Anti-Personnel Mines

by Gérald C. Cauderay

"Mines may be described as fighters that never miss, strike blindly, do not carry weapons openly, and go on killing long after hostilities are ended.

In short, mines are the greatest violators of humanitarian international law, practising blind terrorism".*

Introduction

The problems associated with the use of anti-personnel mines, especially in Cambodia, Afghanistan, Kuwait and Angola, to mention but a few of the countries where they have been deployed in large numbers and in areas where they constitute a threat to civilians long after hostilities have ceased, call for closer examination.

In this article, which does not claim to be exhaustive, we shall review the different types of mines currently in use, their technology, the means of detecting and neutralizing them, and the possibility of equipping them with self-neutralizing or self-destruct mechanisms. Then, last but not least, we shall consider the problems raised by the trade in this type of weapon.

Since anti-tank mines are in a different category and, in general, do not directly endanger the civilian population,** we shall deal only with anti-personnel mines here.

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* Opinion of a former ICRC delegate.

** Our comments are based on information taken from the specialized literature, in particular the 1992-1993 edition of *Jane's Military Vehicles and Logistics*, various press articles published during the past two years concerning recently terminated conflicts (principally in Cambodia, Afghanistan and Kuwait), various publications and the very few specialized technical works that we were able to consult, and reports filed by our delegates and doctors in regions affected by armed conflicts. We have also used information supplied to us by experts and official or private organizations engaged in mine-clearance operations.

- In Afghanistan, since the war started 15 years ago, at least 10 million mines have been scattered throughout the country.[1]
- In the past 25 years, hundreds of thousands of mines - some say four million - have been laid in Cambodia.
- Every month about 60 people are killed or injured by them.
- In Kuwait, there are about one million mines.
- Between 1945 and 1977, about 15 million mines were cleared from Poland. In the same period, some 4,000 civilians were killed and 9,000 injured by mines.[2]
- Libya still has extensive minefields dating from the Second World War.
- Owing to mines, large expanses of the world are permanently no-go areas.
- Mines are as lethal to human beings after the war as during the fighting.
- About 35 countries are known to manufacture mines.
- The great majority of mines have no self-destruct mechanism.

[1] These figures, taken from the written press, are only estimates.
[2] W. J. Fenrick, "The Law of Armed Conflict: the Cushie Weapons Treaty", *CDQ*, Summer 1981.

In the four countries previously mentioned, to which another half-dozen might be added, minefields laid during conflicts have already caused countless civilian casualties. Most of these minefields remain active and still represent an extremely grave danger for the countries' population. Moreover, their very existence makes it difficult, or well nigh impossible, for civilians to return to their places of origin and to engage in any activity offering a means of subsistence. In fact, the sheer number of anti-personnel mines planted, the manner in which they have been deployed and the absence of any record of their location raise such problems that it will take years or even decades before agriculture can be resumed without putting the inhabitants at considerable risk.

As an example[1]*, in just one year following the withdrawal of Soviet troops from Afghanistan, over 4,000 persons reportedly lost

* The numbers 1 to 15 in the text refer to the references at the end.

their lives and more than 20,000 were seriously injured in accidents caused by mines.

The objective in laying minefields

Minefields are generally laid either to slow the advance of the enemy, to divert his advance into more easily defended zones, or to harass him by causing casualties in his ranks.

A.P.V. Rogers, quoting Col. C. Sloan[2], stresses that anti-personnel mines are mainly used:

a) in anti-tank minefields, to hinder their clearance or breach by personnel;
b) as nuisance mining to delay or demoralize advancing enemy infantry;
c) to protect defended localities by denying routes to the enemy and to disrupt the final assault phase of an infantry attack.

Anti-personnel mines are also used to protect military positions and installations or to prevent access to a locality, village or particular region.

Unfortunately, it is also a fact that anti-personnel mines are sometimes laid to prevent the civilian population from leaving a region, or from having access to arable land, pastoral areas and ricefields.

