

Alternative anti-personnel mines

The next generations



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SUMMARY: Alternative anti-personnel landmines

Introduction

The 1997 Ottawa Treaty banned the use, development, production, stockpiling and transfer of anti-personnel mines. Unfortunately, landmine technology has moved on and distinctions between mines designed to kill or injure people and mines labelled anti-tank or anti-vehicle are not always clear. Certain anti-vehicle mines are designed to be dual purpose and may be detonated by both people and vehicles, and in some cases merely the proximity of people or vehicles. Meanwhile it has been unclear to what extent munitions and new technologies that may function as anti-personnel mines (APMs) continue to be deployed and innovated.

The purpose of this report is to identify victim-activated anti-vehicle mines (AVMs) and anti-personnel landmine alternatives, both in existing stocks and in development, which may function as anti-personnel mines or have a similar impact on civilians but which are being retained or developed by armed forces and manufacturers, including those of states that have ratified the Ottawa Treaty.

Landmines and definitions

All landmines have an anti-personnel capability, since all will cause human casualties. The Ottawa Treaty, however, attempted to prohibit mines designed to be activated by a person rather than those activated by a vehicle such as a tank. At the core of the definition in the Treaty are the features of anti-personnel mines that had for many years caused widespread concern: that they are ‘victim-activated’ and therefore indiscriminate.

But landmines designed primarily to attack vehicles increasingly contain these indiscriminate anti-personnel functions, either by containing ‘anti-handling devices’ that are supposed to protect the mine from being moved, or by having fuzes sensitive enough to be triggered by a person. Since the Treaty entered into force, some governments have destroyed stocks of anti-

vehicle mines with the capacity to function as anti-personnel mines, or passed legislation that includes such mines within its prohibitions; but other governments have retained the same weapons.

Anti-vehicle mines with anti-personnel capabilities

ANTI-VEHICLE MINES WITH ANTI-HANDLING DEVICES

By definition, anti-handling devices (AHDs) are anti-personnel – they are designed to prevent a person’s disturbance of an AVM. Like APMs, they cannot distinguish between combatants and civilians, and so represent an equal danger to civilians, humanitarian deminers and soldiers. Although the Ottawa Treaty comprehensively prohibits APMs, it makes a partial exception for AHDs if they will activate the mine only as a result of an intentional attempt to tamper with it. AVMs which, due to their fuze or anti-handling device designs, can explode from an unintentional act of a person are banned by the Treaty.

There are a number of different types of AHD. Specialist sources describe all these devices as very sensitive. Many states now have considerable stockpiles of anti-vehicle mines fitted with anti-handling devices. Technical literature suggests that between 50 per cent and 75 per cent of existing AVM types are equipped with AHDs. Ottawa Treaty states parties including Austria, Belgium, the Czech Republic, France, Germany, Italy, Norway, Spain, Sweden and the UK possess anti-vehicle mines with anti-handling devices.

Anti-vehicle mines with personnel-sensitive fuzes

In addition to anti-handling devices, there is a range of means by which anti-vehicle landmines can be made personnel sensitive.

The anti-personnel mine used as a fuze

The most evident anti-personnel capability of an anti-tank or anti-vehicle mine is achieved by manufacturing the mine so that it is fuze with an APM, in order that a person stepping on the APM initiates both mines.

Low pressure thresholds

A running person can apply pressure up to 150 kg to a mine fuze when striking it with a heel. Different postures, or running or walking, will apply different ground pressures. In addition, the environment in which the mine is emplaced is an important variable; if, for example, a stone is above the mine's pressure plate this can concentrate any pressure applied into a small area and thus increase the chance of detonation. However, much greater sensitivity can be achieved, with some mines capable of detonation due to pressure of 50 kg or less. Low-pressure AVMs are manufactured in the Czech Republic and Slovakia, Egypt, Brazil, Russia and Turkey.

Tilt rod fuzes

A tilt rod is a thin flexible pole protruding from a mine, which is attached to the fuze so that when pressure is applied against the rod the mine is activated. The operating pressure of an AVM tilt rod fuze is typically very low, usually only a few kilograms. Many AVMs have been equipped with additional fuze wells to which tilt rods can be fitted. Tilt rods can be so sensitive that a person walking through undergrowth concealing a mine could initiate it by accidentally striking the rod.

Trip wires and break wires

Trip wires can be made to function when tension in the wire is released or if the wire is pulled. Usually the wire is stretched across a target area and the mine initiates when enough traction or release is applied. Trip wire fuzes can be fitted to almost every mine equipped with suitable fuze wells. A break wire activates a mine when an electric circuit within the wire is broken. This can happen when the break wire is hidden or buried. Both are likely to put the safety of civilians at risk.

Magnetic sensors

Two different types of magnetic sensor are commonly used with anti-vehicle mines: passive and active. Passive magnetic sensors are often used in AVMs because they are cheap and operate with very low battery drain, potentially remaining operative for

extended periods. They may sense a change in the magnetic field, and cause the mine's detonation. Passive magnetic sensors may be very sensitive to any metal objects placed nearby or approaching the sensor, for example hand-held radios brought into the vicinity of the mine or other metallic objects, such as keys, carried by a person. Scatterable AVMs with magnetic fuzes, that are lightweight, remain on the ground surface, and are readily knocked into a different position, are likely to be easily detonated by an unintentional act.

Anti-vehicle mines fuze (or 'woken up') by other sensors

There is a range of sensors designed to initiate modern anti-vehicle mines. Most common among these are seismic sensors, which react to vibrations in the ground. Acoustic sensors react to the noise made by a vehicle engine. Light-sensitive sensors activate when uncovered and exposed to light. Infrared sensors react to radiated heat. Fibre-optic cables often used with off-route mines react to being driven over. Optical and other sensors react to movement. It is unclear how discriminating these sensors are.

Anti-vehicle mines: the humanitarian impact

Reports from non-governmental organisations, including those engaged in mine clearance, reveal that anti-vehicle mines already deployed have caused and continue to cause civilian casualties, deny access to impoverished areas, and create wider socio-economic problems.

Afghanistan

Since 1991, more than 400,000 people have been killed or maimed by landmines in Afghanistan. According to the Comprehensive Disabled Afghans Programme (CDAP), as many as 210,000 people in Afghanistan have disabilities caused by landmines. The United Nations reports that landmines have a considerable impact on roads and other transportation routes. During the course of the war, many important roads and routes were mined. Mining these roads has prevented or restricted the movement of public transport, with the consequence that delivery of goods

to most destinations in Afghanistan has been made more difficult, resulting in price rises which have negatively impacted on local economies. Increased transport fares and extended travel time has resulted, per year, in a loss to the Afghan economy of more than US\$26 million. Mined roads have remained, on average, unusable for nine years and were considered to be one of the major factors contributing to increased commodity prices.

Angola

It has been estimated that in Angola one in every five landmines is an anti-vehicle mine. Mines laid on roads are a major impediment to the freedom of internal movement. At November 2000, the National Institute for the Removal of Obstacles and Explosive Devices (INAROOE) had recorded 2,617 mine fields in Angola. INAROOE reported 204 mine-related accidents throughout the country in the first six months of 2000, with 100 people killed and a further 327 injured. Of these, 327 were civilians. Most of those affected (251 people) were killed or wounded by mines when they travelled in vehicles on roads.

Bosnia

According to UN data, until 1998 15 per cent of all mine casualties in Bosnia were caused by AVMs. The Government of Bosnia reported that as of 1 February 2000 there were 18,293 suspect or mined areas, with one mine in six thought to be an anti-vehicle mine. Minefields in Bosnia and Herzegovina generally remain unmarked.

Other reports

Handicap International reports that in South Senegal 61 per cent of all landmine casualties were identified as being caused by anti-vehicle mines. According to the UN 70 per cent of landmine incidents in Burundi between 1996 and 1998 were caused by AVMs. Existing minefields in Osijek-Baranja County, eastern Croatia contain up to forty five per cent AVMs according to local governmental sources. In Kosovo the UN Mine Action Co-ordination Centre confirmed that over fifty per cent of all cleared landmines between June 1999 and May 2000 have been identified as AVMs.

The HALO Trust reports that the existence of one single AVM can hamper the development and mobility of a whole region. This happened in Mozambique where a single AVM laid on a road linking two district capitals (Milange and Morrumbala) cut off these towns from the rest of the world for over 10 years.

The International Committee of the Red Cross (ICRC) has reported that the use of AVMs can also lead to an enormous increase in the cost of delivering assistance to victims of conflict. When supplies have to be transported by air due to the presence of AVMs on roadways, these costs can increase up to 25 times.

Future alternative anti-personnel mines

The mines of the future may not look like traditional anti-personnel land mines at all. But the design of such technologies means that they can precipitate death and injury or make their targets unable to resist more lethal technologies, which are often deployed in tandem. This report is concerned with future systems of area denial, exclusion and removal which are potentially victim-activated and which can lead to physical injury or death. Some of these future alternative APMs are algorithmic, that is they have some degree of 'built-in intelligence' to actively seek out their victims, and some appear nothing at all like the traditional idea of an anti-personnel mine. Many are given the label 'non-lethal' by their manufacturers.

'OFF-THE-SHELF' ALTERNATIVES TO ANTI-PERSONNEL MINES

Many of the landmine alternative technologies already in existence have formats that give them 'mine-like' characteristics. Some of these technologies can be automated and if operating in this mode are essentially victim activated.

Victim-seeking automated guns and explosive-driven ordnance

Victim-seeking automated guns are now being marketed for border control, embassy protection and controlled

environments such as nuclear power plants. For example, the Automated Weapons System made by the US company Autauga Arms Inc. is a camera-mounted concealed machine gun that can be set to automatically open fire if the boundaries of its control-zone are infringed.

There are several area defence systems which may lend themselves to field adaptation for use as mine-like weapons. It is believed that these technologies with cable activated links can be readily adapted by the manufacturer, or in the field, to become victim activated.

For example, the Lacroix Sphinx-MODER Perimeter Defence system can fire operational rounds including fragmentation, smoke, CS and warning rounds and is ostensibly a 'man-in-the-loop' cable activated system. Other companies such as Mark Three advertise APM conversions to their Bear Trap system. This is ordinarily a jackhammer shotgun with a multi-cartridge cassette but is so designed that the cassette cartridge can be removed, ground emplaced and pressure-activated so that all cartridges are fired together, in other words as an APM.

'Non-lethal' alternatives to anti-personnel mines

'Non-lethal' weapons doctrine in the US

Recognition of the need to fight 'wars of intervention' grew in the early 1990s. One result was the creation of a doctrine where civilians could legitimately be targeted with non-lethal weapons alongside insurgents.

This doctrine says it is unrealistic to 'assume away' civilians and non-combatants, taking the view that the US must be able to execute its missions in spite of and/or operating in the midst of civilians. 'Non-lethal common tasks' have been identified as including:

- Incapacitating or stopping an individual in a room, in a crowd, fleeing;
- Stopping a vehicle, approaching, retreating;
- Blocking an area to vehicles, to personnel;

- Controlling crowds, stopping approach, encouraging dispersal...

The US Army identified a range of tools for these missions, many of which have APM-like qualities or could mimic some of their attributes. By the late 1990s US doctrine on APM alternatives was successfully assimilated into NATO policy.

'Non-lethal' adaptations of existing APMs

A new US variant of the Claymore-type directional fragmentation mine is termed the Modular Crowd Control Munition. This uses 'stinging rubber balls' and the existing Claymore mine dispenser. The MCCM device is listed as a means of breaking up crowds and hostile personnel, temporarily incapacitating at close range (5-15 metres). This proposal has already gone to contract, with Mohawk Electrical Systems, current manufacturers of the Claymore M18A1 mine, involved. The MCCM now has a NATO Stock Number, and costs \$255 per munition.

Calmatives

A range of tranquillising chemicals is being examined for Operations Other Than War (OOTW); some can cause temporary blindness; others can make you think you are smelling something that is not there, or can cause submissiveness or extreme anxiety. Systems for delivering calmativ agents include a micro-encapsulation programme that releases their effects only when trodden on, which was scheduled for completion in September 2000.

Obscurants

These aqueous foams form an impenetrable soap-suds-like barrier that makes both communication and orientation difficult. Fired in bulk from water cannon or specially designed back-packs, such foams can be piled up into semi-rigid barriers and laced either with chemical irritants or calmatives. If the foam is entered and disorientation occurs then the dose received will increase all the time that the person is in contact with the foam. Anyone attempting to cross the boundaries of the obscurant would be unaware of any hazards made invisible by the foam which may include chemicals in the foam itself or wound-inflicting obstacles such as caltrops or razor wire.

Entanglements

Three varieties of entanglement have been identified as having area denial functions: slippery substances, expanding sticky foam guns and barrier devices, and nets, which come with options for including sticky adhesives, chemical irritants, electroshocks and hooks. Many of these entanglement devices, also known in the American vernacular as ‘stickums’ and ‘slickems’, are now available commercially.

Anti-personnel sticky foam was developed as a non-lethal capture system but has now been virtually withdrawn because of the difficulties in decontaminating victims and the risk of killing through suffocation.

Directed energy weapons

The potential use of so-called radio frequency or directed energy weapons, and various other directed energy weapons, has been proposed for anti-personnel area denial. These weapons include dazzling lasers, microwaves and vortex ring technologies.

Devices using the microwave part of the electromagnetic spectrum are probably the most controversial developments. They are seen as offering a potential rheostatic or tunable response from less-lethal to lethal, operating at the speed of light, as so-called ‘progressive penalty munitions’ (PPM). The ‘onion’ or ‘layered defence’ model which accompanies proposals for their deployment describes entering the outer layers as inviting a punitive response whilst the central core is lethal.

Acoustic weapons

Controversy and speculation also surround acoustic weapons. They are allegedly able to vibrate the inside of humans in order to stun, nauseate or, according to one Pentagon official, to ‘liquefy their bowels and reduce them to quivering diarrhoeic messes’.

Also labelled Projected Energy, Sonic, and Forward Area Energy Weapons, three types are being examined by the US Army and Air Force: an acoustic rifle, a vehicle or helicopter-mounted acoustic gun for longer ranges, and an air-dropped acoustic mine. Twenty US companies are involved in developing acoustic weapons in a wide-ranging research effort to support ‘active area denial programmes’. One major contractor, Scientific

Applications and Research Associates, is quoted as saying high power acoustics can produce ‘instantaneous blastwave-type trauma’ and lethal effects with even modest exposure.

Electrical weapons

The US companies Tasertron and Primex Aerospace are testing the Taser Area Denial Device. The Device lands primed to be victim-activated by a trip device and a variety of other sensors. Once activated, barbed darts are fired in a 120 degree multi-directional pattern, with ‘volcano darts’ fired in a single direction. The darts reach out some 15-30 feet and 50,000 volts is pulsed through to the target, temporarily incapacitating the person, even through clothing. The pulses are of short duration (4-6 microseconds) and repeated 8 to 24 pulses per second.

This technology is now a prime candidate in the US as a non-lethal APM-alternative, with functions such as ‘unmanned non-lethal perimeter patrol for border patrol and corrections usage’ confirmed by a recent report.

Bio-weapons for racially selective mass control

As a result of breakthroughs in the Human Genome and Human Diversity Projects and the revolution in neuroscience, the way has opened up to using blood proteins to attack a particular racial group using selected engineered viruses or toxins. As the data on human receptor sites accumulates, the risk increases of breakthroughs in malign targeting of suitable micro-organisms at either cell membrane level or via viral vector, although not all experts agree on this. In the United States the newest micro-encapsulation dispersion mechanisms for chemical and biological weapon agents are being advanced for ‘anti-materiel and anti-personnel non-lethal weapons related to area denial and vessel stopping’.

Isotropic radiators, super-adhesives, -caustics and -lubricants

There are many other so called ‘less-lethal’ munitions that have been developed as anti-personnel and/or area denial systems but which might impact on civilians. For example, isotropic radiators are optical munitions that use an explosive burst to superheat an inert gas to produce a plasma that radiates with a laser-bright light, and are likely to cause the same retinal damage to the eye as low energy lasers.

Other systems use super-adhesive, super-caustic substances and super-lubricants that are designed to incapacitate vehicles. Highly caustic mixtures of concentrated hydrochloric and nitric acid have been suggested in the form of binary weapons to attack metallic structures, armoured vehicles, roads and rooftops.

Robotic area denial systems

A number of companies are also researching the area-denial potential of robots activated by surveillance systems to make selective attacks with less-than-lethal devices. In 1983 Robot Defense Systems of Colorado created the Prowler – an armed two-ton vehicle designed for sentry duties. A number of mobile security robots (for example MDARS, Cyberguard, Andros) have already emerged. Some of these robots are armed, for example the weaponised Andros robot used by the Tucson Police Department since 1997. A range of non-lethal weapons for Special Weapons and Tactics operations has been developed, including robot deployment of a 12 gauge bean bag, a grab net, and chemical munition deployment.

A number of ‘concept demonstration’ robots – armed autonomous robots independently identifying and engaging targets – exist. The most advanced is the Robart 3, which includes a Gatling gun-type weapon that fires darts or rubber bullets. Other armed robot concept models include the Roboguard, developed in Bangkok by Pitikhate Sooraka. Automatic victim activation is possible via heat sensors which track people as they move.

Conclusions and recommendations

ANTI-VEHICLE MINES FUNCTIONING AS ANTI-PERSONNEL MINES

Continual technological development of mines has made old distinctions between anti-personnel, anti-vehicle and anti-tank mines far less clear than may once have been the case. Although a manufacturer or country may designate a mine as anti-vehicle or anti-tank, this does not guarantee that it does not act like an anti-personnel mine. A range of fuzes and anti-handling devices appear to enable anti-vehicle mines to function

as anti-personnel mines, or at least have variants that are anti-personnel.

Some states party to the Ottawa Convention are paradoxically engaged in the export and development of these personnel-sensitive AVMs, in some cases involving enormous financial inputs. ‘Improved’ variants of older mines provide new anti-personnel capabilities, while the safeguards that have been argued to render these weapons harmless, such as self-destruct or self-neutralisation mechanisms, appear to be unreliable and may compound the problems faced by humanitarian deminers and civilians alike. Scatterable anti-vehicle mines present further problems, both by increasing the unreliability of the weapons and their technologies and by being inherently difficult to mark and fence off from civilians. Developers have yet to demonstrate that the new mines’ sensor technologies discriminate reliably; for example, in the case of magnetic fuzes, there are serious questions as to which fuzes are capable in different circumstances of being initiated merely by the approach of a person.

Furthermore, reports from mine affected countries show that AVMs cause the deaths of many civilians in at least 25 countries. They tend to kill rather than maim civilians, and when they are detonated by civilian vehicles there is usually a large number of casualties. Despite the evidence, manufacturers of AVMs continue to export weapons that damage economies and deny civilians the use of land, including access routes, as disastrously as do APMs.

FUTURE ALTERNATIVE APMs

The development of non-lethal alternatives does not herald harmless warfare. The doctrine behind these programmes identifies civilians as a specific target. Some of the new developments appear to be far from ‘non-lethal’ (official documents also use the term ‘less-lethal’). In many of these new weapons systems, and the scenarios in which their use is envisaged, it is difficult to find the discrimination between civilians and enemy combatants and the avoidance of victim-activation which lies at the heart of the Geneva Conventions and the Ottawa Treaty’s prohibition of APMs.

Public knowledge and understanding of the potential human rights implications posed by some alternative landmine technologies remains relatively undeveloped. Most official sources are either lacking in technical detail or overlook the ways in which these emergent technologies are victim-activated and civilian-targeted.

The status of existing and proposed alternative APMs in terms of current international legislation is both problematic and ambiguous. Many of these weapons have been designed in theory to circumvent the provisions of existing treaties.

RECOMMENDATIONS

Anti-vehicle mines

Member states of the Ottawa Convention should transparently assess the sensitivity of all existing AVMs, report this promptly to the United Nations under the existing Ottawa Convention reporting framework, and destroy stocks of all AVMs found to be capable of activation by the unintentional act of a person.

Alternatively, states should provide convincing technical and field information, making it available to independent observers such as specialist non-governmental organisations, that demonstrates these mines are not in breach of the Ottawa Treaty. This could be demonstrated to the appropriate standing committee carrying out the intersessional work of the Treaty. Pending this transparent technical assessment, there should be moratoria on the manufacture export and use of anti-vehicle mines likely to function as APMs. These moratoria should be declared unilaterally and without delay.

For those mines that can be shown not to fall within the Ottawa Treaty, there is an urgent need to impose greater responsibility on users. A new fifth protocol to the UN Convention on Certain Conventional Weapons should impose an unambiguous obligation on the users of anti-vehicle mines to implement full post-conflict clearance and supporting activities. These should include marking mined areas as soon as the affected territory is no longer subject to combat operations. Where this is not practical, the responsible party should be financially responsible for clearance operations carried out by non-governmental organisations under the auspices of the United Nations.

Future alternative anti-personnel mines

Governments should ensure that all weapons research and development is within the limits established by existing international humanitarian law. Existing programmes should be transparently examined for compliance with existing humanitarian law, and terminated if found to be in contravention.

To provide effective oversight of these new technologies by civil society, and to ensure their full compliance with existing humanitarian law:

- research on chemicals used in any alternative mine technologies (eg calmatives and sticky nets and malodorous substances) should be published in open scientific journals before authorisation for any usage is permitted. The safety criteria for such chemicals should be treated as if they were civilian drugs rather than military weapons.
- research on the alleged safety of existing and future crowd control weapons should be placed in the public domain prior to any decision towards deployment. Experience has shown that to rely on manufacturers' unsubstantiated claims about the absence of hazards is unwise. In the US, some companies making crowd control weapons have put their technical data in the public domain without loss of profitability. European companies making such weapons should be legally required to do likewise; all research justifying the alleged harmless status of any 'less lethal' weapon should be published in the open scientific press before authorisation and any product licence granted should be subject to such scrutiny.

Governments should consider institutionalising the decision making process so that common parameters are examined when deciding on alternatives to landmines, along the lines of environmental impact assessments. In practical terms that would mean having formal, independent 'Social Impact Assessments' of such technologies before they are deployed. These assessments could establish objective criteria for assessing the biomedical effects of so called 'less lethal' weapons undertaken independently from commercial or governmental research.

Finally, states devoting resources to the development of alternative anti-personnel mines that are in breach of international humanitarian law should redirect this expenditure towards more rapidly clearing mines already laid, rehabilitating their victims and destroying existing stockpiles of all weapons with prohibited anti-personnel effects.

1 INTRODUCTION

The 1997 Ottawa Treaty banned the use, development, production, stockpiling and transfer of certain mines. Although the Ottawa Treaty does define what it means by an anti-personnel mine, some countries which have ratified the Treaty have applied its comprehensive prohibitions only to those mines which they label ‘anti-personnel’. Calls for an investigation into this by other states have so far failed to achieve consensus. Meanwhile it has been unclear to what extent munitions and new technologies that may function as anti-personnel mines continue to be deployed and innovated.

The Ottawa Treaty is founded on the principle of international humanitarian law that those engaged in conflict do not have an unlimited right to choose their methods or means of warfare. The core element of the Treaty’s definition of what is an APM, and therefore prohibited, is that such devices are victim-activated, and hence cannot discriminate between civilians and combatants. The Ottawa Treaty was thus a direct response to the suffering and casualties inflicted on innocent civilians by anti-personnel mines. To the communities affected by mines, it is of marginal interest as to whether or not the weapons that are denying the use of land or causing casualties are classified as anti-personnel mines by their manufacturers or users. If manufacturers or governments are able to continue with the development of alternative weapons, some may have the same impact on civilians as ‘traditional’ anti-personnel mines. The potential corrosion of the existing anti-personnel landmine legislation (and circumvention through inventions specifically designed to obviate the demands of the Ottawa Treaty) poses a serious threat to recent progress in ridding the world of the scourge of landmines.

The purpose of this report is to identify victim-activated anti-vehicle mines and anti-personnel landmine alternatives, both in existing stocks and in development, which may function as anti-personnel mines or have a similar impact on civilians but which are being retained or developed by armed forces and manufacturers, including those of states that have ratified the Ottawa Convention.

The function of anti-personnel mines

Although this report does not attempt to assess the military utility of the weapons it describes, it is important to set the framework for this study by summarising the theoretical military function or role of anti-personnel mines (APMs). Together with the legal definitions described below, which identify the characteristics of APMs, this functional approach helps explain the thinking behind the development of alternatives identified in this report.

The evidence from military operations and analysis is that the humanitarian costs of anti-personnel mines have overwhelmingly outweighed their military utility. Minefields have proved easy to breach, and have caused mobility problems to user forces as well as casualties among friendly forces.

