler passed testing in Croatia with CROMAC. A minefield of 80,000 m^2 was cleared.

In October 2000, five different machines were tested by the BWB (Bundesamt für Wehrtechnik und Beschaffung) for the German Army. The Mine-Guzzler achieved the best overall results.

In February 2001, the machine was tested by the Egyptian Armed Forces. The test was performed in live minefields in Hurghada and Safaga.

In July 2001, the Swedish Army tested the Mine-Guzzler, Scanjack 3500 and Hydrema MCV 910 at their SWEDEC facilities in Eksjö, Sweden.

Three test reports are available at www.itep.ws:

1. BRTRC Technology Research Cooperation, *Area Mine Clearing System (AMCS)*, Study Report, by US Army Project Manager for Close Combat Systems (PM - CCS), 2002: www.itep.ws//pdf/AMCSStudyReport.pdf
2. SWEDEC, *Performance Test of Demining Machines Performed by SWEDEC, by Scandinavian Demining Group (SDG)*, 2001: www.itep.ws//pdf/Scanjack_mineguzzler_970mcv_performance.pdf
3. Theimer (TRAR), Summary Report MINE GUZZLER, Landmine Clearance Test Facility WTD 51, Germany 2001: www.itep.ws//pdf/MineGuzzler_EN.pdf

REPORTED LIMITATIONS AND STRENGTHS

Limitations

- The Mine-Guzzler is a large, tracked vehicle.
- Over long distances it will require transporting by low loader.

Strengths

- The Mine-Guzzler is designed to destroy AP and AV mines.
- The CROMAC test report said it can easily cope with thick vegetation as well as individual trees up to 20 cm diameter.
- The CROMAC report also said the machine's daily efficiency was "good".

DIMENSIONAL DATA

1. Length without attachment	7,000 mm
2. Length total	8,570 mm
3. Width without attachment	3,590 mm
4. Width total	4,540 mm
5. Clearing | Working width	3,150 mm additional 700 mm with the always attached plows
6. Height | Overall	3,575 mm
7. Mass | Basic vehicle	36,000 kg
8. Mass | Detachable unit(s)	15,000 kg
9. Mass | Overall	51,000 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Number of track plates per side 52 track plate type 3 ridges track plate width 550 mm
11. Ground Bearing Pressure (kPa)	99 kg/dm^2
12. Hill climbing ability (in degrees)	+/- 15° during demining +/- 30° during transport
13. Number of Chains | Chisels | Tools	Teeth 405
14. Beat pattern (hits per m^2) at different operating speeds	1 km/h: 3,158 hits per m^2 1.5 km/h: 2,105 hits per m^2 2 km/h: 1,579 hits per m^2 2.5 km/h: 1,263 hits per m^2 3.0 km/h: 1,053 hits per m^2
15. Length of Chains | Tools	Between tube and teeth 300 mm
16. Diameter of drum	1,200 mm
17. Rotation Speed	190 rpm
18. Clearance | Working depth in varying terrain	100 - 500 mm clearance depending on setting. In very hard terrain it is recommended not to go deeper than 300 mm clearance depth. Standing still the machine can clear down to 700 mm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	9,000 m^2/h
> Medium Soil | Medium Vegetation	6,000 m^2/h
> Heavy Soil | Dense Vegetation	3,000 m^2/h
20. Control of Clearance | Working depth	Active depth holding system using sensors on each side giving signals to hydraulics that control the clearance depth keeping it on preset level at all times
21. Additional attachable working tools	Not given
22. Armour	13 and 16 mm ARMOX steel
23. Remote controlled	Yes incl. camera control and monitor
> greatest distance	500 m
24. Transportation	
> short distances	In one piece on a low bed trailer, otherwise transportable on std trucks divided into parts having a max weight of 20 ton per truck
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	1 machine in Iraq operated by NMAA
26. Other types	This is the third machine developed by Bofors Defence in Sweden
27. Location of use	Basra area in Iraq operated by NMAA
28. Totally cleared so far (m^2)	1,500,000 m^2

ENGINE | FUEL | OIL

29. Engine	CAT 3412E, TTA, 27 l, 12 cylinder diesel engine
30. Engine power at the flywheel	Effect at 2,100 r/min 641 kw (860 hp)
31. Sufficient power supplied to working tool	Effect at 2,100 r/min 550 kw
32. Fuel capacity	800 l
33. Fuel consumption	Between 40 and 90 l/h depends on soil/speed/depth
34. Separate engine for working unit	No
35. Cooling system	Not given
36. Oil capacity (both engines)	60 l
37. Hydraulic oil capacity (both engines)	70 l & 235 l for the transmission

COSTS

38. Cost of system	1.7 million euros
39. Other costs	
> training	Included
> spare part set chains | belts	N/A
> repair costs for one year	165,000 euros
40. Availability for hire	Not at the moment

OTHER

41. Operator comfort	The Mine-Guzzler has a fragment-protected cabin located at the rear of the vehicle. The cabin is mounted on vibration and shock absorbers to minimise accelerating stress effects on the crew when mines are detonated. The driver's seat can be rotated, making it easier to drive the vehicle backwards in transport mode. The large windows, made of armoured glass, allow free sight around the vehicle. The cabin is designed with a high level of comfort and easy access to all controls. For the comfort of the crew, the seats can be adjusted forwards/backwards, in height and for weight, as well as for back support and arm support width. Each seat is also fitted with a four-point safety belt. A fan with filters supplies the cabin with fresh air. The cabin is also equipped with an air conditioning unit with heating and cooling capacity.
42. Air conditioning	Yes

Flensburger Fahrzeugbau GmbH (FFG) | Federal Republic of Germany

GENERAL DESCRIPTION

The *Minebreaker 2000/2* is based on a Leopard 1 chassis. A 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 AP and AV mines. With its main battle tank chassis, the Minebreaker 2000/2 has good all-terrain capability. The crew compartment is protected by 20 mm steel armour and 70 mm glass, and blast-pressure-decreasing shock absorbers.

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/h and a working speed of up to 20 metres per minute.

The Minebreaker 2000/2 is controlled by two joysticks: one to steer the vehicle and the other to adjust the clearance depth. Operator training is uncomplicated. The tilling drum is fitted with removable tungsten steel teeth which can be replaced when worn or broken.

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

MINEBREAKER 2000/2

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.

During testing and evaluation, Minebreaker achieved a clearance rate of 1.5 to 2 hectares per day over soil in temperate regions. As part of normal operation, vegetation and trip-wires 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 is 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 was purchased by the German Armed Forces and deployed to Afghanistan in August 2002 to support ISAF operations. The machine is still in service and has cleared significant areas at Bagram airbase and Kabul airport. According to the manufacturer and the German Armed Forces, the machine cleared more than 1,000 landmines, including AV mines.

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 with different applications from 60 to 100 litres per hour.

FACTORY SUPPORT

The Leopard tank has seen long service in the German Army and numerous other countries. Extensive data is available on the performance of the Minebreaker chassis. The tiller unit's hydraulic system uses standard components which are widely available.

FFG offers logistical support, training and supply of spare parts in the purchase price.

Long-term projects can be provided with a mobile workshop. Operating instructions are currently available in German, English, Croat and Mandarin. The standard warranty covers six months or 500 running hours, whichever comes first, but warranty terms are negotiable.

MINEBREAKER 2000/2

MAINTENANCE AND SUPPORT

One-year service support, on-site technical support once a month and 24-hour callout can be ordered.

FFG offers logistical support and spares service for the system whether purchased or rented. Training and user handbooks describe daily checks to be carried out.

Operators are trained in all aspects of system maintenance. Specialist tools are incorporated into purchasing separately. For long-term operations, a mobile workshop is recommended.

MINEBREAKER 2000/2 | Result of clearing activities

TESTS AND EVALUATIONS

The Minebreaker was tested on live anti-tank mines by the Landmine Clearance Test Facility WTD 51, Germany, in August 2002. The test report (referenced below) said: "The Minebreaker system cleared the following AT mines: three DM 21, one TM 62 and one TM 57. The driver is sufficiently protected in the vibration proof driver cabin (up to 7 kg TNT) as far as the mines explode inside the tiller's working area … The damage that occurred during the trials can be assessed as small."

Three test reports are available at the website www.itep.ws

1. BRTRC Technology Research Cooperation, *Area Mine Clearing System (AMCS), Study Report*, by US Army Project Manager for Close Combat Systems (PM - CCS), 2002: www.itep.ws//pdf/AMCSStudyReport.pdf
2. Theimer (TRAR), *Summary Report MINEBREAKER*, by Landmine Clearance Test Facility, WTD 51, 2002: www.itep.ws/pdf/MineBreaker_EN.pdf
3. Theimer (TRAR), *Summary Report MINEBREAKER 2*, by Landmine Clearance Test Facility, WTD 51, 2002: www.itep.ws/pdf/MineBreaker2_EN.pdf

REPORTED LIMITATIONS AND STRENGTHS

Limitations

- Large, heavy machine difficult to transport.
- 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 AP and AV minefields.

DIMENSIONAL DATA

1. Length without attachment	Not given
2. Length total	10,940 mm
3. Width without attachment	3,250 mm
4. Width total	4,510 mm
5. Clearing | Working width	3,690 mm
6. Height | Overall	3,310 mm
7. Mass | Basic vehicle	33,500 kg
8. Mass | Detachable unit(s)	13,500 kg
9. Mass | Overall	47,000 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Tracks Diehl D 640 A
11. Ground Bearing Pressure (kPa)	960 N/cm²
12. Hill climbing ability	50%
13. Number of Chains | Chisels | Tools	66
14. Beat pattern (hits per m²) at different operating speeds	Not given
15. Length of Chains | Tools	Not given
16. Diameter of drum	1,800 mm
17. Rotation Speed	Up to 100 rpm
18. Clearance | Working depth in varying terrain	
19. Working Speed (m²/h)	
> Light Soil | Medium Vegetation	4,000 m²/h
> Medium Soil | Medium Vegetation	2,400 m²/h
> Heavy Soil | Dense Vegetation	1,000 m²/h
20. Control of Clearance | Working depth	Mechanic
21. Additional attachable working tools	No
22. Armour	Original Leopard 1 chassis; cabin with 20 mm armoured steel and 70 mm protection glass
23. Remote controlled	Optional
> greatest distance	1,000 m
24. Transportation	
> short distances	By road or deployed with trailer
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	3
26. Other types	Minebreaker 2000
27. Location of use	Afghanistan, BiH, Republic of Korea
28. Totally cleared so far (m^2)	Not given

ENGINE | FUEL | OIL

29. Engine	MTU MB 838 with 10 cylinders and 830 hp
30. Engine power at the flywheel	Not given
31. Sufficient power supplied to working tool	Hydrostatic transmission
32. Fuel capacity	940 l
33. Fuel consumption	Max 100 l/h
34. Separate engine for working unit	No
35. Cooling system	Not given
36. Oil capacity (both engines)	Not given
37. Hydraulic oil capacity (both engines)	Not given

COSTS

38. Cost of system	On request
39. Other costs	
> training	Usually included in the system price
> spare part set chains | belts	Not given
> repair costs for one year	Not given
40. Availability for hire	Yes

OTHER

41. Operator comfort	A high degreee of comfort for the operator is achieved by using standard components (seat, instruments, etc.) from industry
42. Air conditioning	Yes

TILLER | HEAVY TILLER | ORACLE II

Countermine plc | United Kingdom

GENERAL DESCRIPTION

The Oracle demining system was developed in Sweden in 1994. It is based on an armoured Caterpillar 973C TTL and is designed to clear both AP and AV mines as well as other explosive objects.

The main mine clearance tool is a rotating tiller drum fitted with replaceable heavy-duty steel teeth. The tool is designed to be easily repairable if it is damaged by a mine blast.

The machine comes with different tools for use depending on conditions. The choice of tool is determined by the depth at which mines are expected to be found, the types of mines on the site, and local soil conditions. Apart from the standard tool a "fine tool" is available to deal with very small mines and a "heavy duty tool" for very tough and rocky ground conditions.

The tiller drum on the standard tool has 252 bits; the drum on the fine tool has 490 bits. The staggered positioning of the digging tools on the rotor is designed to prevent AP mines passing between them. The tiller unit is powered by two commercial Caterpillar diesel engines and a hydraulic pump system, towed behind the prime mover on a trailer armoured to the same specification as the prime mover.

ORACLE II | In desert conditions

The Oracle II uses a standard Caterpillar track vehicle and the system (basic vehicle, hydraulic power unit and tiller tool) weighs 65 tons. Other attachments for the Caterpillar vehicle, such as a demolition bucket and a mine clearance rake, can be fitted. The Caterpillar mine rake is standard equipment for the US Army. Designed to rip mines from the soil, the rake has a clearance width of 366 cm to an average depth of 30 cm. The rake uses 35° tines, replaceable when damaged. The upturned soil, and any mines within it, is pushed to the right side of the unit in a windrow.

The system can be operated directly by an operator or by optional remote control. Operator comfort and ergonomics were priorities during the design. Controls are simple, needing minimum effort from the driver. The cab is pressurised with filtered air and air conditioned.

Oracle II main features are:

- the driver is protected by Armox 370T Class 2 Armour plates with armour glass and polycarbonate at the same level of protection
- the machine is protected by Armox 370T Class 2 Armour plates
- automatic speed control system
- automatic depth control
- three escape routes for driver
- automatic fire extinguisher system and manual fire extinguishers
- designed to destroy both AP and AT mines
- large size tiller machine
- claimed maximum clearance speed is 15,000 m^2/h
- it can be transported by road on a low-bed trailer, or by rail, ship or large cargo aircraft

CLEARANCE METHODOLOGY

The tiller drum rotates clockwise at nominally 200 rpm (depending on soil conditions) and achieves a penetration depth of 20-50 cm depending on required demining depth. A depth sensor fixed to the rotor regulates the clearance depth.

The action of the rotating steel teeth is intended to break up or detonate mines. The clearance width of the system is 322 cm. During demining, the maximum speed is 5 km/h.

Demining and vegetation cutting is done in one operation. Claimed maximum theoretical clearance speed is 15,000 m^2/h in very light soil, but in practice between 4,000 to 8,000 m^2/h under normal conditions. Vegetation has little negative effect on clearance speed.

MACHINES IN USE TO DATE

One Oracle I machine has been operating in Croatia since 2000 with the demining company Terrafirma, a subsidiary of Countermine Technologies AB. Two Oracle II machines have been operating in Libya since 2008.

ENGINE, FUEL AND OIL

The prime mover is powered by a 178 kw Caterpillar C9 diesel engine. The hydraulic system has two 522 kw Caterpillar C18 diesel engines and uses mineral hydraulic oil: fuel capacity for this attached unit is 1,800 litres. Normal fuel consumption for the prime mover is 40 litres per hour, for the hydraulic system 200 litres per hour.

FACTORY SUPPORT

The Oracle II uses Caterpillar components, which are supported by Caterpillar's worldwide service, parts and logistical organisation. Caterpillar claims to deliver parts to almost any location within 48 hours.

Driver and mechanic training are available on request: drivers one week, mechanics two weeks. All documentation is in English and can be translated into any major language on request.

ORACLE II | In service on a minefield

ORACLE II | In action

MAINTENANCE AND SUPPORT

Maintenance is according to Caterpillar standards for track loader machines. Maintenance of the tool depends on type of soil and type of mines. The system requires one operator and one mechanic, backed by a small workshop (in a small bus or container) with the necessary tools for servicing heavy equipment. Daily service: one to two hours. Weekly service: four hours. Service and maintenance schedules are provided.

TEST AND EVALUATION

One test report on the Oracle I is available:

1. BRTRC Technology Research Cooperation, Area Mine Clearing System (AMCS), Study Report, by US Army Project Manager for Close Combat Systems (PM - CCS), 2002. The report is available at: www.itep.ws//pdf/AMCSStudyReport.pdf

REPORTED LIMITATIONS AND STRENGTHS

No information yet available for the new Oracle II.

DIMENSIONAL DATA

1. Length without attachment	6,094 mm
2. Length total	14,712 mm
3. Width without attachment	2,755 mm
4. Width total	3,898 mm
5. Clearing | Working width	3,220 mm
6. Height | Overall	3,650 mm
7. Mass | Basic vehicle	31,500 kg
8. Mass | Detachable unit(s)	Tool 8,000 kg | Hydraulic Power Unit 25,500 kg
9. Mass | Overall	65,000 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Tracks
11. Ground Bearing Pressure (kPa)	Prime Mover with tool: 88.2 kPa HPU: 107.4 kPa
12. Hill climbing ability (in degrees)	30°
13. Number of Chains | Chisels | Tools	252 on standard tool | 490 on fine tool
14. Beat pattern (hits per m^2) at different operating speeds	**Standard tool** 695 hits/m^2 at 1 km/h 227 hits/m^2 at 4 km/h **Fine tool** 1,400 hits/m^2 at 1 km/h 450 hits/m^2 at 4 km/h
15. Length of Chains | Tools	N/A
16. Diameter of drum	1,450 mm
17. Rotation Speed	150 - 205 rpm
18. Clearance | Working depth in varying terrain	200 - 500 mm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	15,000 m^2/h
> Medium Soil | Medium Vegetation	8,000 m^2/h
> Heavy Soil | Dense Vegetation	4,000 m^2/h
20. Control of Clearance | Working depth	Automatic
21. Additional attachable working tools	
22. Armour	ARMOX 370T Class 2 armour plates, protective glass and polycarbonate
23. Remote controlled	As option
> greatest distance	Not given
24. Transportation	
> short distances	Max. speed on tracks 10 km/h
> long distances	By low bed trailer or as per European railway profile or ship or large cargo aircraft
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	3 (1 type Oracle I, 2 type Oracle II)
26. Other types	Oracle (old type)
27. Location of use	Croatia (Oracle I), Libya (Oracle II)
28. Totally cleared so far (m^2)	4,800,000 m^2 (End 2006)

ENGINE | FUEL | OIL

29. Engine	Prime Mover 1xCAT C9 @178 kw
30. Engine power at the flywheel	1,044 kw
31. Sufficient power supplied to working tool	800 kw
32. Fuel capacity	Prime Mover 430 l, HPU 1,850 l
33. Fuel consumption	Prime Mover 40 l/h, HPU 200 l/h
34 Separate engine for working unit	2x CAT C18 @522 kw total 1,044 kw
35. Cooling system	Liquid cooled/air to air after cooled charge air (all engines)
36. Oil capacity (both engines)	Prime Mover 29 l, HPU 2x40 l
37. Hydraulic oil capacity (both engines)	Prime Mover 250 l, HPU 850 l

COSTS

38. Cost of system	1.5 – 2 Million US$
39. Other costs	
> training	On request
> spare part set chains | belts	Spare part kit 2.5% of system cost
> repair costs for one year	Approx 5,000 - 15,000 US$ including maintenance
40. Availability for hire	Yes, on request

OTHER

41. Operator comfort	Driver completely air suspended, 4-point safety belt, three escape doors, fire extinguisher automatic and manual, ergonomic controls
42. Air conditioning	Yes

COMBINED SYSTEMS AND DUAL CAPABILITY FLAIL OR TILLER | MEDIUM SIZE | ARMTRAC 100

Armtrac Ltd. | United Kingdom

GENERAL DESCRIPTION

The *Armtrac 100* is a medium-size, multi-tool machine based on a New Holland tractor fitted with 10 mm armour around the driver's cab, 37 mm toughened glass (polycarbonate/glass laminate) and 6 mm of armour protecting the chassis.

The Armtrac 100 is used with a flail system or tiller tool fitted with an automatic depth control for mine action purposes: for agriculture purposes the machine pulls the Armtrac sifter. The performance speed of the sifter is 10 km/h. In addition, a plough or harrow can be attached to the three-point linkage at the rear.

The vehicle has a 230 hp engine, is a front-steering 4 x 4 and has foam-fill tyres. It has a top road speed of 45 km/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.

ARMTRAC 100 | With tiller

The flail or tiller can remain attached at full road speed, or detached from the tractor in around five minutes. The flail and tiller tool are designed to withstand AP and AV mine blasts. The survivability has been tested against AP and AT mines several times. The tractor is fitted with a winch to enable self-recovery. 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, such as portable welders or generating plants, can also be fitted. The flail or the tiller system is mounted to the front PTO shaft. The flail 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 13.87 m (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 72 m ahead. Consideration should be given to approximately 65% of the load distribution being on the front axle (with flail attached).

An Armtrac trailer is used to carry the flail or tiller header complete with tools. The Armtrac 100 can travel long distances at high speed. The trailer is height adjustable from ground level to 750 mm, to allow for muddy, rutted roads.

Fire suppression systems are fitted to all Armtrac machines in the engine bay, hydraulic bay and cabin. The system operates automatically or manually. The cabin roof is also fitted with an escape hatch.

Airlift is possible by an Ilyushin 76 aircraft and on road by a standard truck.

CLEARANCE METHODOLOGY

The overall width of the vehicle is 3.55 m, with a working width of 3 m. The rotor operates at up to 350 rpm clockwise and clears ground by both the flail and the tiller to a depth of 30 cm in light soil as well as by the flail to 25 cm and by the tiller to 30 cm in heavy soil. The tiller tool has 76 chisels and the flail system has 57 chains. In operational mode, the special gearbox propels the machine at low speed. Clearance depth adjustment is regulated automatically and can be overdriven manually by the operator.

The manufacturer claims that the Armtrac 100 can climb and flail slopes of up to 45° and clear areas at a rate of 1,600 m^2/h in light soil and 530 m^2/h in heavy soil. The average clearance rate recorded in testing was 600 m^2/h.[1] The achieved performance of vegetation cutting in low vegetation is 2,000 m^2/h, 1,600 m^2/h in medium vegetation and 750 m^2/h in high vegetation.

MACHINES IN USE TO DATE

There are 23 machines currently working: one in Angola, one in Bosnia and Herzegovina, one in Jordan, two in Lebanon, two in Iraq, six in Sudan and ten in other locations. The Armtrac 100 has been in service since 1992.

ENGINE, FUEL AND OIL

The tractor has a diesel 230 hp engine with a consumption from 25 to 32 litres per hour. Fuel capacity is 376 litres and hydraulic oil capacity is 400 litres.

ARMTRAC 100 | With flail on a trailer

FACTORY SUPPORT

New Holland tractor parts are available worldwide or from Armtrac. A spare parts catalogue is provided on memory stick or paper hard copy.

The manufacturer recommends a two-week training course for mechanics and drivers, which can be provided in-country or at Armtrac's UK training school. With the purchase of two or more machines training is free of charge for six months.

Manuals and documentation are included in the purchase package, available in Arabic, English and French.

The system has a 12-month or 1,000 hours warranty with factory follow-up. With the purchase of two or more machines Armtrac offers the services of an engineer and a service vehicle in-country for 12 months free of charge. The cost of a set of working tools is based on customer requirements.

MAINTENANCE AND SUPPORT

Maintenance schedules, as per manufacturer's recommendations, are in the manuals, and can vary according to working conditions.

A one hour daily check and a two hour weekly service are recommended. Initial 50 hr and 300 hr services will be carried out by a qualified Armtrac service engineer. A basic workshop complete with welder, generator and tools is adequate for on-site maintenance.

Armtrac recommends operation and maintenance by two operator/mechanics.

TESTS AND EVALUATIONS

One test report is available at www.itep.ws:

1. C. Leach, *Armtrac Report Trial 2002*, by QinetiQ, 2002: www.itep.ws/activities/itep_workplan/results_workplan2.php?form_field=act_number&form_section=3.2.1 &Submit=Search

Performance reports are available from the manufacturer on request.