Technical aspects

There are many different types of anti-personnel mines, ranging from the most rudimentary, sometimes even hand-made, devices, right up to the most sophisticated models incorporating electronic timing, arming and firing mechanisms. However, with the exception of some very special types of mines, they fall largely into three main categories:

- anti-personnel mines of the blast type;
- anti-personnel fragmentation mines (static or bounding type);
- anti-personnel fragmentation mines of the directional type.

The explosives used in the mines are almost always fairly common. For the most part they are nitrate derivatives such as TNT (trinitrotoluene or Tolite, which enters into the composition of

Angola: Children injured by anti-personnel mines (ICRC/Anne-Marie Grobet).

numerous other explosives such as Amatol, Pentolite, Composition B, etc.), picric acid (trinitrophenol or Melinite), Tetryl, as well as PETN (pentaerythritoltetranitrate) and RDX (cyclotrimethylenetrinitramine), two among the most powerful explosives known.

Simple anti-personnel blast mines consist of a casing, frequently made out of plastic, containing an explosive charge, a detonator and a firing device. This may be of the pressure type (the pressure needed for firing is of the order of 2 to 6 kg), a trip-wire mechanism or other type of triggering.

These mines are usually small (less than 80 mm in diameter), and often weigh under 100 g. They are powerful enough, however, to occasion very severe injuries (shattered feet or hands). The blast from the explosion, moreover, causes fragments, dirt and debris of various kinds to be driven into adjacent tissues and beyond, and this frequently

results in serious infections, even gangrene. The shock wave from the explosion may also destroy the blood vessels in the upper part of the injured limb.[3, 4]

Depending on the model, size of charge and type of casing, the lethal effects of this type of anti-personnel mine may be felt within a radius of 1 to 2 m, but rarely beyond. It should also be mentioned that nowadays these mines comprise a minimum of metal components. Their casing is made of wood or plastic and rarely of metal, so they are practically undetectable.

Static anti-personnel fragmentation mines consist of an explosive charge in a metal or plastic casing containing cube-shaped or cylindrical metal fragments with sharp spines, or sometimes steel spheres. These fragments vary between 4 to 6 mm in length or diameter, and weigh between 0.5 and 6 g. Depending on the type of mine, the number of fragments ranges from several hundred to several thousand, and their initial velocity (VØ) may attain more than 1,600 m/s (by way of comparison, the VØ of a rifle bullet is of the order of 800 to 950 m/s and its weight between 3 to 11 g, depending on calibre).

Firing may be effected by a device similar to the one used for blast mines, that is to say by pressure or trip-wire, or by electronic means triggered by sound-activated, magnetic or seismic sensors, infrared (IR) barriers, etc. The detonator then causes the charge to explode, and the fragments are ejected up to a distance of 40 m. According to certain sources consulted, the lethal radius, depending on the explosive charge and the type of fragments, may be up to 15 or even 25 m.

The anti-personnel fragmentation mine of the "bounding" type works on the same principle, but does not explode until it reaches a height of 0.8 to 1.50 m from the ground. In this case the firing system, usually depending on traction by a trip-wire or a similar device, sets off an initial explosion which projects the mine to the pre-determined height (0.8 to 1.50), where the principal charge explodes. The lethal radius is usually comparable to that of the static version, but since the mine explodes at some distance above the ground, the number of fragments reaching the target is appreciably increased. These mines appeared during the Second World War and have since been subject to constant development.

Anti-personnel directional mines (also termed "horizontally active"), are fragmentation mines so constructed that the fragments are discharged in a determined direction within a sector of about 60°. This type of mine is generally mounted on a tripod standing on the ground, but it can also be attached to the trunk of a tree or another suitable

structure. Any of the usual systems of firing such as trip-wire, IR barrier or remote control can be used to detonate it. The fragments, consisting of sharp metal shrapnel or steel spheres, vary in number according to the model, from 700 to 1,500 or even more. They are 4 to 6 mm in length or diameter and weigh between 0.5 and 6 g. Yet again, the effective (lethal) distance is of the order of 50 to 100 m, and even 150 m with certain models, depending on the charge and the type of fragments employed.