However, there are a number of functions that were intended to be carried out by anti-personnel mines. These can be summarised as contributing to surveillance and lethality capabilities. The surveillance function was to provide early warning, especially in ground hidden from view. Intended lethality functions included protecting anti-vehicle mines, reinforcing existing obstacles and providing close protection to defensive troops. APMs were expected to undermine opposing forces’ morale by inflicting casualties and to impede movement, while denying areas of valuable terrain and ‘canalising’ attackers into unfavourable terrain. Scatterable APMs have also been used offensively, blocking withdrawal routes and preventing reinforcements.

It is substitutes for these anti-personnel mine functions that manufacturers and the military are seeking and – where they appear to be victim-activated and in contravention of the Ottawa Treaty – which are the focus of this report.

The legal framework: Geneva Conventions and landmine treaties

International humanitarian law, also known as the laws of war, places limits on how wars can be waged, in part with the aim of protecting civilians. The central pillar of Additional Protocol I to the Geneva Conventions is clear:

In any armed conflict, the right of the Parties to the conflict to choose methods or means of warfare is not unlimited.

The Protocol makes clear the general limitations on the effects of weaponry and the responsibility imposed on combatants to protect non-combatants.

It is prohibited to employ weapons, projectiles and material and methods of warfare of a nature to cause superfluous injury or unnecessary suffering.¹

Indiscriminate attacks are prohibited. Indiscriminate attacks are: (a) those which are not directed at a specific military objective; (b) those which employ a method or means of combat which cannot be directed at a specific military objective; or (c) those which employ a method or means of combat the effects of which cannot be limited as required by this Protocol; and consequently, in each such case, are of a nature to strike military objectives and civilians or civilian objects without distinction.²

An attack is considered indiscriminate if it ‘may be expected to cause incidental loss of civilian life, injury to civilians, damage to civilian objects, or a combination thereof, which would be excessive in relation to the concrete and direct military advantage anticipated’.³

There is also international humanitarian law, building on these general principles in the Geneva Conventions, that specifically addresses landmines. These are the 1980 Convention on Conventional Weapons⁴ and the 1997 Ottawa Convention. Dissatisfaction with the weak and complex provisions that the Convention on Conventional Weapons contains on the use of anti-personnel mines (APMs), led to an Amended Protocol II to the Convention placing further restrictions on the use of landmines. This includes the following general measures:

- Each... party to a conflict is... responsible for all mines, booby-traps, and other devices employed by it and undertakes to clear, remove, destroy or maintain them as specified in Article 10 of this Protocol (Article 3.2).
- It is prohibited in all circumstances to use any mine, booby-trap or other device which is designed or of a nature to cause superfluous injury or unnecessary suffering (Article 3.3).
- It is prohibited to use mines, booby-traps or other devices which employ a mechanism or device specifically designed to detonate the munition by the presence of commonly available mine detectors as a result of their magnetic or other non-contact influence during normal use in detection operations (Article 3.5).
- It is prohibited to use a self-deactivating mine equipped with an anti-handling device that is designed in such a manner that the anti-handling device is capable of functioning after the mine has ceased to be capable of functioning (Article 3.6).

The Amended Protocol also prohibits the indiscriminate use of mines, the targeting of civilians with mines, and the use of anti-personnel mines that are non-detectable. It requires minefields to be marked and cleared after hostilities, unless they are APMs that self-destruct or self-deactivate, or unless the user loses control of the mined territory; and it requires remotely-delivered scatterable mines to be self-destructing or self-deactivating so that no more than one in 1,000 will function 120 days after their emplacement.

The only partial success of these efforts led a group of countries to pioneer a more complete prohibition of APMs, which became known as the Ottawa Convention (also referred to in this report as the Ottawa Treaty) and which entered into force on 1 March 1999.

The full title of the Ottawa Convention is the ‘Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on Their Destruction’. It provides a definition of what is an anti-personnel mine, and makes the prohibition of APMs comprehensive in these clear terms:

Article 1. General obligations

1. *Each State Party undertakes never under any circumstances:*

- *To use anti-personnel mines;*
- *To develop, produce, otherwise acquire, stockpile, retain or transfer to anyone, directly or indirectly, anti-personnel mines;*
- *To assist, encourage or induce, in any way, anyone to engage in any activity prohibited to a State Party under this Convention.*

Thus the development and possession of APMs is banned as absolutely ('never under any circumstances') as is the actual use of these mines. Also, to 'assist, encourage or induce, in any way, anyone' to engage in any of these prohibited activities falls under the same absolute prohibition. This is significant, because this report documents mines retained in possession by countries which are states parties to the Ottawa Convention, and also documents alternatives to APMs currently in development, which may contravene the Treaty.

To reinforce the comprehensive nature of the Ottawa Convention, Article 19 states that the 'Articles of this Convention shall not be subject to reservation'. So states cannot pick and choose which parts of the Convention they will adhere to.

The Ottawa Treaty has quickly gained widespread support throughout the international community, and has gained roughly double the number of States Parties than the much weaker Convention on Certain Conventional Weapons (amended Protocol II). Since it opened for signature on 3 December 1997, one hundred and ten states have ratified or acceded to the Ottawa Treaty, with a further 30 states being in the process of doing so.

The definition of what is an APM, and thus banned, is given in Article 2 of the Ottawa Convention:

Article 2. Definitions

- *'Anti-personnel mine' means a mine designed to be exploded by the presence, proximity or contact of a person and that will incapacitate, injure or kill one or more persons. Mines designed to be detonated by the presence, proximity or contact of a vehicle as*

opposed to a person, that are equipped with anti-handling devices, are not considered anti-personnel mines as a result of being so equipped.

- *'Mine' means ammunition designed to be placed under, on or near the ground or other surface area and to be exploded by the presence, proximity or contact of a person or a vehicle.*
- *'Anti-handling device' means a device intended to protect a mine and which is part of, linked to, attached to or placed under the mine and which activates when an attempt is made to tamper with or otherwise intentionally disturb the mine.*

At the core of these definitions is a feature of APMs that had for many years caused widespread concern: that they are 'victim-activated'. An APM is not aimed at its target and then fired by a soldier, as are rifles and other forms of weaponry. Instead, it is activated by the 'presence, proximity or contact of a person'. In recognition of the indiscriminate and persistent nature of these weapons, the prohibition applies regardless of whether the 'person' or 'victim' is a civilian or a combatant.

Anti-vehicle mines

All landmines have an anti-personnel capability, since all will cause human casualties. The Ottawa Convention, however, attempted to prohibit mines designed to be activated by a person rather than those activated by a vehicle such as a tank. Unfortunately, landmine technology has moved on and such distinctions between anti-vehicle and anti-personnel mines are not always clear. Certain new mines are designed to be dual purpose and may be detonated by both people and vehicles, and in some cases merely the proximity of people or vehicles.

During the negotiations in Oslo in 1997 which led to the Ottawa Convention, the International Campaign to Ban Landmines and the International Committee of the Red Cross expressed concern at a proposal to exempt all anti-vehicle mines with anti-handling devices from the Treaty's prohibition, despite clear evidence from humanitarian deminers that these mines can function as anti-personnel mines. This concern, which was shared by many governments, resulted in a change to the draft definition in Article 2 of the Treaty so that only

those anti-handling devices that activate when the mine is tampered with or *intentionally* disturbed were exempt. This had the effect of banning anti-vehicle mines with anti-handling devices that can explode from an *unintentional* act of a person, and was accepted by all participating governments. Counter to some governments' prevarication on this issue since the Treaty was negotiated, recent published legal opinion is that Article 2 'makes clear that a permissible anti-handling device can only be activated by intentional acts to move or interfere with the mine, and not by unintentional human contact'. It also confirms the view that a mine designed to be exploded by a vehicle *and* by a person, for example because of its sensitive fuzing, is an anti-personnel mine. The opinion continues:

...to allow anti-vehicle mines that behave like anti-personnel mines to escape the ban simply because their primary targets are vehicles would defeat the very purpose of the Convention... A plain reading of the terms of the Ottawa Convention, in its context and in light of object and purpose, yields an unambiguous result: anti-vehicle mines, including those equipped with anti-handling devices, that may be detonated by unintentional human contact are banned under the Convention.⁵

The Ottawa Convention therefore provides a benchmark or test for the legality of existing weaponry and new weaponry developments. Is a weapon (capable of incapacitating, injuring or killing one or more persons):

- designed to be exploded by the presence, proximity or contact of a person?
- a munition designed to be placed under, on or near the ground or other surface area and to be exploded by the presence, proximity or contact of a person or vehicle?
- an anti-vehicle mine with an anti-handling device, that may explode because of unintentional act?

If these characteristics are present in a device, it is defined by the Ottawa Convention as an APM and it is prohibited 'under any circumstances' to 'develop, produce, otherwise acquire, retain or transfer' that device.

Since the Convention entered into force, debate about the scope of the prohibition has renewed as some governments have destroyed stocks of anti-vehicle mines with the capacity to function as indiscriminate anti-personnel mines, or passed legislation that includes such mines within prohibitions, while other governments have retained the same weapons.

Spain and Italy, for example, have included provisions prohibiting anti-vehicle mines in national legislation implementing the Ottawa Treaty. Spain's Law 33/98 refers to anti-personnel mines and weapons with similar effects; the Spanish Ministry of Foreign Affairs confirmed that if an 'anti-handling device or the anti-vehicle explosion mechanism itself made these devices have a similar effect to anti-personnel mines, they would be included in the applicability of the law'.⁶ Italy's Law 374/97 includes within its definition of an APM 'dual use mines and mine equipped with anti-handling devices, as well as any such anti-manipulation devices in general'.⁷

Non-governmental organisations have continued to question the legality of sensitive fuzing mechanisms and anti-handling devices that, by their design, enable anti-vehicle mines to be triggered by a person. This report describes some of the fuzes and devices that appear to incorporate anti-personnel capabilities into anti-vehicle mines. It also summarises information on the known humanitarian impact of anti-vehicle mines already evident in mine-affected countries.

Future alternative anti-personnel mines

The mines of the future may not look like traditional anti-personnel land mines at all, and the labels given to them by manufacturers and some countries may avoid use of the term 'anti-personnel mine'. Such descriptions are more often political than accurate technical descriptions of the device. It is the role and function of the alternative mine and its effects that are important, rather than the label given to it or its appearance.

The design of such technologies means that they can precipitate death and injury or make their targets unable (or less able) to resist more lethal technologies, which are often deployed in tandem. This report is concerned with systems of area denial, exclusion and removal

which are potentially victim-activated and which can lead to physical injury or death. Some of these future alternative APMs are algorithmic, that is they have some degree of 'built in intelligence' to actively seek out their victims, and some appear nothing at all like the traditional idea of an anti-personnel mine. Many of these are given the label 'non-lethal' by their manufacturers.

The term 'non-lethal weapon' itself should be understood more as a public relations term rather than an accurate technical description. The scientific organisation Pugwash has addressed this issue thus:

... this term should be abandoned, not only because it covers a variety of very different weapons but also because it can be dangerously misleading. In combat situations, 'sub-lethal' weapons are likely to be used in co-ordination with other weapons, and could increase overall lethality. Weapons purportedly developed for conventional military or peacekeeping use are likely also to be used in civil wars or for oppression by brutal governments. Weapons developed for police use may encourage the militarisation of police forces, or be used for torture. If a generic term is needed, 'less-lethal' or 'pre-lethal' might be preferable.⁸

This report aims to explore some shapes and varieties of these alternatives. The easiest category to conceptualise is lethal or less-lethal modifications of existing area and perimeter denial systems. These aim to disable, can be victim activated and come in both visible and invisible forms. The next easiest category to conceptualise are less-lethal modifications of existing mine categories, often using the same architecture and firing mechanisms but sometimes substituting plastic for steel in the damage-inducing fragmentation pieces. Other area denial systems such as automated machine guns are lethal but are not usually a permanent feature in the landscape.

The most unusual set of area denial alternatives is victim-activated weapons using radio frequency, acoustic, chemical or biological mechanisms. Some of these systems will be algorithmic; that is, the cybernetic mechanisms released by victim activation will actively track down humans who breach the area denial zone. Robotic forms armed with 'less-lethal' weapons are already at prototype stage.

On the legal tests outlined above, it appears that some new alternatives to APMs being developed may be prohibited by the Ottawa Convention (and in other cases, by other international humanitarian law such as the Chemical Weapons Convention). This report puts information on these weapons in the public domain for further investigation and discussion.

Terminology

In addition to the terms anti-personnel and anti-vehicle, 'anti-tank', 'area denial', and 'area defence' are used by various sources to describe mines and similar devices. As their name suggests, anti-tank or anti-vehicle mines are designed to destroy tanks or vehicles. Area denial describes the function which both APMs and AVMs perform. This report uses the more general term AVM to include both anti-vehicle and anti-tank mines.

Similarly, in descriptions of anti-vehicle mines the terms 'anti-handling device', 'anti-lift device' and 'anti-disturbance device' are frequently used. In this report, the single term anti-handling device (AHD) is used to describe features of mines designed to attack deminers and hinder or prevent them from neutralising or destroying the weapons.

Nothing in this report should be read as supporting or advocating any weapon system over another.

- 1 Article 35.2, Additional Protocol I (1997) to the Geneva Conventions 1949.
- 2 Article 51.3, Additional Protocol I (1997) to the Geneva Conventions 1949.
- 3 Article 51.5, Additional Protocol I (1997) to the Geneva Conventions 1949.
- 4 The Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects. Amended Protocol II to the Convention (amended on 3 May 1996) places prohibitions or restrictions on the use of mines, booby-traps and other devices.
- 5 Arnold and Porter, *Legal Interpretation of the Convention on the Prohibition, Production, Transfer, and Use of Anti-Personnel Mines and on Their Destruction*, Center for International Policy, September 2000.
- 6 *Landmine Monitor 2000*, telephone interview and correspondence with Spain's Ministry of Foreign Affairs, 8 March 2000, ICBL (2000).
- 7 *Landmine Monitor 1999*, ICBL (1999).
- 8 Rotblat, J. (Ed.) Report on Working Group 4, Conventional Disarmament. In: Rotblat, J., (Ed.) 'Remember Your Humanity' – *Proceedings of the 47th. Pugwash Conference on Science and World Affairs 1-7 August 1997*, p.75 World Scientific.

2

ANTI-VEHICLE MINES WITH ANTI-PERSONNEL CAPABILITIES

Anti-personnel mines were first developed (in World War I) to prevent the removal or neutralisation of anti-tank mines. For the same purpose, some current landmine systems, such as the United States' Gator, consist of canisters containing both anti-tank mines (ATMs) and anti-personnel mines (APMs). European countries and mine-producing companies have concentrated for many years on integrating anti-handling devices or personnel-sensitive fuzes into AVMs, to replace the protective role of APMs.

Anti-vehicle mines, even without specific anti-handling devices, may be activated by a person when they have pressure fuzes set for low pressures, and when they have fuzes operated by tilt rods, trip wires or break wires, magnetic fuzes or various other sensor-fuzes.⁹ This section describes some variants of anti-tank or anti-vehicle mines that appear to have anti-personnel capabilities, as summarised in Table 1 below.

TABLE 1: ANTI-VEHICLE MINES WITH ANTI-PERSONNEL CAPABILITIES

Device type	Characteristics
Anti-vehicle mines with low pressure thresholds	Some anti-vehicle mines require less than 10kg of pressure to be exploded
Tilt rods	Usually only a few kg of forward/rearward pressure on the rod protruding from the mine will initiate detonation
Trip wires	When enough traction (usually no more than about 3kg) is applied to the wire, which is stretched across a target area, the mine will be activated
Break wires	The mine is detonated by an electric circuit in a wire being broken
Anti-lift/pressure release devices	A form of booby trap placed beneath a mine. When the heavier mine is lifted, the device explodes, in turn detonating the mine (sympathetic detonation)
Anti-handling/anti-removal/anti-tilt devices	Devices that detonate a mine when it is disturbed or moved
Light-sensitive fuzes	Fuzes designed to initiate the mine when it is uncovered and exposed to light
Seismic disturbance/vibration fuzes	Fuzes to initiate or 'wake-up' the mine when it is vibrated
Magnetic influence fuzes/electro-magnetic signature recognition	Fuzes that react to metal content or the signature of a vehicle. Used as an anti-handling device a magnetic fuze reacts to the change of the earth's magnetic field surrounding the mine

Device type	Characteristics
Acoustic and infra-red sensors	These technologies are programmable, and are designed to identify specific targets. They should not be initiated by people unless misused. However, little is known about their reliability
Self-destruct/neutralisation and random self-destruct mines	These devices increase the danger of minefields, since there is no way of knowing if the mines have self-destructed or failed. Some self-neutralisation mines are programmable to last up to 365 days

2.1 Anti-vehicle mines with anti-handling devices

By definition, anti-handling devices (AHDs) are anti-personnel – they are designed to prevent a person’s disturbance of an AVM. Like APMs, they cannot distinguish between combatants and civilians, and so represent an equal danger to civilians, humanitarian deminers and enemy soldiers.¹⁰ Although the Ottawa Convention comprehensively prohibits APMs, as noted above it makes a partial exception for AHDs if they will activate only as a result of an *intentional* attempt to tamper with the AVM, while prohibiting AHDs capable of activating as a result of an *unintentional* or innocent act.

Tests have rarely been carried out by manufacturers or governments on AHDs to determine specifically if they contravene the Ottawa Convention, and tests that have been carried out have not been published. Research for this section of the report focused on unclassified government and technical sources of information.

In 1971, military authorities in the United States stated that many AHDs could be initiated through a very slight jar, vibration or slight tilt.¹¹ Producers of mine fuzes also warned that any electrical or mechanical manipulation of mines with AHDs might lead to their detonation.¹² More recently, the Dutch Defence Department has warned that ‘everybody approaching an AVM equipped with an AHD takes a risk. Of course this also applies to civilians if they touch the mine in an accidental act’.¹³

There are a number of different types of AHD. For example, an AHD can be a part of a magnetic fuze that reacts to the change of the magnetic field around the mine. Alternatively, some AHDs have a mercury-based fuze mechanism. These systems incorporate two

isolated contacts and mercury contained in glass.

Moving the mine sufficiently to move the mercury closes a circuit and causes detonation of the mine. Mercury is used because it transmits electricity very well and tends to form a bullet-like shape. The Italian AHD AR 4 and the British bomb fuze No. 845 function this way. Other AHDs have ball-shaped metal cages, containing a funnel with a metal ‘bullet’. Moving the mine results in contact between the cage and the ‘bullet’ which closes an electric circuit and causes detonation.

AVMs are also often protected by pressure-release fuzes that detonate the mine if pressure is lifted off the device. Specialist sources describe all these devices as very sensitive.¹⁴

Many states now have considerable stockpiles of anti-vehicle mines fitted with anti-handling devices. Technical literature suggests that between 50 per cent and 75 per cent of existing AVM types are equipped with AHDs. It may be possible to include these devices in almost all mines at little cost.¹⁵

ANTI-HANDLING DEVICE.



Photo: NPA

Countries which are full members of the Ottawa Convention yet which possess AVMs fitted with anti-handling devices include Austria (the ATM 2000 E mine), Belgium (PRM-ATK-3/PRB-M30), the Czech Republic (PT-Mi-DI M), France (HPD F2, MIAC DISP X F1), Germany (AT-2, MIFF and DM 31), Spain (CETME, SB-81/AR-AN), the UK (AT-2, Barmine), Norway (AT-2) and Sweden (FFV 028).¹⁶ Non-members of the Ottawa Convention possessing AVMs with AHDs include Finland (the KP 87) and the United States (the M 19 mine). Many AVMs have prefabricated fuze wells in order to accept additional anti-handling devices (for example, the US M19 has two such recesses for the M2 anti-handling device).¹⁷

CASE STUDY: THE AT-2

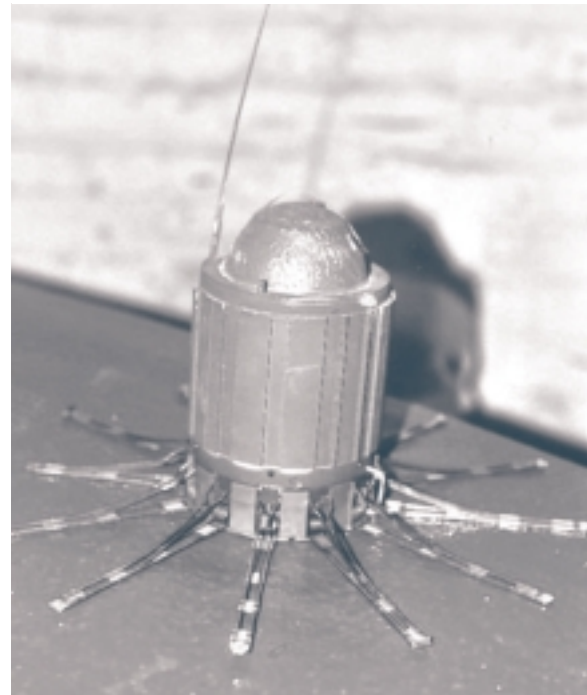
The German AT-2 is a scatterable AVM that is in service in several NATO countries. It is equipped with an anti-handling device to prevent the mine from being lifted.¹⁸

Former UK Defence Minister George Robertson stated in May 1999 that the AT-2 mine ‘...which was procured in co-operation with France, Germany and Italy, is equipped with an anti-handling device which causes detonation after deliberate and sustained movement of the mine’.¹⁹ But earlier when the first AT-2 procurement phase started German military authorities stated that ‘...the AT-2 mine prevents any movement of combat vehicles and dismounted soldiers’.²⁰

Other sources give technical descriptions of the mine that appear to confirm its sensitivity: the mine’s sensors pass on signals to the electronic fuze (to detonate the mine) if there are attempts to handle or move the mine²¹ or if the mine’s S3 target sensor, rising up like an antenna from the top of the mine, is touched.²² Military sources note that the AT-2 detonates when the mine’s position is altered (which conceivably may be the result of an unintentional act) and that the mine contains a magnetic influence fuze.²³ Magnetic fuzes are activated by changes in the immediate magnetic field, including – according to their sensitivity – by the proximity of a person, or by moving the mine. One source recommends not searching for the AT-2 mine with a metallic mine detector, which may cause the mine to detonate.²⁴

Along with its anti-handling device, the magnetic fuzing of the AT-2 makes it possible for the mine to be

AT-2 MINE WITH S3 TARGET SENSOR



detonated by an unintentional act, for example by the slight movement caused by a person walking into or stumbling over it. On detonation the AT-2 mine will normally cause catastrophic damage to a vehicle as well as propel secondary fragmentation out to a radius of 150 to 225 meters. The actual plate, fragment or slug could have a hazardous range over one kilometre.²⁵

In Germany the AT-2 was procured in three periods. Between 1981 and 1986 300,000 AT-2 mines were procured for the LARS-Rocket Launcher and between 1984 and 1992 there was a second procurement phase for the Skorpion mine launcher.²⁶ Altogether 640,000 AT-2 have been produced for this project. Between 1993 and 1995 another 262,080 AT-2 mines were manufactured for the MLRS rocket launcher.²⁷ The total cost for these three weapon systems amounted to 2.11 billion German Marks including mines and delivery systems.²⁸

The AT-2 has been exported to the UK, France, Italy and Norway, and remains in service in Germany, the UK, Norway and France despite its anti-personnel potential. But the Italian government concluded in 1997 that ‘... the AT-2, is sensitive enough to be detonated by a person...’ and ordered the destruction of all 45,000 AT-2 mines in Italian stocks.²⁹

In 1999 it was announced that the German MoD had offered 23 Skorpion mine launchers, including 36,000 AT-2 anti-tank mines, to Greece. Altogether 60 of the 300 German army Skorpion systems were to be sold.³⁰

2.2 Anti-vehicle mines with personnel-sensitive fuzes

The anti-personnel mine used as a fuze

The most evident anti-personnel capability of an anti-tank or anti-vehicle mine is achieved by manufacturing the mine so that it is fused with an APM, in order that a person stepping on the APM initiates both mines. This is possible with the Argentine FMK-3 (production status unknown),³¹ which is fused with the FMK-1 AP mine, Brazil's T-AB-1 (believed to be no longer in production)³² and Pakistan's P2MK2 (production status unknown).³³ Argentina and Brazil are Member States of the Ottawa Convention, as is Belgium whose PRB III and PRB IV anti-vehicle mines are fused in the same way as the PRB M35 anti-personnel mine (no longer produced).³⁴ Another common form of improvised fuzing is simply to place an APM on the top of one or more anti-vehicle mines and/or mortar shells causing their sympathetic detonation.³⁵

Low pressure thresholds

A US military source stated in 1971 that 130 to 180 kg of pressure was needed to activate a common AVM pressure fuze, but that the activation pressure may be modified to produce detonation from lighter pressure, such as soldiers, civilians running³⁶ or light vehicles. According to German military EOD specialists a running person can apply pressure of up to 150 kg to a mine

fuze when striking it with a heel.³⁷ Another source states that most AVM pressure fuzes will react to the steady application of 100 kg. Different postures, or running or walking, will apply different ground pressure. In addition, the environment in which the mine is emplaced is an important variable; if, for example, a stone is above the mine's pressure plate this can concentrate any pressure applied into a small area and thus increase the chance of detonation.