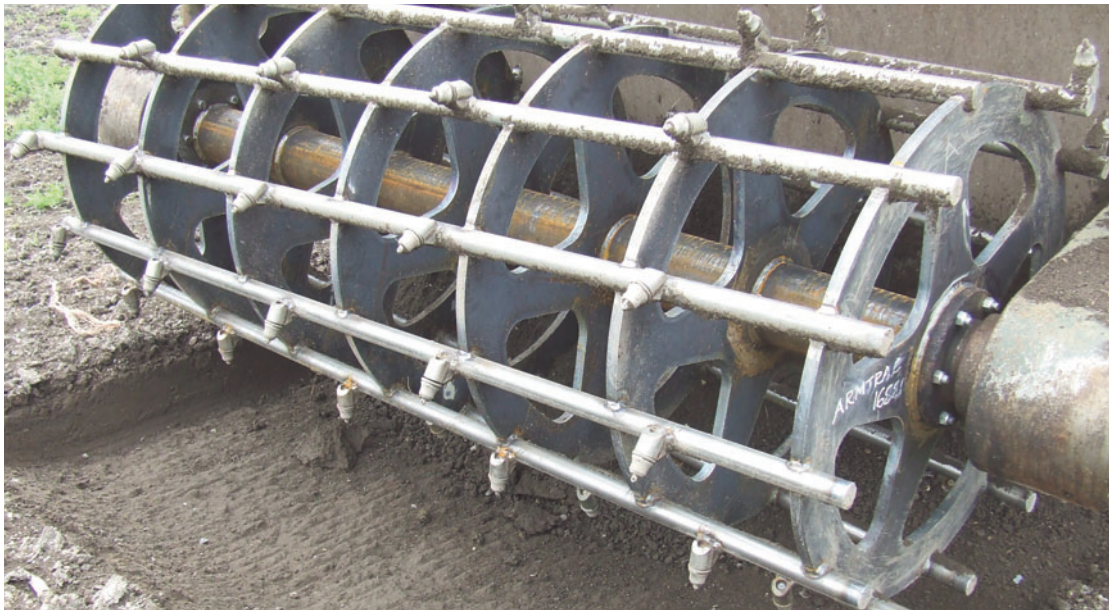
REPORTED LIMITATIONS AND STRENGTHS

Limitations

- Creates huge dust clouds, as with all flail systems in dry environments.
- Maximum road speed with tiller or flail attached to the front is 15 km/h.

Strengths

- Can withstand an AV mine blast under the flail and tiller unit.
- Good vegetation cutting ability.
- High ground clearance (at least 43 cm under the front hitch).
- Road speed with flail and tiller loaded on the trailer is 45 km/h.
- Airlift is possible.



ARMTRAC 100 | Tiller stopped showing achieved depth

ENDNOTES

[1] Armtrac 100 Trial Report, QinetiQ, April 2002, pp. 22 and 24.

DIMENSIONAL DATA

1. Length without attachment	5,100 mm
2. Length total	7,400 mm
3. Width without attachment	2,450 mm
4. Width total	3,550 mm
5. Clearing | Working width	3,000 mm
6. Height | Overall	3,100 mm
7. Mass | Basic vehicle	13,000 kg
8. Mass | Detachable unit(s)	3,000 kg
9. Mass | Overall	16,000 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Wheels with foam filled tyres
11. Ground Bearing Pressure (kPa)	Not given
12. Hill climbing ability (in degrees)	45°
13. Number of Chains | Chisels | Tools	Chains: 57 | Chisels: 76
14. Beat pattern (hits per m^2) at different operating speeds	
15. Length of Chains | Tools	Chains: 1,000 mm
16. Diameter of flail drum	2,200 mm
17. Rotation Speed	350 rpm
18. Clearance | Working depth in varying terrain	15 cm to 30 cm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	2,000 m^2/h
> Medium Soil | Medium Vegetation	1,600 m^2/h
> Heavy Soil | Dense Vegetation	700 m^2/h
20. Control of Clearance | Working depth	Automatic depth control and light bar with skid ground contour
21. Additional attachable working tools	Armtrac sifter
22. Armour	10 mm steel and 37 mm glass to 7.6 (NATO Ball)
23. Remote controlled	
> greatest distance	N/A
24. Transportation	
> short distances	Self propelled for distance on road continuous travel towing own trailer with header and spares Air travel by Iljushin airplane
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	23
26. Other types	Armtrac 75, Armtrac 75T, Armtrac 200, Armtrac 400, Armtrac sifter and Armtrac strimmer
27. Location of use	Angola, Bosnia and Herzegovina , Iraq, Jordan, Lebanon, Sudan
28. Totally cleared so far (m^2)	Not given

ENGINE | FUEL | OIL

29. Engine	New Holland
30. Engine power at the flywheel	230 hp
31. Sufficient power supplied to working tool	Not given
32. Fuel capacity	376 l
33. Fuel consumption	25 - 32 l/h
34. Separate engine for working unit	N/A
35. Cooling system	Water cooled
36. Oil capacity (both engines)	10 l
37. Hydraulic oil capacity (both engines)	400 l

COSTS

38. Cost of system	On request
39. Other costs	On request
> training	On request
> spare part set chains | belts	On request
40. Availability for hire	On request

OTHER

41. Operator comfort	Suspension seat, four point safety harness
42. Air conditioning	Yes

COMBINED SYSTEMS AND DUAL CAPABILITY FLAIL OR TILLER | MEDIUM SIZE | ARMTRAC 200

Armtrac Ltd. | United Kingdom

GENERAL DESCRIPTION

The *Armtrac 200* is a multi-tool system with both a demining and construction capability. Assembled around the customer's host vehicle, a 230 hp power pack at the rear drives the flail at the front for mine clearance. A tiller tool or roller system can be optionally attached. The power pack and working tools can be fitted to any prime mover.

In construction mode the Armtrac 200 uses a four-in-one bucket to load trucks and level or grade roads. Forklift tines can be fitted, useful for site preparation and unloading equipment without additional machinery. This medium-weight multi-purpose system has a capability, according to the manufacturer, of clearing from 1,000 m²/h in heavy soil up to 2,000 m²/h in light soil.

The Armtrac 200 is operator driven or can be remote controlled with a range of 500 m depending on the prime mover used. The cabin of the prime mover can be fitted with an escape hatch.

Vital parts of the machine are well protected, eg the cabin by 10 mm armour and 37 mm safety glass and the engine by 6 mm armour. Fire suppression systems are fitted to all Armtracs in the engine bay, hydraulic bay and cabin. The system operates automatically or manually.

The machine with the attachments can drive on a road or can be transported by road on a standard truck or by a C-130 aircraft.

ARMTRAC 200

CLEARANCE METHODOLOGY

The system can be fitted to any vehicle capable of carrying the weight. Engine range should be at least 230 hp up to 400 hp depending on customer requirements. Power pack and working tools are connected in 20 minutes via the quick hitch system. Hoses from the power pack to the system run down the boom arm with quick release couplings.

The Armtrac 200's flail and tiller system has a 2 m clearance path, but a 2.5 m flail system can be fitted. The flail's 76 chains or 66 chisels of the tiller rotate at 350 rpm achieving a claimed clearance depth for both the flail and the tiller of 30 cm in all soil conditions. Depth control is provided by a ground skid with a manual light bar in the cabin.

The achieved performance of vegetation cutting in low vegetation is 3,500 m²/h, 2,700 m²/h in medium vegetation and 1,400 m²/h in high vegetation. Roller systems are also available. Performance speed using the roller system is 10 km/h.

MACHINES IN USE TO DATE

One machine operates in Bangladesh and has been in service for a year.

ENGINE, FUEL AND OIL

The power pack is equipped with a 176 hp diesel Iveco N76 engine. No special fuel or oil is required.

The fuel capacity is 300 litres and the hydraulic oil capacity is 190 litres. According to the manufacturer the fuel consumption is from 25 to 35 litres per hour during operations (depending on soil conditions).

FACTORY SUPPORT

The manufacturer/supplier provides spare parts over a 12-month period. Most components of the machine are provided by companies operating worldwide and are standard off-the-shelf components. Armtrac also holds the whole range of spare parts in stock at any time.

Armtrac recommends a two-week training course for mechanics and drivers. Training can be provided in-country or at Armtrac's UK training school. With the purchase of two or more machines training is free of charge for six months.

Manuals and documentation are part of the purchase package and available in Arabic, English and French. The system is covered by a 12-month or 1,000 hours warranty and factory follow-up. With the purchase of two or more machines, Armtrac offers the services of an engineer and a service vehicle in-country for 12 months free of charge.

The cost of a set of working tools is based on customer requirements. Spare parts catalogue is available on memory stick or as paper hard copy.

MAINTENANCE AND SUPPORT

The level of maintenance is as per manufacturer's recommendation. Maintenance schedules can be found in the manual as these can vary according to working conditions.

A one hour daily check and a two hour weekly service are recommended. Initial 50 hr and 300 hr services will be carried out by a qualified Armtrac service engineer.

A basic workshop complete with welder, generator and tools is adequate for on-site maintenance. Armtrac recommends operation and maintenance by two operator/mechanics.

TESTS AND EVALUATIONS

The Armtrac 200 underwent trials carried out by the Bangladeshi Army. These reports are available on request from Armtrac.

REPORTED LIMITATIONS AND STRENGTHS

Limitations

- Difficult to operate with precision from greater distances in remote controlled mode, as applies to all remotely controlled machines.
- The flail system creates huge dust clouds, as occurs with all flail systems in dry environments.
- Very wet conditions reduce the forward speed.

Strengths

- Combines flail and tiller systems.
- Versatility.
- The system is air transportable and self-propelled.

DIMENSIONAL DATA

1. Length without attachment	Depends on the prime mover used
2. Length total	Depends on the prime mover used
3. Width without attachment	Depends on the prime mover used
4. Width total	3,600 mm flail
5. Clearing | Working width	3,000 mm flail
6. Height | Overall	1,700 mm flail
7. Mass | Basic vehicle	Depends on the prime mover used
8. Mass | Detachable unit(s)	5,300 kg
9. Mass | Overall	Depends on the prime mover used

OPERATIONAL DATA

10. Wheels | Tracks (description)	Depends on the prime mover used
11. Ground Bearing Pressure (kPa)	Depends on the prime mover used
12. Hill climbing ability (in degrees)	Depends on the prime mover used
13. Number of Chains | Chisels | Tools	Chains: 76 | Chisels: 66
14. Beat pattern (hits per m^2) at different operating speeds	Not given
15. Length of Chains | Tools	1,000 mm
16. Diameter of flail drum	2,200 mm
17. Rotation Speed	350 rpm
18. Clearance | Working depth in varying terrain	15 cm to 30 cm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	2,000 m^2/h
> Medium Soil | Medium Vegetation	1,600 m^2/h
> Heavy Soil | Dense Vegetation	1,000 m^2/h
20. Control of Clearance | Working depth	Ground skid with manual light bar in cabin
21. Additional attachable working tools	Tiller
22. Armour	6 mm ARMOX
23. Remote controlled	
> greatest distance	500 m
24. Transportation	
> short distances	
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	1
26. Other types	Armtrac 75 Armtrac 75T, Armtrac 100, Armtrac 400, Armtrac sifter and Armtrac strimmer
27. Location of use	Bangladesh
28. Totally cleared so far (m^2)	Unknown

ENGINE | FUEL | OIL

29. Engine	Powerpack engine - Iveco N67
30. Engine power at the flywheel	171 kw
31. Sufficient power supplied to working tool	Not given
32. Fuel capacity	300 l
33. Fuel consumption	25-35 l/h
34. Separate engine for working unit	
35. Cooling system	Water cooled
36. Oil capacity (both engines)	25 l
37. Hydraulic oil capacity (both engines)	190 l

COSTS

38. Cost of system	On request
39. Other costs	On request
> training	On request
> spare part set chains | belts	On request
40. Availability for hire	On request

OTHER

41. Operator comfort	N/A
42. Air conditioning	N/A

COMBINED SYSTEMS AND DUAL CAPABILITY FLAIL OR TILLER | MEDIUM SIZE | ARMTRAC 400

Armtrac Ltd. | United Kingdom

GENERAL DESCRIPTION

The *Armtrac 400*, introduced in 2008, is a medium-size, multi-tool machine fitted with 10 mm armour around the driver's cab, 37 mm toughened glass (polycarbonate/glass laminate) and 6 mm of armour protecting the chassis. The frame and chassis is a fully welded X-frame type section using off-the-shelf JCB track and frame components.

The Armtrac 400 is used with a flail system or tiller tool with an automatic depth control for mine action purposes; for constructional work it uses a four-in-one bucket to load trucks and level or grade roads. Forklift tines can be fitted, useful for site preparation and for unloading equipment without additional machinery. A roller as well as a sifter system can also be fitted to the extending boom. The sifter can be towed from the rear tow hitch and connected to the hydraulic power take-off (PTO) drive. The performance speed of the sifter and roller system is 10 km/h.

ARMTRAC 400 | With sifter

The flail and tiller tool are designed to withstand AP and AV mine blasts. The survivability was tested with a crew member on board in the cabin driving the track over a 6 kg Belgium AV mine. The track split but no damage occurred to the cabin and the operator was not injured. The track was repaired in one day.

The Armtrac 400 has a 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 Armtrac 400. The flail or the tiller system is mounted to the front PTO shaft. The machine has a track cruise control and automatic depth control for operator comfort. The cabin can be raised to 1.5 m, enabling the operator to have a 360° view.

Fire suppression systems are fitted to all Armtracs in the engine bay, hydraulic bay and cabin. The system operates automatically or manually. The cabin roof also has an escape hatch. Armtrac 400 can be operator driven or remote controlled with a range of 750 m. Airlift is possible by an Ilyushin 76 aircraft and on road by using a low-bed truck.

CLEARANCE METHODOLOGY

The overall width of the vehicle is 3.76 m, with a working width of 3 m. The rotor operates from 300 to 410 rpm clockwise and clears ground by both flail and tiller to a depth of 30 cm in light soil; the flail alone clears to 40 cm in all soil conditions. The tiller has 66 chisels and the flail has 76 chains. Clearance depth adjustment is regulated automatically and can be overdriven manually by the operator.

The manufacturer claims that the Armtrac 400 can climb and flail slopes of up to 45° and clear areas at a rate of 3,000 m^2/h in light soil and 1,400 m^2/h in heavy soil. The claimed performance for vegetation cutting is 3,000 m^2/h in low vegetation, 2,700 m^2/h in medium vegetation and 1,450 m^2/h in high vegetation.

MACHINES IN USE TO DATE

There are 15 machines currently working, including one in in Sudan. The Armtrac 400 has been in service since 2008.

ENGINE, FUEL AND OIL

The tractor has a diesel Deutz BF6M engine (300 kw) with fuel consumption from 35 to 45 litres per hour. Fuel capacity is 470 litres and the hydraulic oil capacity is 800 litres.

FACTORY SUPPORT

As it is based on JCB machines, parts for the Armtrac 400 are available off-the-shelf worldwide or from the manufacturer. A spare parts catalogue is provided on a memory stick or as a paper hard copy.

The manufacturer recommends a two-week training course of mechanics and drivers. Training can be provided in-country or at Armtrac's UK training school. With the purchase of two or more machines training is free of charge for six months.

Manuals and documentation are part of the purchase package and available in Arabic, English and French. There is a 12-month or 1,000 hours warranty and factory follow-up. With the purchase of two or more machines Armtrac offers the services of an engineer and a service vehicle in-country for 12 months free of charge. The cost of a set of working tools is based on customer requirements.

ARMTRAC 400

MAINTENANCE AND SUPPORT

Maintenance schedules, as per manufacturer's recommendations, are in the manuals, and can vary according to working conditions.

A one hour daily check and a two hour weekly service are recommended. Initial 50 hr and 300 hr services will be carried out by a qualified Armtrac service engineer. A basic workshop complete with welder, generator and tools is adequate for on-site maintenance.

Armtrac recommends operation and maintenance by two operator/mechanics.

TESTS AND EVALUATIONS

The Armtrac 400 is undergoing working trials in Sudan with G4S (a US company which bought RONCO). G4S performance reports on square metres performed and breakdowns are available on request from Armtrac.

REPORTED LIMITATIONS AND STRENGTHS

Limitations

- The flail system creates huge dust clouds, as with all flail systems in dry environments.
- The maximum road speed is 10 km/h, therefore the machine should be transported by a low-bed truck from site to site.

Strengths

- Can withstand an AV mine blast under the flail and tiller unit.
- Good vegetation cutting ability.
- The cabin can be raised to 1.5 m enabling the operator 360° visibility.
- Can be used as a forklift and loading truck.
- The telescopic boom extension can be used to free the machine if it becomes stuck.
- Airlift is possible.

AV mine detonations

DIMENSIONAL DATA

1. Length without attachment	5,550 mm
2. Length total	With tiller attached 7,400 mm With flail attached 7,550 mm
3. Width without attachment	2,510 mm
4. Width total	3,670 mm
5. Clearing | Working width	3,000 mm
6. Height | Overall	3,300 mm
7. Mass | Basic vehicle	12,000 kg
8. Mass | Detachable unit(s)	3,500 kg
9. Mass | Overall	15,500 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Tracks
11. Ground Bearing Pressure (kPa)	0.48 kg/cm^2 (6.83 lb/in^2)
12. Hill climbing ability (in degrees)	45°
13. Number of Chains | Chisels | Tools	Chains: 76 | Chisels: 66
14. Beat pattern (hits per m^2) at different operating speeds	Not given
15. Length of Chains | Tools	Flail chain 1,000 mm
16. Diameter of flail drum	Tiller: 1,200 mm | Flail: 2,200 mm
17. Rotation Speed	410 rpm
18. Clearance | Working depth in varying terrain	Maximum 40 cm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	2,900 m^2/h
> Medium Soil | Medium Vegetation	2,300 m^2/h
> Heavy Soil | Dense Vegetation	1,400 m^2/h
20. Control of Clearance | Working depth	Automatic depth control
21. Additional attachable working tools	Bucket/blade, fork lift tines, back hoe, standard bucket, Armtrac sifter
22. Armour	10 mm ARMOX and 37 mm glass 7.6 (NATO Ball)
23. Remote controlled	
> greatest distance	750 m
24. Transportation	
> short distances	Low loader or air transport by Iljushin 76
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	2 (classified orders 14)
26. Other types	Armtrac 75 Armtrac 75T, Armtrac 100, Armtrac 200, Armtrac sifter and Armtrac strimmer
27. Location of use	Sudan and demonstration
28. Totally cleared so far (m^2)	144,000 m^2

ENGINE | FUEL | OIL

29. Engine	Deutz
30. Engine power at the flywheel	300 kw
31. Sufficient power supplied to working tool	Not given
32. Fuel capacity	470 l
33. Fuel consumption	35-45 l/h
34. Separate engine for working unit	No
35. Cooling system	Water cooled
36. Oil capacity (both engines)	25 l
37. Hydraulic oil capacity (both engines)	800 l

COSTS

38. Cost of system	On request
39. Other costs	On request
> training	On request
> spare part set chains | belts	On request
40. Availability for hire	On request

OTHER

41. Operator comfort	Suspension seat, four point safety harness
42. Air conditioning	Yes

COMBINED SYSTEMS AND DUAL CAPABILITY FLAIL OR TILLER | MEDIUM SIZE | DIGGER D-3

Digger DTR Demining Technologies | Switzerland

GENERAL DESCRIPTION

The *Digger D-3* is a new, medium-size, remotely controlled, multi-tool mine clearance machine developed by the Swiss NGO, Digger Foundation. It can be fitted with both flail and tiller, which can easily be interchanged in a couple of hours, even in the field.

Digger DTR has 11 years of technical background in mechanical demining, acquired through the development of their Digger D-1 vegetation cutter and the Digger D-2 multi-tool machine, the precursor of the Digger D-3. The organisation has five years of field experience, mainly from operational engagement in Bosnia and Herzegovina, Croatia, Macedonia and Sudan.

Digger D-3 | With tiller

The vehicle consists of an armoured, V-shaped hull made of 10 mm hardened steel which minimises the damage caused by AP mines or UXO detonations. All air intake latticing around the Digger D-3 is armoured. The machine can be used for both blast and tripwire mine clearance and vegetation cutting.

The system is remotely controlled from 50 m to 500 m distance by an operator placed behind a shield in the line of sight. The remote control system is shock-, slash- and dust-proof and displays almost all the data from the vehicle.

The Digger D-3 forward speed can be adjusted between 0.03 km/h and 6 km/h, allowing working speeds from 600 to 2,000 m^2 per hour. A forward speed regulation allows the machine to always work at the most suitable speed.

Through a Caterpillar Quick Coupler, every standard Caterpillar tool (such as a shovel or a forklift) can be attached to the front of the D-3. This makes the vehicle highly versatile.

The machine can easily be transported by sea in a 20 ft container. For road transport a 6 x 6 truck with palletised loading system is ideal. Air transport is also possible.

CLEARANCE METHODOLOGY

The rotor on the flail unit operates at approximately 800 rpm, using 26 chains with hardened steel hammers to remove AP mines and vegetation.

From its side, the tiller rotates at 400 rpm and is fitted with 64 hardened steel chisels tipped with tungsten carbide picks.

Clearance depth can be mechanically adjusted from 0 to 25 cm. Depth control is achieved mechanically and hydraulically through an arms pressure regulation system. This guarantees that the flail skids at a constant light pressure on the ground, which can be adjusted by the operator according to soil conditions. The Digger D-3 arms can be raised to 4 m for cutting high and dense vegetation.

MACHINES IN USE TO DATE

The Digger D-1 and D-2 have been used in Switzerland by the Swiss Army to cut vegetation on a military training field with UXO contamination.

Two Digger D-2 machines have been used in North and South Sudan by several demining organisations working for UNOPS since 2006. Another D-2 was delivered in December 2008 to the Ministry of Defence of Macedonia for its foreign operations.

A new Digger D-3 has been in use in Croatia for several months in 2009 and its tiller version has been accredited by HCR-CTRO before being sold to the Lower-Austria Youth Red Cross for operation by its partners in Bosnia and Herzegovina.

ENGINE, FUEL AND OIL

The D-3 is equipped with a 4.5 litre, 173 hp John Deere turbo-diesel engine which is cooled by a double heat exchanger and uses a three-stage air filtration system.

Fuel capacity is 115 litres with a maximal fuel consumption of 34 litres per hour. The engine oil capacity is 20.5 litres. Hydraulic fluid capacity is 160 litres. All lubricants can be changed easily through openings in the hull and quick-coupler connections.

FACTORY SUPPORT

The D-3 can be delivered with an initial spare parts kit, containing all the most-used parts. The manufacturer also offers a "wearing parts kit", which is specifically adapted to each type of operation.

Engine parts can be obtained through the international John Deere network. Initial training can be provided at the Digger DTR facility in Switzerland or at the client's operational base. All technical manuals and training material are available in English and are included in the purchase package. Warranty coverage is 12 months.

Digger DTR's experienced technicians provide technical support throughout the world. If available, a Digger technician can also be hired by the customer and paid at standard international rates.

DIGGER D-3 | With tiller during CROMAC Certification Test

MAINTENANCE AND SUPPORT

Daily/weekly servicing is required (30 min/2 hours). Recommended crew: one operator (remote control) with basic mechanical skills. The machine can be delivered in a 20 ft container, with complete workshop equipment.

TESTS AND EVALUATIONS

The Digger D-3 with tiller was tested and accredited by HCR-CTRO (the official testing authority in Croatia) in April 2009, triggering or neutralizing 100% of the AP mines and achieving productivities of up to 1,000 m²/h at a typical clearing depth of 25 cm, depending on the type of soil. Reports are available from CTRO or the manufacturer on request.

Fiberboard of DIGGER D-3 during CROMAC Certification Test

REPORTED LIMITATIONS AND STRENGTHS

Limitations

- Difficult to operate with precision from greater distances, as with all remotely controlled machines.
- The flail creates huge dust clouds, as with all flail systems in dry environments. This limitation is largely reduced with the tiller version.

Strengths

- Manoeuvrable and easy to transport.
- Can be transported in a 20 ft container.
- Above-average hill-climbing ability.
- Light-weight and rugged design.
- Versatile: various specific and standard tools available, which can easily be interchanged.