Within the category of **anti-personnel fragmentation mines**, mention should be made once more of the very great variety dating back to the Second World War. These mines are constructed from grenades fitted with a casing made of metal or of cement containing metal fragments. They are often attached to a metal or wooden spike so that they can be fixed vertically in the ground, but they can also be buried. They are usually fired by means of a trip-wire, or by pressure if they are buried.

The so-called **"Butterfly"** or **"Green Parrot"** (reference PMF-1 or PMZ)[5] is another type of mine, which was widely used in Afghanistan. These mines are of Soviet manufacture and, like many modern anti-personnel mines, are generally scattered from helicopters or planes. The fuses are armed at the moment of release or during descent to the ground. They can also, like other types of anti-personnel mines, be delivered by artillery shells, mortars or grenade-launchers.

This type of mine, made out of plastic (as indeed are the majority of blast type anti-personnel mines), contains very few metal parts and is intended not to kill but to maim. It is very flat (about 1.5 cm), green or brown in colour, and quickly becomes invisible in grass or in loose soil, where it is soon covered by wind-blown earth or sand, or by snow. Being very light, it is easily carried along by melting snow or by alluvium after heavy rains and is thus transported downstream in water-courses, still intact and capable of causing severe injury to people bathing or doing their washing.

This mine, which is loaded with 40 g of liquid explosive, is detonated by momentary or repeated pressure applied to its thickest part. Holding it between the thumb and forefinger, for example, may be enough to make it explode.

Incorporation of safety, self-destruct or self-neutralizing mechanisms

Although almost all anti-tank mines are fitted with a neutralization mechanism or self-destruct after a predetermined period of time, such

Some of the most common types of mines. In the background, two directional mines (ICRC).

is not the case with anti-personnel mines, because the size and price of such mechanisms, according to those concerned, are disproportionate in relation to those of the mine itself.

For safe transportation, all mines are fitted with a safety mechanism which is removed when they are put into position. To prevent the enemy from removing the mines, most anti-personnel mines cannot be neutralized once the fuse is armed. Indeed, most of them are fitted with external booby-traps to prevent removal, and certain types are even equipped with an internal device which causes them to explode at the least attempt to move or defuse them.

In fact, among the 124 different models of anti-personnel mine that we came across in the documentation we consulted,[6] only four were designated as being fitted with self-neutralizing mechanisms.

These devices can be programmed for an interval of several hours, weeks or even months. Although the self-neutralizing mechanisms are designed for a life-span equivalent to that of the mine itself, and are in principle resistant to adverse climatic and environmental conditions, they are not always sufficiently reliable and are subject to accidental malfunctioning.

Special mines

During our enquiries we have encountered mines categorized as anti-personnel which contain a FAE (fuel air explosive) or chemical charge - in the latter case it is usually mustard gas of the «Lewisite» type! It should be said, however, that these are reportedly soon to be destroyed.

Tactical aspects

The Final Act of the United Nations Conference on Prohibitions or Restrictions on the Use of Certain Conventional Weapons (Geneva, 10 October 1980),[7] and more particularly its Appendix C, Protocol on Prohibitions or Restrictions on the Use of Mines, Booby-Traps and Other Devices (Protocol II), **Article 5, Restrictions on the use of remotely delivered mines**, stipulates that:

"1. The use of remotely delivered mines is prohibited unless such mines are only used within an area which is itself a military objective or which contains military objectives, and unless:

a) their location can be accurately recorded in accordance with Article 7 (1) a); or

b) an effective neutralizing mechanism is used on each such mine, that is to say, a self-actuating mechanism which is designed to render a mine harmless or cause it to destroy itself when it is anticipated that the mine will no longer serve the military purpose for which it was placed in position, or a remotely-controlled mechanism which is designed to render harmless or destroy a mine when the mine no longer serves the military purpose for which it was placed in position.