However, much greater sensitivity can be achieved.³⁸ Examples of low-pressure AVMs include: the Na-Mi-Ba (Czech Republic and Slovakia, activated by as little as 2.2 kg); PT Mi-P (5.7 kg); the AT copy of SACI (Egypt, 63 kg); ACNMAE T1 (Brazil, 60 kg); TMA 1A, TMA-2, TMA-4, TMA-5 (CIS, 100+ kg).³⁹ The Turkish 4.5 kg anti-tank mine operates on pressure of 75 kg.⁴⁰ The ALPRMT 59 fuze is reported to give the French MACI 51 mine an operating pressure of 5 to 25 kg.⁴¹ There are also reports that the German DM-11 anti-tank mine, which is in use in Somalia, can easily be reset to a low-pressure threshold of only a few kg.⁴² The PT-Mi-P mine is currently in stocks of the Czech Republic Army.⁴³

Tilt rod fuzes

TMRP-6 ANTI-VEHICLE MINE WITH TILT ROD FUZE



A tilt rod is a thin flexible pole protruding from a mine, which is attached to the fuze so that when pressure is applied against the rod the mine is activated. The operating pressure of an AVM tilt rod fuze is typically very low, usually only a few kilograms. Many AVMs have been equipped with additional fuze wells to

which tilt rods can be fitted.⁴⁴ For example, the Mk7 mine formerly manufactured in the UK can also be used with a tilt rod fuze (and is in service in at least eight African countries). Tilt rods can be so sensitive that a person walking through undergrowth concealing a mine could initiate it by accidentally striking the rod. The reason tilt rods are designed to be so sensitive is that the mines might tip over before the required detonation pressure was applied if they were more resistant.⁴⁵

BOOBY TRAP WITH ANTI-VEHICLE MINES AND MORTAR AMMUNITION FUZED BY AN ANTI-PERSONNEL MINE



Photo: Sean Sutton, MAG

Russian TM-46 and TM-57 AVMs are equipped with tilt rod fuzes that require 21 kg of pressure to initiate the mines; the TMK-2, also from Russia, requires eight kg. The Czech PT Mi-P and PT Mi-U mines require 5.7 kg, the US M21 mine two kg, and the Yugoslavian TMRP-6 less than two kg.⁴⁶

Trip wire fuzes

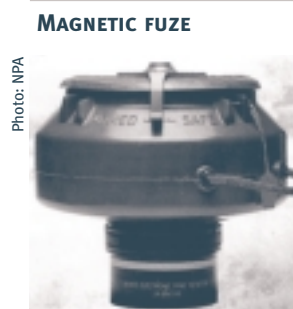
Trip wires can be made to function when tension in the wire is released or if the wire is pulled. Usually the wire is stretched across a target area and the mine initiates when enough traction or release is applied. Trip wire fuzes can be fitted to almost every mine equipped with suitable fuze wells. As with tilt rod fuzes, the operating pressure can be very low. The French MACI 51 AVM requires only 1-3.5 kg pull to detonate (less than one of the most common APMs, the Valmara 69, which requires six kg).⁴⁷ The Yugoslav TMRP-6 AVM requires a pull of only 1.5-4 kg to activate its explosive charge which creates a plug of metal and propels this upwards with over 2,000m/sec acceleration. In Bosnia these mines were used on both ceasefire lines, and some were strapped to trees for horizontal effect.⁴⁸ Military experts believe the new generation of such mines will continue to be a major threat for the next 30 years at least.⁴⁹

Break wire activation

A break wire activates a mine when an electric circuit within the wire is broken. This can also happen when the break wire is hidden or buried. The French MIACAH F1 anti-vehicle mine operates in this way; however, UK stocks of this mine (designated L-27 in the UK) were classified as anti-personnel and have been withdrawn from service.⁵⁰ Other break wire-operated mines are possessed by France: the APILAS-120 (production now discontinued)⁵¹ and MI AC H F1 anti-tank mines.⁵² The German PARM-1 off-route mine (in service with the German Army) is equipped with a fibre optic sensor cable that 'wakes up' the mine when pressure is given to the cable and enables other targeting sensors to function. Canadian forces are warned that 'PARM-1 has a sensitive breakwire fuzing. Use caution when following down the contact wire, ensure not to touch the fibre in any way'.⁵³ Finland, a non-Ottawa Convention country, has the break wire-operated ATM-L-84.

Magnetic sensors

Objects and people generate specific magnetic fields, and for this reason magnetic sensors are fitted to both APMs and AVMs.⁵⁴ Two different types of magnetic sensor are commonly used with anti-vehicle mines: passive and active. Passive magnetic sensors are often used in AVMs because they are cheap and operate with very low battery drain, potentially remaining operative for extended periods. They may sense a change in the magnetic field, and cause the mine's detonation. Passive magnetic sensors may be very sensitive to any metal objects placed nearby or approaching the sensor, for example hand-held radios brought into the vicinity of the mine⁵⁵ or other metallic objects, such as keys, carried by a person. It is controversial how sensitively active magnetic sensors react to passing metal objects and countermeasures, but there are indications that many active sensors are sensitive enough to react to any metal object in the vicinity of a mine.⁵⁶



Scatterable AVMs with magnetic fuzes, that are lightweight, remain on the ground surface, and are readily knocked into a different position, are likely to be easily detonated by an unintentional act.

Mines with magnetic sensors that can be activated by metallic mine probes, tripwire feelers and metal detectors pose a significant threat to demining personnel.⁵⁷ Mines reacting to 'commonly available' mine detectors are prohibited by the Convention on Conventional Weapons (Amended Protocol II, Article 3.5). It remains unclear which magnetic mines do this.

Several states party to the Ottawa Convention have retained in their stockpiles or permit the manufacture of anti-vehicle mines with magnetic fuzes which may be sensitive enough to be activated by the unintentional contact, presence or proximity of a person. The German AT-2, as noted above, contains a magnetic fuze, in addition to a target sensor. The UK's scatterable Shielder L35A1 mine, and the Barmine, contain magnetic fuzes, as do the modern French MIAC DISP X F1 mines which can be scattered by the Minotaur

minelayer.⁵⁸ Detection of the Barmine is described as very hazardous if the (optional) anti-disturbance or magnetic influence fuzes are fitted.⁵⁹ The Austrian ATM 2000E has advanced fuzing with seismic activation and magnetic influence actuation and soldiers are simply warned that it should not be approached.⁶⁰ The Italian SB-81 scatterable anti-tank mine is equipped with a self-neutralisation mechanism and a tilt rod fuze; the SB-MV-1 variant provides a magnetic influence fuze and an anti-handling device.⁶¹ Military advice is that ‘the SB-MV/1 has advanced magnetic influence fuzing and should not be approached’.⁶²

German military authorities, and a German mine producing company, have unofficially confirmed that the DM-31 AVM (in Sweden called the FFV-028) can be detonated by the presence of metallic objects. Canada also stocks the FFV-028 and Canadian military authorities stated that the mine is activated by changes in the electromagnetic field around it.⁶³ An increase in the metal content in the area (for example, a car passing over it) or simply moving the mine (changing its orientation in relation to the earth’s magnetic field) can set it off. The DM-31 is owned by the Dutch forces as well as the Swedish forces;⁶⁴ the Dutch Ministry of Defence apparently believes the mine may not be compliant with the Ottawa Convention because of the highly sensitive nature of its sensor.⁶⁵ The Canadian Forces landmine database confirms this, noting that ‘disturbance of the mine body will cause actuation’, and that the sensitivity of the fuze is ‘similar to an integral anti-disturbance device’.⁶⁶ The database warns soldiers not to approach the mine when it is armed.⁶⁷ The Canadian Forces mine clearance database warns that the DM-31/FFV-028 mine may be set off by sweeping a metal detector over the mine.⁶⁸

In addition there are reports that the Bulgarian TM-62 M mine reacts to metal detectors in the same way.⁶⁹ It is recommended not to approach the mine. The TM-62 M, originally produced by Russia, is in use in 25 states, mostly developing countries.⁷⁰

EXAMPLES OF OTTAWA TREATY STATES PARTIES CURRENTLY STOCKPILING OR PRODUCING AVMS WITH MAGNETIC FUZES⁷¹

Australia	SB-MV-1
Austria	ATM-2000E
Belgium	HPD-F2
Bulgaria	TM-62 M
Canada	FFV-028
France	MI AC DISP X F1, HPD F2
Germany	DM-31 (FFV-028), MIFF, AT-2
Hungary	HAK-1
Italy	SB-MV-1, MIFF, BAT/7, AT-2
Netherlands	FFV-028, N 30 (HPD F2)
Norway	HPD-F2, AT-2
Sweden	FFV-028
Switzerland	Modell 88 (HPD F2)
UK	L35A1 Shilder, Barmine, AT-2

Anti-vehicle mines fuzed (or ‘woken up’) by other sensors

There is a range of sensors designed to initiate modern anti-vehicle mines. Most common among these are seismic sensors, which react to vibrations in the ground. Acoustic sensors react to the noise made by a vehicle engine. Light-sensitive sensors activate when uncovered and exposed to light. Infrared sensors react to radiated heat. Fibre-optic cables often used with off-route mines such as the German PARM-1 react to being driven over. Optical and other sensors react to movement.

From the military point of view high but contrasting demands are made of sensor-fuzed mines. They have to be very sensitive to react to a potential target but ideally they should be passive to countermeasures and accidental activation by a person, animals or by natural environmental influences.⁷² In attempts to achieve this difficult combination, modern AVMs are often equipped with a mixture of sensors. Acoustic and/or seismic sensors are often used to ‘wake a mine up’, while infrared and/or optical sensors seek targets and finally detonate the mine. Modern mine patents describe a mixture of sensor types to try to avoid unintentional mine explosions, but due to the very high costs of these sensors a two-sensor mix (magnetic and seismic) has become the norm. For example, the UK’s Barmine can be equipped with seismic and magnetic sensors, and has been exported to at least 12 countries, mostly in

the Middle East. It is unclear – and there appears to be no published evidence – whether seismic sensors can distinguish between the vibrations caused by a tank and those caused by a heavy civilian vehicle, or that infrared sensors can distinguish between the heat given off by a tank engine and that given off by the engine of a heavy civilian vehicle.⁷³

One case where reliable target discrimination is claimed is the German Cobra scatterable area defence mine.⁷⁴ This is described as able to distinguish between ‘light vehicles’ and a tank, but nothing is said about the mine’s ability to distinguish between a heavy civilian vehicle and a tank. Specialist literature also notes that this mine’s technological risks are not assessable at present.⁷⁵

A recent interview with a representative of the US Textron mine production company stated that its scatterable area defence mine, the Hornet, is not yet technologically mature, and that it would be not advisable to pass a Hornet minefield with a light vehicle or private car.⁷⁶ The ARGES off-route mine, soon to be a NATO standard AVM, features optical sensors to identify and discriminate between targets. Because of this the ARGES should be approached only from an angle to the rear.⁷⁷

In the mid-1980s the addition of autonomous sensors also allowed conversion of existing light and medium anti-armour weapons into ‘off-route mines’. This technology enables minimal modification to the basic AT rocket system to convert most current anti-tank weapons into unmanned, autonomous systems.⁷⁸

TABLE 2: SELECTED INFANTRY ANTI-TANK WEAPONS ADAPTABLE AS ANTI-VEHICLE MINES

Country	Anti-tank weapon	Current production and use
Bulgaria, Czech Republic, Poland, Romania, Russia	RPG-7	In production. Producers: Kovrov Mechanical Plant, SRPE Bazalt. In service with all former Warsaw Pact countries, and general use in Africa, Asia and Middle East
Czech Republic	RPG-75	Available. Producer: Zeveta Group. In service with former Warsaw Pact armies
France	Apilas	In production. Producer: Giat Industries. There are two off route mines: Apilas 120A and Apilas APA. They are equipped with AHDs and are breakwire operated. The Apilas anti-tank weapon is in service with Belgium, Finland, France, Italy, Jordan, South Korea, Saudi Arabia, Spain and many other countries
France	AB-92	Unknown
Germany	Panzerfaust 3	In production. Producer: Dynamit Nobel AG. Target detection functions by break wire. Autonomous firing mounts and aiming devices initiated by sensors or remote control by television cameras
Spain	C-90	In production. Producer: Instalaza. In service with the Spanish Army and other armed forces
Sweden	AT-4	In production. Producer: Bofors. In service with the Swedish Army, US Army, Denmark, Netherlands, Brazil, Venezuela and France
Sweden	AT-12T	Unknown
Sweden	PF89	Unknown
UK	LAW 80	In production. Producer: Hunting Engineering. In service with the British Army, Jordan, Oman and other overseas customers

Sources: Defense Intelligence Agency (1992): *Landmine Warfare – Trends & Projections*, December. Jane’s Infantry Weapons 1999-2000, 25th edition. GICAT (2000): *Eurosatory Catalogue*. Dynamit Nobel (1996): *Panzerfaust 3*, brochure.

2.3 Modern scatterable mine systems

Nearly every modern mine can be remotely scattered in large numbers by a variety of mine-laying systems including artillery rockets, helicopters, ‘dispenser’ weapons (cluster munitions or stand-off weapons), or by combat aircraft. At least six companies, including DASA (Germany), MATRA and Thomson CSF (France) and BAE Systems (formerly British Aerospace) have recently undertaken development and production projects in dispenser weapons. So-called deep-strike delivery platforms are the primary area of ongoing landmine research and development expenditure.⁷⁹

TORNADO AIRCRAFT WITH MW-1 DISPENSER SCATTERING SUBMUNITION MINES (MUSPA & MIFF)



The trend towards scatterable mines raises a number of concerns from a humanitarian perspective. Scattering mines converts them from a defensive, tactical weapon into an offensive, theatre-wide weapon. Marking minefields is not possible using scatterable mines; this is acknowledged by the Convention on Conventional Weapons. According to one military source, ‘artillery delivered mine fields are dangerous, because the absence of positive control on their emplacement, the lack of visual marking systems and the strong chance that all relevant units will not know of their location means that their use must be judicious, if not restricted. Indiscriminate use of such minefields may pose a greater danger to allies than to adversaries’.⁸⁰

The German Ministry of Defence has stressed its scatterable mines are not directed against people, explaining that they are laid in the open and are visible to everybody.⁸¹ But tests with the AT-2 showed that the mine cannot be recognised when laid on a field or a meadow, and even on sand is only visible from a distance of about 15 metres.⁸²

Anti-vehicle or anti-runway mines used with dispenser systems are often classified as sub-munitions, as they

are in Germany. Examples of these include the German MIFF anti-vehicle mine or the anti-runway mine MUSPA. Both mines are classified as anti-personnel by Italy, which has destroyed its stocks of these mines as a result.⁸³ The US classifies the MUSPA as anti-personnel.⁸⁴ Both MIFF and MUSPA can be dispensed by derivatives of the MW-1 cluster munition, specifically the Dispenser Weapon System-24, the Dispenser Weapon System-39, TAURUS 350 A and the Autonomous Free Flight Dispenser (AFDS).⁸⁵ Other potential dispensers include the Low Altitude Dispenser and Tactical Munitions Dispenser SUU-64/65 and various cruise and ballistic missiles; this list is not exhaustive.⁸⁶

2.4 Self-destruct and self-neutralisation features

Self-destructing mines are designed to detonate, activated by their own fuzing mechanisms, after a pre-determined time period, while self-neutralising mines ‘render themselves inert, so they no longer pose a threat’.⁸⁷

It is sometimes suggested that mines designed to self-destruct (SD) and/or self-neutralise (SN) do not represent a long-term threat to civilians. Modern ‘smart’ AVM systems are often equipped with these features, but the majority of existing AVM types are not. Rather than protecting civilians, these technologies were designed to facilitate crossing of their own minefields by military forces.

In practice, SD and SN mines add to the uncertainties and hazards facing civilians in mined areas. Self-destruct mines endanger people merely by the fact that civilians do not know when the mine will explode: being in the immediate vicinity of an SD mine when it happens to explode is an obvious physical hazard. Additionally, uncertainty about when the SD mine was laid, when it was set to self-destruct, and how reliable this is, will both endanger and deter the use of land, potentially including those with accurate knowledge of the mine. With self-neutralising mines, when and whether they have in fact self-neutralised will not be evident to soldiers, deminers or civilians approaching a mined area.

Some AVM types can be pre-set to self-neutralise in a period from one to 127 days, for example the Italian SB-MV mine.⁸⁸ Two other aspects of SD and SN mines increase the uncertainty and hazard they pose: firstly, there is also no assurance to civilians or humanitarian deminers that SD and SN mines will not be used together with other mines without these features, in mixed minefields. Secondly, these technologies are primarily intended for use in remote-delivery systems that scatter thousands of mines in a few minutes. Scatterable systems in general, and their self-destruct systems in particular, have high failure rates.⁸⁹

These ‘smart’ landmines have reportedly failed to self-destruct or self-neutralise in large numbers, with common failure rates of 5-10 per cent. Because of the sheer volume of mines used in scatterable systems, this translates into many unexploded mines. Less sophisticated production methods have been reported to result in failure rates as high as 50 per cent.⁹⁰ A theoretical failure rate of one per 1000 has been asserted by those advocating SD and SN systems, and this standard has been incorporated into the Convention on Conventional Weapons, but no evidence has been put forward to support this.

According to a patent referring to the AT-2 mine held in German, UK and Norwegian stocks, when the mine hits hard surfaces such as concrete (a road) or natural rock the detonator’s programme sequence can be disturbed, altering the mine’s self-destruction to an indefinite period.⁹¹ Field experience also indicates high failure rates of SD and SN mines. During Operation Desert Storm 34 per cent of all US casualties were caused by landmines, many of them caused by US penetration of its own smart, scatterable minefields.⁹² Ten per cent of the US Gator AVMs used in the Gulf War did not self-destruct.⁹³ This means that the mines may remain live for years as a result. The German mine producer DASA acknowledged that increased use of scatterable munitions would result in a considerable increase in dud rates.⁹⁴

2.5 ‘Improved’ landmines

For several years, companies such as Bofors (Sweden), Dynamit Nobel Graz (Austria), Tecnovar (Italy), TDA Thomson CSF-Daimler Chrysler Aerospace (France) and Nea Lindberg (Denmark), have been offering ‘improved’ landmines that incorporate anti-handling mechanisms and/or modern fuzes. Others, such as SM Swiss Ammunition Enterprise Corporation, offer upgrades of existing ammunition, grenades and mines.⁹⁵ Bofors has developed two mine fuzes to improve the effects of older pressure-fuzed AVMs. ‘The mechanical M15 fuze triggers a mine if its sensor wire is moved, similar to the German AT-2 mine produced by Dynamit Nobel’.⁹⁶ The second is the electronic M16 mine fuze that reacts to changes in the magnetic field and has an active life of 6 months.⁹⁷ Nea-Lindberg’s M/88 electronic anti-vehicle mine fuze is used by the Royal Danish Army with the UK’s Barmine. The M/88 is offered as an economical way to retrofit non-metallic mines and provide most of these mines with a capability to be initiated merely by a vehicle passing over it, without the need for direct pressure. It has a built-in anti-tilt device, which can be set to ignore light targets. The M/88 self-neutralises after 90 days. It was also produced under license in the UK by Royal Ordnance (designated the RO 150), for export and domestic use.⁹⁸

These AVMs, ‘improved’ by the addition of AHDs or fuzes that may be personnel-sensitive, are termed ‘look-alike’ because many of them are identical in appearance to their unmodified versions. They are especially common in developing countries and increase the risk of humanitarian demining operations.⁹⁹

ATM 2000 E ANTI-VEHICLE MINE



Photo: GIBL

TABLE 3: 'LOOK-ALIKE' MINES CURRENTLY IN PRODUCTION

Country	Original mine	Look-alike mine with anti-handling feature	Current status	Mine function/type of anti-handling device/personnel-sensitive fuze
Austria	PM 85, PM 3000	ATM-2000E	In production. Producer: Dynamit Nobel Wien/Graz and Intertechnik (Austria)	Magnetic influence fuze, inc. AHD
France	ACPM, HPD, MACIPE	HPD-F2	In production. Producer: TDA (Thomson CSF-Daimler Chrysler Aerospace) Since 1989, more than 400,000 HPD 2 have been ordered	Magnetic influence fuze, inc. AHD
Italy	MATS/2	MATS/2	In production. Producer: Tecnovar	Pressure fuze, blast mine, inc. possible AHD
Italy	SB-MV/T	SB-MV/AR	In production, ordered by Australia. Producer: BPD Difesa	Magnetic influence fuze, inc. AHD
Italy	TC/3.6	TCE/3.6	In production. Producer: TECNOVAR, EXTRA (Portugal)	Pressure fuze, blast mine, inc. possible AHD
Italy	TC/6	TCE/6	In production. Producer: TECNOVAR, EXTRA (Portugal)	Pressure fuze, blast mine, inc. probable AHD
Sweden	FFV028RU	FFV 028 SN	In production. Producer: BOFORS	Magnetic influence fuze, inc. AHD

Note: this table gives examples only; it is not exhaustive.

Sources: UN/DHA Landmine Database 1999, United States Department of State (1998): Hidden Killers. DOD Humanitarian Demining Website Database <http://www.demining.brtrc.com/>. DOD (1997) International Deminers guide, ORDATA CD-ROM. Jane's Mines and Mine Clearance 1999-2000. Pionierschule und Fachschule des Heeres für Bautechnik, Minendokumentationszentrum (1993): Minenhandbuch Somalia, München, Mai 1993. DMS Market Intelligence (1996): Forecast Landmines. Jane's Mines and Mine Clearance 1997-1998. Defense Intelligence Agency (1992): Landmine Warfare - Trends & Projections. ICBL Landmine Monitor 2000.

2.6 Country case studies

UNITED KINGDOM

Policy

The UK's Ministry of Defence believes that anti-tank mines are not illegal and, according to Ministers, the UK will use them if required by an operation.¹⁰⁰ However, the UK's stock of 4,874 L27A1 off route anti-tank blast mines, activated by break wire, were classified anti-personnel, withdrawn from service and destroyed in 1996 and 1997.¹⁰¹

More recently, during discussions at the Standing Committee of Experts (SCE) on the General Status and Operation of the Ottawa Convention in January 2000, nine states parties restated that under the Treaty's definitions and provisions, anti-vehicle mines with anti-handling devices which can be activated by the unintentional act of a person are banned. It was proposed at the SCE to set up an informal, expert group to examine this issue. Only the UK delegation publicly opposed this proposal, and by May 2000 no consensus had been achieved on the establishment of such a group.

At the May 2000 SCE on the General Status of the Convention, the UK delegation stated that the UK had a different understanding of the words in the Convention than that expressed by other states parties, but supported a proposal by the ICRC to hold consultations on this issue of AVMs and AHDs in early 2001.

Although the UK acknowledges that some very sensitive anti-disturbance devices do exist, the MoD argues that these are not found in UK stocks. According to Parliamentary statements, 'all UK weapons systems have been checked for compliance with the provisions of the Ottawa Convention. There are no weapons or munitions in the UK inventory that fall under the Ottawa definition of an antipersonnel mine'.¹⁰² The UK argues that it is problematic to try to distinguish between intentional and unintentional acts that cause a mine to detonate.¹⁰³

Meanwhile the UK retains stocks of mines, which could have anti-personnel capabilities because of their anti-handling devices, or the sensitivity of their fuzes. These are the Barmine (according to the Government 'no anti-handling device is fitted to this weapon, but disturbance of the mine may, in some circumstances cause it to detonate'); the AT-2 ('the anti-handling device fitted to this weapon would cause detonation after deliberate and sustained movement of the mine') and the Shielder's L35A1 ('no anti-handling device is fitted to this weapon, but disturbance of the mine may, in some circumstances cause it to detonate').¹⁰⁴

Of these, Shielder was the most recently procured; it was ordered from the US firm Alliant Techsystems in 1995, at a cost of £110 million.