Digger D-3 | With tiller

DIMENSIONAL DATA

1. Length without attachment	4,380 mm
2. Length total	5,730 mm
3. Width without attachment	1,690 mm
4. Width total	2,320 mm
5. Clearing | Working width	1,800 mm
6. Height | Overall	1,890 mm
7. Mass | Basic vehicle	7,225 kg
8. Mass | Detachable unit(s)	Flail: 1,535 kg | Tiller: 2,000 kg
9. Mass | Overall	Flail: 8,760 kg | Tiller: 9,225 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Steel fabricated tracks / mobile running wheels
11. Ground Bearing Pressure (kPa)	42 kPa
12. Hill climbing ability (in degrees)	35°
13. Number of Chains | Chisels | Tools	Chains: 26 | Chisels: 64
14. Beat pattern (hits per m^2) at different operating speeds	Flail: 6357 | Tiller: 6713 hits per m^2 at 0.1 km/h
15. Length of Chains | Tools	390 mm
16. Diameter of flail drum	Flail axle: 140 mm Flail with chains: 1,000 mm Tiller axle: 100 mm Tiller with chisels: 1,057 mm
17. Rotation Speed	Flail 800 rpm | Tiller 400 rpm
18. Clearance | Working depth in varying terrain	0 up to 250 mm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	2,000 m^2/h
> Medium Soil | Medium Vegetation	1,000 m^2/h
> Heavy Soil | Dense Vegetation	600 m^2/h
20. Control of Clearance | Working depth	Mechanically, arms pressure regulation
21. Additional attachable working tools	Bucket/blade, fork lift tines, back hoe, standard bucket, Armtrac sifter
22. Armour	Hull: 10 mm hardened steel R/C operator shield: shield with FB4 **or** FB6 ballistic protection norm
23. Remote controlled	
> greatest distance	Yes
24. Transportation	
> short distances	International: 20 ft container
> long distances	Local: Ideally on a 6x6 truck, with palletized loading system
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	2
26. Other types	Digger D-2, Digger D-3
27. Location of use	Croatia, Bosnia Herzegovina
28. Totally cleared so far (m^2)	More than 30,000 m^2 (state on June 2009)

ENGINE | FUEL | OIL

29. Engine	John Deere, Turbo Diesel, 4 cylinder
30. Engine power at the flywheel	129 kw | 173 hp
31. Sufficient power supplied to working tool	
32. Fuel capacity	115 l
33. Fuel consumption	28-34 l/h
34. Separate engine for working unit	No
35. Cooling system	Liquid cooling
36. Oil capacity (both engines)	20.5 l
37. Hydraulic oil capacity (both engines)	160 l

COSTS

38. Cost of system	On request
39. Other costs	On request
> training	On request
> spare part set chains | belts	On request
40. Availability for hire	Yes

OTHER

41. Operator comfort	N/A
42. Air conditioning	N/A

COMBINED SYSTEMS AND DUAL CAPABILITY FLAIL OR TILLER | MEDIUM SIZE | MCV-DOVE

KMCRI | South Korea

GENERAL DESCRIPTION

The *MCV-Dove* is a multi-purpose mine clearing vehicle, manufactured by the Korea Mine Clearing Research Institute (KMCRI). Based on an excavating machine, its cab is fully protected by 12 mm steel plate and 30 mm strengthened glass. The bottom plate of the cab is armoured by a double layer of steel plate. The cab can be heated or air conditioned.

Available attachments are:

- a vibratory screen bucket for separating mines from soil dump
- a rotation grab for taking out trees and other obstacles
- an electric magnet for picking up metal mines and ferrous debris
- a crushing roller for destroying mines in the soil

These attachments can be easily connected to the arm of excavating machine and quickly changed to suit terrain conditions. The system is easily operated by one person. A special extension basket can be mounted to detect the mines without stepping on the ground.

MCV-DOVE | Crushing roller and the electro magnet

CLEARANCE METHODOLOGY

Vibratory screen bucket

The vibratory screen bucket is used for digging soil and separating mines from the soil dump. It is worked by hydraulic power vibrating the steel mesh inside rigid bucket so that fine soil passes through the mesh, leaving any mines or ERW on the screen. The working speed is about 50 m^3/h or 200 m^2/h depending on soil conditions.

Rotation grab

The rotation grab is primarily used in mountainous area with dense trees. The operator uses the grab to pull trees from the ground. Hydraulically powered, it has strong teeth and can rotate through 360°. It can also pick up rocks and other large debris.

Electric magnet

The electric magnet detects and removes mines or metal particles remaining after earlier clearance work. The electromagnetic rake is used for final checking of cleared areas. It works from the machine's own electric power.

Crushing roller

The crushing roller is used to crush and detonate AP mines. Hydraulically powered, it has carbon teeth on a rotating roller. Rotating speed is 500 rpm and working depth is usually 30 cm.

MACHINES IN USE TO DATE

Machines with full attachments are working in Iraq and Korea.

ENGINE, FUEL AND OIL

The 25-ton excavator has a six-cylinder diesel engine with an average consumption of 30 litres per hour. All attachments are driven by hydraulic power from the engine.

FACTORY SUPPORT

A basic spare parts kit is supplied by the manufacturer. Operator training and heavy maintenance can be provided on request. The machine has a one-year warranty.

MAINTENANCE AND SUPPORT

Daily basic visual checks as well as oil level control and greasing can be done easily by the operator. The system needs to be transported between sites on a low loader.

TESTS AND EVALUATIONS

In 2000, a Korean Army test found that the cabin was undamaged by the blast of an M15 AV mine (10 kg TNT).

In 2005, the Korea Defense Agency for Technology and Quality tested the screen bucket against live AP and AV mines.

REPORTED LIMITATIONS AND STRENGTHS

Limitations

> Wet soil clogs the screen bucket and crushing roller.

Strengths

> Simple and rugged design.
> Easy to adapt to changing conditions.

TECHNICAL SPECIFICATIONS	MCV-DOVE

DIMENSIONAL DATA

1. Length without attachment	10,020 mm (for transportation)
2. Length total	12,650 mm (boom and attachment, average)
3. Width without attachment	2,990 mm
4. Width total	2,990 mm
5. Clearing | Working width	Depends on the attachments
6. Height | Overall	3,100 mm
7. Mass | Basic vehicle	22,000 kg
8. Mass | Detachable unit(s)	1,000 kg (average)
9. Mass | Overall	25,000 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	600 mm Std tracks
11. Ground Bearing Pressure (kPa)	44.1 kPa
12. Hill climbing ability (in degrees)	35°
13. Number of Chains | Chisels | Tools	N/A
14. Beat pattern (hits per m^2) at different operating speeds	N/A
15. Length of Chains | Tools	N/A
16. Diameter of flail drum	N/A
17. Rotation Speed	N/A
18. Clearance | Working depth in varying terrain	Depends on the attachments
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	Depends on the attachments
> Medium Soil | Medium Vegetation	Depends on the attachments
> Heavy Soil | Dense Vegetation	Depends on the attachments
20. Control of Clearance | Working depth	Depends on the attachments
21. Additional attachable working tools	Extension basket (optional)
22. Armour	12 mm armour plates, 30 mm armour glass
23. Remote controlled	No
> greatest distance	
24. Transportation	
> short distances	Flat bed trailer
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	12
26. Other types	Small version
27. Location of use	Iraq, Korea
28. Totally cleared so far (m^2)	3,000 m^2

ENGINE | FUEL | OIL

29. Engine	DB58TIS / 6-cylinder diesel engine
30. Engine power at the flywheel	
31. Sufficient power supplied to working tool	
32. Fuel capacity	350 l
33. Fuel consumption	Not given
34. Separate engine for working unit	No
35. Cooling system	Water cooled
36. Oil capacity (both engines)	340 l
37. Hydraulic oil capacity (both engines)	120 l

COSTS

38. Cost of system	On request
39. Other costs	On request
> training	On request
> spare part set chains | belts	On request
40. Availability for hire	On reques

OTHER

41. Operator comfort	
42. Air conditioning	Yes

COMBINED SYSTEMS AND DUAL CAPABILITY FLAIL OR TILLER | MEDIUM SIZE | MACROHARD MH-05

Macrohard Mechanic d.o.o. | Bosnia and Herzegovina

GENERAL DESCRIPTION

The *Macrohard Mechanic MH-05* is built on the chassis of an armoured personnel carrier but all other parts, structure and systems are new. The medium-size machine is designed to detonate or destroy all types of AP and AV mines. It has two replaceable work tools, a tiller and a flail. The standard crew of three men needs around one hour to replace the tools in the field.

The driver's cabin is armoured with 13 mm Armox steel and the windows are of 46 mm protective glass. There are two doors on the cabin, in case the vehicle overturns.

Clearance operation is controlled manually and a ground penetration depth up to 30 cm can be achieved by both the tiller and the flail, depending on soil conditions. The machine is operated by only one joystick and works at between 0.2 and 2 km/h. The MH-05 base vehicle can be transported with an ordinary truck trailer if the flail or tiller attachment is dismounted.

MACROHARD MH-05 | With flail and cabin detail

CLEARANCE METHODOLOGY

The tiller's work spindle has two spirals of 36 hard metal chisels each. The working width is 3.06 m, with a clearance depth up to 30 cm. The tiller drum diameter is 80 cm and it rotates at up to 400 rpm. Tiller clearance speed is 3,360 m^2/h (as measured by BHMAC while issuing accreditation).

The flail has 72 chains rotating at up to 550 rpm. Each chain has a 60 mm diameter hammer (mushroom-shaped) attached to the end to detonate or break up AP or AV mines. The chains are 500 mm with the hammer and are set 41 mm apart. The flail's working width is 2.97 m and its maximum clearance depth, depending on soil conditions, is 30 cm. The flail's clearance speed is 2,400 m^2/h (as measured by BHMAC while issuing accreditation).

MACHINES IN USE TO DATE

Seven machines are currently in use, five in Bosnia and Herzegovina and two in Sudan. In B&H, two belong to NGOs, two to the armed forces and one to the Macrohard Mechanic company.

ENGINE, FUEL AND OIL

The V-55 diesel engine, which originally produced 426 kw per 2,000 rpm, has been adjusted to new needs and now produces 300 kw per 1,800 rpm. There is a spare engine power of 126 kw. The engine is constructed to work under difficult dusty conditions. Fuel consumption is 35 - 40 litres per hour. The machine uses normal hydraulic oil.

FACTORY SUPPORT

Spares for the MH-05 are provided directly by Macrohard Mechanic. A package of training, spare parts and equipment support is negotiable with the manufacturer. Instruction manuals are available in English and Serbo-Croatian.

MAINTENANCE AND SUPPORT

Daily, weekly and monthly maintenance checks are laid down in the standard operating procedures. Preventive daily maintenance checks and servicing takes two mechanics about one hour to complete. A two-man crew is recommended. The MH-05 is supported by a mobile maintenance vehicle on site. A one-year warranty is provided.

TESTS AND EVALUATIONS

The machine was tested and certified by the Bosnia and Herzegovina Mine Action Center (BHMAC). The machine is accredited for ground preparation and technical survey operations.

REPORTED LIMITATIONS AND STRENGTHS

Limitations

> It creates huge dust clouds, as with all flail systems in dry environments.

Strengths

> Combined system: tiller or flail can be interchanged.

DIMENSIONAL DATA

1. Length without attachment	5,000 mm
2. Length total	6,500 mm
3. Width without attachment	2,600 mm
4. Width total	4,000 mm
5. Clearing | Working width	3,000 mm
6. Height | Overall	3,200 mm
7. Mass | Basic vehicle	12,000 kg
8. Mass | Detachable unit(s)	2,500 kg
9. Mass | Overall	14,500 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	The track with an elastic suspension
11. Ground Bearing Pressure (kPa)	70
12. Hill climbing ability (in degrees)	25°
13. Number of Chains | Chisels | Tools	72 | 72
14. Beat pattern (hits per m^2) at different operating speeds	1,500 - 3,000 hits per m^2
15. Length of Chains | Tools	500 mm
16. Diameter of flail drum	Flail: 1,300 mm | Tiller: 800 mm
17. Rotation Speed	Flail: 0 - 550 rpm | Tiller: 0 - 400 rpm
18. Clearance | Working depth in varying terrain	Flail and tiller: 300 mm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	Flail 2,700 | Tiller 3,500 m^2/h
> Medium Soil | Medium Vegetation	Flail 1,500 | Tiller 2,000 m^2/h
> Heavy Soil | Dense Vegetation	Flail 900 | Tiller 1,200 m^2/h
20. Control of Clearance | Working depth	Mechanical – front ski
21. Additional attachable working tools	No
22. Armour	AB 13 mm ARMOX
23. Remote controlled	No
> greatest distance	
24. Transportation	
> short distances	Truck trailer
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	7
26. Other types	No
27. Location of use	Bosnia and Herzegovina, Sudan
28. Totally cleared so far (m^2)	6,000,000 m^2

ENGINE | FUEL | OIL

29. Engine	V, 12 cylinders, diesel
30. Engine power at the flywheel	300 kw
31. Sufficient power supplied to working tool	240 kw
32. Fuel capacity	450 l
33. Fuel consumption	35 - 40 l/h
34. Separate engine for working unit	No
35. Cooling system	Water
36. Oil capacity (both engines)	80 l
37. Hydraulic oil capacity (both engines)	600 l

COSTS

38. Cost of system	Negotiable
39. Other costs	
> training	Negotiable
> spare part set chains | belts	Negotiable
40. Availability for hire	Yes

OTHER

41. Operator comfort	The cabin is air-conditioned, upholstered, the seat has the spring shock absorber and safety belt, driving with one joystick, clear view insured through 4 armoured panes on each side of the cabin one respectively.
42. Air conditioning	Yes

COMBINED SYSTEMS AND DUAL CAPABILITY FLAIL OR TILLER | MEDIUM SIZE | MINEWOLF

MineWolf Systems AG | Switzerland and Germany

GENERAL DESCRIPTION

The *MineWolf* has been developed by MineWolf Systems, a Swiss-German provider of mechanical mine clearance machines. It is a medium- to large-scale mechanical demining machine equipped with either a flail or a tiller. Both applications withstand AP and AV mine detonations up to 15 kg TNT. The easily interchangeable tiller and flail units are designed so that detonations cause minimum damage to the working tool. Protection of the operator and machine is assured by Armox steel and armoured glass. The machine can also be operated by remote control. With its highly reliable 367 hp V8 Deutz diesel engine and enhanced filtering and cooling instalments, the vehicle can withstand extreme conditions of hot, cold, dry and dusty environments.

Output has been recorded at 15,000 m^2 to 30,000 m^2 per day depending on the project characteristics (Class I to Class IV terrain with slopes up to 40°), corresponding to the size of two to four football fields. Clearance width is 2,800 mm.

Standard features include automatic depth control, communications system, hydraulic winch, air-conditioning, and an automatic fire-fighting system. A GPS system, mine debris lifter and multi-function attachments (such as a fork or bucket) are also available. The system is designed for transport by road, rail, ship or air. A standard low-loader can be used for transporting between worksites.

MINEWOLF | In Jordan with tiller attachment

CLEARANCE METHODOLOGY

The tiller has 64 teeth mounted on an open-basket drum which rotates in the driving direction with a speed of 500 – 800 rpm. It is designed so that every piece of ground is processed in a tight pattern to a depth of up to 35 cm depending on machine speed and soil conditions. Depending on project requirements, a flail with 72 chains with hammers can be attached. The system is effective against vegetation up to 15 cm in diameter. Automatic depth control facilitates consistent ground penetration quality.

MACHINES IN USE TO DATE

Since 2004, a substantial number of MineWolfs have been produced and deployed in the following countries: Afghanistan, Angola, Bosnia and Herzegovina, Chile, Croatia, Georgia, Jordan, Rwanda, Sudan and United Arab Emirates.

ENGINE, FUEL AND OIL

The 367 hp (270 kw) Deutz diesel engine has:

- V8 engine with exhaust turbo super-charger, water-cooled
- oil sump, designed to accommodate a tilt angle of 45°
- cold start equipment (motor built according to exhaust norm COM1)
- cooling systems for outside temperature up to 55°C
- direct mechanical drive via power take-off shaft
- air filtering system optimised for desert conditions of extreme dust
- tank volume of 440 litres including explosion prevention system to avoid tank detonations

Fuel consumption is 40 to 50 litres per hour. The hydraulic system requires standard oil.

MINEWOLF | With flail attachment

Two MineWolfs with lifter attachment

FACTORY SUPPORT

The manufacturer provides all necessary training, documentation, workshop, consumables and spare parts to render any mine clearing operation completely independent. Project management and consulting services are also available.

Factory support includes:

- delivery of machines, support vehicles and hardware from the factory
- decentralised warehousing in country of operation
- all major spare parts in stock and ready for shipment
- predefined fast delivery schedules with renowned forwarding partners worldwide
- warehousing and efficient resource planning software for customers
- training schedules and spare part packages are available, based on the customer's requirements
- instruction manuals, documentation and SOP (according to IMAS) are available, on request in any language

The spare part package anticipates long delivery times in remote areas. If necessary a fully equipped mobile workshop unit is also supplied. Only standard commercial off-the-shelf components are used.

MAINTENANCE AND SUPPORT

Daily, weekly and monthly maintenance checks are laid down in the operator's manual. The manufacturer can also provide:

- in-country support for major incidents
- assistance on annual inspection with option for check-up of mechanical competence

TESTS AND EVALUATIONS

The following test reports are available at www.itep.ws

1. W.C. Roberts and J.L. Eagles, MineWolf Tiller Test and Evaluation, Defence Research and Development Canada, Canada, 2007: www.itep.ws//pdf/MineWolf_Tiller_DRDC_finalR.pdf
2. H. Rath, D. Schröder, MineWolf Flail and Tiller Machines: Testing the Difference Between Two Demining Technologies, in Journal of Mine Action, Issue 10.2, Winter 2006: www.maic.jmu.edu/journal/10.2/r&d/rath/rath.htm
3. I. Steker, Testing of the demining machine MineWolf, by Croatian Mine Action Centre / Testing, Development and Training Centre (Republic of Croatia), 2005: www.itep.ws//pdf/Minewolf_CTRO2005.pdf
4. O. Nies, Mine-Clearing Vehicle MineWolf. Biomechanical Assessment of Mine-Clearing Tests with Live Mines, by BWB, WTD91, 2004: www.itep.ws//pdf/Report_subtask_MineWolf2004.pdf
5. M. Wagner, MineWolf - Clearing of Live Mines. Final Report, by BWB, WTD 91, 2004: www.itep.ws//pdf/Final_report_MineWolf2004.pdf
6. RUAG Land Systems, Mine Effects to Flail and Engine Armor Shields of the MineWolf, 2003: www.itep.ws//pdf/MinewolfRUAG1.pdf
7. BRTRC Technology Research Cooperation, Area Mine Clearing System (AMCS), Study Report, by US Army Project Manager for Close Combat Systems (PM - CCS), 2002: www.itep.ws//pdf/AMCSStudyReport.pdf

REPORTED LIMITATIONS AND STRENGTHS

The DRD Canada report said the MineWolf was a "capable" machine with "good but not exceptional" performance, which could be improved by minor changes to the tiller configuration and ensuring that operators understood the need for lower forward speed in certain operations (eg clearance rather than follow-on).

Limitations

- Over longer distances the system requires transportation on a low-bed trailer.
- The flail creates dust clouds, as with all flail systems in dry environments.

Strengths

- Proven effective against AP and AV mines with minimum damage to the working tool (German Army, ITEP, CROMAC, RUAG, EOD trials).
- Consistent ground penetration quality.
- Effective against dense vegetation and various terrains (hard, rocky, soft, sandy).
- Maximum flexibility: tiller or flail working tool.
- High safety standard for the operator (German Army Biometric Survivability Trial).
- Rugged design based on mature technology, proven in challenging terrain.
- Tiller working tool minimises dust generation for improved visibility.
- Low running-costs as compared to flail-only systems.
- Additional multi-purpose attachments available (lifter, fork lift, dozer shield, bucket, sifter bucket).

DIMENSIONAL DATA

1. Length without attachment	5,940 mm
2. Length total	7,820 mm (with flail) | 7,420 mm (with tiller)
3. Width without attachment	2,600 mm
4. Width total	3,610 mm (with flail) | 3,480 mm (with tiller)
5. Clearing | Working width	2,800 mm
6. Height | Overall	3,795 mm (manually operated) 2,750 mm (remote control)(without cabin)
7. Mass | Basic vehicle	19,150 kg (without cabin)
8. Mass | Detachable unit(s)	4,800 kg (flail) | 4,500 kg (tiller)
9. Mass | Overall	26,600 kg (flail) | 26,300 kg (tiller)

OPERATIONAL DATA

10. Wheels | Tracks (description)	Tracks
11. Ground Bearing Pressure (kPa)	0.7 (with 600 mm plates)
12. Hill climbing ability (in degrees)	40°
13. Number of Chains | Chisels | Tools	Flail: 72 chains | Tiller: 64 chisels
14. Beat pattern (hits per m^2) at different operating speeds	With tiller: ca. 570 at 0.9 km/h; ca. 510
15. Length of Chains | Tools	950 – 1,115 mm (depending on terrain)
16. Diameter of flail drum	1,100 mm (tiller)
17. Rotation Speed	330 - 740 rpm
18. Clearance | Working depth in varying terrain	0 - 350 mm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	3,800 m^2/h
> Medium Soil | Medium Vegetation	2,500 m^2/h
> Heavy Soil | Dense Vegetation	1,200 m^2/h
20. Control of Clearance | Working depth	Yes
21. Additional attachable working tools	Lifter (quality control tool), fork lift, bucket, sifter bucket, dozer shield
22. Armour	Armoured steel: 6-10-25 mm Armoured glass: 54 mm
23. Remote controlled	Yes (optional)
> greatest distance	1,000 m
24. Transportation	
> short distances	Standard means of transport
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	17
26. Other types	Mini MineWolf, MineWolf Bagger
27. Location of use	BiH, Croatia, Jordan, Sudan, U.A.E, Angola, Rwanda, Georgia, Afghanistan, Chile
28. Totally cleared so far (m^2)	> 16,000,000 m^2

ENGINE | FUEL | OIL

29. Engine	270 kw (367 hp) at 1900 rpm
30. Engine power at the flywheel	Not given
31. Sufficient power supplied to working tool	Not given
32. Fuel capacity	440 l
33. Fuel consumption	40 - 50 l/h
34. Separate engine for working unit	No
35. Cooling system	Yes
36. Oil capacity (both engines)	45 l (engine)
37. Hydraulic oil capacity (both engines)	Not given

COSTS

38. Cost of system	Upon request
39. Other costs	Upon request
> training	
> spare part set chains | belts	
40. Availability for hire	Upon request

OTHER

41. Operator comfort	Radio communication, depth control, superior view, 4-point safety belt, sound and heat insulation, joystick steering integrated in armrests, GPS (optional)
42. Air conditioning	Yes

COMBINED SYSTEMS AND DUAL CAPABILITY FLAIL OR TILLER | MEDIUM SIZE | MINI MINEWOLF

MineWolf Systems AG. | Switzerland and Germany

GENERAL DESCRIPTION

The *Mini MineWolf* has been developed by MineWolf Systems, a Swiss-German provider of mechanical mine clearance machines. It is a medium class (8 tonnes) remote-controlled mechanical demining machine combining flail or tiller. Both applications withstand AP and AV mine detonations. The undercarriage and chassis are protected by Hardox armour plates. The easily interchangeable tiller and flail units are designed so that detonations cause minimum damage to the working tool. With its highly reliable 240 hp Deutz diesel engine and enhanced filtering and cooling instalments the vehicle can withstand extreme conditions of hot, cold, dry and dusty environments.

Output has been recorded at 5,000 m^2 to 12,000 m^2 per day depending on the conditions (Class I to Class IV terrain with slopes up to 35°). Clearance width is 1,860 mm (optional: 2,000 mm).

Standard features include automatic depth control, hydraulic winch and fire-fighting system. The system is designed for 20 ft container transport by road, rail, ship or air. A standard low-loader or 6 x 6 truck can be used for transporting between worksites.

MINI MINEWOLF | With tiller attachment

CLEARANCE METHODOLOGY

The tiller has 40 teeth mounted on an open-basket drum which rotates in the driving direction with a speed of 500-800 rpm. It is designed so that every piece of ground is processed in a tight pattern to a depth up to 25 cm, depending on machine speed and soil conditions.

A flail with 26 chains with hammers can be attached. The system is effective against vegetation up to 15 cm diameter. Automatic depth control facilitates consistent ground penetration quality.