2. Effective advance warning shall be given of any delivery or dropping of remotely delivered mines which may affect the civilian population, unless circumstances do not permit".

The marking of minefields is required so that the civilian population can avoid entering the mined area, and to facilitate their removal at the end of hostilities.

In practice, these provisions can probably be applied only when the minefields are laid or their situation planned before the beginning of hostilities. Minefields put in position and mines scattered during the course of hostilities are rarely recorded. Experience during recent conflicts has shown, moreover, that even when minefields are recorded, the warning signs put up often fall down, are moved or are quite simply taken away, intentionally or by mistake. In addition, the records made of the position of minefields are not always available from the armed forces responsible, since they are often lost, destroyed or simply mislaid.

Mines nowadays are frequently delivered by helicopters, airplanes, mortars or artillery shells. This makes the recording of mined areas even more difficult, and quite impossible for very small mines of the "Butterfly" type (see above), which are inevitably shifted by rain and wind and may be found at quite a distance from the place where they were deployed.

Soldiers driven back by the enemy frequently lay mines to cover their retreat, and naturally do not take the time to record where they were placed.

Most of these procedures are not only illegal but also make it very difficult to locate minefields once the fighting is over.

Locating mines and mine clearance

Before mines can be neutralized or destroyed, they must first be located. Magnetic detectors are normally used for such work, where it is feasible at all.

Indeed, modern methods of manufacture are making mines increasingly difficult, or even impossible, to detect. These methods include the widespread use of synthetic materials, which cannot be detected by magnetic devices. Only a few individual parts are still made out of ferromagnetic materials, principally those used in the firing system (e.g. the percussion pin and some associated parts). In consequence, these mines can be detected only by highly sensitive equipment.

Moreover, a magnetic metal detector will react to any metal fragments or objects (shell shrapnel, smashed weapons, bits of chassis and bodywork of vehicles damaged or destroyed during combat, etc.) that are present in the ground where mines are being sought, and thus

make the work even more difficult. Sometimes metal fragments are deliberately scattered in order to complicate mine-clearing operations.

New detection apparatus using advanced technology (microprocessors, sophisticated electronics, etc.) has been developed during recent years. This is designed to detect not only ferromagnetic metals but other metals as well. According to the manufacturers, this new equipment is very sensitive and capable of detecting even plastic mines containing very few metal components, whether ferromagnetic or not. Specialists consulted on the subject, however, are not unanimous about its efficiency and reliability.

Other detection methods,[8] in particular those using airborne infrared (IR) heat-seeking devices and millimetric radar systems, are apparently being developed and even tested. Unfortunately we have no precise information in this regard, but according to certain sources these new methods are not yet completely satisfactory. Lastly, it is also possible to use dogs specially trained to detect the presence of explosives. The results are usually very good, but unfortunately the dogs tire quickly and cannot work for more than an hour a day.

Further progress in the design of detection equipment is doubtless still possible. A lead could be taken, for example, from the equipment employed for some years in airports to detect the presence of explosives in freight or passenger baggage. This generally functions by reacting to the very faint residual vapour emitted by explosives.

According to information which has recently appeared in the specialized literature,[9] the development of detection systems sensitive to the vapour emitted by explosives is well under way, and will soon be available on an industrial scale. These new systems simulate the olfactory sense of dogs, which is about 10,000 times more sensitive than the standard systems employed for detecting explosives and mines.

Many specialists appear to agree, nevertheless, that the only sure answer is still the "hands and knees method" i.e. moving forward on the knees and probing the area thought to contain mines with a wooden or plastic rod!

