MEETING OF THE STATES PARTIES TO THE CONVENTION ON THE PROHIBITION OF THE USE, STOCKPILING, PRODUCTION AND TRANSFER OF ANTI-PERSONNEL MINES AND ON THEIR DESTRUCTION

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Report on the Technical Expert Meeting
on anti-vehicle mines with sensitive fuses
or with sensitive anti-handling devices*

* The meeting, held from 13 to 14 March 2001, was hosted by the ICRC in Geneva. This summary report is distributed by the ICRC, but does not necessarily reflect the position of the ICRC.

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1. Purpose and structure of the technical expert meeting

1.1 Purpose of the meeting

The international community has devoted considerable resources in recent years to addressing the problems caused by anti-personnel mines - through mine clearance and awareness efforts, assistance to victims and a total prohibition of these weapons. The primary purpose of these efforts has been to prevent civilian casualties. However, the fact that certain anti-vehicle mines with sensitive fuses or sensitive anti-handling devices can also be detonated by the presence, proximity or contact of a person has long been highlighted by organizations concerned with the global landmine problem. Some States have prohibited and destroyed some anti-vehicle mine systems which they consider would pose a similar threat to civilians as do anti-personnel mines. The issue of sensitive anti-vehicle mines was considered in the context of negotiations of the 1997 Convention on the Prohibition of Antipersonnel Mines, in subsequent meetings of States Parties and in the intersessional work carried out in Standing Committees since 1999.

The Co-chairs of the Standing Committee of Experts on the General Status and Operation of the Convention on the Prohibition of Anti-personnel Mines reported to the Second Meeting of States Parties (11-15 September 2000) as follows:

The Committee [in January and May 2000] discussed matters pertaining to Article 2, particularly matters related to anti-handling devices and the sensitivity of anti-vehicle mines' fusing devices. Ideas, like examining these issues through informal expert work and working towards the agreement by States Parties on an understanding on the matter were put forward. There was no agreement on proceeding with either idea at this time, although an ICRC initiative to discuss these matters was welcomed.

On the basis of this statement, the ICRC offered to the December 2000 meeting of the Standing Committee to host a technical expert meeting in March 2001 with the following objectives:

- identify specific technical measures which may be taken by States to minimize the risk that a person might activate the fusing mechanism of an anti-vehicle mine
- identify specific technical measures which may be taken by States to minimize the risk that a civilian might activate the anti-handling device of an anti-vehicle mine by accidentally disturbing it
- identify best practices as regards the design and use of anti-handling and fusing mechanisms for anti-vehicle mines

The ICRC also informed the Standing Committee that a summary report of the meeting, highlighting the discussions and proposals made, would be submitted to the May 2001 Standing Committee on the General Status and Operation of the Convention.

1.2 Structure of the meeting

As indicated in the programme of the meeting (Annex A), the discussions of the expert group focussed on two specific areas. The first day was devoted to **anti-vehicle mines equipped with sensitive fuses**. Specific systems were examined individually with a view to determining the risk that they might be activated by a person. On the second day **anti-vehicle mines equipped with sensitive anti-handling devices** were discussed with a view to determining the risk that they might be activated by civilians who accidentally disturbed them. In each case the experts were invited to suggest possible "best practices" regarding the system's design.

Before the meeting an indicative list of items to be discussed and related questions (Annex B) had been circulated to all the participants so they could prepare for the discussion.

For the purpose of the meeting the term "anti-vehicle mines" was considered to cover all landmines other than anti-personnel mines.

2. Statements by governmental experts

Governmental experts from Canada, the United Kingdom and the Czech Republic presented written statements regarding anti-vehicle mines. The statements are annexed to this report (Annex C).

The governmental expert from the United States presented a verbal statement on the proposal his country had made regarding anti-vehicle mines to the Second Review Conference of the CCW. This statement included aspects related to the detectability and use of self-destruction or self-neutralization mechanisms on anti-vehicle mines.