Of further concern are mines that the Ministry of Defence (MoD) is in the process of acquiring. The MoD is going ahead with the procurement of the ARGES anti-tank weapon (Automatic Rocket Guardian with Electronic Sensor) from the family of weapons known as ACEATM (Aimed Controlled Effect Anti-Tank Mine). A Government statement described this weapon's anti-handling device as 'non-lethal'. Apparently, it would 'switch off the weapon if disturbed'.¹⁰⁵ The system is initiated by an acoustic sensor and a target selection system, while firing is initiated by a passive infrared detection system and laser.¹⁰⁶

Another future UK system in procurement is the Area Defence Weapon, known in the US as the Hornet Wide Area Munition. This is a hand emplaced mine that senses and tracks vehicles, even if the vehicle has not run directly over it, then fires a warhead which fires a heavy metal projectile at the target from above. It uses acoustic and seismic sensors, and can attack a vehicle from a distance of 100 metres. According to the MoD, 'a non-lethal anti-handling device would switch the weapon off if disturbed'.¹⁰⁷ However, as noted already, the US manufacturers of the Hornet recently described this as not yet technologically mature, saying it would be not advisable to pass a Hornet minefield with a light vehicle or private car.¹⁰⁸

Production

UK firms continue to co-operate with European firms on the production or development of anti-vehicle mines: the Ajax-APILAS off-route anti-tank mine produced by Manurhin, BAE Systems, and Giat; and ARGES (Automatic Rocket Guardian with Electronic Sensor), a rocket-launched ATM system produced in a consortium of Giat Industries, Hunting Engineering, Dynamit Nobel and Honeywell Regelsysteme. The MLRS (Multiple Launch Rocket System), manufactured by a consortium of European companies including the UK's BAE Systems and Hunting Engineering, scatters the German AT-2 mine. The main landmine-related elements of the BAE Systems/Royal Ordnance Defence product range are listed by the company as LAW 80, MLRS, the Barmine and MINX (mines in the new century).¹⁰⁹

GERMANY

Production and exports

Many of the mines listed in Table 5 opposite have been exported, including to other states party to the Ottawa Convention. In 1997, before the Ottawa Convention entered into force, Germany exported 468 AT-2 missiles to Norway (one missile is usually equipped with 28 AT-2 mines, which suggests that at least 13,104 AT-2 mines were exported).¹¹¹ An estimated 100,000 AT-2 mines were also exported to the UK. In 1999 there were press reports that the German MoD had offered 23 Skorpion mine launchers, including 36,000 AT-2 mines, to Greece.

TABLE 4: MINES MANUFACTURED BY BRITISH COMPANIES OR STOCKPILED BY THE UK'S MoD

Mk 7 anti-tank (AT) blast mine. Can be used with tilt rod fuze.	Manufactured by BAE Systems/Royal Ordnance Total MoD stock held: not known. To be phased out in 2000/01.
Barmine pressure operated AT blast mine. Has three add-on fuze options including Anti Disturbance Double Impulse (ADDI) fuze (detonates mine when it is rotated about its longitudinal axis); and the Full Width Attack Mine Electronic (FWAM (E)) fuze, with a seismic and magnetic sensor.	Manufactured by BAE Systems/Royal Ordnance Total MoD stock held: not known.
AT2 AT shaped charge mine (scatterable). Contains integral anti-handling device. Designed to self-destruct after a maximum four days.	The MLRS (Multiple Launch Rocket System) containing the AT2 is manufactured by a consortium of European companies including the UK's BAE Systems and Hunting Engineering . Total MoD stock held: estimated 100,000.
Shielder Vehicle Launched Scatterable Mine System L35A1 AT mines with full width attack magnetic influence fuses. L35A1 are designed to self-destruct after a maximum fifteen days. They contain no integral anti-handling device, but moving the mine through the earth's magnetic field will cause it to detonate.	Mine manufactured by Alliant Techsystems (US), vehicle manufactured by Alvis (UK). Total MoD stock held: minimum 63,300 L35A1 mines.

TABLE 5: GERMAN ANTI-VEHICLE MINES WITH LIKELY ANTI-PERSONNEL CAPABILITIES

Mine	Total stocks	Fuzing
AT-2	1,200,000	Contains anti-handling device and magnetic influence fuze (see above).
DM-21	150,000	Pressure-operated fuze, initiated by 180-350 kg.
DM-31/ FFV 028	125,000	Initiated by magnetic influence fuze. Reportedly capable of being detonated by the presence of metallic objects. The sensitivity of the fuze is 'similar to an integral anti-disturbance device' and such that it may be set off by sweeping a metal detector over the mine.
PARM-1	10,000	Activated by pressure via a fibre optical sensor. Target discrimination is described as unreliable. ¹¹⁰
MIFF	125,000	Contains anti-handling device and magnetic fuze. Can also be initiated by ground vibration.
MUSPA	90,000	Electronic sensor fuze, initiated acoustically or by physical contact.

Altogether 60 of the 300 German army Skorpion systems were to be exported.¹¹²

From 1990-1999 Germany spent DM 2.5 billion (£800 million) on modernising mine equipment, including procurement of AVMs with AHD.¹¹³ Major companies have been involved including Dynamit Nobel, Diehl Stiftung, Rheinmetall and Daimler Chrysler, with many other companies producing components. Other major companies which are involved in marketing, developing and producing AVMs, components and delivery systems, include Honeywell, Krauss Maffei, Junghans, RTG-Euromunition, TDA/TDW, LFK, Taurus GmbH, GIWS, STN Atlas Elektronik.¹¹⁴

Shrinking defence budgets and restructuring of the European defence industry have forced many companies to merge their production and development facilities in various ways. The MLRS EPG (European Production Group) project involved European co-operation on a large scale, for production of the MARS/MLRS artillery launcher that can dispense AT-2 mines. The launcher is a European joint license production led by Diehl (Germany), Daimler Benz Aerospace (Germany), Thyssen Henschel (Germany), BPD Difesa (Italy), Aerospatiale (France) and Hunting Engineering (UK) (responsible for the warhead assembly).¹¹⁵ Other UK companies involved in the MLRS project are Marconi, GEC Avionics, Hughes Microelectronics as well as BAE RO Defence.¹¹⁶ A new guided AT-2 rocket for the MARS/MLRS launcher is currently under development.

Similarly, the ARGES autonomous off-route mine is co-produced by Dynamit Nobel (Germany), Honeywell (Germany), GIAT (France) and Hunting Engineering (UK).

ARGES OFF-ROUTE MINE



This is one of the most modern off-route mines on the European market, costing approximately DM 15,000-20,000 (£5,000-7,000) for one mine. ARGES is to be used as a standard NATO weapon, and is expected to be introduced soon. Norway purchased the ARGES under an offset agreement concluded in December 1997 with Giat Industries (France), to the value of approximately NOK 260 million (£22 million).¹¹⁷

Germany produces landmine sub-munitions such as the MIFF or MUSPA (Multi-Splitter Passiv Aktiv) for use with dispenser systems. Both mines are classified as anti-personnel by Italy, and the United States also classifies the MUSPA as an APM.¹¹⁸ Italy has decided to destroy its MIFF and MUSPA stocks, because of their anti-personnel effects.¹¹⁹ The MUSPA is distributed from the MW-1 cluster munition (dispenser system), and is designed for the destruction of semi-hard and soft targets. The MUSPA has a passive sensor system that can detonate by acoustic or physical contact.¹²⁰ MIFF (Mine Flach Flach) was also designed for use with the MW-1 cluster bomb. The MIFF fuze mechanism is activated when the mine is ejected from its dispenser. The main sensor is acoustic, and there are integral anti-handling features.¹²¹

Several countries are considering purchasing scatterable anti-vehicle mine systems, including Greece, the Netherlands and Spain, and industry officials have been promoting these systems to countries such as India, Saudi Arabia, South Korea and Taiwan.¹²² Greece has ordered AFDS (Autonomous Freeflight Dispenser System) weapons from Daimler Chrysler Aerospace/CMS to equip the country's A-7 Corsair, F-4 Phantom and the F-16 fighter aircraft.¹²³ Australia intends to procure the Taurus 350A cluster munition dispenser.¹²⁴ Another new German development is the SMArt-D (AM), a sensor-fuzed anti-material sub-munition, made by GIWS (Diehl/Rheinmetall).¹²⁵ However, the German MoD denied the existence of this scatterable mine/munition system in a recent letter to the German Initiative to Ban Landmines.¹²⁶

Politicians from several parties in Germany have previously supported a ban on AVMs, but there is currently no common position on AVMs in the coalition government. Policy is dominated by the MoD's view that AVMs are essential in view of reduced numbers of military personnel.¹²⁷

THE UNITED STATES

Most current United States AVMs are equipped with AHDs and/or magnetic fuzes. A number of these AVMs have been exported to at least 15 African and Asian countries.¹²⁸ Scatterable AVMs such as Gator were used in the Second Gulf War.¹²⁹

The US Department of Defense spent \$1.68 billion on scatterable landmine systems from 1983 to 1992, including combined anti-vehicle and anti-personnel mine systems. US companies involved include: Hughes Aircraft; ATK (Alliant Techsystems, awarded mine production contracts worth \$336 million between 1985 and 1995); ATK's Wisconsin-based subsidiary Accudyne Corp (awarded similar contracts worth \$150 million in the same period); and Lockheed Martin (awarded mine production contracts worth \$52,444,000 between 1985 and 1990).¹³⁰

President Clinton announced on 16 May 1996 that the US joining the Ottawa Convention would be dependent on the development of APM alternatives. The Under Secretary of Defense for Acquisition and Technology was directed to start a major development effort to find promising alternatives to APMs. The US has tasked its

project manager for 'Mines, Countermine and Demolitions' with a 'three track approach' to developing alternatives to APMs.

Remarkably, this search for APM alternatives starts with the development (Track 1) of new mine systems incorporating APMs, in clear contravention of the Ottawa Convention. Track 2 aspires to reliance in the future solely on AVMs, many of which are of concern due to their likely anti-personnel effects. Track 3 developments of APM-alternatives are described later in this report. For further details of this programme, see chapter 3.

Current Pentagon figures indicate that over \$300 million will be spent on research and development and \$500 million on procurement of APM alternatives through to Fiscal Year 2005. Of this total, the great majority (approximately \$620 million) is to be spent on non-self-destructing alternatives and RADAM, a system incorporating five APMs with seven AVMs in a single projectile. The non-self-destructing alternatives are intended to be a '...hand emplaced munition developed to meet the mission requirements formerly accomplished by M14 and M16 non self-destruct anti-personnel mines'.¹³¹ This consists of a munition

TABLE 6: US ANTI-VEHICLE MINES WITH LIKELY ANTI-PERSONNEL CAPABILITIES

Mine	Fuzing
M15	Pressure fuze and anti-handling device (AHD)
M19	Pressure fuze and AHD
M21	Tilt rod fuze and AHD
M24 off route	Contains AHD, fuzed with sensor wire
M56	Scatterable, pressure fuze and AHD
M70 (RAAM)	Scatterable, magnetic fuze, possible AHD. Once armed the mine is dangerous to move
M75 GEMSS	Magnetic fuze, replaced by BLU-91 Volcano
M-76/M-73	Scatterable, magnetic fuze and AHD
BLU-91-B Gator	Scatterable, magnetic fuze, possible AHD. Once armed the mine is dangerous to move
XM-78 MOPMS	Scatterable, magnetic fuze and AHD
BLU-91 Volcano	Scatterable, magnetic fuze
BLU-101	Scatterable, acoustic & infrared fuze and AHD
M2/M4 Selectable Lightweight Attack Munition	Infrared sensor

Sources: School of Advanced Military Studies, U.S. Army Command and General Staff College, Fort Leavenworth, Kansas (1988): Rethinking FASCAM - Principles for the use of Artillery Delivered Mines. ICBL Landmine Monitor 2000.

(apparently an existing APM like the M16) with a modified sensor/fuze and a control unit activated once the target has been confirmed as a combatant. However, the prototype has an option to allow automatic victim-activation, which would clearly be prohibited by the Ottawa Convention. This programme underwent accelerated prototype testing in October 1999, and a production decision is planned for late 2002. The Pentagon plans to procure 523,000 of these mines between Fiscal Year 2002 and FY 2005.¹³² The Pentagon has admitted that RADAM 'does not technically comply' with the Ottawa Convention, yet the total programme cost is estimated to be \$150 million, including procurement of 337,000 systems by FY 2004.¹³³ A procurement decision is expected in early 2001 with deployment early 2002.¹³⁴

2.7 Exports to mine-affected countries

European states party to the Ottawa Convention continue to produce and export new AVMs to mine-affected countries. For example, the Austrian ATM 2000 E mine, produced by Dynamit Nobel Wien/Graz and Inter Technik, has been delivered to Mozambique.¹³⁵ Dynamit Nobel Wien/Graz is also carrying out overseas distribution of the Hungarian HAK-1 anti-tank mine.¹³⁶ This mine, like the ATM 2000 E mine, incorporates an anti-handling device as well as a magnetic fuze.

AVMs are also frequently licensed or copied. Egypt produces at least twelve types of AVM, including licensed versions or close copies of US, Italian and Russian designs. Egyptian-made mines are known to have been deployed in Afghanistan, Angola, Eritrea, Ethiopia, Iraq, Nicaragua, Rwanda and Somalia.¹³⁷ Russian AVMs are found in almost every mine-affected country; its TM-62 mine is said to be present in large numbers in Angola as well as in other 25 countries. Yugoslav TMA anti-vehicle mines are also found in Angola and Namibia. Currently some east European companies offer modern AVMs for export, for example the Bulgarian firms IMS and Dunarit.¹³⁸ Defence experts believe that mines are still 'very promising export-wise. Mines are weapons of poor countries'.¹³⁹ (See also Appendix II).

2.8 Deployed anti-vehicle mines: the humanitarian impact

Anti-vehicle mines can cause a significant threat to civilians and hamper development and mobility of a whole region. In Mozambique, a single AVM on the road linking Milange and Morrumbala cut these two district capitals off from the rest of the world for over 10 years.¹⁴⁰

The above sections have described technical aspects of concern in relation to anti-vehicle mines. These concerns are heightened by reports from non-governmental organisations, including those engaged in mine clearance, which detail civilian casualties, the denial of access to impoverished areas and wider socio-economic problems caused by anti-vehicle mines that have already been deployed. The International Committee of the Red Cross (ICRC) has reported that the use of AVMs can also lead to an enormous increase in the costs of delivering assistance to victims of conflict. When supplies have to be transported by air due to the presence of AVMs on roadways, these costs increase up to 25 times.¹⁴¹ The following gives brief examples of the impact of anti-vehicle mines in mine-affected countries. The countries included are not an exhaustive listing of areas affected by anti-vehicle mines. (More detailed information about incidents caused by AVMs is available at www.landmine.de).

AFGHANISTAN

Since 1991, more than 400,000 people have been killed or maimed by landmines in Afghanistan. According to the Comprehensive Disabled Afghans Programme (CDAP), as many as 800,000 people, or four per cent of Afghanistan's population, are disabled, including some 210,000 landmine-disabled.¹⁴²

The United Nations reports that landmines have a considerable impact on roads and other transportation routes. During the course of the war, military forces of various warring factions have frequently made use of roads and other routes. To protect their own forces and prevent rival forces advancing, many important roads and routes were mined. Mining these roads has

TRUCK DESTROYED BY AN ANTI-VEHICLE MINE IN ANGOLA

Photo: Sean Sutton, MAG



prevented or restricted the movement of public transport, with the consequence that delivery of goods to most destinations in Afghanistan has been made more difficult, resulting in price rises which have negatively impacted on local economies. Moreover, MAPA's (Mine Action Programme for Afghanistan) data show that around 14,000 private and public vehicles, with a total value of approximately US\$211 million (average price US\$15,000 a vehicle), have been destroyed by landmines in Afghanistan.¹⁴³

Costs of transport and goods have risen due to the need to use dangerous, lengthy or difficult routes. Longer alternative travel routes requires additional time that could otherwise be used productively. Increased transport fares and extended travel time has resulted, per year, in a loss to the Afghan economy of more than US\$26 million. Mined roads have remained, on average, unusable for nine years and were considered to be one of the major factors contributing to increased commodity prices.¹⁴⁴

December 2000

At least twenty-five people have been killed in a landmine explosion in north eastern Afghanistan. Reports say several women and children died and two vehicles were destroyed in the blast, which took place in Takhar province.¹⁴⁵

October 1998

A wedding party was nearly wiped out by a single anti-vehicle mine. The road where the incident took place was unpaved and is used by local transport. The bus was travelling on the roadside, about one metre off the roadway, when it hit the AVM and blew up. Forty-one people were killed and 39 wounded.¹⁴⁶

ANGOLA

It has been estimated that in Angola one in every five landmines is an anti-vehicle mine.¹⁴⁷ Since the renewed civil war in 1998 incidents caused by AVMs have increased dramatically. Mines laid on roads are a major impediment to the freedom of internal movement. According to UN and NGO reports, UNITA has used anti-personnel and anti-vehicle mines to prevent government forces from entering areas under its control and to restrict the movement of civilians, either by keeping them within the areas it controls, or by keeping them from leaving government towns. UNITA also used landmines to make areas unsuitable for cultivation and to deny hostile populations access to water supplies and other necessities.¹⁴⁸ It is reported that UNITA also preferred to deploy anti-handling devices, and laid mines at random, unmarked.¹⁴⁹

By November 2000, the National Institute for the Removal of Obstacles and Explosive Devices (INAROE) had recorded 2,617 mine fields in Angola. INAROE reported 204 mine-related accidents throughout the country in the first six months of 2000, with 100 people killed and a further 327 injured. Of these, 327 were civilians. Most of those affected (251 people) were killed or wounded by mines when they travelled in vehicles on roads.¹⁵⁰ In the town of Luena alone, the German NGO Medico International reported that 59 people became victims of AVMs between April 1998 and September 1999.¹⁵¹

February 2000

A truck hit an anti-tank mine killing 10 people. 18 others were seriously injured.¹⁵²

April 2000

38 people were killed when the vehicle they were travelling in triggered an anti-tank mine.¹⁵³

May 2000

At least 10 people were killed and 21 others seriously wounded when the vehicle in which they were travelling detonated an anti-tank landmine.¹⁵⁴

BOSNIA

According to UN data, until 1998 15 per cent of all mine casualties in Bosnia were caused by AVMs.¹⁵⁵ The Government of Bosnia reported that as of 1 February 2000 there were 18,293 suspect or mined areas, with one mine in six thought to be an anti-vehicle mine. Minefields in Bosnia and Herzegovina generally remain unmarked.¹⁵⁶

December 1999

Three Bosnians were killed and five injured when an anti-tank mine exploded in Sarajevo.¹⁵⁷

June 2000

Two mine experts were killed when an anti-tank mine exploded during a clearance operation.¹⁵⁸

BURUNDI

In Burundi the UN expressed concern over the growing threat posed by AVMs, stating in 1997 that anti-tank mines were 'becoming a growing concern on Burundi's major roads'.¹⁵⁹ According to the UN, between 1996 and 1998 there were 112 mine incidents resulting in 364 casualties, about half of which were deaths. Seventy per cent of incidents were the result of AVMs.¹⁶⁰

March 1997

Three people died and about 10 others were injured when two anti-tank mines exploded in the Burundian capital, just two weeks after similar explosions claimed seven lives there.¹⁶¹

June 1997

An anti-tank mine explosion in Gihanga claimed the lives of eight soldiers and four civilians travelling in a pick-up.¹⁶²

ETHIOPIA/ERITREA

In Ethiopia it is estimated that 20 per cent of all laid mines are AVMs.¹⁶³ Reports indicate that large areas of farmland are expected to remain idle until mines have been cleared; over 15,000 hectares of farmland remain

idle in Badme, Gemhalo, Adiwala, Shebedina, Galwdeos, Mentebetelb and Adameyti as a result of mines, including AVMs.¹⁶⁴ In the 19-month border war between Ethiopia and Eritrea landmines were planted by both sides. These mined areas are currently unmarked and unmapped.¹⁶⁵

There are regular reports of vehicles detonating mines along the frontier with Kenya and the Djibouti-Ethiopia railway line, where both cargo and passenger trains have been derailed on at least three occasions in 2000.¹⁶⁶

In the Somali National Region, a mine destroyed one of the Region's two functioning ambulances, seriously injuring the driver. A local doctor was killed in a mine incident at Qabridahari, and a nurse and a driver working on the national polio immunisation campaign were also killed by a mine.¹⁶⁷

KENYA

There are several reports from Kenya of AVMs blowing up vehicles in Moyale on the border with Ethiopia, with several people killed. In 2000, police in Nairobi confirmed several incidents in which vehicles ran over AVMs in the same area. On 22 March 2000, fourteen civilians were killed and four injured in two incidents when their vehicles drove over mines in Dugo, two miles north of Moyale.¹⁶⁸

'This village was saved by donkeys otherwise we could have starved to death. The road to Moyale was closed for one month and even after it was declared safe, few vehicle owners were willing to put their vehicles at risk of being blown up by landmines. Everything we eat here comes from Moyale. We are used to bandits, the government provides us with armed security escort, but these strange explosives are very deadly, even the escort cannot protect us from them. We are very scared.'¹⁶⁹

Kosovo

In 1999 the Yugoslav Army and security forces used both AVMs and APMs in abandoned positions, around civilian centres and extensively along the Albanian and Macedonian borders. According to the UN Mine Action Co-ordination Centre, a total of 7,232 mines (3,448 APMs and 3,784 AVMs) were cleared between June 1999 and May 2000, following the withdrawal of Yugoslav forces.¹⁷⁰ In the same period, eight people were killed and fifteen injured by AVMs in Kosovo.¹⁷¹

SENEGAL

According to a recent study of 433 landmine casualties in Casamance (Senegal) by Handicap International, landmine accidents usually occurred when people were far from where they lived (76 per cent), although 70 per cent took place in inhabited areas. For 67 per cent of incidents, the victim was in a car or other vehicle; 61 per cent of the casualties were identified as being caused by anti-vehicle mines. Of all the victims, nearly 18 per cent required amputations; 22 per cent were killed.¹⁷²

SUDAN

In Sudan AVMs, grenades and shells, missiles and rockets have reportedly been adapted into APMs.¹⁷³ It is a common practice to attach AVMs to APMs for greater lethality. Truckers reported that all roads except one inside Sudan to Eritrea were heavily mined; there were no warning signs on the roads.¹⁷⁴

‘In the Sudanese war we have come to learn that there is no difference between an APM and ATM. The only difference intended by manufacturers was the quantity of explosive content and the spring that can discriminate weights. That is no longer the case as improvisation techniques could make ATMs, grenades and all types of shells, missiles and rockets into APMs which cause much devastation to humans.’¹⁷⁵

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3

FUTURE ALTERNATIVE ANTI-PERSONNEL MINES

The Ottawa Convention has already translated into shifts in military doctrine. There is evidence of rapid proliferation and procurement of systems that can mimic the function of anti-personnel mines. Some of these alternatives are essentially modifications of existing weapons, while others are based on more advanced weapons technology. Within the US in particular, many different technologies are being investigated to produce APM-alternatives, some labelled lethal and some labelled 'non-lethal'. This chapter illustrates some of the alternatives being developed and the doctrine on which they are based, focusing on technologies specifically designed or promoted as alternatives to anti-personnel mines.

3.1 'Off-the-shelf' alternatives to anti-personnel mines

Many of the landmine alternative technologies already in existence have formats that give them 'mine-like' characteristics. Some of these technologies are activated manually by systems known as 'man-in-the-loop' – a firing mechanism that governments agree would exclude them from the terms of the Ottawa Treaty. Others can be automated and if operating in this mode are essentially victim activated.

As described in chapter 1 of this report, the Ottawa Convention captures characteristics typical of existing anti-personnel landmines: design such that the weapon will 'explode' by the presence, proximity or contact of a person, and in particular as a result of unintentional or innocent acts by a person; and an ability to incapacitate or injure one or more people. The Convention was a response to a third characteristic of anti-personnel mines: their indiscriminate impact on people, causing unnecessary suffering, which can persist for years after deployment. 'Mines' are described by Article 2 of the Convention as munitions designed to be placed under,

on or near the ground or other surface area and to be exploded by the presence, proximity or contact of a person or vehicle.

Alternative APMs appear to share some, if not all, of these characteristics.

VICTIM-SEEKING AUTOMATED GUNS

Victim-seeking automated guns are now being marketed for border control, embassy protection and controlled environments such as nuclear power plants. For example, the Automated Weapons System made by the US company Autauga Arms Inc. is a camera-mounted concealed machine gun that can be set to automatically open fire if the boundaries of its control-zone are infringed. The manufacturers say the system allows a permanent guard to be placed without exposing men to various hazards, there is no fatigue factor and the infra-red cameras can facilitate accurate night firing.¹⁷⁶ A second US-based company, Precision Remotes, produces a similar device.

Other victim-seeking small arms include the Dragonfire, is an autonomous mortar system jointly developed by the US Picatinny Arsenal and Thompson Daimler Benz Aerospace.¹⁷⁷ Sweden was reported to be considering remotely operated sniper systems for use by its Ranger-type forces in rural areas, including 'man-in-the loop' technology.¹⁷⁸

EXPLOSIVE-DRIVEN ORDNANCE

There are several area defence systems which may lend themselves to field adaptation for use as mine-like weapons. It is believed that these technologies with cable activated links can be readily adapted by the manufacturer, or in the field, to become victim

CLAYMORE MINES

From APM to DFC

Although Claymore mines are often advertised as anti-vehicle mines, most of them can also be employed in an anti-personnel role, like the Romanian MAIGA 4.¹⁷⁹

In the case of Claymore-type directional fragmentation anti-personnel mines, the presence of several fuze wells is one of the factors determining whether these mines are able to be used within or outside the limits of the Ottawa Convention. Claymores are typically capable of activation in two ways, by a victim-activated trip wire connected to one of the fuze wells, and by a soldier-activated 'command-wire' connected to the other fuze well. The former clearly falls within the Convention's definition and prohibition of an APM, while the second does not. With the advent of the Ottawa Convention, manufacturers tried a variety of measures in order to put Claymores outside the Convention's definition of an APM.