Concerning the defusing or neutralization of anti-personnel mines, here again opinion is unanimous that this is an extremely dangerous operation and that the only reasonable solution is to explode the mines individually by means of suitable charges.

Another possibility is the use of special devices[10] such as explosive lines, cables or tubes to blow up a determined area *en bloc* (for instance, to open up a passage 60 - 80 cm wide for a distance of 100 m or more; the operation being repeated to increase the neutralized

surface). FAE (fuel air explosive) can also be used to neutralize a larger area more rapidly, as during the Vietnam war. It should be stressed, however, that these methods are not infallible; an increasing number of mines are so constructed that they can withstand the extreme pressure of very short duration caused by explosions in the immediate vicinity, such as those generated by mine clearance and FAE.

Other methods of mine clearance exist, but the logistics are onerous and costly. They involve armoured vehicles, fitted in front with steel blades in the form of a snow plough, wire mesh or rollers fitted with studs, chain flails, etc.

These vehicles, which are frequently employed by armies to clear a way through a minefield, require specialized personnel for their operation and maintenance, and large stocks of spare parts in order to ensure continuous operation. The method, moreover, is less than 70% effective. This is perhaps sufficient for armed forces wishing to open up a breach in a minefield, but certainly not for clearing much larger areas to make them safe for the civilian population after the cessation of hostilities. If mechanical means are employed, the same terrain will have to be covered several times to reach and destroy all the mines, some of which may lie as deep as 40 cm below the surface.

Such an operation will, of course, have to cover the entire area. According to some experts, this method of mine clearance is the most efficient and least dangerous. However, it is not infallible and any remaining anti-personnel mines would have to be removed and destroyed individually by hand.

In addition, the very high initial and operational cost of mine-clearance vehicles makes their utilization impracticable for most of the countries currently affected.

It is evident, therefore, that any mine-clearance operation will be long, costly and very dangerous. In Kuwait, for example, according to different sources,[11] mine-clearance teams have already lost more than 80 operatives from accidents, despite the fact that the minefields and types of mines used there are relatively well-known and the conflict was of short duration. Imagine the scale of mine clearance required in such countries as Cambodia and Afghanistan, where there may be as many as three layers of mines superimposed in certain places.

In Afghanistan,[12] where more than 30 different types of mines were reportedly used, the records of minefields, when such records exist, are very unreliable. Mines were scattered there in very large numbers (an estimated 20 to 40 million!), and certain experts consider that more than three million are still active and ready to explode. Complete

clearance is therefore probably impossible, and in many regions all agricultural activity is precluded for decades.

Bearing in mind the extent of the areas infested by mines in all the countries affected by fairly long armed conflicts, the problem of clearing them so as to ensure a sufficient degree of security for the civilian population to be resettled there can well be imagined. The task will be enormous, and very costly in terms of time and material, not to mention the inevitable risk of accidents during the mine-clearing operations.

In this connection, the question might well be asked whether mine manufacturers should help clear areas where their mines have been employed, or whether those who have laid them should be obliged to remove them once hostilities have ceased. After all, they are the only ones who know the locations and technical characteristics of the weapons they laid. They should therefore be able to ensure their neutralization and destruction at minimum cost and, especially, at minimum risk. Another possibility would be to compel mine manufacturers to contribute financially to mine-clearing operations.[13]*

Countries producing and exporting anti-personnel mines

The short and by no means exhaustive list that we have drawn up of countries producing and exporting anti-personnel mines shows that almost all the highly and moderately industrialized countries are producing this type of weapon and that a good number of them are exporters.