3. Anti-vehicle mines equipped with sensitive fuses

3.1 Introduction

At the beginning of the discussion Mr Patrick Blagden and Mr Adrian Wilkinson of the Geneva International Centre for Humanitarian Demining gave a detailed presentation on technical issues relating to anti-vehicle mines, thus ensuring that the participants were conversant with the terminology and the various categories of mines involved. The presentation covered the following areas:

- philosophy
- engineering
- impact on non-combatants
- types of anti-vehicle mines
- pattern minefields
- scatterable mines
- side-attack or off-route anti-vehicle mines
- area-defence anti-vehicle mines
- challenges of clearance

3.2 Discussion on specific systems

Anti-vehicle mines use a variety of fusing mechanisms, some of which are particularly sensitive and can be activated by a person. The following fusing mechanisms were discussed in detail:

- pressure-activated fuses
- tripwire-activated fuses
- breakwire-activated fuses
- tilt-rod-activated fuses
- magnetically activated fuses
- acoustically activated fuses
- seismically activated fuses
- infrared-activated fuses
- multiple-sensor fusing mechanisms
- other fuses

3.2.1 Pressure-activated fuses

Problem description

Some anti-vehicle mines equipped with pressure activated fuses are set off by pressures as low as 10, 25, 30, 45 or 50 kilograms, that is to say by pressures equivalent to the weight exerted by a person.

Comments from experts

- In general only blast anti-vehicle mines are equipped with pressure-activated fuses.
- It is difficult to set a definitive pressure limit for pressure-activated fuses because the operational pressure needed in the field can vary greatly from the pressure indicated by manufacturers.
- Reconnaissance vehicles can redistribute their weight so as to ensure mobility when travelling off prepared tracks and roads over soft ground and under certain circumstances they can exert less pressure on the ground than a person. The setting of a minimum activation pressure for anti-vehicle mines could lead to the immediate development of vehicles with lower ground-bearing pressures, making anti-vehicle mines useless.
- In response to the previous comments it was stated that it is certainly possible to reduce the minimum ground-bearing pressures of vehicles to very low thresholds, as was done with the Rhodesian "Pookie", which has a ground-bearing pressure of only 2.5 kg. In the foreseeable future, however, it is highly unlikely that anyone would go to the expense of making massive and radical modifications to entire military transportation fleets simply to ensure that the pressure of vehicles is under the threshold set for anti-vehicle mines.
- Although one of the characteristics of tracked vehicles is that they exert very low ground-bearing pressures, they do so over a large area. Consequently it is feasible to design mines that can discriminate between a vehicle and a person, for example by requiring pressure to be exerted across a wide portion of the pressure plate of an anti-vehicle mine. This is the case with one existing anti-vehicle mine.
- Anti-vehicle mines are aimed at military transport and the lightest military mode of transport is a dispatch rider with his personal weapon and equipment mounted on a motorbike. The threshold could therefore be set on the basis of this type of vehicle as follows:

Average soldier with weapon and equipment:	75 kg
Ground-bearing weight of an average motorbike:	100 - 150 kg
Expected target weight for an anti-vehicle mine:	175 - 225 kg

- Interchangeable fuses raise a problem. Through misuse or degradation, anti-vehicle mines using anti-personnel fuses or anti-personnel mines as fusing mechanisms can function at anti-personnel weight thresholds.

Possible best practices as regards design

The expert group recognized that certain low-pressure anti-vehicle mines could be activated by a person. Some experts strongly recommended that anti-vehicle mines should not be capable of being activated at a pressure of less than 150 kg. Where possible, anti-vehicle mine should be designed in such a way that pressure must be exerted over a significant area rather than at a single point.

3.2.2 Tripwire-activated fuses

Problem description

Some anti-vehicle mines are equipped with tripwire-activated fuses that are suspended over the road and can easily be activated by a person exerting a low pull pressure (between 1 and 4 kg).

Comments from experts

- If it is still to fulfil its military function, a tripwire mechanism used as the sole fuse on an anti-vehicle mine cannot be designed in such a way as to prevent it from being activated by the presence, proximity or contact of a person.
- There is nothing to indicate that such fusing mechanisms serve any specific military purpose when used on anti-vehicle mines.

Possible best practices as regards design

Several experts thought that tripwire mechanisms should not be used as the only fuses on anti-vehicle mines. According to these experts, it was not a viable option to use tripwires this way and anti-vehicle mines equipped with such mechanisms should be regarded as anti-personnel mines. The use of tripwires as fusing mechanisms on anti-vehicle mines was not considered to be common practice and several experts indicated that such systems should be removed from arsenals, as was being done.

3.2.3 Breakwire-activated fuses

Problem description

Some off-route anti-vehicle mines use breakwires stretched out in line with the mine. The mine explodes when the wire is crushed (in the case of a fibre-optic sensor cable) or broken (in the case of a fine breakwire) by a weight equivalent to that of a person stepping on it.