One example of this process is the Austrian manufacturer Dynamit Nobel Graz/Wien, which first simply renamed the mines 'directional fragmentation charges' (DFC), then tried supplying the mines without the trip wire included (but which could easily be retro-fitted), but subsequently reached the Convention-compliant position of sealing the second fuze well so that the mines could only be soldier-activated. However, it is also possible to combine electrical command detonation and tripwire fusing within the same fuse well.¹⁸⁰ Since 1991 over 180,000 'Directional Fragmentation Charges' (until 1996 sold as anti-personnel mines) have been manufactured by Dynamit Nobel Graz/Wien and have been delivered mainly to European countries.¹⁸¹ Austrian APM-1 and APM-2 Claymore mines produced by Hirtenberger have been encountered by demining organisations in developing countries.¹⁸²

The production of Claymore-type mines continues in Austria (DFC 29 and AVM 100 & 195, DNG Giant Shotgun), France (MAPED F1), South Korea (K 440 & KM18A1), Czech Republic (PD MI-PK) and Columbia (Carga Direccional Dirigida).¹⁸³

activated. Where such anti-personnel systems are automatic and victim-activated, this may bring them within the scope of the Ottawa Convention. However, it remains unclear which of them are to be considered munitions 'designed to be placed under, on or near the ground or other surface area'. Where military personnel are certain to be involved in the decision to activate and/or aim such systems, they appear to fall outside the victim-activation element of the Ottawa Convention's definition of what is an anti-personnel mine or munition.

The French Ruggieri DIPS Area Defence System (Spider) consists of a multiple grenade launcher which can distribute a variety of disorientating, chemical irritant and wounding ammunition (900 tungsten balls released with an initial velocity of 800 m/s which will pierce 7mm aluminium at 20 metres). The manufacturers imply the potential for 'victim-activation' in their brochure stating 'all sensors allowed (use like mines or weapon systems)'.¹⁸⁴ The manufacturers claim that within a 240

degree arc, there is a 60 per cent chance of inflicting casualties covering a total radius of 5500 square metres.¹⁸⁵ Israeli Military Industries manufacture the POMALS (Pedestal Operated Multi-Ammunition Launching Systems) which is another weapon of this type, as is the Lacroix Sphinx-MODER Perimeter Defence which can fire operational rounds including fragmentation, smoke, CS and warning rounds¹⁸⁶ and is ostensibly a 'man-in-the-loop' cable activated system.

Other companies such as Mark Three advertise APM conversions to their Bear Trap system. This is ordinarily a jackhammer shotgun with a multi-cartridge cassette but is so designed that the cassette cartridge can be removed, ground emplaced and pressure-activated so that all cartridges are fired together, in other words as an APM. Pakistan Ordnance Factories have until recently marketed anti-personnel landmines primarily based on a hand grenade design, which is made under licence from ARGES in Austria.¹⁸⁷

ELECTROSHOCK FENCING

Modern border protection, area denial and perimeter protection systems might be thought of as the equivalent of the marked minefield since their hazards are usually clearly marked. Although victim-activated and persistent they are clearly visible and there is usually some choice in whether or not to activate their mechanisms.

One of the most infamous of such fences was the ‘snake of fire’ electrified fence which separated South Africa from its borders with Mozambique and Zimbabwe. This was supplied by the Johannesburg company Eclair, and allegedly caused more deaths in three years than the Berlin Wall did in its entire history – thought to be about 200 electrocuted each year in the 1980s.¹⁸⁸

Others who survived have suffered severe burns and some have lost limbs.¹⁸⁹ The fence has been at non-lethal detection mode, which alerts army patrols to transgressions, since 1990 but more recently in 1997, Joe Modise (South African Defence Minister) was reported as stating that the fence would be switched to lethal mode if the Botswana, Zimbabwe and Mozambique borders were continually crossed by illegal immigrants.¹⁹⁰

Other South African companies such as Microfence Pty have developed computerised intelligent intruder detection technology with stun and kill options. These fences are formidable floodlit structures above and below ground, with CCTV-scanned moats and walls with huge coils of electrified razor wire. The non-lethal options operate with a pulsed voltage of between 3,000 and 10,000 volts to deliver a powerful electric shock. The lethal option operates with AC or DC voltage of between 2,500 and 11,000 volts but with a much higher current of up to 800 milliamps. Microfence’s systems are reported to offer sophisticated zoning capabilities to enable an intrusion attempt to be electronically pinpointed to within 20 metres of the actual occurrence and the option of being switched from non-lethal ‘monitor’ mode to ‘lethal’ mode upon detection of a perimeter intrusion alarm.^{191, 192}

The impact of such fence systems on refugees, asylum seekers and nomadic peoples could be devastating. Without adequate accountability and control, a ‘push-

button refugee execution capability’ can effectively be built into such lethal electrified fence systems. South African companies have also been reported to be in negotiation for the construction of a fence system along the Kuwait-Iraq border.¹⁹³ Whilst it is not known whether this fence system will be electrified, the company advertises its ability to supply both non-lethal and lethal electrified fences.

These are examples of ‘off-the shelf’ systems which provide area denial functions as APM replacements. But the most significant determinant of future APM replacement technologies is likely to be the new US ‘non-lethal warfare’ doctrine that was formally adopted by NATO in 1999.

3.2 The development of alternative anti-personnel mines: the role of the United States

In a speech given on 16 May 1996 the President announced the US anti-personnel mine policy,¹⁹⁴ which predicated the US signing the Ottawa Treaty on finding alternatives to APMs by 2006. The Under Secretary of Defense for Acquisition and Technology was then directed to start a major development effort to find promising alternatives to APMs.

LETHAL ALTERNATIVES

Lethal alternatives to APMs currently being pursued under the policy are thought likely to contain three elements, namely:

- Precise real time surveillance systems to automatically detect, classify and track vehicles and/or people;
- Precise firepower to immediately suppress movement of enemy forces;
- Command and control systems (a ‘man-in-the-loop’) to cue the precise firepower.¹⁹⁵

A three-track approach is being co-ordinated by the Tank-Automotive and Armaments Command (TACOM).

The concepts all have sensors to detect and locate intrusion; command and control systems to direct response; and mechanisms to deliver APM effects. According to TACOM, 'an essential feature of replacement concepts is man in the loop control'. This is because TACOM sees such technology as making replacement mines capable of resetting, self-destruction or neutralisation, redeployment, being open to command fire, and 'location reporting'. This 'prevents fratricide', and perhaps most important but not mentioned is because such a feature helps to take the technology out of the provisions incorporated in the Ottawa Treaty.¹⁹⁶

Track 1 is required to meet the goal of finding alternatives to non-self-destructing APMs for use in Korea by 2006. Prototype replacements were tested in October 1999, a major contract for testing is imminent and a production decision is scheduled for September 2002.¹⁹⁷ Track 1 also incorporates a demand to retrofit existing 155 mm projectiles so that they contain a mix of anti-tank mines and APMs for delivery by artillery, a system known as RADAM. Because of the APM content, RADAM breaches the Ottawa Treaty and is arguably unnecessary given the rapprochement between North and South Korea. Critics argue that relinquishing this programme would allow the new President of the USA to sign the Ottawa Treaty.

Track 2 (under the Defense Advanced Research Projects Agency, DARPA) was initiated in October 1997 to find innovative alternatives. One proposal is the 'self-healing minefield', where mines have the capacity to act intelligently, using neural network logic to determine that a gap has occurred in their network and able to physically reorientate to fill any breaches made by an enemy force, thus obviating the need for protective APMs around anti-tank mines. DARPA is reported to have begun preliminary development of design issues, algorithms and initial demonstration of subsystems for the self-healing minefield in 1999, continuing through 2000 and beyond,¹⁹⁸ with contract awards of up to three years and totalling \$13 million.¹⁹⁹

For example, scientists from the Sandia National Laboratories have developed 'intelligent' mines to make anti-tank minefields 'self healing'. Without using anti-personnel mines, this concept is based upon a hopping

landmine equipped with a powerful piston-dash driven foot, ultrasonic sensors and radios. These mines can 'hop' up to 30 foot in the air and fill any gaps left in the minefield by clearance operations (or detonation).²⁰⁰

Research is also focusing on alternative target tagging systems such as micro-electronic tags which identify targets for direct and indirect fire using so called minimally guided munitions.

Track 3 is concerned with finding APM alternatives and alternative operational concepts to both anti-tank mines and mixed anti-tank mines with APMs. It was validated on 9 April 1999 and allocated a total of \$228 million for research, development, test and evaluation.

It has been recently reported that the US Army has picked five contractors to develop prototype designs for replacing mixed landmine systems that are comprised of anti-personnel and anti-tank landmines. The contractors are Alliant Techsystems of Hopkins MN (awarded a \$1.9 million contract); BAE Systems of Austin Texas (awarded a \$2 million contract); Raytheon of El Segundo, California (awarded a \$3.9 million contract); Sanders of Nashua New Hampshire (awarded a \$1.9 million contract) and Textron of Wilmington Massachusetts (awarded a \$3.9 million contract). Concepts solicited include 'system of systems and operational concepts involving changes to doctrine, tactics and force structure. Concepts may include, but are not limited to, sensors, command and control and communications systems, precision guided munitions, autonomous robotic systems, combat identification systems and algorithms and improvements to direct and indirect fire weapon systems'.²⁰¹

In addition, a search for 'non-lethal' alternatives to APMs is being co-ordinated by the US military's Joint Non-Lethal Weapons Program (JNLWP), which is described in the following sections of this report. This is based on newly developed military doctrine. The United States is driving most of the crucial developments in this field of area denial and alternative anti-personnel landmine technologies.

3.3 'Non-lethal' alternatives to anti-personnel mines

'NON-LETHAL' WEAPONS DOCTRINE IN THE US

The impetus for 'non-lethal' alternatives to APMs derives from two aspects of the so-called Revolution in Military Affairs:

- the need to find policy and military solutions to intervening in conflicts where combatants and civilians are both present, and
- the need to adapt existing military doctrines and weapons technologies to comply with recent shifts in International Humanitarian Law such as the Ottawa Convention, Convention on Conventional Weapons and Chemical Weapons Convention.

Recognition of the need to fight 'wars of intervention' grew in the early 1990s with the end of the Cold War, and the failure of US missions such as 'Restore Hope' in Somalia which left US troops and several thousands of civilians dead. One result was the creation of a doctrine where civilians could legitimately be targeted with non-lethal weapons alongside insurgents, emphasising that this change in tack was legitimate because the targets would not be harmed. In 1994 President Clinton enshrined this new approach into official policy whilst ratifying the Chemical Weapons Convention: 'I will... direct the Office of the Secretary of Defense to accelerate efforts to field non-chemical, non-lethal alternatives to Riot Control Agents for use in situations where combatants and non-combatants are intermingled'.²⁰² A series of new military postures ensued.

'We've got to find ways of taking people out without killing them and causing damage - something that can do more than a Riot Control Agent. I'm talking about the whole American peacekeeping mission (needing such harmless but effective agents). We're looking at things that can be used on crowds of people.'

General Wayne Downing - CINC USSOCOM

'Military Police operations, particularly military operations other than war (OOTW) combined with restrained rules of engagement, lend themselves to scenarios where non-lethal technologies would be preferred.'

US Army Military Police School²⁰³

New non-lethal technologies were rapidly promoted as both more effective and more humanitarian, and progressed from being a tactical option to a central and strategic role in the anticipated intervention wars of the 21st century. Charles Swett, US Assistant for Strategic Assessment in the Special Operations Policy Office at SO/LIC (Special Operations/Low Intensity Conflict), summarised the Non-Lethal Weapons policies of the US in 1997 as:

...to reinforce deterrence and expand the range of options available to commanders... to accomplish the following objectives:

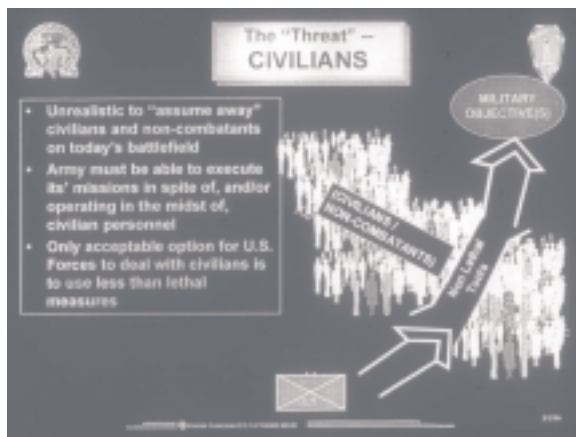
- Discourage, delay or prevent hostile actions
- Limit escalation
- Take military action in situations where lethal force is not the preferred option
- Better protect our forces
- Temporarily disable equipment, facilities and personnel.

*'Non-Lethal Weapons must achieve an appropriate balance between the competing goals of having a low probability of causing death, permanent injury, and collateral material damage, and a high probability of having the desired anti-personnel or anti-materiel effects.'*²⁰⁴

This doctrine says it is unrealistic to 'assume away' civilians and non-combatants, taking the view that the US must be able to execute its missions in spite of and/or operating in the midst of civilians. Therefore the US Army Non-lethal Warfare Requirements assume a dirty battlefield meaning civilians and non-combatants will be mixed with combatants and therefore targeted together. Seven 'non-lethal common tasks' have been previously identified in more detail as to:

- Incapacitate/stop an individual in a room , in a crowd, fleeing;
- Distract an individual, in a room, in a crowd;
- Seize an individual in a crowd, singly, stationary, moving;
- Stop a vehicle, approaching, retreating;
- Block an area to vehicles, to personnel;
- Control crowds, stop approach, encourage dispersal;
- Disarm or neutralise equipment.²⁰⁵

CIV THREAT: IN FUTURE CIVILIANS AND COMBATANTS WILL BE DELIBERATELY TARGETED TOGETHER BY NEW WEAPONS



Source: Proceedings of Non-lethal Defence II Conference 1996.

The US Army identified a range of tools for these missions, many of which have APM-like qualities or could mimic some of their attributes. These included anti-traction devices, acoustic weapons, entanglements or nets; malodorous munitions; barriers; foams; non-lethal mines; directed energy systems; isotropic radiators and radio frequency weapons. The potential target categories for these non-lethal weapons are combatants, criminals, hostages, hostages (willing), non-combatants, refugees, rioters and disaster victims.²⁰⁶

'NON-LETHAL' WEAPONS DOCTRINE IN NATO AND OTHER COUNTRIES

By the late 1990s US doctrine on APM alternatives was successfully assimilated into NATO policy. The process began with the first NATO-sponsored seminar on Non-Lethal Weapons in 1996, with 148 participants from 12 NATO nations (Belgium, Canada, Denmark, France,

Germany, Greece, Italy, the Netherlands, Norway, Turkey, the United Kingdom and the United States) and two non-NATO countries (Sweden and Switzerland).²⁰⁷

The stated objectives of the new NATO doctrine agreed on 27 September 1999 were twofold: 'to clarify the legal ambiguities surrounding the use of non-lethal weapons and to broaden the combat options for military commanders especially for purposes of peacekeeping and peace enforcement'.²⁰⁸ However, any hope of more humanitarian military action which the development of non-lethal weapons might suggest is contradicted by the 1999 NATO doctrine document, which echoes statements made repeatedly by US military commanders: that non-lethal weapons augment rather than replace lethal technologies in their arsenals.

'The availability of Non-Lethal Weapons shall in no way limit a commander's or individual's inherent right and obligation to use all necessary means and to take all appropriate action in self defence.'

'Neither the existence, the presence nor the potential effect of Non-lethal Weapons shall constitute an obligation to use non-lethal weapons or impose a higher standard for, or additional restriction on, the use of force. In all cases NATO forces shall retain the option for immediate use of lethal weapons consistent with applicable national and international law and approved 'Rules of Engagement'.'

'Non-Lethal weapons should not be required to have zero probability of causing fatalities or permanent injuries. However, while complete avoidance of these effects is not guaranteed or expected, Non-Lethal Weapons should significantly reduce such effects when compared to the employment of conventional lethal weapons under the same circumstances.'

'Non-Lethal Weapons may be used in conjunction with lethal weapons to enhance the latter's effectiveness and efficiency across the full spectrum of military operations.'

NATO, 1999.²⁰⁹

EUROPEAN RESEARCH AND DEVELOPMENT OF ‘NON-LETHAL’ ALTERNATIVES TO ANTI-PERSONNEL MINES

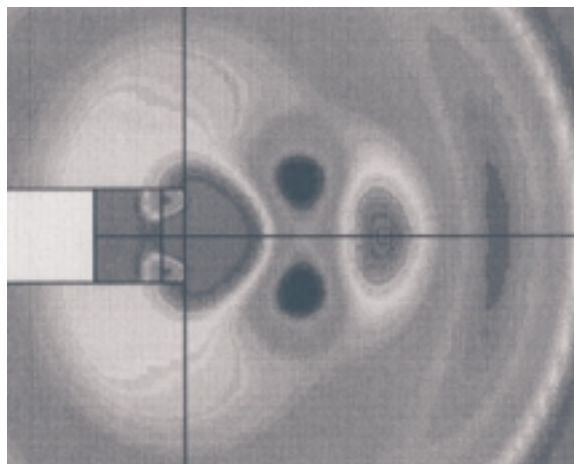
Relatively little has been published on European work on ‘non-lethal’ alternatives to APMs. What is known concerns the work of largely government-funded research laboratories in Germany, the UK, and Sweden. Details have emerged at specialist conferences in the United Kingdom²¹⁰ and the United States.²¹¹ Other European states may also be undertaking research – the US is liaising with Italy, France and Norway on these developments.²¹² In 1998 the German research organisation Fraunhofer Institut ICT founded a European Working Group on Non-Lethal Weapons ‘in agreement with the German Centre of Competence for NLW’. Six other European nations are involved: the UK, Italy, the Netherlands, Austria, Sweden and Switzerland. Further meetings took place at ICT in 1999.²¹³ The Director of the arms research branch of ICT reported that ‘...its task is to push ahead the co-operation between the participating countries in the NLW sector... in order to introduce non-lethal weapons into this subject area and to create the basis for the execution of research based work...’²¹⁴

Germany

German research on non-lethal weapons undertaken at Fraunhofer ICT began at the end of 1993 when the German MoD ‘placed an order with DASA for working out a study on NLW [Non Lethal Weapons]’. Work has included a presentation at the Army test area in Hammelburg in 1996, and resulted in the placing of three orders in 1997 for: ‘(i) the development of a ranging gun with an ‘Effector Net’; (ii) an infra-sound generator and (iii) an audible irritating sound machine’.²¹⁵ Work on the infra-sound generator using an oscillating combustion process was scheduled for completion in November 1998.

ICT is also involved in testing expanding foams and entanglements made sticky by a solution of cyanogen acrylate. The Director of ICT’s non-lethal programme advocates mixing various technologies such as infra-sound with or without irritant materials, foams and entanglements, for example the use of infra-sound with combinations of pulsed energy; supersonic energy; irritant gas; sticky foam and high power microwaves.²¹⁶ ICT is also working on vortex ring generators.²¹⁷

ICT VORTEX RING SYSTEM: FORMATION OF VORTEX RING IN A GERMAN EXPERIMENTAL LABORATORY



In October 1999 ICT hosted the first National Workshop on ‘New Technology-Non-Lethal Weapons’ together with the German Centre for Competence for NLW.²¹⁸ A workshop on High Power Microwaves and Non-Lethal Weapons was also held that same year.²¹⁹ A personal intervention made by ICT at the Non-Lethal Defense IV Conference in Washington in March 2000 led, says the ICT Director, to non-lethal weapons being included in the equipment of US soldiers stationed in Kosovo.

United Kingdom

The UK has been researching new classes of ‘less-lethal’ weaponry at the Defence Research and Evaluation Agency (DERA) since 1992. For many years the United States has shared research on ‘less-lethal’ weapons with the UK under the 1963 Quadripartite Agreement.²²⁰ At the Jane’s Information Group’s NLW 98 conference (Jane’s Non Lethal Weapons, Developments and Doctrine, 1-2 December 1998), it was revealed that technologies being examined in the UK include foam barriers, infra-sound weapons, high powered microwaves, slippery substances, laser dazzlers, and entanglement nets. Human volunteers have been used to test slippery barriers, smoke and foam.²²¹ The Infantry Trials and Development Unit and other organisations have participated in the entanglement trials involving nets. However, the programme’s research co-ordinator warned that it is ‘impossible to guarantee absolute safety of any system which causes incapacitation, disorientation or any other temporary effect – the aim was to minimise permanent effects’.²²²

DERA has been provided with the operational analysis of US studies on anti-vehicle initiatives such as entanglement nets, soil destabilisation and tyre attack.²²³ In February 1998 the US established an Information Exchange Agreement on 'non-lethal' weapons with the UK. Two exchange meetings in 1999 focused on APM-alternatives, modelling and simulation, crowd behaviour, training, doctrine, NLW vision and laser dazzlers. Initial planning for combined US/UK war games began in 1999 with joint events planned to continue into 2001.

3.4 Future technologies

To illustrate the forms of these second generation 'less than lethal' APM replacements the following section describes a range of projects, including those already commissioned by the US Joint Non-Lethal Weapons Programmes (JNLWP). (It should be remembered that in addition to so-called less lethal alternatives the US is also pursuing lethal 'alternatives' such as the RADAM mixed anti-tank and anti-personnel munition, as described above.) Although US manufacturers lead the field in this work, Australian, South African, and UK companies among others are also developing future alternatives to APMs.

What follows is a simplified outline of some of the key technologies being pursued, together with an indication of the estimated timescale before prototype or deployment stages. Many of these technologies serve as victim-activated high-tech booby traps or victim-activated variants of area denial technology which have the capacity to inflict either wounds or forms of punishment which require medical treatment.

EXPLOSIVE AREA DENIAL SYSTEMS

In April 2000 it was announced that Australian ballistics company Metal Storm is working to produce alternative landmine replacement systems which do not place active explosives in or on the ground. The system is based on an (up to) 100-barrel, sensor-activated electronic detection and multiple-mortar targeting system 'capable of direct and indirect fire'. The barrels can be loaded with a wide variety of 40 mm munitions, including less-

lethal munitions and even micro-cameras – ostensibly to enable the system to differentiate between civilians and combatants. There are no guarantees that such humanitarian guidelines will be operated in the field. The system is estimated to be ready in about two years.²²⁴ The Australian Army committed an initial A\$450,000 to the project, and an international consortium team of leading US and UK weapons manufacturers is contributing some A\$3 million over the next three years, according to a press release.²²⁵

South Africa's weapons development organisation Denel has been researching APM alternatives since 1996. Denel's view is that APMs are no longer necessary since area denial can be provided using a camera or other observation mechanism coupled to a simplified artillery system which is sufficiently precise to hit pre-registered points on what is in effect a 'virtual minefield', at ranges over one kilometre.²²⁶ The Mechem Division of Denel has an automated mortar sighting system, using a Differential Global Positioning System which links an observer and a mortar equipped with Automated Mortar Sighting System (AMS) by fibre optic cable. Mechem claims that, following a minimum of training, observers are able to hit the target on a 'look and click' basis, and subsequently announced that it would completely automate the 'layout' process during 1997.²²⁷

However, it is US developments of non-lethal alternatives to APMs that dominate publicly available sources of information. Many other countries are being drawn into these developments. The US Joint Non-lethal Weapons Program has recently briefed the following countries on non-lethal weapons: Australia, Canada, Colombia, France, Italy, Germany, Norway, the Republic of Korea, Sweden, and the United Kingdom. Data Exchange Agreements were signed with the UK (1998) and Israel (1999).

'NON-LETHAL' ADAPTATIONS OF EXISTING APMs

A new US variant of the Claymore-type directional fragmentation mine is termed the Modular Crowd Control Munition. This uses 'stinging rubber balls' and the existing Claymore mine dispenser. No kinetic energy figures for this munition are provided, but US researchers report that impact energies below 15 foot

pounds (20.3 Joules) are safe or low hazard (provided the projectile is large enough not to damage the eyes). Impact energies between 30 and 90 foot pounds (40.7 - 122 Joules) are described as dangerous, while impacts above 90 foot pounds (122 Joules) are assessed as being in the severe damage region.²²⁸ The MCCM device is listed as a means of breaking up crowds and hostile personnel, temporarily incapacitating at close range (5-15 metres). It can be integrated into 'layered perimeter' defence, and can be mounted on vehicles. This proposal has already gone to contract, with Mohawk Electrical Systems, current manufacturers of the Claymore M18A1 mine, involved.²²⁹ The MCCM now has a NATO Stock Number, and costs \$255 per munition, but as part of its further development 'tactical manual, tactics and procedures, Front Cover lethality and trip line development will be worked...'²³⁰ This implies that there are still unresolved issues regarding whether the front cover can kill or injure, and that trip wire initiation is being considered; but taken together, it is apparent that this weapon is likely to be victim-activated, designed to kill or injure, and therefore subject to the Ottawa Convention ban, as are conventional Claymore mines when trip wire-activated.