MACHINES IN USE TO DATE

Since 2006 when the machine was introduced, a substantial number of Mini MineWolfs have been produced and deployed in the following countries: Afghanistan, Bosnia and Herzegovina, Colombia, Croatia, Congo, Georgia, Iraq, Jordan, Lebanon, Sudan and USA.

ENGINE, FUEL AND OIL

The machine is equipped with a 176 kw (240 hp) Deutz diesel engine with:

- V6 engine with exhaust turbo super-charger, water-cooled
- oil sump, designed to accommodate a tilt angle of 45°
- cold start equipment (motor built according to exhaust norm COM1)
- cooling systems for outside temperature up to 55°C
- direct mechanical drive via power take-off shaft
- air filtering system including ejectors optimised for desert conditions of extreme dust
- tank volume of 210 litres including explosion prevention system to avoid tank detonations

Fuel consumption is 19 to 25 litres per hour. The hydraulic system requires standard oil.

FACTORY SUPPORT

The manufacturer provides all necessary training, documentation, workshop, consumables and spare parts to render any mine clearing operation completely independent. Project management and consulting services are also available.

Factory support includes:

- delivery of machines, support vehicles and hardware from the factory
- decentralised warehousing in country of operation
- all major spare parts in stock and ready for shipment
- predefined fast delivery schedules with renowned forwarding partners worldwide
- warehousing and efficient resource planning software for customers
- training schedules and spare part packages available, based on the customer's requirements
- instruction manuals, documentation and SOP (according to IMAS) are available, on request in any language

The spare part package anticipates long delivery times in remote areas. If necessary a fully equipped mobile workshop unit is also supplied. Only standard commercial off-the-shelf components are used and most suppliers have worldwide service networks.

MAINTENANCE AND SUPPORT

Daily, weekly and monthly maintenance checks are laid down in the operator's manual. The manufacturer also provides:

- in-country support for major incidents
- assistance on annual inspection with an option for check-up of mechanical competence

MINI MINEWOLF operating in Iraq

TESTS AND EVALUATIONS

- 2006 CROMAC tested the Mini MineWolf in November 2006 against live AP mines. A full test report can be provided by the manufacturer.
- 2007 MineWolf Systems successfully tested the Mini MineWolf's flail attachment against TMRP 6 AT mines in June 2007 at the CROMAC test site at Cerovac.
- 2007 The German Army conducted an extensive test series of the Mini MineWolf tiller and flail against medium to heavy AV mines.

Six test reports are available at www.itep.ws:

1. Mini MineWolf Test and Evaluation, Bundeswehr Technical Center for Weapons and Ammunition (WTD 91), Germany 2007: www.itep.ws//pdf/FinalReportMiniMineWolf2007.pdf
2. Steker, Mini MineWolf demining machine testing report, by Croatian Mine Action Centre / Testing, Development and Training Centre, 2006: www.minewolf.com/fileadmin/user_upload/documents/Reports/CROMAC_report_Mini_MineWolf_Nov_2006.pdf
3. Christoph Frehsee and Carl Fenger, Remote Operation of the Mini Mine Wolf in High-Threat Mine Environments, The 7th IARP International WS HUDEM'2008, AUC, Cairo, March 28-30, 2008: www.itep.ws//pdf/MiniMineWolf_HUDEM2008.pdf

MINI MINEWOLF

4. Thomas Sponfeldner, Testing the Effectiveness and Survivability of the Mini MineWolf, Journal of Mine Action, Issue 12.1, Summer 2008: www.maic.jmu.edu/journal/12.1/rd/sponfelder/sponfelder.htm

5. Christoph Frehsee, Humanitarian Mine Clearance in the Balkans, Journal of Mine Action, Issue 11.1, Summer 2007: www.maic.jmu.edu/journal/11.1/r-and-d/frehsee/frehsee.htm

6. Geoff Coley, Machine Demonstration Analysis and Preliminary Results, International Symposium "Humanitarian Demining 2007" 24 - 27 April 2007, ŠIBENIK, CROATIA, 2007: www.itep.ws//pdf/MachineDemoSibenik2007_Coley.pdf

REPORTED LIMITATIONS AND STRENGTHS

Limitations

- Over longer distances the system requires transportation on a trailer or in a container.
- With flail attached, creates dust clouds as with all flail systems in dry environments.
- Difficult to operate with precision from greater distances, as with all remotely controlled machines.

Strengths

- Proven effective against AP and AV mines with minimum damage to the working tool (CROMAC, manufacturer's test).
- Easily transported.
- Consistent ground penetration quality.
- Effective against dense vegetation and various terrains (hard, rocky, soft, sand).
- Combined system: tiller or flail may be interchanged.
- The machine is comparatively lightweight for its output and class.
- Rugged design based on mature technology, proven in challenging terrain.
- Tiller working tool minimises dust generation for improved visibility.
- Low running-costs as compared to flail-only systems.
- Additional multi-purpose attachments available (lifter, fork list, dozer shield, bucket, sifter bucket).

DIMENSIONAL DATA

1. Length without attachment	3,860 mm
2. Length total	5,130 mm (with flail) | 5,561 mm (with tiller)
3. Width without attachment	1,700 mm
4. Width total	2,500 mm (with flail) | 2,292 mm (with tiller)
5. Clearing | Working width	1,860 mm (with flail) | 1,860 mm (2,000 mm option with tiller)
6. Height | Overall	2,219 mm
7. Mass | Basic vehicle	6,100 kg with fuel
8. Mass | Detachable unit(s)	2,035 kg (flail) | 1,900 kg (tiller)
9. Mass | Overall	8,135 kg (tiller) | 8,000 kg (tiller)

OPERATIONAL DATA

10. Wheels | Tracks (description)	Tracks
11. Ground Bearing Pressure (kPa)	0.5 - 0.7 kg/cm²
12. Hill climbing ability (in degrees)	Max 30° (longitudinal and transversal)
13. Number of Chains | Chisels | Tools	Flail: 26 chains | Tiller: 40 chisels
14. Beat pattern (hits per m²) at different operating speeds	Not given
15. Length of Chains | Tools	400 mm
16. Diameter of flail drum	Tiller: 830 mm
17. Rotation Speed	500 - 800 rpm
18. Clearance | Working depth in varying terrain	0- 250 mm
19. Working Speed (m²/h)	
> Light Soil | Medium Vegetation	1,500 m²/h
> Medium Soil | Medium Vegetation	750 m²/h
> Heavy Soil | Dense Vegetation	500 m²/h
20. Control of Clearance | Working depth	Automatic
21. Additional attachable working tools	Fork lift, bucket, sifter bucket, dozer shield
22. Armour	Armour plates 4, 5, 8 mm
23. Remote controlled	Yes
> greatest distance	1,000 m
24. Transportation	
> short distances	20 ft containers, standard means of transport
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	19
26. Other types	MineWolf, MineWolf Bagger
27. Location of use	BiH, Croatia, Jordan, Colombia, USA, Iraq, Sudan, Georgia, Afghanistan, Lebanon, Congo
28. Totally cleared so far (m^2)	10,000,000 m^2

ENGINE | FUEL | OIL

29. Engine	176 kw (240 hp) at 2100 rpm
30. Engine power at the flywheel	Not given
31. Sufficient power supplied to working tool	Not given
32. Fuel capacity	210 l
33. Fuel consumption	19 - 25 l/h
34. Separate engine for working unit	No
35. Cooling system	Yes
36. Oil capacity (both engines)	21 l (engine)
37. Hydraulic oil capacity (both engines)	Not given

COSTS

38. Cost of system	On request
39. Other costs	On request
> training	
> spare part set chains | belts	
40. Availability for hire	On request

OTHER

41. Operator comfort	Remote controlled
42. Air conditioning	N/A

COMBINED SYSTEMS AND DUAL CAPABILITY FLAIL OR TILLER | MEDIUM SIZE | MV-10

DOK-ING d.o.o | Croatia

GENERAL DESCRIPTION

DOK-ING is a Croatian company which has earned its reputation from extensive experience in humanitarian mine clearance. The *MV-10* medium mine clearance system was developed in 2005 and can be configured as either a flail-and-tiller system or as a double-flail system. The MV-10 can be also equipped with a roller unit and a special blade/gripper unit. It is a remote-controlled, tracked system, designed for destruction of AP and AV mines and UXO.

The machine is protected by Swedish Hardox 400 armoured plates 10-20 mm thick. It is operated by a single operator from a safe distance or from the protection of a second mine-protected vehicle, or from behind a solid structure. Maximum operating range of the remote-control unit is 3,000 m. The video control system is used for operating distances over 800 m.

The MV-10 can endure climatic conditions from -19°C to +54°C and can function in up to 100% relative humidity. The system weighs around 19 tons, and can be loaded and transported on a flat-bed trailer. It can also be transported with the C-130 Hercules aircraft without any modification or shoring of the system.

The MV-10 has been developed exclusively for mine clearance purposes, with high performance abilities and resistance to all types of mine detonations. It is not adapted from any existing construction machine, loader or forestry machine.

DOK-ING | Product range

CLEARANCE METHODOLOGY

The MV-10 normally uses both tools – a rotating flail (designed to activate or shatter AP and AV mines) and a rotating tiller (designed to be a second activating method while maintaining a constant digging depth). It can penetrate soil to a maximum depth of 60 cm, depending on soil type. The force of the flail hammers cuts through dense vegetation and digs into soil. AP and AV mines are destroyed by the impact force of the suitably shaped tools – the hammers at the ends of 44 flail chains, or the 60 chisels on the tiller unit.

Flail chains and hammers and tiller chisels can be replaced quickly in case of damage. The MV-10 can turn 360° on a single point and is highly manoeuvrable. It can drive and work on highly inclined terrain – on transversal slopes up to 25° and on longitudinal slopes up to 37°.

MACHINES IN USE TO DATE

Four systems are currently being used by DOK-ING Demining in Croatia. In 2008, one system was produced and delivered for the Lithuanian Army. In 2009, one system was delivered to the ENIGMA demining company in Croatia. In 2009, DOK-ING started production of eight MV-10 systems for the Australian Ministry of Defence.

ENGINE, FUEL AND OIL

The MV-10 is powered by the Caterpillar C18 diesel engine with 571 kw (766 hp). Fuel consumption is about 50 litres per hour depending on terrain and soil conditions. Fuel tank capacity is 480 litres. The hydraulic system uses 400 litres of hydraulic oil.

FACTORY SUPPORT

The major components not produced by DOK-ING, such as the engine (Caterpillar) and hydraulics (Rexroth Bosch), are from major international manufacturers, so spare parts can be easily obtained worldwide.

DOK-ING has its own in-house service capabilities and can send a service team at short notice to any location in the world. DOK-ING maintains adequate stocks of spare parts – both those produced itself and those outsourced.

Instruction manuals are available in Croatian and English, and translation into the customer's language is possible. Manuals and documentation are part of the purchase package. Basic training of operators and mechanics is provided free by the manufacturer. The system has a one-year warranty. General support service is provided by the manufacturer. Additional equipment available includes additional tool attachments and a video system.

MAINTENANCE AND SUPPORT

The manufacturer recommends daily inspections, monthly maintenance and a major annual inspection. One operator and two mechanics are required for transport, operation, and repairs and maintenance.

TESTS AND EVALUATIONS

Two test reports are available at www. hcr.hr or www.ctro.hr:

1. Croatian Mine Action Centre – Centre for Testing, Development & Training, *Testing of the Mine Clearance Machine MV-10*, Zagreb, Croatia, October 2005.
2. Croatian Mine Action Centre Demining Machine Testing Committee: *Possible Effects of Tested Demining Machines, Appendix to CROMAC SOP 05.01: Efficiency Assessment of Technical Survey and Demining*, 2007.

Four other test reports are available at www.itep.ws.

1. Patrik Blomander, Test and Evaluation Report for DOK-ING MV 10, SWEDISH EOD AND DEMINING CENTRE, Sweden, 2008: www.itep.ws//pdf/MV10_SWEDEC2008.pdf
2. R.W. Fall, W.C. Roberts, D.J. Roseveare, and J.L. Eagles, DOK-ING MV-10 Double Tool Mine Clearance System Test and Evaluation, Defence Research and Development Canada (DRDC), Canada 2007: www.itep.ws/pdf/MV10_DRDC_Suffield.pdf
3. Geoff Coley, Machine Demonstration Analysis and Preliminary Results, International Symposium "Humanitarian Demining 2007" 24 - 27 April 2007, Šibenik, Croatia, 2007: www.itep.ws//pdf/MachineDemoSibenik2007_Coley.pdf
4. Croatian Mine Action Centre – Centre for Testing, Development & Training, Testing of the Mine Clearance Machine MV-10, Zagreb, Croatia, 2005: www.itep.ws//pdf/MV10_ReportHCR_trans.pdf

MV-10 | In service, detailed view of the working tool, driving on a flat bed trailer

REPORTED LIMITATIONS AND STRENGTHS

The 2005 CROMAC test report (cited above) said (page 44) of the MV-10:

“
1. It is well suited for the mechanical processing of a mine suspected area.
2. It can be used on a terrain with a soil type ranging from I to V.
3. It removes low, medium and high vegetation successfully.
4. It destroys all types of anti-personnel and anti-tank mines successfully…”

Limitations

> Difficult to operate with precision from long distance, as with all remotely controlled machines.

Strengths

> The machine combines the strengths of a tiller and a flail system.
> High quality armour for vital parts of the machine

DIMENSIONAL DATA

1. Length without attachment	4,607 mm
2. Length total	7,232 mm
3. Width without attachment	2,240 mm
4. Width total	2,975 mm
5. Clearing | Working width	2,450 mm
6. Height | Overall	2,181 mm
7. Mass | Basic vehicle	14,000 kg
8. Mass | Detachable unit(s)	Flail/tiller: 4,680 kg Blade/gripper: 1,340 kg Roller: 3,730 kg
9. Mass | Overall	19,000 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Metal tracks, 600 mm width
11. Ground Bearing Pressure (kPa)	0.47 kg/cm^2
12. Hill climbing ability (in degrees)	Longitudinal 37° | Transversal 25°
13. Number of Chains | Chisels | Tools	Flail: 44 chains | Tiller: 60 chisels
14. Beat pattern (hits per m^2) at different operating speeds	Not given
15. Length of Chains | Tools	Flail chain: 550 mm | Tiller chisel: 320 mm
16. Diameter of flail drum	Flail: 1,600 mm | Tiller: 1,100 mm
17. Rotation Speed	Flail rotation: 0-800 rpm tiller rotation: 0-350 rpm
18. Clearance | Working depth in varying terrain	Up to 600 mm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	Not given
> Medium Soil | Medium Vegetation	Not given
> Heavy Soil | Dense Vegetation	Not given
20. Control of Clearance | Working depth	Mechanically adjusted
21. Additional attachable working tools	
22. Armour	10 – 20 mm HARDOX steel plates
23. Remote controlled	Yes
> greatest distance	3,000 m
24. Transportation	
> short distances	Road speed of 10 km/h and 20 t low bed trailer
> long distances	C130 transportable
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	13
26. Other types	
27. Location of use	Croatia, Lithuania, Australia
28. Totally cleared so far (m^2)	3,000,000 m^2

ENGINE | FUEL | OIL

29. Engine	CATERPILLAR C18
30. Engine power at the flywheel	571 kw / 766 hp
31. Sufficient power supplied to working tool	Not given
32. Fuel capacity	480 l
33. Fuel consumption	25-50 l/h
34. Separate engine for working unit	No
35. Cooling system	Water cooled
36. Oil capacity (both engines)	68 l
37. Hydraulic oil capacity (both engines)	400 l

COSTS

39. Cost of system	On request
40. Other costs	On request
> training	
> spare part set chains | belts	
41. Availability for hire	Yes

OTHER

41. Operator comfort	Remote and video controlled operation
42. Air conditioning	N/A

SIFTER SYSTEMS | ALLU SCREENER CRUSHER

ALLU Finland Oy | Finland

GENERAL DESCRIPTION

ALLU Finland Oy manufactures attachments for excavators and wheel loaders in Hollola, Finland. It delivered its first *ALLU Screener Crusher* processing attachment for AP mine clearance to the British HALO Trust organisation in 2002.

The machine's most common applications are the treatment of soil, gravel or demolition waste. It can screen, crush, pulverize, aerate, blend, mix, separate, carry, feed and load, all in one-step operation. This working method is called "ALLUizing" by the manufacturer.

When the Screener Crusher is used for AP mine clearance the wheel loader or excavator must be armoured, so that the operator is fully protected against any possible mine blast. In addition to the SCH 4-25 model shown, the manufacturer can also supply its SCH (heavy duty) and SCM (extra heavy duty) models for mine clearance. The size of the loader determines the model of bucket to choose.

ALLU | Screener crusher

CLEARANCE METHODOLOGY

Contaminated soil is collected from the affected soil storage area with the ALLU bucket. The bucket is then placed under a splash screen or it is equipped with a hydraulic closing lid to prevent possibly exploding mine pieces being blown out of the bucket. The contaminated soil is processed through the Screener Crusher, thus destroying all mines (residual minuscule crushed particles remain in the processed soil). The Screener Crusher has a rigid steel frame, onto which horizontally rotating screening and crushing drums have been mounted. All the drums rotate in the same direction. The blades of the drums crush, screen, aerate, pulverize and force the material through the drums, leaving big and hard fragments in the bucket from where they can easily be piled separately for further inspection. The working speed is about 40 cubic metres per hour or up to 200 m^2/h depending on soil conditions. The manufacturer says that mine-contaminated soil, when processed through the Screener Crusher, is safe to return to cleared land.

MACHINES IN USE TO DATE

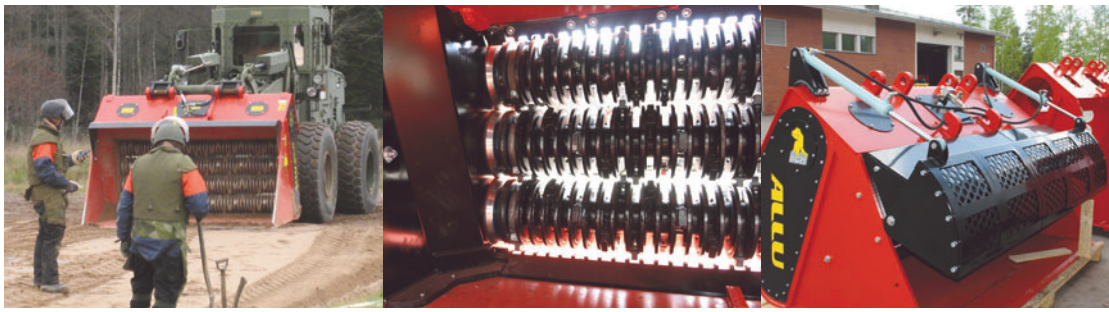
Screener Crushers have been used in Afghanistan, Angola, Cambodia and Sri Lanka. New units were delivered to Lebanon in August 2007 for demining by SRSA, Svenska Räddningsverket.

ENGINE, FUEL AND OIL

Depends on the prime mover used.

FACTORY SUPPORT

Spare parts are available from the manufacturer or from the supplier of the prime mover. Training will be done by supplier or dealer in one hour and is part of the purchasing package. Instruction manuals and documentation are part of the package and are available in different languages on request. One-year warranty. A spare parts catalogue is supplied.



ALLU | Detailed view of the system

MAINTENANCE AND SUPPORT

- Recommended level of required maintenance is ten minutes a day.
- Weekly servicing also takes about ten minutes, plus any time needed for changing blades. The lifetime of the blades depends on the material processed, varying from 20 to 100 cubic metres per blade.

TESTS AND EVALUATIONS

One test report is available at the website www.itep.ws

1. J. Morrissey, *Test and Evaluation Report. Volvo L90 Armoured Front End Loader and ALLU SCH 4-25 Crushing and Screening Bucket*, by SRSA, SWEDEC, 2006.

REPORTED LIMITATIONS AND STRENGTHS

Limitations

- The system is relatively time consuming.

Strengths

The tools and most of the vehicle are produced commercially. The test report cited above states: *"… the system has the ability to perform well within anti-personnel contaminated areas. The system would prove extremely useful, and versatile, in cases where standard clearance methodologies would be rendered ineffective due to high metal contamination, extensive use of minimum metal mine types, deeply buried mines and shifting soil conditions. This system is highly capable in the activation and neutralisation of anti-personnel landmines, if the points raised during the trials are carefully addressed, recommendations incorporated and strict guidelines for the employment of the system are implemented. This coupled with thorough internal and external quality assurance methods, will ensure the system is capable of providing 'clear ground'."*

DIMENSIONAL DATA

1. Length without attachment	
2. Length total	1,500 - 1,650 mm (depending on the model)
3. Width without attachment	
4. Width total	2,152 - 3,090 mm (depending on the model)
5. Clearing | Working width	1,742 - 2,680 mm (depending on the model)
6. Height | Overall	1,350 - 1,600 mm (depending on the model)
7. Mass | Basic vehicle	Wheel loader (14,000 - 24,000 kg)
8. Mass | Detachable unit(s)	2,500 - 3,700 kg (depending on the model)
9. Mass | Overall	Wheel loader (14,000 - 24,000 kg) + bucket 2,500 - 3,700 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Not given
11. Ground Bearing Pressure (kPa)	Depending on the wheel loader
12. Hill climbing ability (in degrees)	Not given
13. Number of Chains | Chisels | Tools	N/A
14. Beat pattern (hits per m^2) at different operating speeds	N/A
15. Length of Chains | Tools	N/A
16. Diameter of flail drum	300 mm
17. Rotation Speed	300 rpm
18. Clearance | Working depth in varying terrain	N/A
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	Up to 200 m^2/h
> Medium Soil | Medium Vegetation	Up to 150 m^2/h
> Heavy Soil | Dense Vegetation	Up to 70 m^2/h
20. Control of Clearance | Working depth	
21. Additional attachable working tools	Wheel loader + Allu Screener Crusher
22. Armour	Depending on the wheel loader
23. Remote controlled	
> greatest distance	No
24. Transportation	
> short distances	With the wheel loader
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	Wheel loader + Allu Screener Crusher
26. Other types	Not given
27. Location of use	Afghanistan, Angola, Cambodia, Lebanon, and Sri Lanka
28. Totally cleared so far (m^2)	Not given

ENGINE | FUEL | OIL

29. Engine	Depending on the wheel loader
30. Engine power at the flywheel	Depending on the wheel loader
31. Sufficient power supplied to working tool	Max 120 kw
32. Fuel capacity	Depending on the wheel loader
33. Fuel consumption	Depending on the wheel loader
34. Separate engine for working unit	N/A
35. Cooling system	Depending on the wheel loader
36. Oil capacity (both engines)	Depending on the wheel loader
37. Hydraulic oil capacity (both engines)	Depending on the wheel loader

COSTS

38. Cost of system	46,000 - 80,000 euros
39. Other costs	
> training	Not given
> spare part set chains | belts	BLADES 10 euros/pc (88-216 pieces needed, depending on the model)
> repair costs for one year	Not given
36. Availability for hire	No

OTHER

41. Operator comfort	Depending on the wheel loader
42. Air conditioning	Depending on the wheel loader

SIFTER SYSTEMS | ARMTRAC SIFTER

Armtrac Ltd. | United Kingdom

GENERAL DESCRIPTION

The *Armtrac Sifter* is designed for towing behind the Armtrac 100/400 or other prime movers that can prepare the ground suitably for soil sifting and separation. The drawbar of the sifter has a robust construction, with a depth indicator on the ram.

ARMTRAC 400 | Pulling Sifter

CLEARANCE METHODOLOGY [1]

A single share covers the full width of the machine and the soil is lifted from a depth down to 40 cm and any ERW or other debris is raised to the top of the star bed. Large, serrated, independently-sprung discs with a large rolling radius reduce skipping in the soil and maintain downward pressure. Shaped blades are designed to stop stone trap and maintain an unrestricted flow onto the stars.

A steel roller transfers the soil and stones evenly from shares onto the star unit. The flow rate is provided by a constant hydraulic pump, and the drive system is protected by a slip clutch on the input transmission. The star bed consists of 12 rows of stars in a spiral configuration. The stars move the soil away from the middle of the machine towards the sides of the star bed, where the reverse configuration moves it back and away from the end discs. Choice of star spacing ensures the most effective soil and stone separation. Star shafts are mounted individually with plastic end discs and active stars: adjustable rubber fingers are mounted above the stars to assist with breaking up clods.