The term "breakwire" very often includes fibre-optic sensor cables. A distinction is made hereafter between breakwires made out of fine wires and breakwires made out of fibre-optic sensor cables.

Comments from experts

- Fuses activated by fine-wire breakwires are extremely sensitive and can be activated by almost any moving object. Since such fuses cannot be made to discriminate between vehicles and other targets, some countries have already removed them from their stockpiles of anti-vehicle mines.
- An anti-vehicle mine equipped with a fine-wire breakwire has been reclassified as an anti-personnel mine by one country and destroyed. The breakwire on this mine was considered as a tripwire.
- A manufacturer has discontinued the development of an off-route anti-vehicle mine which would have used one, two or three fine-wire breakwires.
- It does not seem very practical to use a fine-wire breakwire as part of a multi-sensor fusing mechanism as there is no way of resetting such a breakwire from a distance once it has been broken.
- Fibre-optic cables are now more commonly used than fine wires, since they are capable of reasserting themselves after being crushed. They are generally used as part of a multi-sensor fusing mechanism where the pressure required to crush the fibre-optic cable is the first level of target discrimination, the next sensor being activated when the cable is crushed. Fuses of this kind are rarely used alone.

Possible best practices as regards design

Breakwire-activated fuses, whether made out of fine wires or fibre-optic cables, can easily be activated by a person and should not be used as the sole fusing mechanisms on anti-vehicle mines. If used, they should be combined with other fuses that can discriminate between vehicles and persons.

3.2.4 Tilt-rod-activated fuses

Problem description

Some anti-vehicle mines are equipped with tilt rods that activate the mines when a low pressure (1.5, 8, 10, 14.5 or 21 kilograms) is exerted on the rods at an angle varying between 20 and 36 degrees.

Comments from experts

- Tilt-rod-activated fuses require a mechanical advantage lever or roller and castor mechanism to function. This means that the amount of pressure needed to activate the fuse depends on where the pressure is placed. At the top of the tilt-rod mast very little pressure needs to be placed since the length of the mast provides sufficient mechanical leverage. If applied to the lower section of the mast, however, much more pressure is needed. Such pressure could pull the mine from the ground and tip it over without causing the fuse to function, thus rendering the mine ineffective. One type of mine is equipped with a stake that can be buried in the ground so as to prevent the mine from tilting prior to explosion and missing its target. A similar device could be used on other anti-vehicle mines fitted with tilt rods so as to raise the threshold of force needed to set off the mines.
- Since they are activated by contact with the entire width of a vehicle and not by the pressure exerted by tyres or tracks, tilt-rod-activated fuses give pressure-activated anti-vehicle mines a 'full-width capacity' which greatly improves their ability to attack enemy armour. This is why they are still considered to have a viable military anti-vehicle role, in particular in conditions of snow and ice where battery-activated mines are more problematic.
- It is difficult to imagine a tilt-rod-activated fuse which could not be activated by a person while still fulfilling its military function. As a result there appears to be a trend of removing tilt-rod-activated fuses from anti-vehicle mine stockpiles.

Possible best practices as regards design

Several experts pointed out that it was difficult to identify an effective means of preventing tilt-rod-activated fuses from being accidentally activated by a person while maintaining their military role.

Several experts suggested that tilt rods should be replaced with more discriminating fusing systems which used multiple sensors, as to some extent was already being done.

3.2.5 Magnetically activated fuses

Problem description

A magnetically activated fuse operates by measuring the amount of metal in its immediate vicinity.

Military publications and the material provided by manufacturers warn not to approach anti-vehicle mines equipped with magnetic fuses since they may be activated by the presence of metallic objects.

Comments from experts

- Magnetically activated fuses are not only activated by the presence of metallic objects, but also by the change in magnetic field which such objects create when a vehicle approaches and drives over a mine.
- Such fuses only function when the required amount of metal enters the area. The functioning threshold must be quite high, otherwise the mine would detonate when a tank or armoured vehicle drove past it rather than over it, which would have little or no effect on the target.
- In theory, metal mine prodders, radios (when transmitting), metal tripwire feelers, mine detectors and other metallic objects could activate such a mine. In practice, however, it is unlikely that the manufacturers would want a relatively expensive mine, designed to destroy a multi-million dollar tank, to function when a soldier or civilian inadvertently passes by with a low amount of metal on him.
- A magnetically activated fuse would almost certainly function under the normal magnetic signature of a civilian car or a farm vehicle such as a plough or tractor.
- There is a tendency today to use magnetically activated fuses in conjunction with secondary fuses, which makes it possible to better discriminate between targets and to detonate the mine at the appropriate moment.

