Conclusion

As a conclusion, it appears that the European Community should not become involved in the fight against mines at any price. The point is not to do just like the others, to follow such or such leader or expert in virtue of tradition or experience; the point is to adopt a sensible and exemplary position which praises both the rationality and humanism of Europe. Nobody to date may claim that they have the solution to such a complex issue. Military expertise itself provides but a restricted solution.

It might be argued that the authors neglect the short run in favour of the long run, and that they place too much hope in technology and sciences. Indeed we firmly believe that to solve a technological problem, you should call upon appropriate technological means of a superior level of knowledge and development. We believe that techniques, and consequently technologies and modes of action of a new generation will help face the challenge that the science of death and destruction has presented to us.

Until then, the maximum should be done, not only to remove mines, but to reduce the number of casualties. As a «humanitarian» operation, mine clearance, whether for emergency or development, is more about the human person than about mines themselves. There can be no exception to this principle. The aim should not be seen in terms of figures (number of mines to be destroyed, depolluted areas...) but rather in «humanistic» terms: preserve the individuals' health and life, give a new chance to a community and reinforce a newly restored peace.

Destruction of treacherous devices is a means, not an aim.
Preventive measures should therefore not only accompany mine clearing operations but also precede them. It will be noted that these «soft» operations, when conducted with modern techniques and in a professional manner, usually guarantee relative safety to the inhabitants of risky regions. Very often, this safety is based on the participation of the people, and is by far greater than in cases of poor-quality mine clearance.

The operations that go along with surveying and mine destruction should then be given all attention. Until the emergence of new efficient mine-clearing means, these operations should be regarded as actual means of action, and not as mere side-measures.
This should be the main tenet of the European Commission.

THE EXPLOSIVES

• Study of nitro-compound explosives: nitration
Many substances contain hydrogen atoms (H), which are particularly sensitive to the action of nitric acid. If we write 'RH' for one such element, then the SALSIFICATION reaction of nitric acid can be described as follows:

$$RH + HNO_3 \longrightarrow R\text{-}NO_2 + H_2O + \text{ENERGY}.$$

This reaction (explosion) thus results from the substitution of a combustive (NO_2) for a combustible agent (H). Given that the reaction produces water (H_2O), it will necessarily be facilitated by the presence of a water-absorptive substance (sulfo-nitric mixture).

This operation- fixation on to a combustible molecule of combustive elements supplied by the nitric acid- is called «nitration»· it is characteristic of the production of explosives. Nitro-compound explosives belong to three families:

• Aromatic derivatives
- **T.N.T. (Trinitrotoluene or Tolite)** is produced, as its name suggests, by a triple nitration of toluene (a derivative of benzene) and comes in the form of pale yellow flakes. It is water-insoluble. It burns at 290øC, but can spontaneously combust as of 240°C. When it is in thin layers (of less than 5 cm) and is unconfined, it burns slowly. Its low fusion temperature allows it to be melted. T.N T. is not highly sensitive to mechanical effects. T.N.T. comes into the composition of many explosives:

- **Amatol** (British):	T.N.T + Ammonium nitrate
- **Ammonal:**	T.N.T. + Ammonium nitrate + Aluminium
- **Tritonal** (American):	T.N.T. + Aluminium, etc.

• Nitric esthers
- Pentrite (Pentaerythrite tetranitrate), also known as Nitropentaerythrite or P.T.N and as Nitropenta or N.P., is produced by nitration of a formol derivative and acetic aldehyde. It comes in the form of white, water-insoluble crystals. Pentrite is stable up to 100°C, but begins to decompose as of 120°C- preventing melted use; it burns at 220°C. In thin layers (of less than 5 cm) and unconfined, pentrite burns slowly, but can detonate when its mass exceeds a few tens of kilogrammes or if it is confined. It is highly sensitive to mechanical effects and to fusing, and, if dry, electrifies easily. It is more sensitive to friction than are most other commonly used explosives. The above characteristics make pentrite an ideally suitable ingredient in the production of detonators and fuzes. Pentrite is an active hypotensor, but is not toxic. It goes into the composition of the following:
- plastic explosives (**Plastic**): Pentrite (87%) + transformer oil + gelatine;
- leaf explosives (**Formex**): Pentrite (80%) + natural rubber

• Nitramines
- **Hexogen (Cyclotrimethylene-trinitramine)** is also known, in Great Britain, as R.D.X., and, in Italy, as T 4. Produced by the reaction of nitric acid on hexamine (hexamethylene tetramine), hexogen comes in the form of white crystals which have low solubility in water. Easily destroyed under heat by soda and bases, hexogen is stable up to 100°C and decomposes as of around 160°C, preventing melted use.
Its combustion (at 260°C) is strong and fast, easily giving detonation. Highly sensitive to mechanical effects and to fusing, it is less reactive to electric sparks than are the other common explosives. Its high sensitivity makes it suitable for use in relay/boosters and in fuzes. Water reduces its sensitivity. It is toxic.

- Hexogen often comes into the composition of the new PLASTIC EXPLOSIVES.