The Vari-Flow hillside kit has remote variable speed. This maintains an even flow of stone, clod and ERW over the star bed, particularly on hillside work. As an optional extra, a Cross Conveyor can be provided. It is 55 cm wide with hydraulic variable speed and can work either side of the machine. It is mechanically auto folding with manual locking choice of 28 mm or 40 mm pitch. A manually operated magnet system allows collection of ERW and other metallic objects. Steel-based wheels and tyres are available as options.

MACHINES IN USE TO DATE

> One old model is in service in Bosnia and Herzegovina.
> The new sifter is in use in Jordan and Bosnia and Herzegovina.

ARMTRAC Sifter picking up mines

ENGINE, FUEL AND OIL

Depends on the prime mover used.

OTHER CATEGORIES

No information provided.

ENDNOTES

[1] see: http://www.armtrac.net/Sifter.php.

DIMENSIONAL DATA

1. Length without attachment	6,450 mm
2. Length total	Depends on the prime mover used
3. Width without attachment	Depends on the prime mover used
4. Width total	2,400 mm
5. Clearing | Working width	Adjustable to the width of the prime mover used
6. Height | Overall	2,200 mm
7. Mass | Basic vehicle	N/A
8. Mass | Detachable unit(s)	7,000 kg
9. Mass | Overall	Depends on the prime mover used

OPERATIONAL DATA

10. Wheels | Tracks (description)	Sifter has wheels
11. Ground Bearing Pressure (kPa)	N/A
12. Hill climbing ability (in degrees)	N/A
13. Number of Chains | Chisels | Tools	N/A
14. Beat pattern (hits per m^2) at different operating speeds	N/A
15. Length of Chains | Tools	N/A
16. Diameter of flail drum	N/A
17. Rotation Speed	N/A
18. Clearance | Working depth in varying terrain	
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	
> Medium Soil | Medium Vegetation	
> Heavy Soil | Dense Vegetation	
20. Control of Clearance | Working depth	Automatic
21. Additional attachable working tools	N/A
22. Armour	
23. Remote controlled	N/A
> greatest distance	
24. Transportation	Can be towed short distances by prime mover ie Armtrac 100 or by low bed truck
> short distances	
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	2
26. Other types	
27. Location of use	Jordan and demonstation
28. Totally cleared so far (m^2)	Unknown

ENGINE | FUEL | OIL

29. Engine	N/A
30. Engine power at the flywheel	N/A
31. Sufficient power supplied to working tool	N/A
32. Fuel capacity	N/A
33. Fuel consumption	N/A
34. Separate engine for working unit	N/A
35. Cooling system	N/A
36. Oil capacity (both engines)	N/A
37. Hydraulic oil capacity (both engines)	N/A

COSTS

38. Cost of system	On request
39. Other costs	On request
> training	
> spare part set chains | belts	
> repair costs for one year	
40. Availability for hire	No

OTHER

41. Operator comfort	N/A
42. Air conditioning	N/A

ASA | Northern Iraq

GENERAL DESCRIPTION

The *Rotational Sifter* is designed and built by the ASA company, a regional manufacturer of mechanical demining equipment in Northern Iraq. The sifter system is made up of a cylinder covered by mesh which is attached to a Volvo truck. It is used to sieve soil of mine-contaminated areas, particularly from high fragmentation areas.

This machine is medium-sized, portable and easy to transfer from area to area. The driver cabin is protected by armour plating inside the truck's original cabin. A separate engine is used to power the sifter unit.

Use of the Rotational Sifter speeds the mine clearance process and minimises risk for deminers. The retained contaminated soil after sifting is almost free of fragmentations, so that any mines are more visible and easier to find.

ASA ROTATIONAL SIFTER

CLEARANCE METHODOLOGY

An armoured wheel loader or armoured excavator drops dry soil into the sifter container. The soil is fed into the sifting cylinder by a conveyor belt at the base of the container (hopper). The sifting cylinder rotates continually at 15 - 25 rpm. The cylinder is covered by steel mesh (45 mm x 45 mm) which is smaller than the smallest mines. Fine soil passes through this mesh and drops on to a conveyor belt which carries it to one side of the machine where it falls to the ground. The remaining soil, which includes any mines and ERW, is transferred to the back of the container where it is stored until the container is full. Contaminated soil is then offloaded in a specific, demarcated area where it is checked by deminers.

This is a powerful machine which gives a high daily production rate. It is suitable for use with most kinds of soil except for wet soil. The sifting process is suitable to tackle mine clearance in areas highly polluted with metal fragmentations where metal detectors are not suitable.

MACHINES IN USE TO DATE

Two machines are currently being used in Northern Iraq (Kurdistan)/Suleimanyah, by ASA.

ENGINE, FUEL AND OIL

The engine of the truck is the original Volvo. The second engine, used to power the sifting unit, is a six-cylinder Perkins.

Sifter loaded by excavator

FACTORY SUPPORT

A basic spare parts set is included in the purchase package. Heavy maintenance for the machine can be provided on request. Mechanic and operator training and refresher training can be provided.

MAINTENANCE AND SUPPORT

On-site visits by a technical team with mobile workshop can be arranged with the manufacturer.

TESTS AND EVALUATIONS

No information yet available.

REPORTED LIMITATIONS AND STRENGTHS

No information yet available.

DIMENSIONAL DATA

1. Length without attachment	N/A
2. Length total	7,000 mm
3. Width without attachment	N/A
4. Width total	2,500 mm
5. Clearing | Working width	N/A
6. Height | Overall	3,700 mm
7. Mass | Basic vehicle	6,000 kg
8. Mass | Detachable unit(s)	8,000 kg
9. Mass | Overall	14,000 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Wheel
11. Ground Bearing Pressure (kPa)	N/A
12. Hill climbing ability (in degrees)	20°
13. Number of Chains | Chisels | Tools	N/A
14. Beat pattern (hits per m^2) at different operating speeds	N/A
15. Length of Chains | Tools	N/A
16. Diameter of flail drum	Sifting mesh is 45 mm x 45 mm
17. Rotation Speed	N/A
18. Clearance | Working depth in varying terrain	As required
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	100 m^3/h
> Medium Soil | Medium Vegetation	
> Heavy Soil | Dense Vegetation	80 m^3/h
20. Control of Clearance | Working depth	N/A
21. Additional attachable working tools	
22. Armour	8 mm
23. Remote controlled	N/A
> greatest distance	N/A
24. Transportation	
> short distances	Self driven
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	2
26. Other types	No
27. Location of use	Northern Iraq
28. Totally cleared so far (m^2)	Not given

ENGINE | FUEL | OIL

29. Engine	Volvo
30. Engine power at the flywheel	N/A
31. Sufficient power supplied to working tool	N/A
32. Fuel capacity	400 l
33. Fuel consumption	15 - 17 l/h
34. Separate engine for working unit	Perkins
35. Cooling system	Water cooled
36. Oil capacity (both engines)	20 l
37. Hydraulic oil capacity (both engines)	200 l

COSTS

38. Cost of system	Not given
39. Other costs	Not given
> training	
> spare part set chains | belts	
> repair costs for one year	
40. Availability for hire	Not given

OTHER

41. Operator comfort	Not given
42. Air conditioning	No

SIFTER SYSTEMS | KZC VIBRATION GRID SIFTER

Khabat Zanganga Company | Sulaimaniyah, Iraq

GENERAL DESCRIPTION

This machine consists of a commercial agriculture tractor with a special attached vibrating grid sifter, manufactured by Khabat Zangana Company (KZC), which was founded in 1998. KZC also manufactures a special cabin with armoured plate and safety glass to protect the driver. No more information was provided by the manufacturer.

KZC VIBRATION GRID SIFTER

CLEARANCE METHODOLOGY

A front-end loader (with armoured cabin) or an excavator (with armoured cabin) is used to excavate and transfer the suspected soil to the vibration sifter. The vibration separates the larger soil pieces (which may contain mines) into the hopper. The sifter has 4 cm x 4 cm grid so that larger pieces (eg a M14 mine) remain within the sifter. Suspect items are examined by a deminer. If a mine or UXO is found on the screening bed, EOD-trained personnel are notified.

The machine can excavate up to 500 m^2/h and can operate in all kinds of soil conditions.

MACHINES IN USE TO DATE

There are 14 sifters in operation in Northern Iraq and three in Southern Iraq.

ENGINE, FUEL AND OIL

No information provided.

FACTORY SUPPORT

No information provided.

MAINTENANCE AND SUPPORT

No information provided.

TESTS AND EVALUATIONS

No information available.

REPORTED LIMITATIONS AND STRENGTHS

Limitations

- It operates in a time- and resource-consuming method.

Strengths

- It is in a simple and rugged design.
- It is useful for AT and AV mine clearance or ERW clearance.

Sifter in mine clearance area

DIMENSIONAL DATA

1. Length without attachment	3,000 mm
2. Length total	7,000 mm
3. Width without attachment	2,000 mm
4. Width total	2,500 mm
5. Clearing | Working width	N/A
6. Height | Overall	2,500 mm
7. Mass | Basic vehicle	5,000 kg
8. Mass | Detachable unit(s)	3,000 kg
9. Mass | Overall	8,000 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	N/A
11. Ground Bearing Pressure (kPa)	N/A
12. Hill climbing ability (in degrees)	N/A
13. Number of Chains | Chisels | Tools	N/A
14. Beat pattern (hits per m^2) at different operating speeds	N/A
15. Length of Chains | Tools	N/A
16. Diameter of flail drum	N/A
17. Rotation Speed	N/A
18. Clearance | Working depth in varying terrain	
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	100 m^2
> Medium Soil | Medium Vegetation	75 m^2
> Heavy Soil | Dense Vegetation	50 m^2
20. Control of Clearance | Working depth	N/A
21. Additional attachable working tools	No
22. Armour	Yes
23. Remote controlled	N/A
> greatest distance	
24. Transportation	Low loader
> short distances	
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	17
26. Other types	No
27. Location of use	Northern and Southern Iraq
28. Totally cleared so far (m^2)	More than 400,000 m^2

ENGINE | FUEL | OIL

29. Engine	Depending on the prime mover
30. Engine power at the flywheel	Depending on the prime mover
31. Sufficient power supplied to working tool	Depending on the prime mover
32. Fuel capacity	Depending on the prime mover
33. Fuel consumption	Depending on the prime mover
34. Separate engine for working unit	Depending on the prime mover
35. Cooling system	Depending on the prime mover
36. Oil capacity (both engines)	Depending on the prime mover
37. Hydraulic oil capacity (both engines)	Depending on the prime mover

COSTS

38. Cost of system	On negotiation
39. Other costs	On negotiation
> training	
> spare part set chains | belts	
> repair costs for one year	
40. Availability for hire	No

OTHER

41. Operator comfort	N/A
42. Air conditioning	N/A

SIFTER SYSTEMS | NOMA VIBRATION SIFTER

Ararat Company | Northern Iraq

GENERAL DESCRIPTION

The *NOMA Vibration Sifter* consists of a vibration mesh layer attached to an Oral 4 x 4 truck. It is used to sieve mine-contaminated soil which is loaded into it by an armoured excavator or armoured wheel loader. The sifter system vibrates the mesh layer to sieve the soil. Fine soil drops down during the sieving process leaving the contaminated soil in the container. The supervisor oversees the unloading of the contaminated soil into a selected area.

The dimensions of the mesh are 45 mm x 45 mm, which is smaller than the smallest mine. The sifting process is recommended for use in high fragmentation areas. The machine is sufficiently powerful for work in difficult terrain.

NOMA VIBRATION SIFTER

CLEARANCE METHODOLOGY

The armoured wheel loader or armoured excavator drops dry soil into the top container of the sifter. The operator then starts lifting the container to feed the soil into the vibration mesh layer. After sieving, the same process is repeated until the second container is full. The sifted soil is then unloaded into a specific area where deminers check the soil visually and with metal detectors.

MACHINES IN USE TO DATE

Four machines are currently being used by Ararat in Northern Iraq (Kurdistan)/ Sulaymania.

ENGINE, FUEL AND OIL

The engine is a Russian six-cylinder, as supplied in the Oral 4 x 4 truck.

FACTORY SUPPORT

- A basic spare parts set is included in the purchase package.
- Heavy maintenance can be provided on request.
- Mechanic and operator training as well as refresher training can be provided.

MAINTENANCE AND SUPPORT

On-site visits by a technical team with mobile workshop can be arranged with Ararat.

TESTS AND EVALUATIONS

No information yet available.

REPORTED LIMITATIONS AND STRENGTHS

No information yet available.

Sifter systems in operation

DIMENSIONAL DATA

1. Length without attachment	6,000 mm
2. Length total	6,000 mm
3. Width without attachment	2,500 mm
4. Width total	2,500 mm
5. Clearing | Working width	N/A
6. Height | Overall	3,000 mm
7. Mass | Basic vehicle	4,000 kg
8. Mass | Detachable unit(s)	Sifter 3,000 kg
9. Mass | Overall	7,000 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Wheels
11. Ground Bearing Pressure (kPa)	N/A
12. Hill climbing ability (in degrees)	30°
13. Number of Chains | Chisels | Tools	N/A
14. Beat pattern (hits per m^2) at different operating speeds	N/A
15. Length of Chains | Tools	N/A
16. Diameter of flail drum	N/A
17. Rotation Speed	N/A
18. Clearance | Working depth in varying terrain	As required
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	20 cubic m/h
> Medium Soil | Medium Vegetation	
> Heavy Soil | Dense Vegetation	15 cubic m/h
20. Control of Clearance | Working depth	N/A
21. Additional attachable working tools	
22. Armour	8 mm
23. Remote controlled	No
> greatest distance	
24. Transportation	Self driven
> short distances	
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	4
26. Other types	No
27. Location of use	Northern Iraq
28. Totally cleared so far (m^2)	Not given

ENGINE | FUEL | OIL

29. Engine	Oral
30. Engine power at the flywheel	N/A
31. Sufficient power supplied to working tool	N/A
32. Fuel capacity	300 l
33. Fuel consumption	15 - 20 l/h
34. Separate engine for working unit	No
35. Cooling system	Water cooled
36. Oil capacity (both engines)	20 l
37. Hydraulic oil capacity (both engines)	100 l

COSTS

38. Cost of system	Not given
39. Other costs	Not given
> training	
> spare part set chains | belts	
> repair costs for one year	
40. Availability for hire	Not given

OTHER

41. Operator comfort	Not given
42. Air conditioning	No

SIFTER SYSTEMS | ROTAR CLEANER

Rotar International BV | The Netherlands

GENERAL DESCRIPTION

Rotar International BV is a manufacturer of hydraulic attachments for excavators and wheeled loaders in the Netherlands.

It supplies several Rotar Cleaner screening attachments suitable for wheeled loaders, excavators, skid-steer loaders as well backhoe loaders.

The *Rotar Cleaner* (also called the "Rotar Bermsifter") is a commercial, off-the-shelf product designed for clearance of AP mines. Rotar also offers customised units, such as units with a special digging width related to the outside tyre width of the carrying vehicle.

The most common application of the Rotar Cleaner is for clearance of AP mines in large soil and gravel areas, such as riversides and berms beside roads. The attachment can load, screen, clear and unload in an efficient "one man – one machine" operation. Vehicles using the equipment for mine clearance must be armoured and the operator must be fully protected against possible mine blasts.

Rotar supplies several sizes of Rotar Cleaners in two different versions – for wheeled loaders (the HPL Series) and for excavators (the HEX-Series).

ROTAR CLEANER | Filling the rotar drum

CLEARANCE METHODOLOGY

The drum/centrifuge of the Rotar Cleaner is mounted in a solid frame. The drum is built in two parts: two-thirds of the radius is the bucket and one-third is the closing door. Inside it has solid round vertical bars 45 mm apart. An insert screen fits into the drum to regulate the gap for sifting. The caps of the screen are covered by a 2 mm steel plate.

The Rotar Cleaner can load and screen soil at the same location. (It can also be moved without losing soil already loaded.) While the drum is sifting material, some mines can explode. All oversize material left within the bucket must be stored and inspected for any unexploded devices. The drum is locked mechanically during operation.

The Rotar Cleaner is heavy duty but easy to operate and service. It can clear up to 250 m^2/h depending on soil conditions. When using a wheeled loader, the bucket width must be wider then the outside tyre width to protect against detonations from the underside. All hydraulic components are protected by V-shaped defence plates.

MACHINES IN USE TO DATE

Since 1998, some 25 units have been supplied to Afghanistan, Angola, Chile, Honduras, Iraq, Mozambique and Thailand. The best selling unit is the extended HPL 1500 XXL, suitable for common-size wheeled loaders of 12 to 15 tons.

ENGINE, FUEL AND OIL

Depends on the carrier machine used.

FACTORY SUPPORT

Spare parts are available Rotar or the supplier of the carrier machine. Training and installation can be part of the purchasing package, which also includes instruction and installation manuals, in hard copy or digital format on request.

The equipment has a one-year warranty. A spare parts catalogue is supplied.

MAINTENANCE AND SUPPORT

- Daily: Greasing every eight hours / checking of locking mechanism (tighten strainers).
- Weekly: Inspections of fasteners around machine, other attachments and chain.

TESTS AND EVALUATIONS

One test report is available from the Institute for Defense Analyses, 4850 Mark Center Drive, Alexandria, VA 22311-1882, USA: www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA460322&Location=U2&doc=GetTRDoc.pdf

REPORTED LIMITATIONS AND STRENGTHS

Limitations

- For use in clearance of AP mines or small-calibre ammunitions only.

Strengths

- Commercially available as off-the-shelf products.
- Simple technology, using common, trade-marked components.
- Permits adapting a standard carrier vehicle for demining purposes.
- Performed well against AP mine detonations within the bucket.
- Can be serviced in the field or in any small workshop.

DIMENSIONAL DATA

1. Length without attachment	Depending on carrier
2. Length total	700 mm - 1,500 mm (rotar only)
3. Width without attachment	
4. Width total	1,290 mm - 3,430 mm (rotar only)
5. Clearing | Working width	885 mm - 2,889 mm (rotar edge width)
6. Height | Overall	700 mm - 1,500 mm (rotar only)
7. Mass | Basic vehicle	4,000 - 35,000 kg
8. Mass | Detachable unit(s)	400 - 3,500 kg
9. Mass | Overall	5,000 to 40,000 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	
11. Ground Bearing Pressure (kPa)	Depending on carrier
12. Hill climbing ability (in degrees)	Not given
13. Number of Chains | Chisels | Tools	N/A
14. Beat pattern (hits per m^2) at different operating speeds	N/A
15. Length of Chains | Tools	N/A
16. Diameter of flail drum	610 mm - 1,170 mm
17. Rotation Speed	28 rpm
18. Clearance | Working depth in varying terrain	0 - 500 mm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	250 m^2/h
> Medium Soil | Medium Vegetation	150 m^2/h
> Heavy Soil | Dense Vegetation	100 m^2/h
20. Control of Clearance | Working depth	
21. Additional attachable working tools	Screen meshes / plates
22. Armour	On request
23. Remote controlled	N/A
> greatest distance	
24. Transportation	Land / sea / air
> short distances	
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	Wheeled loaders and excavators with rotar
26. Other types	Occasionally solid rubber tyres
27. Location of use	Afghanistan, Angola, Iraq, Mozambique
28. Totally cleared so far (m^2)	Not given

ENGINE | FUEL | OIL

29. Engine	Depending on carrier
30. Engine power at the flywheel	Depending on carrier
31. Sufficient power supplied to working tool	40 up to 150 kw
32. Fuel capacity	Depending on carrier
33. Fuel consumption	Depending on carrier
34. Separate engine for working unit	N/A
35. Cooling system	Depending on carrier
36. Oil capacity (both engines)	Depending on carrier
37. Hydraulic oil capacity (both engines)	Depending on carrier

COSTS

38. Cost of system	35,000 - 95,000 euros
39. Other costs	
> training	In consultation
> spare part set chains | belts	Sustainment package 2,500 - 5,000 euros
> repair costs for one year	Not given
40. Availability for hire	No

OTHER

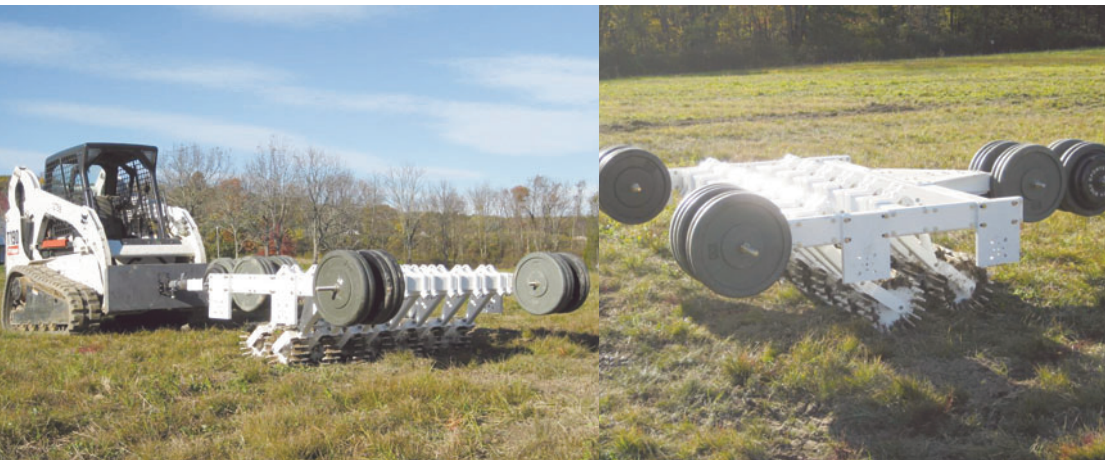
41. Operator comfort	Depending on carrier
42. Air conditioning	Depending on carrier

SCAMP Roller from Humanistic Robotics, Inc | USA

GENERAL DESCRIPTION

The *SCAMP mine-clearance roller* is produced by Humanistic Robotics, Inc, a US-based manufacturer of humanitarian and military demining equipment. The SCAMP is a highly customisable roller attachment that can be easily adapted to a variety of remote-controlled or manned prime-mover vehicles. The rollers are designed to effectively deliver force to anti-personnel mine fuses while venting blast loads and preventing mud accumulation or bow-wave effects in soft soil.

The SCAMP utilises a proprietary pneumatic suspension system to independently suspend individual rollers, allowing the system to deliver constant ground force over undulating terrain. The SCAMP's suspension also allows the user to customise the ground pressure by varying the supplemental ballast load carried by the system. Using locally-sourced ballast materials (steel plate, sand, or concrete) minimises transportation costs, reduces logistical footprint, and allows the operator to tailor the ground force for different soil conditions and mine types.



THE SCAMP ROLLER

CLEARANCE METHODOLOGY

The SCAMP roller can be pushed in front of or towed behind a manned or remote-controlled prime mover vehicle. The SCAMP's frame is modular, allowing the operator to tailor the roller width to match the prime mover vehicle or clearance requirements. The modular design also allows individual components to be replaced easily and rapidly, minimising machine down-time and maintenance costs. The roller frame contains an integral towing module which allows the system to be transported at road speed easily between clearance locations using commonly-available trucks or 4x4 vehicles. The roller can be employed in a primary clearance and risk reduction capacity, as well as for technical survey and quality control functions.

MACHINES IN USE TO DATE

Several rollers have been built and tested, and HRI is working on accreditation so that field trials can be completed.