Possible best practices as regards design

Manufacturers should have no need to design these fuses in such a way that they could be activated by an amount of metal less than that contained in a vehicle, as this would defeat the intended military purpose. Magnetically activated fuses should be used with secondary fuses to ensure that a vehicle is present before the mine detonates.

3.2.6 Acoustically activated fuses

Problem description

Acoustically activated fuses are equipped with electronic sensors which determine the acoustic signature of a target. Such signatures could include that of a person.

Comments from experts

- The experts could not identify a single mine that operates only with an acoustically activated fuse. Acoustic sensors tend to be used in multi-sensor fusing mechanisms rather than on their own.
- It is technically feasible to discriminate between a vehicle and a person with acoustically activated fuses.

Possible best practices as regards design

Such fuses should not be designed in such a way that they could be activated by the acoustic signature of a person (e.g. a voice, footsteps). To further enhance their capacity of discrimination they should not be used alone on anti-vehicle mines.

3.2.7 Seismically activated fuses

Problem description

Seismically activated fuses react to specific seismic frequencies and could, at least theoretically, be activated by human passage.

Comments from experts

- The experts could not identify a single mine that operates only with a seismically activated fuse. Seismic sensors tend to be used in multi-sensor fusing mechanisms rather than on their own.
- Seismically activated fuses cannot locate their targets precisely and are therefore of no use on their own.

Possible best practices as regards design

Such fuses should not be designed in such a way that they could be activated by the seismic signature of a person (e.g. footsteps). To further enhance their capacity of discrimination they should not be used alone on anti-vehicle mines.

3.2.8 Infrared-activated fuses

Problem description

Infrared-activated fuses can function in an active or passive role, reacting to the heat of certain objects and possibly even of persons.

Comments from experts

- There is no military purpose to designing passive infrared-activated fuses that could be activated by a person and it is technically feasible to develop infrared-activated fuses that can discriminate between body heat and vehicle heat.
- There is one known anti-vehicle mine equipped with a passive infrared-activated fuse that can be activated either by a person or by a vehicle, but this is the result of bad manufacturing.
- Usually, passive infrared-activated fuses are used in certain off-route mine systems as part of a multi-sensor fusing mechanism.
- There is one known off-route anti-vehicle mine equipped with an active-passive infrared-activated fuse. The active infrared sensor detects the approaching target and the passive infrared sensor detonates the mine at the appropriate moment.
- Active infrared-activated fuses work like tripwires and should be considered as such when used alone.

Possible best practices as regards design

Infrared-activated fuses should not be used alone on anti-vehicle mines and it is unlikely that they will be.

Some experts suggested that active infrared-activated fuses should be avoided, particularly when used alone, since their "tripwire" capability could cause anti-vehicle mines to function as anti-personnel mines.

3.2.9 Double-sensor fusing mechanisms

Description

These types of fusing mechanisms tend to be highly sophisticated and are usually equipped with one of the following combinations of sensors: acoustic/magnetic, acoustic/infrared, seismic/magnetic or even acoustic/microwave.

Comments from experts

- Multiple-sensor fusing mechanisms are designed to be highly discriminating so as to ensure optimum performance against targeted vehicles and avoid firing at other objects.
- Not only do these types of fusing mechanisms tend to be highly sophisticated, they are usually very expensive to produce. It would not be in the manufacturer's interest to design them in such a way that that they could be activated by any target other than the intended one.
- Side-attack or off-route anti-vehicle mines tend to be equipped with double- or triple-sensor fusing mechanisms.
- One type of anti-vehicle mine provides an example of a fairly simple double-sensor fusing mechanism. Not only does the hydraulic fuse require a direct pressure of 150–200 kg to be exerted on the pressure plate, but the pressure must be spread over a 300 mm section of the mine fuse to create the right amount of fluid displacement to detonate the mine. This simple mechanism helps in the discrimination process and can reduce the risk of an anti-vehicle mine being triggered by a person.

Possible best practices as regards design

Double-sensor fusing mechanisms can help discriminate between vehicles and persons. When such is their purpose, their increased use is desirable.