A non-lethal munition for site security and perimeter defence which functions similarly to the tactical bounding APERS mine has also been considered, dispensing entanglement nets, malodorous substances and riot control agents as possible immobilisation devices. Also proposed is an 'unmanned aviation vehicle' to deliver various non-lethal munitions including chemical irritants to affect large crowds. These devices potentially breach the Chemical Weapons Convention.

CALMATIVES

A range of tranquillising chemicals is being examined for Operations Other Than War (OOTW). The human brain has thousands of so-called receptor sites, defined by CBW expert Professor Mathew Messelson as a molecule on a cell which 'when a certain other kind of molecule called a ligand, binds to it, causes something to happen. Of the few that have been identified, some can cause temporary blindness; others can make you think you are smelling something that is not there, or can cause submissiveness or extreme anxiety'.²³¹

A report in May 2000 to the European Parliament's Science and Technology Options Assessment panel²³² names the likely chemical candidates for calmatives drugs as derivatives of the fentanyl family which are more commonly used in surgical practice as injectable anaesthetics. Some (for example, carfentanyl) are extremely toxic – more so than nerve agents like VX - with doses of 10mg/kg bodyweight being capable of inducing paralysis. These opioids can cause respiratory arrest and dose/effect ratios are extremely variable – one person's tranquillisation is another's lethal dose. Some of these calmatives produce mental confusion, elevated blood pressure, vomiting, prostration and coma with varying periods of duration.

The JNLWD Annual Report for 1999 refers to '...an experiment to identify alternate means of offensive operations that will provide the National Command Authority (NCA) and Joint Force Commanders (JFC) additional operational options when executing a coercive campaign'.²³³ The report refers to systems for delivering calmatives agents, including Active Denial Technology, the Low Cost Autonomous Attack System, Unmanned Aerial Vehicle, and the Extended Range Guided Munition. There is also a micro-encapsulation programme that lends itself to the dispersion of victim-activated calmatives (to release their effects only when trodden on), which was scheduled for completion in September 2000.

OBSCURANTS

These aqueous foams form an impenetrable soap-suds-like barrier that makes both communication and orientation difficult.²³⁴ They were developed in the 1920s as a fire suppressant in British coalmines and first saw military application during the Vietnam War. Fired in bulk from water cannon or specially designed back-packs, such foams can be piled up into semi-rigid barriers and laced either with chemical irritants or calmatives (in Vietnam, United States forces used CS-laden foam in 'tunnel-denial operations').²³⁵ If the foam is entered and disorientation occurs then the dose received will increase all the time that the person is in contact with the foam.²³⁶ Anyone attempting to cross the boundaries of the obscurant would be unaware of any hazards made invisible by the foam which may include

chemicals in the foam itself or wound-inflicting obstacles such as caltrops or razor wire.

During the 1980s further development was undertaken for the National Defense Agency to create anti-personnel aqueous foams laced with chemical irritants. Sandia National Laboratories provided the US Marine Corp with prototype aqueous foam-producing hardware in 1996 and a series of potential roles were identified including 'crowd control, blocking choke points, protected area access delay and area denial'.²³⁷ Oak Ridge Laboratories recommended that 'visual augmentation systems should be developed in conjunction with a new family of multi-spectral obscurants that would obscure the enemy's observation while allowing US forces to see through'.²³⁸ This is an example of the potential for 'non-lethal' systems to increase the lethality of more conventional weapons, as shooting disoriented people with obscured vision would be simple for those equipped for clear vision.

ENTANGLEMENTS

Three varieties of entanglement have been identified as having area denial functions: slippery substances,²³⁹ expanding sticky foam guns and barrier devices, and nets, which come with options including sticky adhesive, chemical irritant, electroshock and hooks.²⁴⁰ Many of these entanglement devices, also known in the American vernacular as 'stickums' and 'slickems', are now available commercially.

Anti-personnel sticky foam was developed as a non-lethal capture system but has now been virtually withdrawn because of the difficulties in decontaminating victims and the risk of killing through suffocation. Applications for rigid sticky foams are presented as sealing things together, sealing people out of security zones, or putting barrier systems like caltrops into place and making them immovable.

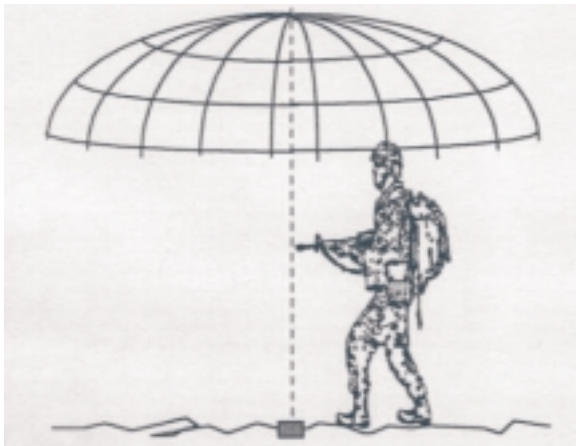
Ultra-slippery substances are not new but have been researched more recently as an area denial technology. Slippery substances were dropped on the Ho Chi Minh Trail during the Vietnam war in the 1960s, and several products (for example, Riotrol, Separan AP-30; others were dubbed 'instant banana peel' and 'slippo') were

promoted for riot control. Now known as counter-traction materials, they are generally supplied as dry powders containing polyacrylamides, carboxyvinyl polymers or polyethylene oxides, to which water is added. Typically they are aimed at producing friction coefficients of less than 0.5 since this is what is considered to be hazardous for people walking. A second generation of super-lubricants is emerging based on hydrocarbons with the addition of micro-fine fluorocarbon particles. Another alternative is teflon-based 'confetti' since teflon has a co-efficient of friction of less than 0.1.²⁴¹

In the mid-1990s the US Army at Edgewood Chemical Biological Command examined over two dozen commercially available polymer materials. Subsequent field demonstrations were reported to be successful but by 1998 the US Marine Corp required improvements in both materials and dissemination.²⁴² The JNLWP report for 1999 stated that contracts have been awarded for laboratory exploration, and for prototype dispensing systems and field evaluation. One non-lethal slippery foam has moved from concept exploration in May 1999 to Milestone I this year, an Initial Operating Capability in FY 2003 and a Field Operating Capability in FY 2005.

Gun-launched flight-stabilised entanglement nets started to become commercially available during the 1990s. As the technology matured, variations emerged which included super-strong spider filaments and chemical irritant-laced and electrified nets that were regarded as effective options for the alternative APM programme. The development of systems by which the nets are launched by a bounding munition such as the M16A2 APM or a canister-launched system was underway. The bounding munition was capable of firing nets with a radius of between 5-10 metres, designed to delay for between 5-15 minutes, and other payloads including chemical and plastic kinetic rounds. For the last several years this munition has been illustrated in nearly all US military presentations advocating non-lethal APM replacements. Yet the JNLWP report indicated termination of these programmes 'due to significant cost, schedule and performance issues'.²⁴³ Given that these were relatively established technologies in their lethal variant, the conclusion must be drawn that technicians were unable to deliver the non-lethality demanded by the programme.

BOUNDING NET MINE



Source: Graphic by US Joint Non-lethal Weapons Directorate.

MALODOURANTS

Some smells are more disgusting to particular cultures than others and military research to find powerful stench weapons that are race-specific has officially been going on for nearly forty years.²⁴⁴ In 1972, the US Security Planning Corporation suggested that malodorous substances might have a role as ‘non-lethal’ weapons.²⁴⁵

A number of synthetic malodourants now exist commercially, such as DeNovo’s Dragonbreath. This smells like a metallic mixture of rotten eggs and petrol and is said to produce a cross-contamination effect when a person doused with it runs through a crowd, in other words it sticks to other people when the fleeing target passes them.²⁴⁶ Stench weapons in development include concentrates of natural odours such as rotting meat, faeces, skunk and body odour.²⁴⁷ Scientific Applications and Research Associates (SARA) are already weaponising prototype malodourants which are intended to warn, annoy, disgust or nauseate. The aim is to produce a multi-sensory distraction device that combines the effects of sound, light and ‘an intense repugnant smell (malodourant)’. Proposed applications include clearing of facilities and landing zones, as well as dispersing civil unrest.

It is likely that any malodourant would breach the Chemical Weapons Convention if used in war. Nevertheless, research commercialisation is continuing apace.²⁴⁸ Micro-encapsulation techniques, unmanned aerial vehicles, helicopters, extended range guided

munitions and OLDS (Overhead Liquid Dispersal System) canisters are all being considered as dispersal systems some of which would be victim-activated. The US Joint Warfighting Centre was scheduled to model the effects of using caltivate and malodorous payloads and the Low Cost Autonomous Attack System early in 2000.

DIRECTED ENERGY WEAPONS

The potential use of so-called radio frequency or directed energy weapons has been widely reported.²⁴⁹ Various other directed energy weapons have also been proposed for anti-personnel area denial including laser, microwave and vortex ring technologies, which are the most controversial and potentially illegal variants of alternative APMs.

Some laser dazzler systems are already commercially available and sold as an optical shield.²⁵⁰ Others are currently under investigation by the US Air Force Research Laboratory for so-called ‘non-lethal point defence’.²⁵¹ A recent development has been to use an ultra-violet laser to ionise the air sufficiently for it to conduct an electrical charge, creating muscle paralysis or tetanisation.²⁵² A fully working prototype is still some way off but the principle has been successfully tested using a Lumonics Hyper X-400 excimer laser at the University of California at San Diego.²⁵³

Devices using the microwave part of the electromagnetic spectrum are probably the most controversial developments. They are seen as offering a potential rheostatic or tunable response from less-lethal to lethal, operating at the speed of light, as so-called ‘progressive penalty munitions’ (PPM). This term is graphic since it implies an overall philosophy as well as a set of particular weapon types. The ‘onion’ or ‘layered defence’ model which accompanies proposals for their deployment describes entering the outer layers as inviting a punitive response whilst the central core is lethal. Already demonstrated is the ability to induce a heating effect up to 107 degrees F to induce an artificial fever. There has been much speculation but a dearth of hard data about these psychotronic weapons.²⁵⁴ Such electronic neuro-influence weapons would be in breach of the recent EU resolution regarding technologies, which interact directly with the human nervous system.

High-powered microwave weapons are likely to become an increasingly common feature of 21st century warfare as manufacturers aim to design systems which fire electrons rather than bullets.

ACOUSTIC WEAPONS

Controversy and speculation also surround acoustic weapons. They are allegedly able to vibrate the inside of humans in order to stun, nauseate or, according to one Pentagon official, to 'liquefy their bowels and reduce them to quivering diarrhoeic messes'.²⁵⁵

Also labelled as Projected Energy, Sonic, and Forward Area Energy Weapons, three types are being examined by the US Army and Air Force: an acoustic rifle, a vehicle or helicopter-mounted acoustic gun for longer ranges, and an air-dropped acoustic mine.²⁵⁶ Twenty US companies are involved in developing acoustic weapons in a wide-ranging research effort to support 'active area denial programmes'.²⁵⁷ One major contractor, Scientific Applications and Research Associates, is quoted as saying high power acoustics can produce 'instantaneous blastwave-type trauma' and lethal effects with even modest exposure. Others, such as the German experimental physicist Jurgen Altman, have argued that claims for a viable acoustic weapon are nonsense,²⁵⁸ based on other research undertaken by Daimler-Benz Aerospace for the German Ministry of Defence.²⁵⁹

It is likely that any workable device would be based on making continuous controlled explosions but probably to produce vortex rings rather than just sound propagation. Altman recognised that 'it is plausible that a metre size vortex ring travels to 100m and more' but 'for vortex rings a detailed study would need to be done'. Scientific Applications and Research Associates was reported to be building a system working on the vortex ring concept which was undergoing trials in 1998 by the US Marine Corp. At a UK conference in 1999 on non-lethal technologies, Altman said it was critical that scientific information on such work be made openly available in the recognised scientific press and be subject to peer review. Secrecy has led to an enormous waste of public funds. The latest JNLWP annual report reinforced this scepticism by announcing that after 10

years of research into infrasound, the US non-lethal acoustics program was officially terminated. Other damning criticism came during a US symposium in 1999 where Dr. David Swanson of Penn State University said simply 'if you want to deliver energy across a space in air, acoustics is not the medium to use'.²⁶⁰

ELECTRICAL WEAPONS

The US companies Tasertron and Primex Aerospace are testing the Taser Area Denial Device, which uses the Volcano launcher. The Device lands primed to be victim-activated by a trip device and a variety of other sensors. Once activated, barbed darts are fired in a 120 degree multi-directional pattern, with 'volcano darts' fired in a single direction.²⁶¹ The darts reach out some 15-30 feet and 50,000 volts is pulsed through to the target, temporarily incapacitating the person, even through clothing. The pulses are of short duration (4-6 microseconds) and repeated 8 to 24 pulses per second. Four darts are fired at different angles to prevent anyone crouching to avoid a mid-torso strike, and the various cartridges can take down multiple targets if they approach at the same time.

Tasertron claim that 'the electronic pulse will temporarily incapacitate anyone within an inch of the darts by overriding the brain's signal to near surface motor control nerves, causing uncontrollable spasms of the subject's motor control functions. The subject will fall and temporarily be incapacitated. The subject remains conscious and alert but cannot control his muscles. A timing circuit will permit keeping the subjects incapacitated until they can be taken into custody by nearby troops'.²⁶² No mention is made of what happens if troops are not nearby.

This technology is now a prime candidate in the US as a non-lethal APM-alternative, with functions such as 'unmanned non-lethal perimeter patrol for border patrol and corrections usage'²⁶³ confirmed by a recent report.²⁶⁴

The 1999 JNLWP Annual report envisaged that the Technology Investment Program (TIP) for the Taser Landmine would be completed in January 2000. TADD is described as a 'fully reloadable device [and] features a remote alarm and control system that permits the

TASERTRON MINES



Source: Proceedings of Non-Lethal Defense IV Conference

capture of incapacitated intruders by nearby troops'.²⁶⁵ A key variant of the Taser mine called the Sentinel was presented at the Non-Lethal Defense IV symposium in Virginia in March 2000. Taser mines can be combined with video cameras to permit remote firing from an observation point – the so called ‘man-in-the-loop’ – which attempts to avoid the Ottawa Convention prohibition on victim-activated munitions. However, by targeting one element of the body (the human nervous system) and leaving the victim paralysed potentially for many hours, it is arguable that this weapon breaches the Geneva Convention restrictions on inhumane weapons. Commercially available stun weapons, from which the TADD technology is derived, are associated with reports of injury and death in Los Angeles,^{266 267 268} other cities in the US,^{269 270} within US prisons²⁷¹ and the UK.^{272 273} Stun weapons have also been reported as having a causal link with the miscarriage of a pregnant woman.²⁷⁴

BIO-WEAPONS FOR RACIALLY SELECTIVE MASS CONTROL

As a result of breakthroughs in the Human Genome and Human Diversity Projects and the revolution in neuroscience, the way has opened up to using blood proteins to attack a particular racial group using selected engineered viruses or toxins. A recent report to the Scientific and Technological Options Assessment Committee of the European Parliament suggested that breakthroughs in biotechnology (including gene therapy and computerised mathematical modelling of brain

function at a molecular level) have made such ‘bio-weapons’ feasible now. The report warns that as the data on human receptor sites accumulates, the risk increases of breakthroughs in malign targeting of suitable micro-organisms at either cell membrane level or via viral vector.²⁷⁵ Although not all experts agree on this,²⁷⁶ in the United States the newest micro-encapsulation dispersion mechanisms for chemical and biological weapon agents are being advanced for ‘anti-materiel and anti-personnel non-lethal weapons related to area denial and vessel stopping’.²⁷⁷ All such products would be illegal under the 1972 Biological and Toxic Weapons Convention. Unfortunately, this has no agreed verification procedures, unlike the Ottawa Convention and the Chemical Weapons Convention. However, there will be a review conference of the BTWC in 2001, which could address these issues. Meanwhile, the intensive research efforts of drug companies to map human receptor sites in the brain, in order to bio-engineer specific drug effects, will be examined meticulously in some CBW weapons laboratories in order to discover malign applications.²⁷⁸

ISOTROPIC RADIATORS, SUPER-ADHESIVES, -CAUSTICS AND -LUBRICANTS

There are many other so called ‘less-lethal’ munitions that have been developed as anti-personnel and/or area denial systems but which might impact on civilians. For example, isotropic radiators are optical munitions that use an explosive burst to superheat an inert gas to produce a plasma that radiates with a laser-bright light, and are likely to cause the same retinal damage to the eye as low energy lasers.²⁷⁹

Other systems use super-adhesive, super-caustic substances and super-lubricants that are designed to incapacitate vehicles. Highly caustic mixtures of concentrated hydrochloric and nitric acid have been suggested in the form of binary weapons to attack metallic structures, armoured vehicles, roads and rooftops.²⁸⁰ To be effective, these chemicals would need to be persistent in the short-term to avoid being washed away by rain and invisible to avoid military personnel taking avoidance action. Such usage in war would certainly breach the Chemical Weapons Convention.

Other systems have been proposed, based on ‘liquid metal embrittlement’ using chemical agents that alter the structure of base metals and alloys, causing their tensile strength and rigidity to decay. Similar approaches have been suggested to environmentally modify soil structures making them unstable, to deny road access to vehicles and civilians. By contaminating terrain on a widespread scale, such technologies will undoubtedly have long-term human and environmental implications.

ROBOTIC AREA DENIAL SYSTEMS

The use of robots in bomb disposal or explosive ordnance operations has become routine over the past 20 years, and their use in clearing landmines is now a focus of research activity (although it is difficult to see any prospect of successful outcomes appropriate to mine-affected developing countries). A number of companies are also researching the area-denial potential of robots activated by surveillance systems to make selective attacks with less-than-lethal devices. In 1983 Robot Defense Systems of Colorado created the Prowler – an armed two-ton vehicle designed for sentry duties.²⁸¹ A number of mobile security robots (for example MDARS, Cyberguard, Andros) have already emerged.²⁸² Some of these robots are armed, for example the weaponised Andros robot used by the Tucson Police Department since 1997. A range of non-lethal weapons for Special Weapons and Tactics operations has been developed, including robot deployment of a 12 gauge bean bag, Sage riot gun, a grab net, chemical munition deployment, plus a door and window breaching capability.²⁸³

DARPA have a programme on ‘self-deciding vehicles’.²⁸⁴ Sandia National Laboratories have fielded a robotic perimeter detection system that relies on gangs of small RATTler robotic all-terrain vehicles, to protect the perimeters of large bases.²⁸⁵ The Mobile Detection Assessment and Response System Exterior (MDARS-E) is a similar system for warehouses and other flat areas.²⁸⁶

The origins of these developments can be traced back to the US.²⁸⁷ Although most robots and unmanned vehicles have been designed for surveillance functions, increasingly military doctrine is looking to this

technology to remove the soldier from hazardous situations. In the late 1990s the US Marines became interested in the potential of robotic vehicles for ‘military operations in urban terrain’ (MOUT) and identified future requirements for 2000 onwards that include advanced delivery robots and unmanned vehicles carrying less-lethal weapons.²⁸⁸ In 1998, the US Defense Advanced Research Projects Agency (DARPA) planned to spend \$40 million over a four-year period on a tactical mobile robotics programme. DARPA’s third phase of its Robotics for Urban Terrain initiative began in 1999 (at a cost of some \$15 million) designed to produce a robot ‘pointman’.²⁸⁹ Sandia and ARL are also reported to be involved in the creation of a lethal robotic pointman.²⁹⁰ Recently, DARPA selected NASA’s Jet Propulsion Laboratory to lead a consortium to create a miniature tactical mobile robot for urban operations.²⁹¹

A number of ‘concept demonstration’ robots – armed autonomous robots independently identifying and engaging targets – exist. The most advanced is the Robart 3, which includes a Gatling gun-type weapon that fires darts or rubber bullets. Other armed robot concept models include the Roboguard, developed at King Mongkut’s Institute of Technology in Ladkhaabang, Bangkok by Pitikhate Sooraka. The Roboguard’s gun can be controlled by a camera on a motorised holder, which can be targeted using a laser sighter from anywhere in the world over the internet. Automatic victim activation is also possible via heat sensors which track people as they move.

Critics have pointed out that things will always go wrong with such automated killing systems including time delays across the internet when it is busy.²⁹²

ARMED ROBOT



The Rand Corporation’s Arroyo Urban Operations Team advocates the use of robots armed with ‘less-lethal’ weapons as area clearance operatives to save a World War II style house-to-house fight when super-cities must be forced into surrender. One Rand Corporation expert points

to the implications of undertaking urban operations in the South where populations have increased massively: 'At the turn of the century the population of Seoul will be 13 million; the United States Army will number roughly 0.5 million men and women. The implications are multi-fold... the tasks associated with the control and support of non-combatants could easily demand more manpower than was necessary to seize entire cities in the mid twentieth century...' ²⁹³

The proffered solution is to use non-lethal technologies to deny access of enemy troops and non-combatants into proscribed areas by using 'sector and seal capabilities'. These 'hyper-controlled engagements' would involve 'robotic delivery of foams to seal passageways, use of acoustic or microwave non-lethal systems, and remotely delivered lethal or non-lethal obstacles that would act to fix, canalise, turn or block forces that could then be targeted via the co-ordinated use of enhanced ISR (Intelligence, Surveillance and Reconnaissance) capabilities and accurate engagement systems'. ²⁹⁴

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- 267 *Police Review*, 16 September 1988. 'Two Los Angeles men have died after being shot by police stun guns. They were overcome by the electric darts as police arrested them in separate incidents on suspicion of drug abuse. Police use Taser guns to disable violent suspects temporarily. An investigation has been ordered'.
- 268 *Los Angeles Times*, 12 March 1993. 'Questions raised in death of man shot by Taser'. The death of Los Angeles barber Michael James Bryant, who died after being chased by police and, refusing to get out of a swimming pool, was shot with an electric stun gun, has raised serious questions about the incident. An autopsy on 10 March 1993 did not determine the cause of Bryant's death.
- 269 *Chicago Defender*, 1 July 1995. Section PG, Col 6:1. 'Woman guilty in stun gun death'. On 28 June 1995, Francine Knox was convicted in the death of her nephew, Brandon Jordan, an infant who died after being shocked with a stun gun. The Peoria Illinois woman could face up to 20 years in prison when she is sentenced for the death.
- 270 *New York Times*, 25 November 1994. 'A Baby's Stun-gun death'.
- 271 *San Francisco Chronicle*, 19 June 1992, Section A, 23:1. 'Lawsuit Seeks \$6 million in Duels Prisoner's Death'. Guards trying to subdue a prisoner at Duell Vocational Institution in Tracy CA in 1991 shocked the man to death with an electronic stun gun, according to a lawsuit filed in federal court 18 June 1992. The man, Donnie Ray Ward, was mentally ill.
- 272 Burdett-Smith, P. 'Stun Gun Injury'. *Journal of Accident & Emergency Medicine*. November 1997, vol. 14, no. 6, pp. 402-4.
- 273 Other reports of injuries have emerged where illegal stun guns have been used by robbers to immobilise their targets, enabling them to inflict physical injuries to the prone victim. See for example 'Hunt for brutal stun gun robbers', *Manchester Evening News*, 13 May 2000, p1.
- 274 Mehl, L.E. 'Electrical Injury from Taser and Miscarriage'. *Acta. Obstet. Gynaecol. Scand*, Summer. February 1992 vol. 71, no. 2, pp118-123. 'A case report is presented of a woman who was 'Tasered' by law enforcement personnel while 12 weeks pregnant. The Taser is an electronic immobilization and defense weapon that has been commercially available since 1974. The TASER was developed as an alternative to the .38 special handgun. The patient was hit with TASER probes in the abdomen and the leg. She began to spontaneously miscarry seven days later and received a dilation and curettage procedure 14 days later for incomplete abortion. As use of the TASER becomes more common, obstetrical clinicians may encounter complications from the TASER more often.'
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- See <http://www.isisuk.demon.co.uk/0811/isis/uk/bwproject/brpapers/no5.html>
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- 280 Knoth, A. *March of the Insectoids*, *Jane's International Defense Review* 55-58 (1994).
- 281 Robot Defense Systems went into liquidation in 1986. See Everett, 2000.
- 282 Everett, H. R. *A Brief History of Robotics* in *Physical Security* (14 June 2000). <http://www.nosc.mil/robots/land/robart/history.html>
- 283 See <http://www.ci.tucson.az.us/police/departments/swat/robot.htm> Remotec offer a range of robots which can be weaponised for SWAT operations.
- 284 See for example Perimeter Detection web page. Sandia National Laboratories. <http://www.sandia.gov/isrc>
- 285 [Http://www.sandia.gov/isrc/capabilitie...ter_detection/perimeter_detection.html](http://www.sandia.gov/isrc/capabilitie...ter_detection/perimeter_detection.html) (14 June 2000).
- 286 Jane's Police and Security Equipment Catalogue (1999-2000), p514.
- 287 Knoth, A. *March of the Insectoids*, *Jane's International Defense Review* 55-58 (1994).
- 288 See Presentation of Colonel Mazarra, United States Marine Co., 'A View To the Future', Janes Non-Lethal Weapons - Development & Doctrine conference, 1-2 December 1998.
- 289 Hewish, M. and Pengelley, R. *Warfare in the Global City*, *Jane's International Defense Review* No. 31, 32-43, 1998.
- 290 Glenn, R. and RAND Corporation *Mailed Fist and Velvet Glove, Non Lethal Weapons and Urban Operations* (Paper presented to Jane's 'Fielding Non Lethal Weapons in the New Millennium' Conference, 1-2 November 1999).
- 291 <http://www.robotbooks.com/war-robots.htm> 'JPL to develop miniature robots for tomorrows soldiers', (31 July 2000).
- 292 Sample, I. 'You have Twenty Seconds To Comply,' *New Scientist*, 2 September 2000.
- 293 See Glenn R, (Rand Corporation) (1999) *Mailed Fist and Velvet Glove, Non-Lethal Weapons And Urban Operations*, paper presented to Janes 'Fielding Non-Lethal Weapons in the New Millennium, November 1-2.
- 294 Ibid.