TECHNICAL SPECIFICATIONS	SCAMP ROLLER
DIMENSIONAL DATA	
1. Length without attachment	
2. Length total	3,620 mm
3. Width without attachment	
4. Width total	2,700 mm
5. Clearing | Working width	1,825 mm
6. Height | Overall	1,230 mm
7. Mass of roller without ballast	335.6 kg
8. Mass of ballast, maximum	1,980 kg
9. Mass of roller with ballast, maximum	2,315.6 kg
OPERATIONAL DATA	
10. Wheels | Tracks (description)	
11. Ground force	Up to 1,150 kg / metre of roller width, dependent on supplemental ballast load. Suggested ballast load was determined by HRI through iterative testing of soil type, soil compaction and mine type
12. Hill climbing ability (in degrees)	Limited by prime mover traction
13. Number of Chains | Chisels | Tools	
14. Beat pattern (hits per m^2) at different operating speeds	
15. Length of Chains | Tools	
16. Diameter of flail drum	
17. Rotation Speed	
18. Clearance | Working depth in varying terrain	
19. Working Speed (m^2/h) > Light Soil | Medium Vegetation > Medium Soil | Medium Vegetation > Heavy Soil | Dense Vegetation	550 m^2/h, in terrain with light to medium vegetation, or after vegetation has been cleared
20. Control of Clearance | Working depth	
21. Additional attachable working tools	
22. Armour	
23. Remote controlled > greatest distance	
24. Transportation > short distances > long distances > sea transport > air transport	
SYSTEM STATUS AND DEPLOYMENT	
	Two prototypes of the SCAMP roller have been built by HRI and tested internally and with the US Army. HRI is currently in the process of organising accreditation trials for private sector operations

GROUND PREPARATION MACHINES

Ararat Company | Northern Iraq

GENERAL DESCRIPTION

The *NOMA Flail* is manufactured by the Ararat Company, a regional producer of mechanical demining equipment in Northern Iraq. The mini flail system is designed for ground preparation tasks by cutting vegetation, softening the ground and removing obstacles. The machine is remotely controlled by an operator from a suitable distance. All the parts, even the chassis, are designed to resist explosion pressure. It is an economic, simple machine and easy to maintain.

A prototype machine was manufactured in 2001. Following a successful six-month test, UNOPS Mine Action Programme then requested six more machines with minor modifications from the prototype. In November 2001, Ararat was contracted by UNOPS to manufacture the six machines. Support teams were recruited, trained, accredited and deployed by May 2002.

NOMA FLAIL

GROUND PREPARATION METHODOLOGY

NOMA flails have 65 chains each tipped with a reinforced steel hammer. Depending on terrain and soil conditions, the flail can penetrate the ground up to depth of 20 cm. The flail is designed to prepare the ground by cutting vegetation, removing obstacles, loosening the soil and breaking and/or detonating the AP mines as well as AV mines like the VS2.2. Depending on ground type, the production rate is approximately 3,000 m^2 per day.

MACHINES IN USE TO DATE

Seven machines were used by Ararat for the UNOPS programme from 2000 to 2003 and since then in Iraq/Suleimanyah.

ENGINE, FUEL AND OIL

The NOMA Flail has one diesel engine, the 160 hp F6L913 Deutz requiring 12-13 litres per hour under normal conditions.

FACTORY SUPPORT

A basic spare parts set is included in the purchase package. Heavy maintenance for the machine can be provided on request. Mechanic and operator training as well as refresher training can be provided.

MAINTENANCE AND SUPPORT

On-site visits by a technical team with mobile workshop can be arranged with the manufacturer.

TESTS AND EVALUATIONS

No information yet available.

REPORTED LIMITATIONS AND STRENGTHS

- Creates dust clouds, as with all flail systems in dry environments.
- Difficult to operate with precision from greater distances, as with all remotely controlled machines.

TECHNICAL SPECIFICATIONS	NOMA FLAIL

DIMENSIONAL DATA

1. Length without attachment	4,000 mm
2. Length total	5,200 mm
3. Width without attachment	2,100 mm
4. Width total	2,800 mm
5. Clearing | Working width	2,300 mm
6. Height | Overall	2,500 mm
7. Mass | Basic vehicle	5,000 kg
8. Mass | Detachable unit(s)	2,000 kg
9. Mass | Overall	7,000 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Wheels
11. Ground Bearing Pressure (kPa)	Not given
12. Hill climbing ability (in degrees)	Not given
13. Number of Chains | Chisels | Tools	65 Chains
14. Beat Pattern (hits per m^2) at different operating speeds	Not given
15. Length of Chains | Tools	70 cm
16. Diameter of drum	Not given
17. Rotation Speed	350 - 400 rpm
18. Clearance | Working depth in varying terrain	
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	500 m^2/h
> Medium Soil | Medium Vegetation	
> Heavy Soil | Dense Vegetation	400 m^2/h
20. Control of Clearance | Working depth	Manual
21. Additional attachable working tools	
22. Armour	10 mm
23. Remote controlled	Yes
> greatest distance	
24. Transportation	
> short distances	From site to site by a low bed trailer
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	7
26. Other types	No
27. Location of use	Northern Iraq
28. Totally cleared so far (m^2)	2,000,000 m^2

ENGINE | FUEL | OIL

29. Engine	Deutz diesel engine with 160 hp
30. Engine power at the flywheel	Not given
31. Sufficient power supplied to working tool	Not given
32. Fuel capacity	Not given
33. Fuel consumption	8 - 10 l/h
34. Separate engine for working unit	No
35. Cooling system	Air cooled
36. Oil capacity of engine (both engines)	13 l
37. Hydraulic oil capacity (both engines)	120 l

COSTS

38. Cost of system	Not given
39. Other costs > training > spare part set chains | belts > repair costs for one year	Not given
40. Availability for hire	Not given

OTHER

41. Operator comfort	N/A
42. Air conditioning	N/A

DEMCO (Pty) Ltd. | South Africa

GENERAL DESCRIPTION

DEMCO have a range of landmine detonating systems that can be fitted to commercial platforms (prime movers). The prime movers are armour plated with 10 mm, 8 mm and 6 mm Armox, depending on the vulnerability of the components needing protection and also the design structure of the machine chassis, doors, bonnets, etc.

All cabs have double doors or an escape hatch in the roof to ensure that the operator is not trapped in an emergency.

The Komatsu W93R-2 is fitted with 8.5 mm Armox for the cab, doors, bonnet, engine, radiator, fuel and oil tanks, transmission and drive train. The armour glass is 52 mm. The cabin is air-conditioned and the windows provide all-round visibility.

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 detonating disc system
- double detonating disc system for roads and runways (width 1 m to 4 m)
- filter buckets
- ripper rakes
- rotovators (width 1 m to 4 m)
- flailing system (width 1 m to 4 m) optional with magnetic debris removal array
- bush cropping buckets
- movers and stump removers
- magnetic debris removal 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. The attachments are well suited to clearance of difficult ground such as ditches and banks. All attachments are adaptable to small or large machines.

CLEARANCE METHODOLOGY

Single Detonating Disc System

The single array consists of 24 serrated discs each fitted with two connecting arms to a central shaft. This allows for individual movement up and down for each disc on uneven ground so that the disc edge retains contact with the ground. 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 50 mm. This distance is smaller than the average diameter of AP mines generally encountered. Each disc and arm weighs 130 kg. The 24 sets of discs and arms cover a width of 2,470 mm and the static impact detonates all AP mines including boosted mines. Heavier discs can be fitted for detonating AV mines if required. The free mounting suspension protects the system against a detonation under any individual disc. The discs and arms are easy to replace. A test report said wet clay and mud will clog up the serrated edges of the discs as well as the space between the rollers.

Double Detonating Disc System

The double array of disc rollers consists of two single arrays similar to the single array configuration. It contains 31 discs each attached to their own shaft by connecting arms. Disc size is similar to the discs used in the single array. The discs are offset between front and rear 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. Depending on the lengths of the arm from the excavator (up to 15 m) any mine detonations, including AV mines, occur well away from the operator in the excavator cabin, reducing the danger. DEMCO flailing systems fitted to excavators and working in a 180° arc can safely clear open areas, banks (up or down), canals and other difficult-to-access sites. Passing over the same area in the arc four times every 1-2 minutes achieves a high production figure on ground preparation.

Bush croppers and ripper rakes

Both the bush cropper and ripper rake systems are applied for loosening hard ground, rubble and vegetation to prepare for inspection of suspect sites which are hazardous and difficult to access. The systems fit easily to excavators with either standard or extended booms and dipper arms.

Rotovator

DEMCO's hydraulically operated rotovators are used for loosening hard ground. The rotovator discs can be easily replaced and are inexpensive.

MACHINES IN USE TO DATE

More than 20 detonating disc systems mounted on comprehensively armour-plated tractor loader backhoes have been sold in the last three years.

FACTORY SUPPORT

Worldwide operating manufacturers of suitable prime movers, such as Caterpillar or Komatsu, ensure the availability of spare parts and service facilities.

MAINTENANCE AND SUPPORT

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

TESTS AND EVALUATIONS

The system was tested by CSIR DEFENCETEK in 2002. The test was restricted to pressure-activated blast AP. (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.)

REPORTED LIMITATIONS AND STRENGTHS

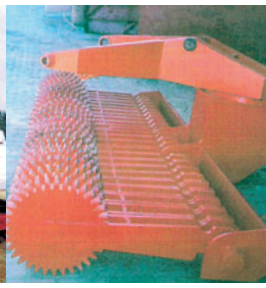
Limitations

- Wet soil clogs up the edges of the disc roller.

Strengths

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





TECHNICAL SPECIFICATIONS	DEMCO SYSTEMS EG KOMATSU WB93R-5 WITH SINGLE DETONATING DISC ASSEMBLY
DIMENSIONAL DATA	
1. Length without attachment	2,175 mm wheel base
2. Length total	5,895 mm
3. Width without attachment	2,320 mm
4. Width total	2,470 mm
5. Clearing | Working width	2,400 mm
6. Height | Overall	3,710 mm
7. Mass | Basic vehicle	7,460 kg
8. Mass | Detachable unit(s)	Not given
9. Mass | Overall	12,420 kg including armour plating, detonating disc assy and mulcher
OPERATIONAL DATA	
10. Wheels | Tracks (description)	4 wheels front tyres 12.5/80 R18-10PR | rear 16.9 x 28-12PR
11. Ground Bearing Pressure (kPa)	Not given
12. Hill climbing ability (in degrees)	Not given
13. Number of Chains | Chisels | Tools	Discs: 24 | Double disk assy: 32
14. Beat Pattern (hits per m^2) at different operating speeds	Not given
15. Length of Chains | Tools	Not given
16. Diameter of drum	N/A
17. Rotation Speed	N/A
18. Clearance | Working depth in varying terrain	N/A | Working widths: 2,470 mm
19. Working Speed (m^2/h)	Not given
> Light Soil | Medium Vegetation	
> Medium Soil | Medium Vegetation	
> Heavy Soil | Dense Vegetation	
20. Control of Clearance | Working depth	N/A
21. Additional attachable working tools	
22. Armour	Armour plates 8.5 mm | Armour glass 52 mm
23. Remote controlled	No
> greatest distance	N/A
24. Transportation	
> short distances	Travelling speed up to 20 km/h
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	More than 20
26. Other types	Double detonating disc system; flail system; movers and stump removers; bush croppers; ripper rakes; filter buckets; magnetic debris removal system; rotovator
27. Location of use	Not given
28. Totally cleared so far (m^2)	Not given

ENGINE | FUEL | OIL

29. Engine	Komatsu S4D104E-3 diesel engine with 74 kw (99.2 hp)
30. Engine power at the flywheel	Not given
31. Power at the working tool	Not given
32. Fuel capacity	150 l
33. Fuel consumption	Not given
34. Separate engine for working unit	No
35. Cooling system	Radiator with dry air filter with safety element
36. Oil capacity (both engine)	12.8 l
37. Hydraulic oil capacity (both engine)	97 l

COSTS

38. Cost of system	Average costs for a TLB's 72,000 US$ + armour plating; Detonating Disc system 40,000 US$; Flail system 26,000 US$; Mulcher/Shredder system 23,000 US$
39. Other costs > training > spare part set chains | belts > repair costs for one year	
40. Availability for hire	Yes

OTHER

41. Operator comfort	Best visibility, ergonomics, low noise and comfort; full adjustable seat, fresh filtered air intake ventilation, easy to read front and side dash board
42. Air conditioning	Yes

MULTI-TOOL SYSTEMS | NOMA CRUSHER AND PENETRATOR

Ararat Company | Northern Iraq

GENERAL DESCRIPTION | CRUSHER ATTACHMENT

The *NOMA Crusher* attachment is manufactured by the Ararat Company, a regional producer of mechanical demining equipment in Northern Iraq. The attachment works by rotating carbon teeth to crush the topsoil of the mined area. It can be attached to excavating machines (such as the Hitachi Excavator). The attachment is used to crush the topsoil of mine-suspected areas, and detonates or destroys the mines in the soil.

The Crusher can be used in all ground conditions, even in difficult terrain. The tool and method of mine clearance were developed by Ararat and have been accredited by the General Directorate for Mine Action in Iraq. Ararat is currently building a number of crusher attachments in different sizes.

NOMA CRUSHER ATTACHMENT

CLEARANCE METHODOLOGY | CRUSHER ATTACHMENT

The crushing action is powered by a rotational axle which is surrounded by carbon teeth with no gaps between them. Rotation speed is up to 400 rpm and the machine can achieve a working depth of up to 30 cm.

NOMA | Detailed view of the crusher and penetrator

MACHINES IN USE TO DATE | CRUSHER ATTACHMENT

Two machines owned by Ararat are in operation in Northern Iraq/Sulaimanyah, working for the Iraqi Government-Kurdistan region.

GENERAL DESCRIPTION | PENETRATOR ATTACHMENT

The *NOMA Penetrator* attachment consists of carbon teeth combined with high vibration energy and can be attached to excavating machines (such as the Hitachi Excavator). It is used to penetrate the topsoil of mine-suspected areas, and detonates or destroys the mines in the soil. It can be used in all ground conditions, even in difficult terrain.

The Penetrator was designed in 2005 and manufactured by Ararat. The tool and method of mine clearance have been accredited by the General Directorate for Mine Action in Iraq. Ararat is currently building a number of penetrator attachments in different sizes.

NOMA PENETRATOR ATTACHMENT

CLEARANCE METHODOLOGY | PENETRATOR ATTACHMENT

The Penetrator functions by driving spikes into the ground, powered by the excavator's hydraulic transmission. The force is made more effective by vibration energy to destroy or detonate buried mines and ERW. Each strike of this tool covers about 0.5 m^2 and the achieved penetration depth is up to 40 cm.

MACHINES IN USE TO DATE | PENETRATOR ATTACHMENT

Two Penetrators are being operated by Ararat in Northern Iraq/Sulaimanyah.

ENGINE, FUEL AND OIL | BOTH ATTACHMENTS

Both tools are driven by the hydraulic power of the excavator machine. Rotational torque is also determined by the excavator's hydraulic power.

FACTORY SUPPORT | BOTH ATTACHMENTS

- A basic spare parts set is included in the purchase package.
- Heavy maintenance can be provided on request.
- Mechanic and operator training as well as refresher training can be provided.

MAINTENANCE AND SUPPORT | BOTH ATTACHMENTS

On-site visits by a technical team with mobile workshop can be arranged with the manufacturer.

TESTS AND EVALUATIONS | BOTH ATTACHMENTS

No information yet available.

REPORTED LIMITATIONS AND STRENGTHS | BOTH ATTACHMENTS

No information yet available.

DIMENSIONAL DATA

1. Length without attachment	Depends on the excavator used
2. Length total	Depends on the excavator used
3. Width without attachment	Depends on the excavator used
4. Width total	Depends on the excavator used
5. Clearing | Working width	0.5 m^2
6. Height | Overall	Depends on the excavator used
7. Mass | Basic vehicle	Depends on the excavator used
8. Mass | Detachable unit(s)	1,500 kg
9. Mass | Overall	Depends on the excavator used

OPERATIONAL DATA

10. Wheels | Tracks (description)	Depends on the excavator used
11. Ground Bearing Pressure (kPa)	Not given
12. Hill climbing ability (in degrees)	Depends on the excavator used
13. Number of Chains | Chisels | Tools	77 teeth
14. Beat Pattern (hits per m^2) at different operating speeds	
15. Length of Chains | Tools	25 cm
16. Diameter of drum	N/A
17. Rotation Speed	N/A
18. Clearance | Working depth in varying terrain	20 - 40 cm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	300 m^2/h
> Medium Soil | Medium Vegetation	
> Heavy Soil | Dense Vegetation	200 m^2/h
20. Control of Clearance | Working depth	Manual
21. Additional attachable working tools	
22. Armour	Yes, necessary; 8 mm Hitachi Excavator used
23. Remote controlled	N/A
> greatest distance	
24. Transportation	
> short distances	Depends on the excavator used
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	2
26. Other types	No
27. Location of use	Northern Iraq
28. Totally cleared so far (m^2)	Not given

ENGINE | FUEL | OIL

29. Engine	Depends on the excavator used
30. Engine power at the flywheel	Depends on the excavator used
31. Sufficient power supplied to working tool	Depends on the excavator used
32. Fuel capacity	Depends on the excavator used
33. Fuel consumption	Depends on the excavator used
34. Separate engine for working unit	Depends on the excavator used
35. Cooling system	Depends on the excavator used
36. Oil capacity of engine (both engines)	Depends on the excavator used
37. Hydraulic oil capacity (both engines)	Depends on the excavator used

COSTS

38. Cost of system	Not given
39. Other costs > training > spare part set chains | belts > repair costs for one year	Not given
40. Availability for hire	Not given

OTHER

41. Operator comfort	Depends on the excavator used
42. Air conditioning	Depends on the excavator used

MULTI-TOOL SYSTEMS | MINEWOLF BAGGER

MineWolf Systems AG | Switzerland and Germany

GENERAL DESCRIPTION

The *MineWolf Bagger* has been developed by MineWolf Systems, a Swiss-German provider of mechanical mine clearance machines. The tool consists of a standard excavator (Liebherr R 916) that is equipped with a modular tiller head and power pack.

The complete weight is around 28 tonnes. The tiller and power pack weigh 5,000 kg. All integration efforts, including armouring, will be provided by the manufacturer

The Bagger can typically clear up to 1,200 m²/h and may effectively be used to clear areas where manual demining proves to be very tedious or impossible: trenches and dams, heavy and dense vegetation, craters and areas where other machines cannot manoeuvre.

The vehicle covers short distances by itself and relies on standard means for longer transport, for example a low-loader.

MINEWOLF BAGGER | With tiller attachment

CLEARANCE METHODOLOGY

The tiller unit cuts vegetation up to 15 cm in diameter and reaches a clearing depth of up to 15 cm in light, medium and heavy soil. The maximum reach radius is ca. 8 m. The tiller head has a working width of 1.4 m, and is equipped with 40 replaceable teeth.

MACHINES IN USE TO DATE

One unit is being operated in Bosnia and Herzegovina and a further unit is working in Southern Sudan with Norwegian s People Aid (NPA).

ENGINE, FUEL AND OIL

The power pack consists of a 240 hp (176 kw) Deutz turbo-diesel engine, typically integrated into the prime mover and sharing the main fuel tank. Fuel consumption under average conditions is 15-20 litres per hour. The hydraulic system uses standard oil.

FACTORY SUPPORT

The manufacturer provides all necessary training, documentation, workshop, consumables and spare parts to render any mine clearing organisation completely independent. Project management and consulting services are also available from the manufacturer. Factory support includes:

- delivery of machines, support vehicles and hardware from the factory to point of delivery
- decentralised warehousing in country of operation
- all major spare parts in stock and ready for shipment
- predefined fast delivery schedules with renowned forwarding partners worldwide
- warehousing and efficient resource planning software for customers
- training schedules as well as spare part packages are provided based on the customer's resources
- instruction manuals, documentation and SOP (according to IMAS) are available, on request in any language; a spare parts kit is included in the purchase package

The spare part package anticipates long delivery times in remote areas. If necessary a fully equipped mobile workshop unit is also supplied. Only standard commercial off-the-shelf components are used and most suppliers have worldwide service networks.

MAINTENANCE AND SUPPORT

Daily, weekly and monthly maintenance checks are laid down in the operator's manual. The manufacturer offers:

- in-country support for major incidents
- assistance on annual inspection with option for check-up of mechanical competence

TESTS AND EVALUATIONS

Demonstrated first at the Humanitarian Demining Symposium 2007, Sibenik, Croatia.

REPORTED LIMITATIONS AND STRENGTHS

Limitations

- Over longer distances the system will require transportation on a low-bed trailer.

Strengths

- Effective for ground treatment and clearance in areas where manual demining proves to be very tedious or impossible.
- Rugged design based on mature technology, proven in challenging terrain.
- Tiller working tool minimises dust generation for improved visibility.
- Complements the MineWolf and Mini MineWolf to provide a comprehensive mechanical demining portfolio for all terrains.

DIMENSIONAL DATA

1. Length without attachment	Depends on excavator used
2. Length total	Depends on excavator used
3. Width without attachment	Depends on excavator used
4. Width total	Depends on excavator used
5. Clearing | Working width	1,400 mm
6. Height | Overall	Depends on excavator used
7. Mass | Basic vehicle	23,500 kg - 25,600 kg (without armour)
8. Mass | Detachable unit(s)	2,500 kg
9. Mass | Overall	Typically 25,000 - 27,000 kg depending on excavator used, eg CAT 320, Liebherr 924, O&K RH9.ETC. (incl. armour, powerpack, tiller)

OPERATIONAL DATA

10. Wheels | Tracks (description)	Tracks (50 segments, 600 mm)
11. Ground Bearing Pressure (kPa)	Depending on excavator used
12. Hill climbing ability (in degrees)	Depending on excavator used
13. Number of Cutting Tools	40
14. Beat Pattern (hits per m^2) at different operating speeds	N/A
15. Length of Chains | Tools	N/A
16. Diameter of drum	800 mm
17. Rotation Speed	800 rpm (max)
18. Clearance | Working depth in varying terrain	15 cm in all terrain
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	1,200 m^2/h
> Medium Soil | Medium Vegetation	600 m^2/h
> Heavy Soil | Dense Vegetation	300 m^2/h
20. Control of Clearance | Working depth	Manual
21. Additional attachable working tools	Budget other standard attachment available
22. Armour	Not given
23. Remote controlled	No
> greatest distance	
24. Transportation	
> short distances	Standard means of transport
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	2
26. Other types	MineWolf, Mini MineWolf
27. Location of use	BiH, Sudan
28. Totally cleared so far (m^2)	Not given

ENGINE | FUEL | OIL

29. Engine	Diesel engine 157 hp (base vehicle), diesel engine 240 hp (power pack)
30. Engine power at the flywheel	Not given
31. Power at the working tool	Not given
32. Fuel capacity	Depending on excavator used
33. Fuel consumption	15 - 20 l/h
34. Separate engine for working unit	Yes (Deutz turbo diesel engine)
35. Cooling system	Water cooled
36. Oil capacity (both engine)	Not given
37. Hydraulic oil capacity (both engine)	Not given

COSTS

38. Cost of system	Quotation upon request
39. Other costs > training > spare part set chains | belts > repair costs for one year	Quotation upon request
40. Availability for hire	Upon request

OTHER

41. Operator comfort	Depending on excavator used
42. Air conditioning	Depending on excavator used

Pearson Engineering Ltd. | United Kingdom

GENERAL DESCRIPTION

The *Pearson Minefield Tractor* is a medium-sized, armoured, mine-protected tractor designed to operate with a wide range of tools (described below). The Minefield Tractor is based on a 110 kw (150 hp) John Deere 6920 tractor with continuously variable transmission (CVT) providing a stepless speed range from 0.05 to 40 km/h. It is fitted with an armoured cab, fuel tank and body panels. It also has "blast-off wheels" on the rear axle, which detach in the event of a mine strike, protecting the driver from life-threatening accelerations. Pearson say the Tractor has been successfully tested against a 10 kg TNT equivalent mine detonation.

The two-door cab is reversible, allowing bidirectional operation. The Tractor has a 8,500 kg lift capacity rear category II/III three-point hitch, three-speed mechanical power take off and up to four double-acting hydraulic power take offs. A 3,500 kg front three-point linkage and 2,000 kg front loader are available. A wide range of commercial attachments, such as buckets and forks, are available for the loader. The Tractor is supplied with pneumatic tyres and with solid tyres capable of withstanding multiple AP mine blasts.

THE PEARSON MINEFIELD TRACTOR | Mine comb in heavy vegetation | Area reduction roller

WORKING METHODOLOGY

The Minefield Tractor is the prime mover and can carry tools on the front or rear for a wide variety of tasks. Most tools can be attached and removed in less than five minutes. Depending on the task, the CVT transmission can operate manually at constant engine speed (for power-take-off work) or work automatically in draft mode to provide maximum fuel economy.