According to the sources consulted, but bearing in mind that published information is often incomplete or imprecise, the main producing countries are the Russian Federation, Italy, the United States of America, Yugoslavia, Austria, China, France, and also Belgium, Egypt and Portugal. Most of these countries are also known as exporters, either of finished products or of manufacturing licences. Missing from this list is Singapore which, to our knowledge, is a

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* This idea is not as strange as it might appear, because *Middle East Watch*, in a report entitled *"Hidden death: Land mines and civilian casualties in Iraqi Kurdistan*, October 1992, p. 62, invited the Italian government to become a major contributor in covering the costs of mine clearance in Iraqi Kurdistan, seeing that the majority of the mines found there appeared to be of Italian manufacture and this implied a moral obligation!

major manufacturer (under licence) and exporter, frequently working with Western countries. Lastly, it should be mentioned that mines of German and Israeli manufacture, among others, have occasionally been found in the Republic of South Africa and elsewhere. When mines manufactured in the above-mentioned countries are found elsewhere, this does not necessarily mean that the producing countries are also the direct exporters; the weapons may easily have been acquired on the unofficial arms market, captured from the enemy or quite simply stolen from depots. The political upheavals of recent years in Eastern Europe and the former Warsaw Pact countries have meant that very large stocks of arms, including enormous quantities of anti-personnel mines, are now available on both the official and the unofficial markets at knock-down prices.

With regard to prices, anti-personnel mines lend themselves to large-scale semi-automated manufacture involving very low production costs. Although we have been unable to obtain precise information on current selling prices, there are certain indications[14] that the unit price may lie between 20 Swiss francs (or even half that amount) and 100 Swiss francs for the simplest types. We learned quite recently that mines of Chinese origin had apparently been offered for a unit price of less than 50 US cents.

The more elaborate types - bounding and directional fragmentation mines - are certainly more expensive. Unfortunately, the only reliable information we possess concerning their selling price relate to dummy mines used in training mine-clearing personnel. The unit cost for small quantities ranges between 300 and 500 Swiss francs. It should be remembered, however, that these models are manufactured in very much smaller quantities than real mines, and the cost price is therefore probably higher.

Conclusion

The problems raised by anti-personnel mines have taken on considerable importance because they extend well beyond the period of armed conflict during which the mines were laid, and beyond the countries where the conflict occurred. In the first instance we have seen that anti-personnel mines can remain operational for decades after their deployment, and in the medium or long term can constitute a threat to the very survival of the local population, which finds itself unable to carry on normal activities such as agriculture. As the countries concerned are frequently developing countries, they lack the

necessary financial resources to undertake complete mine clearance and will therefore have to rely on technical and financial aid provided by the international community. This will also slow their development, with consequences that are only too evident.

There is thus an urgent need for measures to prevent the uncontrolled use of anti-personnel mines. Nowadays this smacks more of terrorism than of proper battlefield conduct, whose aim, according to all the applicable instruments of international humanitarian law, should be to spare the civilian population. Perhaps the States should seriously consider banning non-detectable anti-personnel mines, whose military effectiveness we consider more than doubtful, as well as those not provided with self-neutralization or self-destruct mechanisms.[15]

In view of the difficulty of clearing them once hostilities are over and the dramatic consequences for the civilian population, the effects of these mines are clearly disproportionate to the military advantages which are claimed for them.

Many official and private organizations are aware of the magnitude of the problem and are seeking ways of putting a stop to this kind of terrorism. Its target is increasingly the civilian population, which pays by far the heaviest toll in present-day armed conflicts.

Gérald C. Cauderay

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Gérald C. Cauderay trained and worked for several years as a merchant navy radio navigator and radar operator. He later held a number of senior positions in the electronics industry, in particular in the fields of telecommunications and marine and aeronautical radio navigation, before being appointed Industrial and Scientific Counsellor to the Swiss Embassy in Moscow. At the ICRC Mr. Cauderay is in charge of matters relating to the identification and marking of protected medical establishments and transports and to telecommunications. He published an article entitled "Visibility of the distinctive emblem on medical establishments, units and transports" in the *IRRC*, No. 277, July-August 1990, pp. 295-318, and, together with Louise Doswald-Beck, an article entitled "The development of anti-personnel weapons" (*IRRC*, No. 279, November-December 1990, pp. 565-576).