3.2.10 Triple-sensor fusing mechanisms

Description

Triple-sensor fusing mechanisms also tend to be highly sophisticated and can be equipped with various combinations of fuses (e.g. infrared/seismic/acoustic).

Comments from experts

- Like double-sensor fusing mechanisms, these fusing mechanisms are designed to ensure optimum performance against targeted vehicles and avoid firing at other objects. They are even more discriminating than double-sensor fusing mechanisms.
- Again, such mechanisms tend to be highly sophisticated and very expensive to produce. There is little incentive to design them in such a way that they could be activated by any other target than the intended one.

Possible best practices as regards design

Triple-sensor fusing mechanisms can be of even greater help then double-sensor fusing mechanisms in discriminating between vehicles and persons. When such is their purpose, their increased use is desirable.

3.2.11 Other fuses

At the end of the first day, experts discussed some "exotic" fuses such as electronic fuses operated by inertia, light or heat. A number of experts did not consider them as the main fusing mechanisms of anti-vehicle mines, but rather as anti-handling devices or booby-traps.

4. Anti-vehicle mines equipped with sensitive anti-handling devices

4.1 Introduction

At the beginning of the second day, Mr Patrick Blagden and Mr Adrian Wilkinson of the Geneva International Centre for Humanitarian Demining gave a detailed presentation on technical issues related to anti-handling devices, thus ensuring that the participants were conversant with the terminology. The presentation covered the following areas:

- philosophy
- engineering
- impact on the enemy
- impact on non-combatants
- problems of definition

The accurate definition of the term "anti-handling device" was the first issue to be addressed since technically such devices could be placed under the follow headings:

- anti-handling devices
- anti-disturbance devices
- anti-movement devices

Since it was the understanding of a number of experts that the term "anti-handling device" covered anti-disturbance and anti-movement devices as well, hereafter only the term "anti-handling" device is used.

4.2 Discussion on anti-handling devices

Problem description

Many anti-vehicle mines equipped with anti-handling devices, in particular remotely-delivered mines, can easily be activated when civilians who are making no attempt to clear them accidentally disturb them. The threat presented by remotely delivered mines fitted with anti-handling devices is compounded by the fact that they are typically laid on the surface of the ground, often hidden by debris or vegetation, where it is easier for them to be inadvertently activated. Such mines have a tendency to be more potent than buried mines since their explosive force is less contained and explosions are typically accompanied by secondary anti-personnel fragmentation. Anti-handling devices fitted to this type of mine include mercury tilt switches or electronic sensors that are activated when a person touches, handles or moves the mine or when the mine is lifted or tilted at an angle of more than 20 to 40 degrees.

Comments from experts

- Countries must acknowledge that anti-handling devices present a very real danger for civilians. A device that can be activated by the unintentional contact of a person is very similar to a device that can be activated by the presence, proximity or contact of a person.

- One expert reaffirmed his country's position that an anti-vehicle mine which inadvertent contact can cause to explode must be considered as an anti-personnel mine.
- Anti-handling devices require a certain sensitivity in order to achieve their military objective, which is to prevent mechanical and manual clearance. However, such sensitivity could enable them to be inadvertently activated by civilians.
- According to many experts, there is still a military need to have anti-vehicle mines equipped with anti-handling devices. Even when such devices are not actually deployed, the very fact that they might be leaves a doubt in the mind of the enemy and forces him to slow down and take much greater care than he might otherwise. They therefore help to achieve the military objective of delaying the enemy. Anti-handling devices protect anti-vehicle mines from both mechanical and hand clearance and the military rely on them to complicate the task of the enemy. When detonated, anti-handling devices fitted to anti-vehicle mines laid in a defensive minefield can also help give a clear indication of the presence, location and intentions of enemy forces.
- Military planning still requires some type of anti-handling device to be deployed with anti-vehicle mines so as to prevent the reuse of hand-emplaced anti-vehicle mines or the loss of military weapons technology to enemy forces. Such devices are often used to destroy sophisticated fusing mechanisms before they can be examined by the enemy.
- One expert challenged the military need to having anti-handling devices fitted on buried anti-vehicle mines in planned (as opposed to remotely-delivered) minefields. In such minefields, anti-handling devices are generally used in the rows of mines that will be closest to the enemy. According to military doctrine, anti-vehicle minefields should be observed and covered by direct or indirect defensive fire to prevent their disruption. There are many other devices and mechanisms of a non-lethal nature that can be used to detect military activity in the area. Such devices, which include remote ground sensors (RAGS), unattended ground sensors (GUS) and pyrotechnical signalling devices, could easily replace anti-handling devices as a means of detecting the presence of an enemy.
- In light of the most recent military conflicts, it was also questioned whether there was still a need for anti-vehicle mines to be fitted with anti-handling devices or booby-traps. The military tactics used in the Gulf War, for example, called for rapid mechanical breaching devices such as mine ploughs, explosive clearance devices and mechanical flail machines rather than the old fashioned hand breaching drills of World War II.