Anti-vehicle mines functioning as anti-personnel mines

Continual technological development of mines has made old distinctions between anti-personnel, anti-vehicle and anti-tank mines far less clear than may once have been the case. Although a manufacturer or country may designate a mine as anti-vehicle or anti-tank, this does not guarantee that it does not act like an anti-personnel mine. A range of fuzes and anti-handling devices appear to enable anti-vehicle mines to function as anti-personnel mines, or at least have variants that are anti-personnel.

Some states party to the Ottawa Convention are paradoxically engaged in the export and development of these personnel-sensitive AVMs, in some cases involving enormous financial inputs. 'Improved' variants of older mines provide new anti-personnel capabilities, while the safeguards that have been argued to render these weapons harmless, such as self-destruct or self-neutralisation mechanisms, appear to be unreliable and may compound the problems faced by humanitarian deminers and civilians alike. Scatterable anti-vehicle mines present further problems, both by increasing the unreliability of the weapons and their technologies and by being inherently difficult to mark and fence off to protect civilians. Developers have yet to demonstrate that the new mines' sensor technologies discriminate reliably; for example, in the case of magnetic fuzes, there are serious questions as to which fuzes are capable in different circumstances of being initiated merely by the approach of a person.

Differences of interpretation of the Ottawa Convention exist. Some states have destroyed anti-vehicle mines because of their anti-personnel capabilities, or (in the case of Italy and Spain) enacted legislation that explicitly identifies and bans certain anti-vehicle mines. Furthermore, reports from mine affected countries show that AVMs cause the deaths of many civilians in at least 25 countries. They tend to kill rather than maim civilians, and when they are detonated by civilian vehicles there is usually a large number of casualties.

Despite the evidence, manufacturers of AVMs continue to export weapons that damage economies and deny civilians the use of land, including access routes, as effectively as APMs. They put humanitarian deminers at risk. Some developed countries argue that they will use AVMs responsibly. But experience shows that as long as AVMs remain uncontrolled, their supply and use by 'less responsible' armed forces will continue.

Future alternative anti-personnel mines

The development of non-lethal alternatives does not herald harmless warfare. The doctrine behind these programmes identifies civilians as a specific target. Some of the new developments appear to be far from 'non-lethal' (official documents also use the term 'less-lethal').

In many scenarios, the purpose of 'non-lethal' alternatives to APMs is to increase the effective application of complementary lethal weapons systems. In these new weapons systems, and the scenarios in which their use is envisaged, it is difficult to find the discrimination between civilians and enemy combatants and the avoidance of victim-activation which lies at the heart of the Geneva Conventions and the Ottawa Treaty's prohibition of APMs. The Treaty prohibits munitions that are placed on or near the ground, are activated by the presence, contact or proximity of a person and 'will incapacitate, injure or kill one or more persons'. The spirit, if not the letter, of this prohibition may apply to many of these alternative devices.

The overall target for the US alternative APM programmes is the goal of producing viable alternatives to APMs by 2006. Despite the rhetoric of non-lethal doctrine and the need to prepare for interventionist wars and 'military operations in urban terrain', the actual identification and development by the US of viable alternatives to APMs on all three 'tracks' appears to be making slow progress. RADAM, the Track 1 system closest to production, is clearly not Ottawa Convention compliant, because it combines APMs with ATMs.

Track 3 development of alternatives to APMs, including many of the technologies noted above, is the least advanced. The broad agency solicitation issued in August 1999 was withdrawn in September 1999 and reinstated on 27 March 2000 seeking ‘critical or unique component technology that might provide or enhance near, mid and far term solutions to Track 3 of the Landmine Alternatives program’.²⁹⁵ Current plans are already set to fund Track 3 work through to 2005 at an estimated cost of \$170 million.²⁹⁶

However, some of these high profile projects have been cancelled abruptly, such as the acoustic and bounding net programmes, due to ‘significant cost, schedule and performance issues’.²⁹⁷ These costly technologies, once quoted as the shape of alternative anti-personnel technologies of the future, now join earlier variants of sticky foam which were discontinued because of fears of suffocation and the difficulty of cleaning-up victims. A US Human Effects Process Action Team (HEPAT) concluded that methods of quantifying non-lethal human effects have all been inadequate: ‘HEPAT has reviewed the missions, resources and processes of several DoD organisations involved in medical and bio-effects research, and has concluded that none can be applied directly to fulfil the need to characterise NLW human effects. This was attributed to the very new nature of NLW development and the dramatic differences from lethal weapons in developing effectiveness criteria’.²⁹⁸

Such research underlines the point that the search for a truly non-lethal alternative APM is likely to be a contradiction in terms. Nevertheless current plans will spawn further generations of dubious weapons based on dubious research. Future generations of civilians may be confronted not only with the sub-lethal replacements for APMs but also the range of new technologies outlined in this report. This could be a future humanitarian problem in the making, being driven by the manufacturers and military of developed countries.

Public knowledge and understanding of the potential human rights implications posed by some alternative landmine technologies remains relatively undeveloped. Most official sources are either lacking in technical detail or overlook the ways in which these emergent technologies are victim-activated and civilian-targeted.

International humanitarian law

The status of existing and proposed alternative APMs in relation to current international human rights legislation is both problematic and ambiguous. After all, many of these weapons have been designed in theory to circumvent the provisions of existing treaties. Some of these technologies are highly sensitive politically, and without proper regulation they can threaten or undermine many of the human rights enshrined in international law, such as the rights of assembly, due process, freedom of political and cultural expression, protection from torture, arbitrary arrest, cruel and inhumane punishments and extra-judicial execution. The 1863 Lieber code, for example, established for the first time that military necessity does not permit methods and means of warfare which are cruel and that the long term consequences of any weapon must be taken into account²⁹⁹. Many of these new incapacitating alternatives to APMs rely on pain or paralysing mechanisms that in certain contexts might fall foul of the Lieber code. One example might be a civilian electroshocked into paralysis by a Taser mine until an enemy soldier can be spared to carry out a rescue.

Consequently, the actual deployment of such weapons in war could easily lead to challenges under existing international law, although many grey areas will remain when they are used in conflicts other than war, peace keeping and internal security operations. According to the ICRC, such alternative area denial technologies should not be considered as a separate unique category of weapons but as new technologies coming within the scope of the existing laws of war. There are several basic principles that guide international perceptions of what is a legitimate use of a particular weapons technology and what is not. These include the principles of (i) unnecessary suffering (Hague Convention 1899); (ii) the principle of distinction (which distinguishes between civilians and combatants and requires that military operations are only against military objectives); (iii) the Martens Clause which maintains that civilians and combatants remain under the protection and authority of international law; and (iv) the rule of proportionality which decrees that there should be a reasonable relationship between the amount of destruction caused and the military significance of the attack.

Article 3, which is common to all four Geneva Conventions, is regarded as a treaty in miniature and says that all persons not taking part in the conflict including civilians, refugees and combatants who have laid down their arms should be treated humanely and that the wounded and sick shall be collected and cared for. Acts against such persons that are specifically prohibited include:

- violence to life and person, in particular murder of all kinds, mutilation, cruel treatment, torture;
- taking of hostages;
- outrages against personal dignity, in particular humiliating and degrading treatment;

- the passing of sentences and the carrying out of executions without sentences pronounced by a regularly constituted court.

The information available suggests that alternative APMs may breach not only the Ottawa Convention but also other existing international humanitarian law. The table below summarises relevant legal instruments and weaponry described in this report that may fall within scope of the restrictions they contain.

TABLE 7: INTERNATIONAL HUMANITARIAN LAW AND ALTERNATIVE LANDMINES

International humanitarian law	Scope
1997 Ottawa Convention Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on Their Destruction.	Bans anti-personnel landmines. Bounding net entanglement mines, less-lethal Claymores and the proposed Taser mines may be open to a legal challenge on this basis. Mixed mine systems such as RADAM would certainly not comply with the Ottawa Convention.
1949 Geneva Conventions (Convention I for the Amelioration of the Condition of the Wounded and Sick in Armed Forces in the Field; Convention III concerning the Treatment of Prisoners of War; Convention IV concerning the Protection of Civilian Persons in Times of War) 1977 Geneva Protocol I & Geneva Protocol II concerning the Protection of Victims of International Armed Conflicts and Non-International Armed Conflicts.	Attacks on civilians and refugees by weapons that lead to mutilation are banned under the Geneva Conventions. Sub-lethal Claymore mines which can lead to mutilation; paralysing and punishment inflicting Taser electroshock systems and robot systems which can punish and execute without resort to 'due process' would appear to violate the provisions of the Geneva Conventions. Indiscriminate weapons such as caltivate drugs and directed energy weapons would appear to conflict with the duty of care for anyone who is wounded and sick.
1980 Convention on Conventional Weapons Protocol II on Prohibitions or Restrictions on the Use of Mines, Booby Traps and Other Devices (Amended 3 May 1996); Protocol IV on Blinding Laser Weapons 1995. (The Inhumane Weapons Convention or CCW)	Regulates rather than bans weapons in international conflicts that cause superfluous injury or unnecessary suffering. Restricts use of mines and booby traps. Acoustic weapons which cause permanent loss of hearing; paralysing lasers; Taser mines; sleeping or caltivate or incapacitating weapons could be in breach of this Convention. Protocol IV bans any laser weapon system designed to cause permanent blindness or severe damage to the eyes.

International humanitarian law	Scope
1949 Convention Against Torture and Other Cruel, Inhumane & Degrading Treatment; 1997 European Convention for the Prevention of Torture and Inhumane or Degrading Treatment or Punishment.	Weapons that paralyse, incapacitate or are used to induce pain and punishment are in breach of this Convention. The use of Taser mines which shock a victim every few minutes or the UV laser which shocks at a distance could be considered pain inflicting punishment systems likely to induce post traumatic stress syndrome.
1972 Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction (BTWC). 1993 Convention on the Prohibition of the Development, Production, Stockpiling and use of Chemical Weapons and on their Destruction (CWC).	Ban the use of chemicals and toxins in war. The provisions of the BTWC outlaw all genetic weapons; the CWC makes the use of calmatives and malodourants illegal in war; foam irritant area denial barriers are prohibited but their application during internal security or peacekeeping operations is a grey area requiring further legal clarification. Sensory irritant chemicals, for example, are permissible for law enforcement purposes but the CWC does not define this.
1977 Convention On The Prohibition of Military or any Other Hostile Use of Environmental Modification Techniques. Montreal Protocol on Substances that Deplete the Ozone Layer.	Bans environmental modification techniques that have long lasting, widespread or severe effects on dynamics, composition or structure of the earth. Stick'em and slick'em, soil destabilisation, super-caustic and super-lubricant weapons may violate this convention. The use of freons in sticky foams as area denial technology was rapidly phased out when a US court judgement concluded it violated the Montreal Protocol.
1986 Nairobi International Telecommunications Convention.	Also restricts the use of electromagnetic weapons such as directed energy systems.

Note: Some developments in weapons technology are not fully covered by extant International Humanitarian Law. However, the European Parliament has started to identify technologies which ought to be subject to an international ban eg. 1999 EU resolution calling for a Ban on Weapons Directly Intervening With Brain Function agreed by the European Parliament, Committee on Foreign Affairs, Security and Defence Policy, 14 January 1999-PE227.710/fin. An agreement only applicable to the EU; its status has never been tested. In principle it would prohibit calmatives, directed energy weapons and electroshock systems like the Taser mine whose action is based on central nervous system paralysis.

Recommendations

ANTI-VEHICLE MINES

Member states of the Ottawa Convention should transparently assess the sensitivity of all existing AVMs, report this promptly to the United Nations under the existing Ottawa Convention reporting framework, and destroy stocks of all AVMs found to be capable of activation by an unintentional act.

Alternatively, states should provide convincing technical and field information, making it available to independent observers such as specialist non-governmental organisations, that demonstrates anti-vehicle mines are not in breach of the Ottawa Treaty. This could be demonstrated to an expert group assembled by the appropriate standing committee carrying out the intersessional work of the Ottawa Convention.

Pending this transparent technical assessment, there should be moratoria on the manufacture, use and export of anti-vehicle mines likely to function as APMs. These should be declared unilaterally.

For those mines that can be shown not to fall within the Ottawa Treaty's ban, there is an urgent need to impose greater responsibility on users. A new fifth protocol to the Convention on Conventional Weapons should impose an unambiguous obligation on the users of anti-vehicle mines to implement full post-conflict clearance and supporting activities. These should include marking mined areas as soon as the affected territory is no longer subject to combat operations. Where this is not practical, the responsible party should be financially responsible for clearance operations carried out by non-governmental organisations under the auspices of the United Nations.

ALTERNATIVE ANTI-PERSONNEL MINES

Governments should ensure that all weapons research and development is within the limits established by existing international humanitarian law. Existing programmes should be transparently examined for compliance with existing humanitarian law, and terminated if found to be in contravention.

To provide effective oversight of these new technologies by civil society, and to ensure their full compliance with existing humanitarian law:

- research on chemicals used in any alternative mine technologies (eg calmatives and sticky nets and malodorous substances) should be published in open scientific journals before authorisation for any usage is permitted. The safety criteria for such chemicals should be treated as if they were civilian drugs rather than military weapons.
- research on the alleged safety of existing crowd control weapons and of all future innovations in crowd control weapons should be placed in the public domain prior to any decision towards deployment. Past experience has shown that to rely on manufacturers' unsubstantiated claims about the absence of hazards is unwise. In the US, some companies making crowd control weapons have put their technical data in the public domain without loss of profitability. European companies making such weapons should be legally required to do likewise; all research justifying the alleged harmless status of any 'less lethal' weapon should be published in the open scientific press before authorisation and any product licence granted should be subject to such scrutiny.

Governments should consider institutionalising the decision making process so that common parameters are examined when deciding on alternatives to landmines along the lines of environmental impact assessments. In practical terms that would mean having formal, independent 'Social Impact Assessments' of such technologies before they are deployed. These assessments could establish objective criteria for assessing the biomedical effects of so called 'less lethal' weapons undertaken independently from commercial or governmental research.

States devoting resources to the development of alternative anti-personnel mines that are in breach of international humanitarian law should redirect this expenditure towards more rapidly clearing mines already laid, rehabilitating their victims and destroying stockpiles.

- 295 US Army TACOM-ARDEC, BAA solicitation package DAAE30-00BAA-0101, 27 March 2000.
- 296 *US Programs to Develop Alternatives to Antipersonnel Mines*, Human Rights Watch backgrounder, April 2000.
- 297 Joint Non Lethal Weapons Directorate (JNLWD) *Joint Non Lethal Weapons Program: A Year in Review. Annual Report 1999* (2000).
- 298 Ibid.
- 299 ICRC, International humanitarian law – answers to your questions, December 1999.

GLOSSARY

ACTD	Advanced Concept Technology Demonstration	DEW	Directed Energy Weapons
ADAM	Area Denial Anti-personnel Munition	DGPS	Differential Global Positioning System
ADPA	American Defense Preparedness Association	DMSO	Dimethylsulphoxide
AD-P	Area Denial to Personnel	DNA	Deoxyribonucleic Acid
ADT	Active Denial Technology	DNA	Defense Nuclear Agency
AHD	Anti Handling Device	DoD	(US) Department of Defense
AP/AT	Anti-Personnel / Anti-Tank	DRG	NATO's Defence Research Group
APM-A	Anti-Personnel Landmine Alternative	DSTO	Defence Science and Technology Organisation (Australia)
APM	Anti-Personnel Landmine	DSTO	Defence Science and Technology Organisation (USA)
ARCAT	Advanced Riot Control Technology	ECBC	Edgewood Chemical and Biological Command (USA)
ARDEC	Armament Research and Development Engineering Centre (US Army)	EMD	Engineering, Manufacturing, Development Phase
AVM	Anti-Vehicle Mine	ERGM	Extended Range Guided Munitions
ATL	Airborne Tactical Laser	EWG-NLW	European Working Group on Non-Lethal Weapons
ATM	Anti-Tank Mine	FOA	Swedish Defense Research Establishment
BAA	Broad Agency Agreement	FY	Fiscal Year
BMVg	German Ministry of Defence	GE	Ground Emplaced
BNLM	Bounding Non-Lethal Munition	GEMSS	Ground Emplaced Mine Scattering System
BTCW	Biological & Toxin Weapons Convention	GVS	Ground Vehicle Stopper Program
CBW	Chemical and Biological Weapons	HEAP	Human Effects Advisory Panel
CEP	Concept Exploration Program	HEPAT	Human Effects Process Action Team
CFAC	Clear Facilities	HERB	Human Effects Review Board
CinC	Commander in Chief	HMMWV	Highly Mobile Multipurpose Wheeled Vehicle
CISAM	Centro Interforze Studi per le Applicazioni Militari	HPW	High Powered Microwaves
CLADS	Canister Launched Area Denial System	ICRC	International Committee of the Red Cross
COTS	Commercial Off-The -Shelf	IEA	Non-Lethal Weapon Information Exchange Agreement
CR	Dibenz - 1,4 - oxazepine	IOC	Initial Operating Capability
CS	2-Chlorobenzylidene malonitrile (Tear Gas)	ISR	Intelligence, Surveillance and Reconnaissance
CWC	Chemical Weapons Convention	JCATS	Joint Conflict and Tactical Simulation
DARPA	Defense Advanced Research Projects Agency	JCIG	Joint Co-ordination and Integration Group
DBBL	Dismounted Battlespace Battle Lab (USA)		
DCD	Directorate of Combat Developments		
DERA	Defence Evaluation and Research Establishment (UK)		

JFCOM	Joint Forces Command	PDM	Pursuit Deterrent Munition
JNLWP	Joint Non-Lethal Weapons Program	PDRR	Program Definition Risk Reduction phase
JNLWD	Joint Non-Lethal Weapons Directorate	POTUS	President of the US
LASER	Light Amplification of the Stimulated Emission of Radiation	PTSS	Post Traumatic Stress Syndrome
LOCAAS	Low Cost Autonomous Attack System	PVAB	Portable Vehicle Arresting Barrier
LOE	Limited Objective Experiment	QDR	Quadrennial Defense Review (USA)
LVOSS	Light Vehicle Obscuration Smoke System	RAAM	Remote Anti-Armour Munition
MCCM	Modular Crowd Control Munition	RAAMS	Remote Anti-Armour Mine System
MCD	Mines, Countermines and Demolitions (Picatinny Arsenal)	RADAM	Remote Area Denial Artillery Munition
MDARS-E	Mobile Detection Assessment and Response System Exterior	RATTLER	Rapid Tactical Terrain Limiter
MOA	Memorandum of Agreement	RDT&E	Research, Development, Test and Evaluation
ModSAF	Modular Semi-Automated Forces	RMA	Revolution in Military Affairs
MOPMS	Modular Pack Mine System	RIG	Requirements Integration Group
MOOTW	Military Operations Other Than War	SANDF	South African National Defence Force
MOU	Memorandum of Understanding	SARA	Scientific Applications and Research Associates
MOUT	Military Operations in Urban Terrain	SCG	Security Classification Guide for NLW programmes
MTF	Microwave Test facility	SIRUS	Project to determine which weapons cause Superfluous Injury or Unnecessary Suffering
MTW	Major Theatre Wars	SNL	Sandia National Laboratories (US)
NASA	National Aeronautical Space Administration	SSC	Small Scale Contingencies
NDIA	National Defense Industrial Association	STOA	Scientific and Technological Options Assessment Committee of the European Parliament
NIJ	National Institute of Justice (USA)	TACOM	Tank-Automotive & Armaments Command
NLAW	Non-Lethal Acoustic Weapons Program	TIP	Technology Investment Program
NLCDC	Non Lethal Crowd Dispersal Cartridge	TRADOC	Army Training and Doctrine Command
NLRF	Non-Lethal Rigid Foam	UAV	Unmanned Aerial Vehicle
NLSF	Non-Lethal Slippery Foam	USA	United States Army
NLW	Non-Lethal Weapons	USMC	United States Marine Corp
NLW-AAT	Non-Lethal Weapon Acceptability Advisory Team	VMADS	Vehicle Mounted Active Denial System
NSD	Non Self Destruct	VMS	Vehicle Mounted System
NSD-A	Non Self Destruct (Anti-Personnel Landmine) Alternative	VSS	Vessel Stopper System
NTARS	Non-Lethal Technology and Academic Research Symposia	WEAO	Western European Armament Organisation-Research Cell
OC	Oleoresin Capsicum	WIPT	Working Integrated Product Team
OLDS	Overhead Liquid Dispersal System		
OPCW	Organisation for the Prohibition of Chemical Weapons		
OSD	Office of the Secretary of Defense (USA)		

APPENDIX I

Examples of companies and institutions with patent activities in landmine-related technologies, January 1998 and October 2000

Landmines F42B023/00, -04, -16 F42B1/028	Landmine components F42B023-24	Projectiles, missiles or mines (i.e. submunitions) F42B012-58, -36, -62	Landmine fuzes F42C (only landmine related sub classes)	Fuzes for controlled mines F42C015-42	Mine clearing vehicle F41H011-16
Bofors AB (Celsius/Sweden), TZN GMBH (Rheinmetall/Germany), US Secretary of the Army, Rheinmetall W&M GMBH (Germany), Giat Industries (France), IKA (Russia), Dynamit Industries (France), Nobel GMBH (Germany), STN Atlas Elektronik (Rheinmetall/Germany), ARIS Mardirossian Inc (USA), TRW Inc. (USA), Thomson CSF (France), US Secretary of the Navy	TDA (Thomson CSF- Daimler Chrysler Aerospace/France- Germany), Royal Ordnance PLC (UK), Giat Industries (France)	Giat Industries (France), Diehl GMBH (Germany), Gosudarstvennoe Nauchno- Proizvodstvenno (Russia), Kawasaki Jukogyo Kabushiki Kaisha (Japan), Bofors AB of Bofors (Sweden), Buck Werke GMBH & CO (Rheinmetall/Germany), Diehl Stiftung (Germany), Israel Military Industries LTD, Oerlikon-Contrares Pyrotec AG (Rheinmetall/ Switzerland), NEC Corporation (USA), Lockheed Martin (USA), Kawasaki Heavy Industries (Japan), National Space Defence Agency Japan	STN Atlas Elektronik (Rheinmetall/ Germany), Gebrüder Jungmans GMBH (Diehl Stiftung/Germany), TZN GMBH (Rheinmetall/ Germany), US Secretary of the Army, Israel Military Industries Ltd., Giat Industries (France), Honvedelmi Minisztrium Hadite (Hungary), Wojskowy Instytut Techniki Inz (Poland)	Dynamit Nobel GMBH (Germany), Giat Industries (France)	Flensburger Fahrzeugbau GmbH (Diehl/Germany), MAK System GmbH (Rheinmetall/Germany), Thomson CSF (France), GIAT Industries (France), AB of Bofors (Sweden), STN Atlas Elektronik (Rheinmetall/Germany), TZN GMBH (Rheinmetall/Germany), Rheinmetall W&M GMBH (Germany), Yamanashi Hitachi (Japan), Raytheon (USA), NEC Corporation (USA)

Sources: World Patent Index, (main classes and sub classes), www.delphion.com, US Patent and Trademark office, www.depanet.de
Data given above are not complete because they represent only examples of main patent classes for publicly available patents.