ATTACHMENTS

The following tools are available. All carry a one-year warranty from date of delivery and are supplied with operation, maintenance and parts books in English, with other languages available to order. Spare parts are available from Pearson Engineering.

Mine Comb

The *Mine Comb* is a vehicle-mounted AV mine clearing tool designed for unearthing AV mines in a wide range of ground conditions, including sand, clay and non-metallic roads and dense vegetation. The Mine Comb has a low power requirement and handles the mines gently. Clearing depth is up to 40 cm and width is 3.3 m, and clearing speed ranges from 0.1 to 0.5 km/h, depending on ground conditions. In trials in sand, heavy clay and non-metallic quarry roads, the power requirement never exceeded 80 kw. The Mine Comb is designed to be mounted on the Minefield Tractor or any other suitable prime mover of at least 100 kw and with sufficient hydraulic lift and a mechanical power take off.

The Mine Comb can be used for both route clearance and area clearance and clears all types of AV mines. The manufacturer says that in tests with more than 400 AV mines, the unearthing rate exceeded 99.5%. Tests also showed good results against large (greater than 100 mm diameter) AP mines. The Mine Comb has been blast tested with charges of 10 kg TNT equivalent in various locations. The main structure and drive train was undamaged. Damage was limited to field-replaceable parts.

The Mine Comb is pushed by the prime mover and operates by combing large objects including mines gently to the ground surface from where they can then be disposed of in an appropriate manner. It can be lowered to full working depth and lifted up while stationary and requires a forward travel of less than 2 m from encountering a mine to bringing it to the surface, therefore requiring a very small space envelope around the suspected area. It causes negligible soil displacement, creates very little dust and does not pulverise the soil. The tines move through the soil at a maximum speed of only 1.8 m/s.

The Mine Comb is simple to operate, requiring only one day of training. Routine maintenance can be done by the operator and requires no special tools or skills. There are no consumables.

> Four units have been supplied to the US Department of Defense Humanitarian Demining Program.

Area Reduction Ruler

The *area reduction roller* is a vehicle-mounted roller for rapid identification of the presence of AP mines in suspect areas and for area reduction. The roller is normally mounted on the front of a minefield-intrusive prime mover such as the Minefield Tractor or an armoured loading shovel. It is then pushed through the minefield. Operation methodologies are discussed in UNMAS Technical Notes For Mine Action (TNMA) 09.50/01 and in *A study of Mechanical Applications in Demining* (GICHD, May 2004).

The roller works by detonating any near-surface or surface pressure-activated mines. It is designed to withstand AP mine blasts only. The roller consists of a series of individually "floating" steel discs, each exerting a load of 50 kg on the ground. This feature ensures that the roller is effective on uneven ground.

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

No special training, few spares and no routine maintenance required.

> The HALO Trust has approximately ten rollers in service in Abkhazia, Afghanistan, Cambodia, Georgia, Kosovo, Mozambique and Somaliland and confirms their robust construction and versatility.

> The US Department of Defense owns three rollers, two with the Thailand Mine Action Centre and one in Nicaragua.


HEAVY ROTARY MOWER | MINE TRACTOR AND COMB | MEDIUM ROTARY MOWER

Magnet

The *magnet* is a vehicle-mounted system for removing metal fragmentations from the ground to reduce the number of false signals encountered by manual deminers. It consists of two large permanent magnets mounted on a frame for attachment to vehicles with a hydraulic lift. Each magnet is fitted with a hydraulically operated ejector plate for dumping the collected fragments. The magnet has a 2.7 m operating width with a 0.8 m uncleared gap in the middle to provide the necessary separation between the two magnets. The uncleared gap can be cleared on the next pass.

The magnet may be pushed or pulled through the minefield by a minefield-intrusive prime mover such as the Minefield Tractor or an armoured wheeled loader. At suitable intervals the material collected is taken to a suitable dumping point and ejected by the operator from inside the cab. The magnet is most effective when used in conjunction with the Pearson Area Reduction Roller and ground preparation tools. It is recommended that the minefield is rolled with the Area Reduction Roller before using the magnet, as the magnet is susceptible to damage from the blast of an AP mine. The magnet is not intended for use where there is an AV mine threat. Further information on working methodologies can be found in *A study of Mechanical Applications in Demining* (GICHD, May 2004). No special training required for operation or maintenance.

> The US Department of Defense has bought two magnets: one unit has been operational in Thailand with TMAC since 2001, the other in Nicaragua since 2005.

Sifter

The *sifter* is pulled by the Minefield Tractor or other suitable prime mover. The sifter is designed for sifting soil in areas with an AP mine threat. It is mounted to a prime mover fitted with an agricultural three-point linkage, power take-off shaft and hydraulic outlets. The mine sifter is based on a commercial agricultural de-stoner. It is capable of sifting to a depth of 300 mm in prepared ground and can operate at speeds up to 4 km/h, with a working width of 1.6 m. The sifter uses plastic star wheels arranged in a double helix to sift the soil. Operating depth is controlled by manually-adjustable depth rollers. This ensures the soil flows side to side as it progresses up the sifter bed, ensuring maximum performance. For maximum durability the sifter is fitted with a one-piece share and automatic drawbar overload protection.

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

The 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. Blast tests with a 100 g AP mine on the conveyor caused bending of the conveyor bar. No further damage was recorded.

No special skill required to operate or maintain/repair the sifter. The only routine maintenance is greasing surface-bearing areas and checking gearbox oil level.

> One machine is in operation with the US Department of Defense Humanitarian Demining Program and the Nicaraguan army in Nicaragua.

Vegetation Cutting Tools

The *vegetation cutting tools* are mounted to the Minefield Tractor or other suitable prime mover with agricultural three-point linkage. A range of vegetation cutting tools are available:

Rotary mower the medium rotary mower has a working width of 2.9 m and can cut material up to 50 – 60 mm diameter. The heavy rotary mower has a working width of 1.8 m and can cut material up to 150 mm diameter.

Reach mower the reach mower is fitted with a 1.2 m flail head and can be used to reach into a minefield from a safe area and to cut banks and ditches and around obstacles. It is capable of cutting material up to 75 mm diameter.

Routine maintenance can be carried out by the operator. The only consumables are the blades which require periodic replacement.

> Units belonging to US DoD are in use in mine clearance in Thailand with TMAC and in Nicaragua.

Tree Extractor

The *tree extractor* is designed for extracting trees complete with roots. The 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. A pair of lifting legs provides extra force to pull the tree out of the ground. There are two tree extractor models. The *light tree extractor* for use on agricultural loaders has a maximum force of 14 tons; the *heavy tree extractor* is for use on loading shovels of the 12 - 18 tons class such as the Volvo BM 4400. The lifting legs have a tear-out force of up to 25 tons.

No special skill is required to operate or maintain and repair the tree extractors. Tests by both MAG and TMAC have proven the effectiveness of the tree extractors. The only routine maintenance required is the greasing of bearing surfaces. No special skills are required. The length for both extractors is 1.1 m. The width of the light extractor is 3 m, while the heavy extractor is 2.7 m wide. The light extractor weighs 520 kg. The heavy extractor weighs 1,100 kg.

> Units belonging to US DoD are operational in Thailand with TMAC and in Nicaragua.

Ground Preparation Tools

The *ground preparation tools* consist of a heavy soil loosener capable of working to a depth of 400 mm in undisturbed soil and a lighter spring tine cultivator for breaking up previously loosened soil. These tools fit on the Minefield Tractor or any other suitable prime mover with an agricultural category two- or three-point linkage.

The tools are pulled through the minefield and can be used to prepare ground for other mechanical clearing processes or as an aid to manual deminers where ground conditions are tough. They are particularly useful in enhancing the effectiveness of the Pearson Magnet and Area Reduction Roller. Further information on working methodologies can be found in *A study of Mechanical Applications in Demining* (GICHD, May 2004).

No specific operator training is required and there is no routine maintenance. The tine tips require periodic replacement. The soil loosener is fitted with shear bolt protection to each leg.

> Units are operational with the US Department of Defense in Thailand and Nicaragua.

THE PEARSON MINEFIELD Reach Mower | TREE EXTRACTOR in operation | Mine Sifter

MACHINE IN USE TO DATE

One Minefield Tractor supplied to the US Department of Defense has been operational in Nicaragua since early 2005, with operator training and maintenance provided by the local John Deere dealer. Two other machines have been operational in Thailand since 2001.

ENGINE, FUEL AND OIL

The tractor is driven by a 110 kw turbocharged John Deere diesel engine. Fuel capacity is 180 litres and fuel consumption is approximately 5 – 20 litres per hour depending on conditions.

FACTORY SUPPORT

Full operation, maintenance, repair and spares manuals are available in English, with other languages available to order. Full spares backup is provided by Pearson Engineering. Operator training, tractor spares and service available from the worldwide John Deere dealer network. John Deere manuals available in major European languages. One-year warranty by Pearson and John Deere.

MAINTENANCE AND SUPPORT

Daily maintenance consists of checking fluid levels and greasing bearing surfaces. Engine oil change interval 500 hours. All filters and top-up points easily accessible without tools. The operator can undertake these tasks. No special workshop facilities are required. The tractor requires one operator. An assistant is required to attach and remove tools.

TESTS AND EVALUATIONS

Field testing of the old version of the Pearson Minefield Tractor was done in Thailand in 2001. For the report see:
www.humanitarian-demining.org/demining/pubs/catalog/contents/clearn40.htm

One test report on the new version is available at www.itep.ws

> Institute for Defense Analyses, *Proof of Performance Test Report on Mine Clearing/Survivable Vehicle (MANTIS)*, by Humanitarian Demining Research and Development Program, Night Vision and Electronic Sensors Directorate – Office of the Assistant Secretary of Defense Special Operations and Low-Intensity Conflict, 2005.

REPORTED LIMITATIONS AND STRENGTHS

No information provided.

DIMENSIONAL DATA

1. Length without attachment	5,200 mm
2. Length total	Depending on the attachement
3. Width without attachment	2,300 mm (standard wheels) 2,800 mm (blast off wheels)
4. Width total	Depending on the attachement
5. Clearing | Working width	Depending on the attachement
6. Height | Overall	2,900 mm
7. Mass | Basic vehicle	9,600 kg with solid tyres
8. Mass | Detachable unit(s)	Varies
9. Mass | Overall	Depending on the attachement

OPERATIONAL DATA

10. Wheels | Tracks (description)	4wd with pneumatic and solid tyres
11. Ground Bearing Pressure (kPa)	Not given
12. Hill climbing ability (in degrees)	30° depending on ground condition
13. Number of Chains | Chisels | Tools	N/A
14. Beat Pattern (hits per m^2) at different operating speeds	N/A
15. Length of Chains | Tools	N/A
16. Diameter of drum	N/A
17. Rotation Speed	N/A
18. Clearance | Working depth in varying terrain	
19. Working Speed (m^2/h)	Not given
> Light Soil | Medium Vegetation	Not given
> Medium Soil | Medium Vegetation	Not given
> Heavy Soil | Dense Vegetation	Not given
20. Control of Clearance | Working depth	Not given
21. Additional attachable working tools	
22. Armour	8 mm high tensiled steel cab
23. Remote controlled	Available See www.pearson-eng.com for more details
> greatest distance	Not given
24. Transportation	
> short distances	Can road on pneumatic tyres max 40 km/h
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	3
26. Other types	Not given
27. Location of use	Nicaragua
28. Totally cleared so far (m^2)	Not given

ENGINE | FUEL | OIL

29. Engine	6 cylinder turbo diesel
30. Engine power at the flywheel	110 kw (150 hp)
31. Power at the working tool	Not given
32. Fuel capacity	180 l
33. Fuel consumption	5 - 20 l/h
34. Separate engine for working unit	No
35. Cooling system	Not given
36. Oil capacity (both engine)	Not given
37. Hydraulic oil capacity (both engine)	Not given

COSTS

38. Cost of system	Not given
39. Other costs	Not given
> training	Available
> spare part set chains | belts	
> repair costs for one year	
40. Availability for hire	Not given

OTHER

41. Operator comfort	Air suspension seat
42. Air conditioning	Yes

Development Technology Workshop | Cambodia

GENERAL DESCRIPTION

The *Tempest MK VII* is a remotely-controlled, lightweight machine with proven vegetation cutting and tripwire clearing capabilities. It is manufactured by Development Technology Workshop (DTW), a non-profit organisation, which has been producing demining machines since 1998.

The Tempest MK VII is an upgraded version of the MK VI incorporating several innovations. It is now a multi-tool system. A range of attachments – such as a ground-engaging flail head, large and small magnets for the removal of metal fragmentations, a horizontal cutter – can easily be fixed to the basic vehicle. The MK VII has double-acting rams to allow the use of dozer attachments and to assist in recovery of the vehicle when stuck. The machine is fitted with a standard bobcat attachment plate so any bobcat tool can be used.

TEMPEST MK VII | In operation with HALO

This latest Tempest also has an intelligent flail head, a unique feedback system which can sense the load on the flail. If the load becomes too great, the system automatically reduces the forward speed which in turn reduces the load on the flail head. The intelligent flail head enables an operator to set the speed control to maximum; the Tempest will then adjust automatically to control its cutting rate and drive speed. The result is quicker land clearance coverage since the operator no longer has to back the machine off when encountering more dense vegetation.

The new MK VII with improved software control, affording greater flexibility in the automatic control of the machine, allows the operator to adjust the machine to minefield conditions through a user- friendly joystick system. Software parameters can be set by end users using a laptop and free software available from the internet. Vegetation cutting to ground engaging parameters can be changed at a flick of a switch.

Improved software has allowed the electrical system to be simplified. The electrical modular system also improves troubleshooting in case of problems. The automatic fan reversal helps clear blockages of the hydraulic cooler. All pumps are now piston type for greater system efficiency. A flail stall alarm system is fitted as well as an improved track running gear to reduce tracks coming off.

DTW has enhanced the Tempest's engine combustion and cooling air filtration to cope better with dust problems. A new hydraulic filling system ensures hydraulic oil cleanliness. Improvements have also been made to the flail head float system and to internal and external hose layouts. Deutz supplies an improved diesel engine.

Like its predecessor, the MK VII chassis is V-shaped with an 8 mm steel plate to minimise damage from AP mine or UXO detonation. It can operate on most soil conditions and terrains, especially since DTW has now adopted a rubber track which has been successfully blast tested against 250 g TNT mines.

The manufacturer points out that the Tempest was specifically designed for demining operations. Its mechanics are simplified. It is user friendly and versatile. It enjoys low operational costs. Its small size and light weight make for ease of transport and agility over difficult terrain.

OPERATING METHODOLOGY

The Tempest was originally purely a vegetation cutting device, clearing down to 25 mm above the ground. DTW has since developed an alternative flail head (Ground Engaging Flail - GEF) designed to dig into the soil in order to destroy or expose mines. The GEF can clear down to 100 - 150 mm; it can clear deeper if the forward speed is sufficiently slow. Spring steel GEF hammer heads significantly improve the machine's ground speed.

Both the vegetation cutting and the GEF heads have a mini flail head containing 36 chains and 40 chains respectively with either a cutter for vegetation or a specially designed hammer for impacting the ground. The rotor can work at up to 1,300 rpm. A magnet can be fixed to the machine to pick up ferrous fragments and debris, which can help speed up the demining process by reducing the false alarm rate of metal detectors.

MACHINES IN USE TO DATE

Seven demining organisations are now deploying 26 Tempest machines in Angola, BiH, Cambodia, DR Congo, Ecuador, Mozambique and Thailand. Many of the machines have been operating in the field continuously for more than six years.

ENGINE, FUEL AND OIL

The Tempest MK VII is fitted with a newer, turbo-charged Deutz diesel engine. Fuel capacity is 30 litres with a fuel consumption of approximately 9 litres per hour. Hydraulic tank capacity is 130 litres. The fuel tank is protected by 8 mm steel plate.

FACTORY SUPPORT

The Tempest is manufactured in Cambodia. Repairs and maintenance are relatively easy and inexpensive. According to the manufacturer, spares are supplied with the unit and are thereafter available worldwide or are easily fabricated.

As part of the purchase, DTW offers a full spare parts package, all manuals and documentation, warranty and factory follow-up for 12 months. DTW also offers a number of other packages relating to parts, maintenance and training – all tailored to meet the needs of the user organisation. Packages take into account the number of machines, the destination country, local skill levels as well as the level of support required. Another useful option is a custom-modified 20 ft enclosed container complete with all relevant tools. It is designed to be used as a field workshop.

MAINTENANCE AND SUPPORT

Daily, weekly and monthly routine check lists must be followed. Daily checks take one man-hour, weekly checks three man-hours and monthly servicing five man-hours.

DTW offers a full-service maintenance programme for the Tempest. They can also set up provincial workshops and offices, where DTW maintains a constant presence with a fully trained staff.

The Tempest was designed to be easily repairable without factory support and has tried to incorporate materials that are locally available. No special workshop equipment is needed to carry out maintenance or more substantial repairs.

TEMPEST MK VII | Vegetation cutting task

TESTS AND EVALUATIONS

The Tempest has undergone extensive tests in Cambodia for AP and AV mines. The US Army has tested Tempest in the United States and abroad. Full test reports and photographs are available from the manufacturer.

In April 2005, a Tempest MK V was tested by QinetiQ. During the trial the standard vegetation flail head, the PROMAC Slasher and the large magnet were assessed. "The machine has the ability to clear both mines and vegetation." (Leach Chris, Blatchford Pete, Coley Geoff (CCMAT), Mah Jennifer (CCMAT). Tempest V System with Ground Engaging Flail Cambodia Trials Report. Farnborough: QINETIQ/FST/LDS/TRD052379, 2005. p. 3, available at www.itep.ws//pdf/Tempest_V_GEF.pdf)

A 2007 test and evaluation of the Tempest's Ground Engaging Flail by W.C. Roberts and D.J. Roseveare at the Defence Research and Development Canada is available at: www.itep.ws//pdf/DRDC_Suffield_Tempest2007.pdf

REPORTED LIMITATIONS AND STRENGTHS

The Tempest VII with the ground engaging flail or the vegetation head is able to withstand blasts from AP as well as fragmentation attacks. The machine is not intended to be used against AV mines.

Limitations

- The flail creates huge dust clouds, as with all flail systems in dry environments.
- Difficult to operate with precision from greater distances (as with all remotely controlled machines).

Strengths

- Removes vegetation to greatly increase the speed of subsequent clearance, either manually or with dog teams.
- Removes the tripwire threat.
- Transports easily. Can be moved with a 4 x 4 with trailer or 5 t flatbed truck.
- Resilient: the blast of AP mines under the flail, skids and wheels did not affect the operational capability of the system; repairs took only minutes to perform.
- Versatile.
- Easy-to-use.
- Low maintenance.
- Light weight which facilitates access to difficult areas and improves manoeuvrability.
- Tailor-made packages geared to user needs in terms of parts, maintenance and training.

	Basic Machine	Veg Flail	GEFH
DIMENSIONAL DATA			
1. Length without attachment	3,000 mm		
2. Length total		3,900 mm	4,100 mm
3. Width without attachment	1,550 mm		
4. Width total		1,600 mm	2,350 mm
5. Clearing | Working width		1,200 mm	1,500 mm
6. Height | Overall	1,600 mm		
7. Mass | Basic vehicle	2,400 kg		
8. Mass | Detachable unit(s)		500 kg	700 kg
9. Mass | Overall		3,300 kg	3,500 kg
OPERATIONAL DATA			
10. Wheels | Tracks (description)	Blast tested rubber tracks as standard, steel wheels as optional		
11. Ground Bearing Pressure (kPa)	33 kPa		
12. Hill climbing ability (in degrees)	30°		
13. Number of Chains | Chisels | Tools		36	40
14. Beat Pattern (hits per m^2) at different operating speeds			
15. Length of Chains | Tools		280 mm	380 mm
16. Diameter of drum		140 mm	180 mm
17. Rotation Speed		1,300 rpm	500 rpm
18. Clearance | Working depth in varying terrain			
19. Working Speed (m^2/h)			
> Light Soil | Medium Vegetation	1,800 m^2/h		
> Medium Soil | Medium Vegetation	1,300 m^2/h		
> Heavy Soil | Dense Vegetation	1,000 m^2/h		
20. Control of Clearance | Working depth	Manual float		
21. Additional attachable working tools	Fitted with a standard bobcat attachment plate so any bobcat tool can be used		
22. Armour	8 mm steel plated		
23. Remote controlled	Yes		
> greatest distance	Over 250 m		
24. Transportation			
> short distances	Standard 4 t truck with crane		
> long distances			
> sea transport			
> air transport			

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	26 in 8 countries with 7 different organisations
26. Other types	Previous versions of the machine
27. Location of use	Angola, BiH, Cambodia, Congo DR, Ecuador, Lao, Mozambique and Thailand
28. Totally cleared so far (m^2)	Over 5,000,000 m^2

ENGINE | FUEL | OIL

29. Engine	DEUTZ diesel 4 cylinder turbocharged
30. Engine power at the flywheel	55 kw
31. Power at the working tool	30 kw
32. Fuel capacity	30 l
33. Fuel consumption	8 l
34. Separate engine for working unit	N/A
35. Cooling system	Oil/air
36. Oil capacity (both engine)	10.5 l
37. Hydraulic oil capacity (both engine)	130 l

COSTS

38. Cost of system	120,000 US$
39. Other costs	
> extra flail head	11,000 US$
> large attachable magnet	9,000 US$
> pro-mac slasher	12,000 US$
> workshop container (including all tools)	40,000 US$
> training	11,000 US$ plus trainer's expenses
> spare part set chains | belts	20,000 US$
> repair costs for one year	Minimal
40. Availability for hire	Lease and lease to buy options available

OTHER

41. Operator comfort	N/A
42. Air conditioning	N/A

Yamanashi Hitachi | Japan

GENERAL DESCRIPTION

The *Hitachi BM307* demining machine series is based on the company's most commonly used hydraulic excavator with a special demining attachment on its arm. Two attachments, a rotary cutter (tiller system) and a flail hammer can be attached. These can be complemented by a magnet or metal detector if needed. The magnet is intended to speed demining by reducing the false alarm rate caused by scrap metal. The cutter unit's bit is mounted on a rotating drum directly connected to a hydraulic motor.

The BM307 series is available in five weights from 19 tonnes to 35 tonnes. Any type of machine above 24 tonnes can be equipped with either the cutter or the flail attachment. A rake-grapple can be added to both attachments to remove bushes and stones. The flail system performed well in a 2006 field trial in Cambodia, going through a survivability test using AV mines without critical damage.

The machine can also be used for construction or agriculture with the application of other attachments, such as a bucket. One operator controls the machine from a cab protected by special bullet-proof glass (Rexguard) and high-tension steel plates. Critical parts – such as the hydraulic cylinder, fuel tank and hydraulic oil tank – are protected against fragmentation mine detonations.

BM307 V33 | Flail head attached

CLEARANCE METHODOLOGY

The rotary cutter rotates at up to 530 rpm with a working width of 1,200 mm. The cutter's 48 bits cut vegetation, fragment stones and destroy AP mines to a depth of 300 mm. The hydraulic arm can reach to 10 m. The flail head rotates at 400 rpm and destroys AP mines to a depth of 300 mm. As the attachments are attached to the arm of the hydraulic excavator the machine can work on undulating or steep ground.

MACHINES IN USE TO DATE

Rotary cutter

- Two BM307s (version S16) in Cambodia since 2000.
- One BM307 (version V20) in Afghanistan since June 2000 (with UNOCHA).
- Two BM307s (version V20) in Nicaragua since September 2001.
- Twenty BM307s (version V27) in Vietnam since June 2003.
- Eight BM307s (version SG16) in Cambodia since July 2003.
- Two BM307s (version V21 wheel type) in Afghanistan since November 2003.
- Fourteen BM307s (version SG16) in Cambodia since June 2005.
- One BM307 (version V23 with metal detector) in Nicaragua since September 2001.
- Two BM307s (version V33) in Angola since August 2007.
- Two BM307s (one version V23 and one version V35) in Afghanistan since September 2007.