Possible best practices as regards design

The experts had difficulty providing any specific technical recommendations as to how anti-handling devices could be designed in such a way as to minimize the risk that they might be accidentally activated by civilians while ensuring that they could still fulfil their military function. Several experts thought that it would be technically difficult to differentiate between the disturbance caused by inadvertent contact and an attempt to tamper with or clear the anti-vehicle mine.

Further research on this technical matter was encouraged. It was also suggested that States review the sensitivities of the anti-handling devices which they currently employ, determine how existing sensitivities had been established and work out the minimum sensitivity needed to ensure that such devices would fulfil their military function.

Many experts felt that the problem could be partly solved by reducing the active lifetime of anti-vehicle mines and their anti-handling devices. To this end, remotely-delivered anti-vehicle mines could be equipped with self-destruction or self-neutralization mechanisms backed up by self-deactivation mechanisms. The following discussion focussed on this aspect.

5. Anti-vehicle mines equipped with self-destruction or self-neutralization mechanisms

Description

Self-destruction mechanism
An incorporated mechanism automatically destroys the mine at a preset time.

Self-neutralization mechanism
An incorporated mechanism automatically renders the mine inert at a preset time, leaving it in place on the battlefield.

Self-deactivation mechanism
The irreversible exhaustion of a component (a battery, for example) that is essential to the operation of the mine automatically renders a mine inoperable.

Comments from experts

- All self-destruction and self-neutralization mechanisms should be armed on deployment to ensure they will function as designed.
- Anti-vehicle mines equipped with self-neutralization mechanisms can be collected and reused by the military forces that have deployed them and are thus a relatively economic system.
- If mines are physically present on the ground after self-neutralization, they will still deny the local population access to the mined area. Alternatively, they may lead to complacency among the civilian community by creating the impression of failed devices.
- Self-neutralizing anti-vehicle mines should be fitted with some form of external indicator such as a flag to show that neutralization has taken place. They should also include a fail-safe feature so that in the event of any conceivable malfunction such as power loss the mines revert to a neutralized state.
- If anti-handling devices are used, they should be integrated into the anti-vehicle mines in such a way that they will also be neutralized by the self-neutralization mechanisms.
- Anti-vehicle mines equipped with self-destruction mechanisms may pose a risk for anyone present when self-destruction takes place.
- While part of the threat posed for civilians by remotely-delivered anti-vehicle mines equipped with anti-handling devices will certainly be removed by fitting such mines with self-destruction and self-neutralization mechanisms, there is doubt that these systems would be as reliable as manufacturers predict.
- There are strong trends today in military doctrine to have the lifetimes of remotely-delivered anti-vehicle mines set at around four to six days. It seems that there is no real military need for lifetimes of up to 30 days, as permitted for remotely-delivered anti-personnel mines in amended Protocol II of the 1980 UN Convention.

6. Miscellaneous

Detectability

The experts briefly addressed the question of whether anti-vehicle mines should be detectable. A large number of experts could think of no reason why they should not. The simple need to detect anti-vehicle mines will help achieve the delay required by the military. An even greater number of anti-vehicle mines should be highly detectable and not merely detectable.

Battery life of self-destruction and self-neutralization mechanisms

Battery designs have been significantly improved over the last decade and electronic fusing systems are now extremely reliable. However, there are still areas of concern:

- shelf life of batteries
- active operational life of batteries

Shelf life of batteries

The problem of battery shelf life is gradually becoming a thing of the past as the batteries of many munitions remain inert during storage and are only charged with electrolyte prior to launching. This should resolve all storage and shelf life issues.

Active operational life of batteries

Variations in environmental conditions and temperatures can dramatically affect the active operational life of batteries, but not quite as much as previously experienced. Many electronically timed self-destruction mechanisms are also connected to a battery-decay self-destruction system which ensures that the device automatically detonates when the battery voltage drops below that required to operate the system.

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