APPENDIX II

Examples of anti-vehicle mine types encountered or in service in mine affected countries

Country	Examples and sources of anti-vehicle mine types encountered or in service in mine affected countries
Afghanistan	Mk7 UK, MV-5 Russian Federation, SH-55 Italy, TC-2.4 Italy, TC-3.6 Italy, TC-6 Italy, TCE / 6 Italy, TM-41 Russian Federation, TM-46 Russian Federation, TM-57 Russian Federation, TM-62 Russian Federation, TM-62 M Russian Federation, TMA-5 Yugoslavia, TMB-41 AT Russian Federation, TMB-44 AT Russian Federation, TMD-B Russian Federation, TMK-2 Russian Federation, TMN-46 Russian Federation, Type 69 China
Angola	C-3-A Spain, FFV 013 AVM Sweden, M-15 United States, M-19 United States, M-24 United States, M6A2 United States, M7A2 United States, MAT 76 Romania, Mk-5 HC UK, MV-5 Russian Federation, No. 8 South Africa, PRB M3 Belgium, PT-Mi-Ba-II Czech Republic, PT-Mi-Ba-III Czech Republic, PT-Mi-K Czech Republic, TM-46 Russian Federation, TM-57 Russian Federation, TM-62 Russian Federation, TM-62M Russian Federation, TMA-2 Yugoslavia, TMA-3 Yugoslavia, TMA-4 Yugoslavia, TMA-5 Yugoslavia, TMD-41 Russian Federation, TMD-44 Russian Federation, TMD-B Russian Federation, TMK-2 Russian Federation, TMN-46 Russian Federation, TMN-46 Russian Federation, Type 69 China, Type-72a China, UKA-63 Hungary
Bosnia and Herzegovina	MAT 76 Romania, PT Mi-Ba II Czech Republic, PT Mi-Ba III Czech Republic, PT-Mi-K Czech Republic, TM 57 Russian Federation, TM 62 M Russian Federation, TM-46 Russian Federation, TMA-1A Yugoslavia, TMA-2 Yugoslavia, TMA-3 Yugoslavia, TMA-4 Yugoslavia, TMA-5 Yugoslavia, TMM-1 Yugoslavia, TMN-46 Russian Federation, TMR-P6 Yugoslavia
Cambodia	M 15 USA, M 19 USA, M7 A2 USA, MV-5 Russian Federation, PT Mi-Ba II Czech Republic, PT Mi-Ba III Czech Republic, Pt-Mi-K Czech Republic, TM-46 Russian Federation, TMN-46 Russian Federation, TM-57 Russian Federation, TM-62 Russian Federation, TM-62 M Russian Federation, Type 69 China
Croatia	TMA-1A Yugoslavia, TMA-2A Yugoslavia, TMA-3 Yugoslavia, TMA-4 Yugoslavia, TMA-5 Yugoslavia, TMN-1 Yugoslavia
Eritrea	M-15 United States, M7A2 United States, Mk-7 UK, MV-5 Russian Federation, PRB M3 A1 Belgium, PRB M3 Belgium, PT Mi-Ba II Czech Republic, TM-46 Russian Federation, TMN-46 Russian Federation, TM-57 Russian Federation, TM-62M Russian Federation, TMK-2 Russian Federation
Ethiopia	M15 USA, M7A2 USA, Mk-7 UK, MV-5 Russian Federation, PRB M3 Belgium, PRB M3 A1 Belgium, PT Mi-Ba II Czech Republic, TM -46 Russian Federation, TMN-46 Russian Federation, TM-57 Russian Federation, TM-62M Russian Federation, TMK-2 Russian Federation
Georgia	TM-57 Russian Federation, TM-62 Russian Federation, TM-62P Russian Federation
Iraq	Barmine UK, HPD F2 France, M19 USA, MV-5 Russian Federation, PRB M 3 Belgium, SB 81 Italy, TC 6 Italy, TCE 6 Italy, TM-46 Russian Federation, TMN-46 Russian Federation, TM-57 Russian Federation, TM-62 M Russian Federation
Kuwait	HPD F2 France, MAT-76 Romania, MV-5 Russian Federation, Pt-Mi-Ba III Czech Republic, TM-46 Russian Federation, TMN-46 Russian Federation, TM 57 Russian Federation, TM62 M Russian Federation

Country	Examples and sources of anti-vehicle mine types encountered or in service in mine affected countries
Lebanon	M-19 United States, M7A2 United States, TM-46 Russian Federation, TM-57 Russian Federation, TMA-4 Yugoslavia, TMA-5 Yugoslavia, VS-1.6 Italy
Mozambique	ATM 2000 E Austria, MAT-76 Romania, Mk-5 HC UK, MV-5, PT Mi-Ba III Czech Republic, TM-46 Russian Federation, TMN-46 Russian Federation, TM-57 Russian Federation, TM-62D Russian Federation, TM-62M Russian Federation, TM-62P Russian Federation, TMK-2 Russian Federation, TMD 41 Russian Federation, TMD 44 Russian Federation, TMD-B Russian Federation, TMN-46 Russian Federation, Type 69 China
Namibia	Mk-7 UK, MV-5 Russian Federation, PT Mi-Ba II Czech Republic, PT Mi-Ba III Czech Republic, PT Mi-K Czech Republic, TM-46 Russian Federation, TMN-46 Russian Federation, TM-57 Russian Federation, TM-62M Russian Federation, TMA-2 Former Yugoslavia, TMA-3 Former Yugoslavia, TMA-4 Former Yugoslavia, TMA-5 Former Yugoslavia, TMD-41 Russian Federation, TMD-44 Russian Federation, TMD-B Russian Federation, TMK-2 Russian Federation, UKA-63 Hungary
Rwanda	M 15 USA, M6A2 USA, MV-5 Russian Federation, PRB M 3 Belgium, TM-46 Russian Federation, TMN-46 Russian Federation, TM-57 Russian Federation, TM-62M Russian Federation, TMD-41 Russian Federation, TMD-44 Russian Federation, TMD-B Russian Federation
Somalia	DM-11 Germany, M/71 Egypt, M-15 United States, M7A2 United States, Mk-7 UK, MV-5 Russian Federation, PRB M3 A1 Belgium, PRB M3 Belgium, PT-Mi-Ba-III Czech Republic, SACI Italy, T-72 AT China, TM-46 Russian Federation, TMN-46 Russian Federation, TM-57 Russian Federation, TM-62 Russian Federation, TM-62M Russian Federation, TMN-46 Russian Federation, Type-72b China
Western Sahara	C-3-A Spain, M 15 USA, M 19 USA, PRB M3 Belgium, SB-81 Italy
Sudan	M15 United States, TM-46 Russian Federation, TM-57 Russian Federation, TM-62 Russian Federation, Type 69 China
Yemen	Pt-Mi-K Czech Republic, TM-46 Russian Federation, TM-57 Russian Federation, TM-62 Russian Federation, TM-62M Russian Federation, TMN-46 Russian Federation, UKA-63 Hungary
Former Yugoslavia	TMA-1A Yugoslavia, TMA-2A Yugoslavia, TMA-3 Yugoslavia, TMA-4 Yugoslavia, TMA-5 Yugoslavia, TMM-1 Yugoslavia, TMR-P6 Yugoslavia
Zambia	M 19 USA, M7A2 USA, MAT-76 Romania, Mk-7 UK, MV-5 Russian Federation, TM-62M Russian Federation, TM-46 Russian Federation, TMN-46 Russian Federation, PRB M3 Belgium, TM-57 Russian Federation, TMD-41 Russian Federation, TMD-44 Russian Federation, TMD-B Russian Federation
Zimbabwe	Mk-5 HC UK, Mk-7 UK, MV-5 Russian Federation, TM-46 Russian Federation, TMN-46 Russian Federation, TM-57 Russian Federation, TM-62M Russian Federation

Sources: UN/DHA Landmine Database 1999, United States Department of State (1998): Hidden Killers. DOD Humanitarian Demining Website Database <http://www.demining.brtrc.com/>. DOD (1997) International Deminers guide, ORDATA CD-ROM. Jane's Mines and Mine Clearance 1999-2000. Pionierschule und Fachschule des Heeres für Bautechnik, Minendokumentationszentrum (1993): Minenhandbuch Somalia, München, Mai 1993. DMS Market Intelligence (1996): Forecast Landmines. Jane's Mines and Mine Clearance 1997-1998. Arbeitsgemeinschaft für Wehrdienstverweigerung, Gewaltfreiheit und Flüchtlingsbetreuung (1997): Österreichische Minen in Moçambique.

APPENDIX III

Examples of anti-vehicle mine types with likely anti-personnel capabilities
(a more extensive table is available on www.landmine.de)

Mine	Country	Producer	Remarks	SD	SN	Anti-handling/ anti-disturbance device	Fuzing
ATM 2000E Anti-tank Mine	Austria	Dynamit Nobel Graz/Wien GmbH / Intertechnik	Automatic deactivation facility	No	Yes	Yes	Magnetic and seismic sensor
DFC 19 & 29 Anti-vehicle/ Anti-personnel mine	Austria	Dynamit Nobel Wien/Graz	Can be initiated by electrical detonator, detonating cord, pull type, shock tube system				Tripwire
AVM 100 & 195 Anti-vehicle / Anti-personnel mine	Austria	Dynamit Nobel Wien/Graz	Can be initiated by electrical detonator, detonating cord, pull type, shock tube system				Tripwire
Giant Shotgun	Austria	Dynamit Nobel Wien/Graz		Yes	Yes	Yes	Infra-red, optical and acoustic sensors
PRB M3 Anti-tank Mine (PRB-ATK-M3)	Belgium	PRB		No	No	Probable. The PRB M3 has a variant with two secondary fuze wells for booby trap purposes. The mine can be used with PRB-M30 anti-lift device	
HPD F2 Anti-tank Mine	Belgium	TDA	Stockpiled	No	Yes	Yes (inherent with the seismic and magnetic sensor)	Magnetic sensor

Mine	Country	Producer		SD	SN	Anti-handling/ anti-disturbance device	Fuzing
PMN-150 u. PMN-250 (Claymore)	Bulgaria	KINTEX	Used against unprotected personnel, soft-skinned vehicles and helicopters. Can be used with microwave sensor		Yes		Acoustic and seismic sensors
TM-62 D	Bulgaria					Yes, seismic fuse can be used as AHD	Magnetic and seismic sensor
TM-62 M PZ	Bulgaria	KINTEX	Used with MVP-62 fuze, the mine also accepts the more advanced NV-PDTM fuze. May be set off by sweeping a metal detector over the mine				Magnetic and acoustic sensor
TM-62 P	Bulgaria					Yes	Magnetic and seismic sensor
TM-62IV	Bulgaria	Dunarit	Used in minefields against armoured vehicles and transport automobiles. Fuze: MVCH-62 or MVP-62				
TMD-1	Bulgaria		Scatterable		Yes	Yes (magnetic fuze initiates when mine is moved)	Magnetic sensor
PTM-BA-III	Bulgaria		See entry PT Mi-Ba III, Czech Republic				

FFV 028 Anti-tank Mine	Canada	Bofors AB	FFV 028 anti-tank mine contains a shaped charge and the magnetic fuze. May be set off by sweeping a metal detector over the mine	Yes	No	Yes	Magnetic influence fuze
Type 84 A/B/C	China		Scatterable	Yes	No	Yes (within magnetic fuze)	Tiltrod and magnetic sensor
PD Mi-PK Anti-tank Mine	Czech Republic	Polické Strojirny	Off route, in service with the Czech Republic Army. Also named Horizontal anti-transport off route mine	No	No	Possible	Tripwire. Infra-red sensor upgrade possible
Prominent Anti-tank mine	Czech Republic	Polické Strojirny	Modernisation of PT Mi-U mine	Yes		Possible	Tiltrod
PT Mi-Ba III Anti-tank Mine	Czech Republic	Polické Strojirny	The mine is also produced in Bulgaria where it is known as the PTM-BA-III. In service with the Czech Republic Army	No	No/possible	Yes when the RO-2 fuze is used; however, when the RO-4 is used, the fuze cannot be removed without initiating the mine	
PT Mi-K & PT Mi-K II Anti-tank Mine	Czech Republic	Czech and Slovak state factories	Czech Republic has apparently decided to keep its PT-Mi-K mines, as well as other AVMs with tilt rod fuzes	No	No/possible	Yes / Possible (the RO-3 anti-disturbance fuze is designed to be used under the RO-5 or RO-9 fuzes)	

Mine	Country	Producer	SD	SN	Anti-handling/ anti-disturbance device	Fuzing
PT-Mi-U Anti-tank Mine	Czech Republic	Polické Strojírny	No	No	Possible	RO-9 tiltrod fuze
M/75 Panzermine	Denmark				Yes	
M/88 Anti-tank Mine fuze	Denmark	Nea-Lindberg A/S, Royal Ordnance		Yes, after 90 days	Anti-tilt device	Infra-red sensor upgrade possible
KP 87 Anti-tank Mine	Finland		No	No	Yes, the magnetic fuze will initiate the mine if moved	Magnetic influence fuze
MSM MK2 Anti-tank Mine	Finland	Elcoteq			Possible	Magnetic, acoustic and seismic sensors
TMA-1/2/3/4/5	Former Yugoslavia			Possible	Yes	
TMRP-6	Former Yugoslavia			Possible	Yes, an auxiliary fuze well is located in the base	Tripwire and tiltrod
HPD F2 Anti-tank Mine	France	TDA	No	Yes	Yes (inherent with the seismic and magnetic sensor)	Magnetic sensor

MI AC AH F1 Anti-tank Mine IRMAH MLE	France	Giat Industries	Stockpiled	No	No	No	Breakwire, infra-red and acoustic sensor
MI AC DISP F1 Anti-tank Mine	France	Giat Industries	Used with Minotaur mine layer. Stockpiled	Yes	No	Yes, the magnetic fuze will initiate the mine if moved	Magnetic fuze
AT II Anti-tank Mine	Germany	Dynamit Nobel AG	Scatterable. Classified anti-personnel by Italy	Yes	No	Yes	Magnetic and seismic sensor
DM 31	Germany	Bofors / Dynamit Nobel	See also FFV 028 (Sweden). The DM-31 is produced in Sweden as the FFV 028 anti- tank mine. DM-31 contains a shaped charge and the magnetic fuze. May be set off by sweeping a metal detector over the mine			Yes	Magnetic fuze
MIFF Anti-tank Mine	Germany	Daimler Chrysler Aerospace, TDW/TDA	Secondary killing effect: the mine uses 38 plate charges located around the periphery of the body. Detonated by ground vibration or magnetically. Scatterable. Classified anti-personnel by Italy	No	Possible	Yes (inherent in magnetic fuze)	Magnetic fuze, seismic sensor
MUSPA Anti-vehicle/ anti-personnel mine	Germany	Daimler Chrysler Aerospace, TDW/TDA, Rheinmetall	Scatterable. Classified anti-personnel by Italy and the US DoD	Yes	No	Possible	Acoustic sensor

Mine	Country	Producer	SD	SN	Anti-handling/ anti-disturbance device	Fuzing
Pyrkal Anti-tank mine	Greece	Pyrkal			Yes	Magnetic sensor
HAK-1 Anti-tank mine	Hungary	INNO-COOP Ltd.			Yes	Magnetic sensor
UKA-63 Anti-tank Mine	Hungary		No	No	Yes (there is a secondary fuze well)	Tiltrod
BAT/7	Italy	Tecnovar			Yes	Magnetic and acoustic sensors
MATS/2 Anti-tank Mine	Italy	Tecnovar	Possible	No	Yes	
MAT/5 Anti-tank Mine	Italy	Tecnovar	No	No	Yes	
MAT/6 Anti-tank Mine	Italy	Tecnovar	No	No	Yes	
SB MV / 1 Anti-tank Mine	Italy	BPD Difesa e Spazio srl	Yes	Yes	Yes	Magnetic and seismic sensors
TCE / 3.6 Anti-tank Mine	Italy	Tecnovar	No	No	Yes	

TCE / 6 Anti-tank Mine	Italy	Tecnovar	It is also produced in Portugal by Explosivos da Trafaria, SARL.	No	No	Yes	
MIFF Anti-tank Mine	Italy	Daimler Chrysler Aerospace, TDW/TDA	Secondary killing effect: the mine uses 38 plate charges located around the periphery of the body. Detonated by ground vibration or magnetically. Scatterable. Classified anti-personnel by Italy	No	Possible	Yes (inherent in magnetic fuze)	Magnetic and seismic sensors
MUSPA Anti-vehicle/ Antipersonnel mine	Italy	Daimler Chrysler Aerospace, TDW/TDA, Rheinmetall	Scatterable. Classified anti-personnel by Italy and the US DoD	Yes	No	Possible	Acoustic sensor
AT 2 Anti-tank Mine	Italy	Dynamit Nobel AG	Scatterable. Classified anti-personnel by Italy	Yes	No	Yes	Magnetic and seismic sensors
FFV 013 (Claymore) Anti-vehicle Mine	Japan	Bofors AB	Can be initiated electrically or by tripwire		May be neutralised by inserting the safety pin or by cutting the shock tubing	No	Tripwire
Type 99	Japan				Yes		Magnetic influence fuze

Mine	Country	Producer		SD	SN	Anti-handling/ anti-disturbance device	Fuzing
NR 29	Netherlands	Giat Industries	See also: MI AC AH F1 Anti-tank Mine (France) IRMAH MLE. In the UK the mine has been discontinued mainly as a result of the Ottawa Treaty	No	No	Possible	Breakwire; infra-red and acoustic sensors
NR 30	Netherlands	TDA	See also: HPD Anti-tank Mine (France). Also in production for Belgium, France, Norway and Switzerland	Possible	Possible	Yes (inherent in magnetic fuze)	Magnetic fuze and seismic sensor
FFV 028 Anti-tank Mine	Netherlands	Bofors AB	In service with the Swedish, Dutch and German Army. Requirement for the latter was the SD variant as well as the long operational life models. May be set off by sweeping a metal detector over the mine	Yes	No	Yes	Magnetic influence fuze
HPD F2 Anti-tank Mine	Norway	TDA		No	Yes	Yes (inherent with the seismic and magnetic sensor)	Magnetic and seismic sensors
FFV 013 (Claymore) Anti-vehicle Mine	Norway	Bofors AB	Can be initiated electrically or by tripwire		May be neutralised by inserting the safety pin or by cutting the shock tubing	No	Tripwire

AT2 Anti-tank Mine	Norway	Dynamit Nobel AG	Scatterable. Classified anti-personnel by Italy	Yes	No	Yes	Magnetic and seismic sensors
MN-111 & 121 Anti-tank Mine	Poland	BZE 'BELMA' S.A.	Scatterable, in production for domestic and export requirements	Yes	No	Yes (inherent due to magnetic fusing). Initiation by any attempt to move the mine	Magnetic fuze
TM-62D Anti-tank Mine	Poland			No	No	Yes	Magnetic and seismic sensors
M 453 Anti-tank Mine	Portugal	SPEL/ (licensed) reproduction BDP Difesa (Italy), EXPAL (Spain)	Scatterable; also made under licence as Spanish Expal SB-81	Probable, if SB-81/AR mines are also employed	Probable, especially if SB-81/AR mines are also employed	Yes / Probable, especially if SB-81/AR mines are also employed	
TCE/6	Portugal	Explosivos da Trafaria EXTRA, Tecnovar Italiana	Produced under Tecnovar licence in Portugal and Egypt (TC/6)	No	No	Yes	
MAI GA 4 Claymore type	Romania			No	No	Possible	
MC-71 Anti-tank Mine	Romania	Romanian state factories		No	No	Probable (tension initiated device)	
PTM-3 Anti-tank Mine	Russia	VO GED, General Export for Defence	Scatterable	Yes		Yes	Magnetic sensor
TM-46 & TMN-46	Russia/CIS				Possible	Yes	Tripwire and tiltrod

Mine	Country	Producer	SD	SN	Anti-handling/ anti-disturbance device	Fuzing
TM-57 Anti-tank Mine	Russia/CIS			No	Yes	Tiltrod
TM-62 series Anti-tank Mine	Russia/CIS			Possible	Yes	Tiltrod, magnetic and seismic sensors
TM-62M Anti-tank Mine	Russia/CIS	State factories. TM-62 is also produced in Bulgaria by KINTEX		Possible	Yes	Magnetic sensor
TM-72	Russia/CIS				Yes, if used with MVN-72 or MVN-80 magnetic influence fuze. Fuze initiates by movement through magnetic field changes	Magnetic sensor
CETME Anti-tank Mine	Spain		No	No	Yes	
SB-81/AR Anti-tank Mine	Spain	Probable EXPAL, BDP Difesa (Italy)	Yes	Yes	Yes	Tiltrod

FFV 013 (Claymore) Anti-vehicle Mine	Sweden	Bofors AB	Can be initiated electrically or by tripwire. In service with ground forces of Ireland, Japan, Norway and Switzerland		May be neutralised by inserting the safety pin or by cutting the shock tubing	No	Tripwire
FFV 028 Anti-tank Mine	Sweden	Bofors AB	In service with the Dutch and German Army. Requirement was for both the SD variant as well as the long operational life models	Yes	No	Yes	Magnetic influence fuze
Mine Fuze 15 (ATF 1)	Sweden	CelsiusTech Electronics, Bofors AB					Tiltrod
Mine Fuze 16	Sweden	CelsiusTech Electronics, Bofors AB					Magnetic sensor
Modell 88	Switzerland		Swiss version of the French HPD F2. Procured in 1988, contract worth \$ 314m	No	Yes	Yes (inherent with magnetic fuzes)	Magnetic sensor
FFV 013 (Claymore) Anti-vehicle Mine	Switzerland	Bofors AB	Can be initiated electrically or by tripwire		May be neutralised by inserting the safety pin or by cutting the shock tubing	No	Tripwire

Mine	Country	Producer	SD	SN	Anti-handling/ anti-disturbance device	Fuzing
Model 4.5 kg	Turkey	Makina MKEK	The mine is actuated by 75 kg pressure			
ADDER Anti-tank Mine	UK	Hunting Engineering Limited	No This mine is essentially a LAW 80 shoulder fired infantry anti-tank weapon mounted on a tripod attached to a sensor package	Possible	Yes	Tripwire (with Addermine) and infra-red and acoustic sensors
Barmine Anti-tank Mine FWAM	UK	British Aerospace Defence Limited, Royal Ordnance	Neither the Barmine nor the Barmine Layer are currently in production		Yes	Magnetic sensor
Shielder L35A1 Anti-tank Mine	UK	Alliant Techsystems Inc. (US)	Yes		No integral AHD, but moving the mine will cause it to detonate	Magnetic and seismic sensors
AT2 Anti-tank Mine	UK	Dynamit Nobel AG	Yes Scatterable. Classified anti-personnel by Italy	No	Yes	Acoustic sensor
BLU-101	USA		Yes	No	Yes	Magnetic sensor
BLU-91/B GATOR Anti-tank Mine	USA	US government facilities and Aerojet Ordnance Company			Yes. Once armed, dangerous to move	

M15 Anti-tank Mine	USA					Yes	Yes	Tiltrod possible
M19 Anti-tank Mine	USA			Produced under licence by Industrias Cardoen in Chile, by the Korea Explosives Company and the Daewoo Corporation in South Korea and by MKEK in Turkey		Possible	Yes. Auxiliary fuze wells are provided in the side and base for booby trapping	
M21 heavy Anti-tank Mine	USA							Tiltrod
MOPMS XM-78	USA	Alliant Techsystems Inc					Yes	Magnetic sensor
Remote Anti-armour Mine (RAAM)	USA	Alliant Techsystems Inc		Scatterable	Yes			Magnetic sensor

Sources: DOD Humanitarian Demining Website Database <http://www.demining.brtrc.com/>. DOD (1997) Int. Deminers guide ORDATA CD-ROM, Jane's Mines and Mine Clearance 1999-2000, Pionierschule und Fachschule des Heeres für Bautechnik, Minendokumentationszentrum (1993): Minenhandbuch Somalia, München, Mai 1993. Jane's Mines and Mine Clearance 1997-1998. Jane's Mines and Mine Clearance 1996-1997. Handbook of Employment Concepts for Mine Warfare Systems (no year): Appendix A: Mine and Mine Dispensing Systems' Characteristics. Küchenmeister/Nassauer (1995): Gute Mine zum bösen Spiel. DOD: Mine facts CD-ROM. Ministerrat der DDR (1988): Pionierkampfmittel der NATO- und französischen Landstreitkräfte. ICBL (2000): Landmine Monitor 2000. Forecast International (1998): Ordnance & Munitions Forecast - Landmine (Europe), March. Swietokrzyska Agencja (1993): Catalogue of Polish Defence Industry. GICAT (1994): Catalogue Matériels Français De Defense Terrestre. Diverse company profiles given at weapon exhibitions. Canadian Forces (1999): CF Mine Awareness Database 99.

Note: Multiple assessments of mines capabilities by different sources possible.



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