Flail hammer

- Two BM307s (version V33) in Angola since August 2007.
- One BM307 (version V35) in Afghanistan since September 2007.

ENGINE, FUEL AND OIL

The engine is an ISUZU 6HK1 202 kw diesel and the system uses standard oil types for engine, gear box and hydraulics. Fuel consumption varies from 25 to 45 litres per hour.

FACTORY SUPPORT

Spare parts – including consumable parts such as cutter bits, bearings, seals, etc. – are included in the purchase package. Availability of spares is good due to a worldwide servicing network. One month's training is provided in the buyer's country. Training courses for operators and maintenance staff are included in the purchase package. Manuals are provided in the language required by the purchaser. Comprehensive manuals and documentation are part of the purchasing package. Warranty period is one year or 1,000 hours, whichever comes first. A spare parts catalogue is available.

MAINTENANCE AND SUPPORT

Regular maintenance – daily, monthly and other periodic checks – is required as per the operating instructions. Daily servicing takes 30 minutes, weekly servicing takes one hour.

TESTS AND EVALUATIONS

No information provided.

REPORTED LIMITATIONS AND STRENGTHS

No information provided.

DIMENSIONAL DATA

1. Length without attachment	5,840 mm
2. Length total	Rotary cutter: 13,600 mm Flail hammer: 15,000 mm
3. Width without attachment	3,290 mm
4. Width total	3,290 mm
5. Clearing | Working width	Rotary cutter: 1,200 mm Flail hammer: 1,600 mm
6. Height | Overall	3,160 mm
7. Mass | Basic vehicle	35,000 kg
8. Mass | Detachable unit(s)	Rotary cutter: 3,000 kg Flail hammer: 4,900 kg
9. Mass | Overall	Rotary cutter: 38,000 kg Flail hammer: 39,900 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Tracks / Grouser-shoe Std. 600 mm | Opt. 700 mm
11. Ground Bearing Pressure (kPa)	54 kPa
12. Hill climbing ability (in degrees)	35°
13. Number of Chains | Chisels | Tools	Rotary cutter: 48 | Flail hammer: 50
14. Beat Pattern (hits per m^2) at different operating speeds	Not given
15. Length of Chains | Tools	Rotary cutter: 195 mm | Flail hammer: 860 mm
16. Diameter of drum	Rotary cutter: 559 mm | Flail hammer: 267 mm
17. Rotation Speed	Rotary cutter: ~530 rpm Flail hammer: ~400 rpm
18. Clearance | Working depth in varying terrain	~300 mm
19. Working Speed (m^2/h)	
> Light Soil | Medium Vegetation	RC 700 m^2/h | FH 500 m^2/h
> Medium Soil | Medium Vegetation	RC 600 m^2/h | FH 400 m^2/h
> Heavy Soil | Dense Vegetation	RC 500 m^2/h | FH 250 m^2/h
20. Control of Clearance | Working depth	Manual
21. Additional attachable working tools	
22. Armour	Armoured cabin, protection cover on fuel tank, hydraulic tank, cylinders and hoses of front devices
23. Remote controlled	
> greatest distance	Option 100 m
24. Transportation	
> short distances	By trailer or own trip for short distance
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	Two units to be operated in Angola from Sep 2007
26. Other types	Not given
27. Location of use	Angola
28. Totally cleared so far (m^2)	Not given

ENGINE | FUEL | OIL

29. Engine	ISUZU 6HK1
30. Engine power at the flywheel	202 kw
31. Power at the working tool	Not given
32. Fuel capacity	630 l
33. Fuel consumption	25 - 40 l/h
34. Separate engine for working unit	No
35. Cooling system	Water cool
36. Oil capacity (both engine)	41 l
37. Hydraulic oil capacity (both engine)	180 l

COSTS

38. Cost of system	Not given
39. Other costs > training > spare part set chains | belts > repair costs for one year	Not given
40. Availability for hire	Yes

OTHER

41. Operator comfort	Suspension seat, radio, hot and cool box
42. Air conditioning	Full auto air conditioner

Sarvatra | Sri Lanka

GENERAL DESCRIPTION

The *Arjun* is a track-driven, hydraulic excavator used as a mechanical asset for humanitarian demining. In addition to the rake and the vegetation rotary cutter as the ground preparation tools, available working tools are a sifter bucket, a dozer blade and a bucket for survey and construction tasks.

The operator's cabin is protected with reinforced steel plates and equipped with splinter-proofed glass windows. The engine compartment, hydraulic hoses and fuel hoses are protected by metal casings. In case of emergency the operator can escape by opening the inner latch of the cabin. The cabin also has a small fire extinguisher.

Speed control and contouring systems are provided for vegetation cutting in hydraulically operated travel mode.

Tests carried out using live P4 MK1 and Chinese Type-72 mines confirmed the survivability of the system against AP mine blasts. The system has not been tested against an AV mine blast but it is estimated that damage should only occur to the rake tool while the excavator should not be affected.

The Arjun is capable of winging and traversing the hydraulic arm simultaneously. It can rake and loosen ground up to 200 m^2/hour for further follow-on clearance by manual deminers. Attachable working tools are designed to reach into and process small areas such as trenches, ditches, canals, bridges, culverts, dry river banks, shallow water, around trees and around destroyed buildings and rubble.

A "quick change" device at the end of the hydraulic arm makes changing the working tools simple and fast.

The Arjun moves independently within the working site. It can be transported over long distances by air, train or road (on a flat-bed trailer).

ARJUN

CLEARANCE METHODOLOGY

The machine is a non-intrusive system. The hydraulic arm of the machine reaches into the minefield/suspected hazardous area while the machine stays on safe ground. The machine removes dense undergrowth, scarifying the ground and raking it to a depth of 200 mm (beyond if required). Performance results show a 100% exposure of UXO, AV mines, fragmentation mines, IEDs and 80% of AP mines. When fitted with a vegetation rotary cutter, it can also remove high density vegetation.

The machine has always located pattern-laid mines. The machine is used for primary ground preparation, which is followed by manual deminers as the main clearance asset.

MACHINES IN USE TO DATE

There are a total of seven machines working in Sri Lanka.

ENGINE, FUEL AND OIL

The current model is based on the TATA 697 NA 80 hp, water-cooled diesel engine consuming an average of 10 litres of fuel per hour of continuous working.

FACTORY SUPPORT

Spares for fast-moving parts for 2,000 working hours are supplied with the machine. Training of operators can be arranged on request.

MAINTENANCE AND SUPPORT

Maintenance is required at every 250 hours of engine operation and at every 1,500 hours of the hydraulic system. Routine maintenance and servicing is carried out by the mechanic as per the operator's manual. Repair facilities are available all over the world. The Arjun requires one team leader, two operators and a mechanic during operation in the field.

TESTS AND EVALUATIONS

Operational performance and survivability tests to fulfil the requirements of UNDP and the National Steering Committee for Mine Action have been conducted in Sri Lanka.

REPORTED LIMITATIONS AND STRENGTHS

- It cannot be operated at gradients of 35° or more.
- It cannot be used in marshy and water-logged areas.
- Ground preparation speed is limited to 200 m^2 per hour.
- Softening the ground through watering is required for hard and dry soil.

Strengths

- The Arjun can achieve from 40 to 60 m^2 clearance (REDS) per deminer/day.
- The system exposes mines/UXO instead of detonating them as with other mechanical demining machines. This enhances the lifecycle of the machine and safety. No detonation has happened in six years of operation in Sri Lanka.
- Use of the rake or the bucket enables survey of bunkers, embankments and fortifications.
- It can also be used for construction of roads, drains, embankments and foundations.

DIMENSIONAL DATA

1. Length without attachment	3,790 mm
2. Length total	7,270 mm
3. Width without attachment	2,490 mm
4. Width total	2,490 mm
5. Clearing | Working width	2,490 mm
6. Height | Overall	2,690 mm
7. Mass | Basic vehicle	11,000 kg
8. Mass | Detachable unit(s)	Not given
9. Mass | Overall	11,500 kg

OPERATIONAL DATA

10. Wheels | Tracks (description)	Track mounted hydraulic excavator
11. Ground Bearing Pressure (kPa)	0.39
12. Hill climbing ability (in degrees)	35°
13. Number of Chains | Chisels | Tools	Two track chains
14. Beat Pattern (hits per m^2) at different operating speeds	Not given
15. Length of Chains | Tools	3,340 mm
16. Diameter of drum	N/A
17. Rotation Speed	N/A
18. Clearance | Working depth in varying terrain	200 mm, more if required
19. Working Speed (m^2/h)	Up to 200 m^2/h
> Light Soil | Medium Vegetation	Not given
> Medium Soil | Medium Vegetation	Not given
> Heavy Soil | Dense Vegetation	Not given
20. Control of Clearance | Working depth	Not given
21. Additional attachable working tools	Bucket, sifter, vegetation cutter
22. Armour	Not given
23. Remote controlled	No
> greatest distance	
24. Transportation	
> short distances	Not given
> long distances	
> sea transport	
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	7
26. Other types	No
27. Location of use	Sri Lanka
28. Totally cleared so far (m^2)	50,000,000

ENGINE | FUEL | OIL

29. Engine	Tata 697
30. Engine power at the flywheel	80 hp
31. Power at the working tool	Not given
32. Fuel capacity	250 l
33. Fuel consumption	10 l/h
34. Separate engine for working unit	No
35. Cooling system	Water
36. Oil capacity (both engine)	14 l
37. Hydraulic oil capacity (both engine)	Not given

COSTS

38. Cost of system	85,000 US$
39. Other costs	
> training	10,000 US$
> spare part set chains | belts	5,000 US$
> repair costs for one year	2,000 US$
40. Availability for hire	No

OTHER

41. Operator comfort	Not given
42. Air conditioning	Optional

MINE PROTECTED VEHICLES | RG-31 (Mk3 & Mk5)

BAE Systems, Land Systems OMC | Republic of South Africa

GENERAL DESCRIPTION

The *RG-31 Mk3* and *Mk5* are derived from the successful RG-31 and feature a military wiring harness, central tyre inflation and several other new features. The RG-31 is a 4 x 4 mine-protected armoured vehicle, also available as an armoured personnel carrier (APC) or utility vehicle. The Mk3 has a 125 kw diesel engine and the Mk5 a 205 kw diesel.

All variants are readily adaptable to other applications including ambulance, explosive ordnance disposal and humanitarian demining. Access is through a wide rear door while roof hatches ensure emergency access and egress. Both the Mk3 and Mk5 are available with additional front doors. The APC variant can take a driver and up to nine crew members.

Mk3

SPECIFICATIONS

The all-steel, welded armour, monocoque V-shaped hull protects the crew against small arms fire and AV mine detonations. According to the manufacturer, the vehicle is blast resistant against the detonation of a double TM57 AV mine (the equivalent of 14 kg TNT) under any wheel, or a single TM57 under the hull.

With a 5-speed automatic transmission, permanent 4 x 4 drive and a two-speed (high and low) transfer case the RG-31 is easy to drive, both on and off road.

VEHICLES IN USE TO DATE

More than 580 RG-31 mine protected vehicles (several variants) have been sold, including to the US and Canadian armies. Through General Dynamics Land Systems Canada, Land Systems OMC has sold 624 RG-31 Mk5E MRAP vehicles to the US Marine Corps.

Mk5

ENGINE, FUEL AND OIL

- The Mk3 is equipped with a Mercedes Benz diesel engine with 125 kw.
- The Mk5 is equipped with a Cummins QSB diesel engine with 205 kw.

No more information was provided by the manufacturer.

FACTORY SUPPORT

No information provided.

MAINTENANCE AND SUPPORT

Commercial off-the-shelf components facilitate maintenance, repair and support.

TESTS AND EVALUATIONS

No information provided.

REPORTED LIMITATIONS AND STRENGTHS

Limitations

No information provided.

Strengths

- Protection against AP and AV mines.
- Variety of uses.

A. DIMENSIONAL DATA

1. Length total	6,000 mm | 6,600 mm
2. Width total	2,470 mm
3. Height | Roof	2,650 mm | 2,727 mm
4. Mass | Basic vehicle	9,000 kg | 10,500 kg
5. Playload	1,200 kg | 3,700 kg
6. Crew	9
7. Gross Vehicle Weight	10,200 kg | 14,200 kg
8. Ground clearance	322 mm | 389 mm

B. DRIVING SPECIfiCATION

9. Wheels | Drive train	Rim type 11.0 x 20, 335/80 R20 Michelin XZL or 365/80 Michelin XZL
10. Fording capability	Not given
11. Hill climbing ability | Side slope	Angle of approach: 35° | 32° Angle of departure: 45° | 40°
12. Maximum speed	105 km/h
13. Turning circle diameter	18 m kerb to kerb

C. SYSTEM SPECIfiCATION

14. Engine | Fuel | Oil	Mercedes Benz OM 366T with 125 kw Cummins QSB with 205 kw
15. Fuel capacity	Not given
16. Fuel consumption	Not given
17. Range	Not given
18. Cooling system engine	Not given
19. Oil capacity	Not given
20. Hydraulic oil capacity	Not given
21. Brakes	Dual circuit pneumatic, drums front and rear Dual circuit pneumatic disc front and rear with ABS
22. Gear box	5-speed automatic transmission
23. Vehicles of use	More than 1,200
24. Location of use	Not given

D. COMFORT AND SECURITY

25. Air conditioning	Yes
26. Operator comfort	Not given
27. Armour	7.62 x 51 mm NATO Ball, 5.56 x 45 NATO Ball, AP and AV mine protection / 7.62 x 39 mm API BZ, AP and AV mine protection
28. Remote controlled	N/A

E. COST

29. Cost of system	On request
30. Other costs	On request
31. Transportation	Self driven
32. Availability for hire	On request

Krauss Maffei Wegmann | Germany

GENERAL DESCRIPTION

The *Dingo 2* is a light mine-proof vehicle which is based on the well-known commercial Unimog chassis by Daimler with all-wheel drive and differential lock. This concept ensures excellent mobility in any type of terrain with low-cost procurement as well as low lifecycle costs. It can operate under any climatic conditions. A tyre inflation system provides high mobility and emergency tyres ensure continued mobility. Support services are provided by Daimler's worldwide service network. The vehicle is constructed on a modular basis and therefore offers a variety of applications in the field.

The hull is specially designed and proven to withstand the detonation of AV mines. Fragment protection is ensured through the double hull, and a belly pan inside the vehicle reduces pressure waves as well as deformations in the event of AP or AV mine detonation. Dingo 1 vehicles were involved in AV mine and IED incidents in Afghanistan and none of the crew was injured.

DINGO 2 in action

SPECIFICATIONS

The Dingo 2 can be used in many roles, eg personnel carrier, reconnaissance vehicle for EOD or demining staff, or ambulance.

The crew is protected against AV and AP mines, as well as effective ballistic protection up to AP small arms fire, which fulfils the STANAG requirement 4569. A wide range of options is available.

DINGO 2 in the field

VEHICLES IN USE TO DATE

There are 147 Dingo 1 vehicles in service with the German Army, in Afghanistan and in Kosovo. The armed forces of Belgium ordered 220 Dingo 2 vehicles in January 2005. Other recent buyers of the Dingo 2 include the Austrian and German armed forces.

ENGINE, FUEL AND OIL

The Dingo 2 has a 170 kw DC engine (Euro 3 Standard) with a semi-automatic gearbox. Its range is 1,000 km and fuel capacity is 260 litres.

FACTORY SUPPORT

Like all KMW products, the Dingo 2 is supported by the company's worldwide support and maintenance network. Spare parts are available worldwide through the Daimler sales network.

MAINTENANCE SUPPORT

Main components are of rugged design and commercially available worldwide. KMW is contracted for maintenance purposes in several crisis areas around the world.

TESTS AND EVALUATIONS

The German Armed Forces have fully qualified the Dingo 2.

REPORTED LIMITATIONS AND STRENGTHS

No information provided.

TECHNICAL SPECIFICATIONS	DINGO 2 LONG WHEELBASE

A. DIMENSIONAL DATA

1. Length total	6,800 mm
2. Width total	2,300 mm
3. Height | Roof	2,500 mm
4. Mass | Basic vehicle	10,000 kg
5. Payload	2,500 kg
6. Crew	8 passengers
7. Gross Vehicle Weight	12,500 kg
8. Ground clearance	480 mm

B. DRIVING SPECIfiCATION

9. Wheels | Drive train	Permanent 4 wheel drive
10. Fording capability	1,200 mm
11. Hill climbing ability | Side slope	70° / 30°
12. Maximum speed	100 km/h
13. Turning circle diameter	

C. SYSTEM SPECIfiCATION

14. Engine | Fuel | Oil	DC 170 kw; 4,800 ccm
15. Fuel capacity	260 l
16. Fuel consumption	Not given
17. Range	1,000 km
18. Cooling system engine	Not given
19. Oil capacity	Not given
20. Hydraulic oil capacity	Not given
21. Brakes	Not given
22. Gear box	EPS/EAS (optional)
23. Vehicles of use	Not given
24. Location of use	Afghanistan, Kosovo, Macedonia

D. COMFORT AND SECURITY

25. Air conditioning	Yes
26. Operator comfort	N/A
27. Armour	AP + AV Mines, 7.62 x 54 AP
28. Remote controlled	N/A

E. COSTS

29. Cost of system	Upon request
30. Other costs	Not given
31. Transportation	Air transport C-160, C-130
32. Availability for hire	Not given

Armoured Project Vehicles | Gibralta

GENERAL DESCRIPTION

The *APV Toyota Landcruiser 200 series and 76 series,* produced by Armoured Project Vehicles are discreetly protected vehicles constructed to BRV1999-VR6/Stanag level 1 incorporating a mine-resistant floor extending across the whole passenger compartment. The modified vehicles are based on the proven Toyota platforms and offer all-wheel drive and differential locks if required. A run flat insert is used inside upgraded tyres along with weight-bearing upgraded suspensions to provide high mobility and continued driveability with deflated or damaged tyres. Upgraded brakes are offered as an optional upgrade. This configuration ensures excellent mobility in any terrain with low-cost procurement as well as low lifecycle costs. It can operate under any climatic conditions.

The vehicle is constructed as a shielded box to derive maximum passenger protection. The inner vehicle can be configured for multiple uses and therefore offers a variety of applications. Performance can be further enhanced with a range of off-road and 4 x 4 accessories along with the option to include HF/VHF/UHF and satellite communications equipment.

The hull is designed and proven to withstand the detonation of AV mines to up to Stanag 4569 level 1. Fragment protection is ensured through the double hull, and a belly pan inside the vehicle reduces pressure waves and deformations in the event of AP or AV mine detonation.

Putting in armour and finished exterior

SPECIFICATIONS

The APV protected vehicles can be used in many roles, eg, personnel carrier, reconnaissance vehicle for EOD or demining staff, or ambulance.

The crew is protected against mine explosion up to Stanag 4569 level 1 ie, detonation under belly with DM51 grenades or similar. Increased blast protection to Stanag level 2a (mine detonation caused by any wheel up to 6 kg TNT) is an option. Effective ballistic protection up to AP small arms fire, which fulfils the standard requirement of the benchmark BRV 1999 at B6 level, is part of the APV design shield.

VEHICLES IN USE TO DATE

APV has more than 300 units currently in service worldwide. NATO forces operate a fleet of long-range patrol units in Afghanistan. The UN uses units in many African locations and across Pakistan and Afghanistan. Units are also in service with ordnance disposal and mine clearance projects in Afghanistan.

ENGINE, FUEL AND OIL

No information provided.

FACTORY SUPPORT

APV has a dedicated after-sales manager who joined APV after 22 years of British Army service specialising in mechanical and electrical vehicle engineering. APV maintains full factory production records and component tracking to ensure complete lifetime support for each vehicle. APV also offers full Toyota platform parts support along with sea freight options and can arrange to freight urgent items by air if necessary. APV offers full warranty on its products and armouring components.

MAINTENANCE SUPPORT

APV Gibraltar operates a service/maintenance/warranty programme similar to that offered by the original (un-armoured) vehicle manufacturer ie 20,000 kms or one year on the vehicle platform. APV also offers a two-year defect/delamination warranty on the glass and a three-year anti-corrosion and anti-perforation warranty on the hardened steel.

APV works closely with reputable service partners or agents in locations where the units are in use. APV also maintains a "flying service" team.

TESTS AND EVALUATIONS

APV units are constructed with certified glass and steel and then the complete unit is independently tested for ballistic and blast integrity. The standards applied are the 1999 BRV at VR6 level along with roof and underbody tests against 2 x DM51 hand grenades. Increased blast protection is available. More details of test data can be requested via the APV website: www.apv-gib.com.

REPORTED LIMITATIONS AND STRENGTHS

Limitations

No information provided.

Strengths

- APV re-engineers all vehicle doors to integrate 8 mm armoured steel using a unique close-to-skin design.
- All vehicle doors are supported by upgraded hinges, upgraded door straps and include a Teflon roller or block on each door to support the additional weight while the door is closed.
- Door-locking mechanisms are rebalanced and adjusted to changes in the design.
- All door handles, which are known as critical or weak areas due to the presence of holes in the door panels, are completely sealed from the inside using 8 mm steel to protect occupants from blast and ballistics from any angle.
- APV intends to offer protection for occupants against blast from DM 31 grenades and a wheel strike detonation from an AV mine of approximately 4 kg TNT.
- Both model series have been designed for use in harsh climates.

Invisible armour and finished exterior


MineWolf
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Contact: Natasha Pheiffer, Marketing Communications Manager
T. + 27 (0)11 747 3381 | M. + 27 (0)79 526 2362 | F. +27 (0)11 845 1261
natashap@baesystemsomc.co.za

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graham.ashton@corusgroup.com

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Marcelo Galant | T. + 385 35 / 218.822 | F. + 385 35 / 218.824
GSM + 385 98 / 263.064 | mgalant@ddsv.hr

Marinko Pajkovic | T. + 385 35 / 218.822 | F. + 385 35 / 218.833
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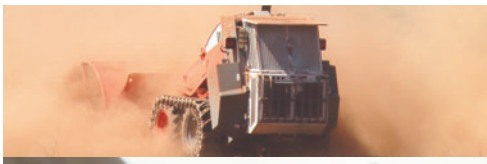
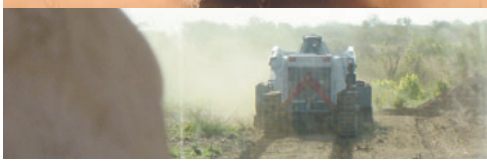
B. GLOSSARY OF TERMS

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
COTS	Commercial off-the-shelf
CROMAC	Croatian Mine Action Centre
DERA	Defence Evaluation and Research Agency (UK)
DIN	Deutsche Industrie Norm
DoD	Department of Defense (US)
DRES	Defense Research Establishment Suffield
EPP	External Power Pack
EOD	Explosive Ordnance Disposal
ERW	Explosive Remnants of War
FACS	Flail Assembly Control System
FFG	Flensburger Fahrzeugbau Gesellschaft
GDMA	General Directorate Mine Action (Iraq)
GICHD	Geneva International Centre for Humanitarian Demining
GSCS	Ground, Sift & Clear Systems

B. GLOSSARY OF TERMS

The HALO Trust	The Hazardous Area Life Support Organisation (NGO)
HPU	Hydraulic Power Unit
IKMAC	Iraqi Kurdistan Mine Action Centre
IED	Improvised Explosive Device
ISO	International Organization for Standardization
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. (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 (NGO)
OCU	Operator's Control Unit
PTO	Power Take-Off
QinetiQ	British defence technology company
RF	Radio Frequency
RUAG	Rüstungsunternehmen Aktiengesellschaft
SDTT	Survivable Demining Tractor and Tools
SFD	Swiss Foundation for Mine Clearance
SOP	Standard Operating Procedures
STS	Safety Technology Systems
SWEDEC	Swedish Explosive Ordnance Disposal 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 Humanitarian Demining
Centre International de Déminage Humanitaire | Genève

7bis, av. de la Paix | P.O. Box 1300 | 1211 Geneva 1 | Switzerland
t. + 41 (0)22 906 16 60 | f. + 41 (0)22 906 16 90
info@gichd.org | **www.gichd.org**