- **Tetryl (Tetranitromethylaniline)** is produced by nitration of methylaniline. It comes in the form of pale yallow crystals which are virtually insoluble in water Water, on the other hand, gives rise to a hydrolysis resulting in mela-

nite (picric acid), which attacks metals (with possible production of picrates). Tetryl is stable up to 100°C, whereafter decomposition begins. Its fusion temperature is 128°C and its combustion temperature 240°C Tetryl burns violently, which can result in detonation in case of confinement or of critical mass. It is toxic (irritation of skin, mucosa and upper airways, and digestive disorders).
- Tetryl is used in the production of detonators (Tetryl + Lead nitride) and of relay/boosters. It is often employed in tablet or in powder form, or mixed with T.N.T.. It is possible to graphite it 1% and so to enhance its mechanical sensitivity and electrical conductivity.

- **Ammonium nitrate,** although not used alone, does come into the composition of explosives such as dynamite, Amatol and ammonal, where it plays the part of an oxydant. It comes in the form of colourless, water-insoiluble crystals. Stable up to 150°C, it melts at 169.6°C and is insensitive to friction or fusing. In a damp evironment, it will attack metals- and in particular copper, forming copper nitrate, a highly sensitive explosive; it does not attack aluminium, it is not toxic.

APPENDIX II

THE MAIN TYPES OF FIRING DEVICES

• Pressure-activated systems
The target, individual or vehicle, brings a certain part of its weight to bear on the sensor, setting off the explosion of a device which is thus vertical to the target. In the case of antipersonnel mines, the minimum trigger-pressure (ranging from a few hundred grammes to twenty or so kilogrammes) is set so that the device will not be triggered by small animals passing over it. In the case of an antitank mine, the firing device must not be set off by a pedestrian passing over it, and minimum trigger-pressure must therefore be at least **100 or 150 kg**.

Certain pressure-activated devices are fitted with «racks» which are intended to make the mine react only after a certain number of pressure-events («double impulsion» or «multiple impulsion»). The aim here is to let several targets penetrate the mined area before striking them (immobilization of a column, whether of foot-soldiers or vehicles). During a mechanical de-mining operation, mines fitted with this kind of firing device may damage or destroy vehicles equipped with forward-acting anti-mine apparatus (flails or rollers).

Other, so-called «anti-blast» systems (with integrated pneumatic firing device) can be triggered only by a relatively long (approx. 1 second) pressure such as produced by a human foot-step or the passage of a vehicle. The aim here is to avoid the device being triggered by thrown stones or by the blast of neighbouring explosions (including nuclear blast)

Alongside pressure-firing devices as such, there are also «pressure-release» firing devices, which are especially suitable for booby-trapping objects or mines (anti-lift action): these are triggered by the release of a pressure exerted on them.

• «Trip-wire» systems
Such wires stretched across pathways allow activation of devices positioned at any chosen distance and which may be hidden without being buried. In the case of «traction wires», the target exerts a traction, by «tripping» the wire, which triggers the explosion. This method enables a pathway of several metres' width to be made inaccessible. Just as there are pressure-release systems, so are there also traction-release systems. Set off by «release wires», this kind of firing device enables booby-trapping of fences, for example, and, in particular, is able to catch out a de-mining operator who cuts what he supposes, without having properly checked, to be a traction wire.

• Other mechanical firing devices
- **Tilt-rod devices** are nowadays very widely used. a stem protruding from the ground (where the mine has been buried) triggers the charge when bent. Such a rod, however, will not catch out an alert marcher
- **«Seismic» or «vibration»** firing devices react to the vibrations caused by the passage of a vehicle or even by human foot-steps.

These types of firing devices are obviously primarily adapted for use on antitank mines. They have the advantage over ordinary pressure-activation of making it possible to strike the tank from elsewhere than along its path (ventral strike).

• Electronic firing devices
Other sophisticated, usually electronic, activation systems have been developed to activate buried or other charges.
- **«Wire-break»** firing devices use a wire with a low-intensity electric current (of a few mA) passing through it- the so-called «monitoring current» Relatively little effort (a few kilogrammes) is required to break these very fine wires and thus transmit the firing signal to the charge. Such firing devices are thus completely different from the mechanical «release-wire» systems.
- **«Induction»** firing devices are operated by variation in the magnetic field Mine-layers can thus set up induction firing devices using electrical or electro-magnetic signals, such as:
* the nearby passage of a large metallic mass,
* the electro-magnetic waves sent out by a detector, or
* the displacement of the mine itself (within the Earth's magnetic field).

- «**Infra-red radiation**» firing devices are set off by a heat-source (for example, a motor). «Acoustic» firing devices have also been developed, which react to certain particular sounds (as of motors), as have electronic «seismic» firing devices, more selective than mechanical systems.

These kinds of firing devices, which are triggered without any direct contact with the target, are known as «**influence**» firing devices. By reason of their cost and of their way of operating, such devices are more specifically intended for antitank mines; even so, antipersonnel applications have, of course, been found for them.

Finally, certain mines may be equipped with **remote control firing devices**, operated by an artificer hidden in ambush. This variety of firing device is more particularly adapted to use with powerful mines (for example, directional mines); it goes without saying that fitting such an firing device changes the very nature of the device thus equipped, in as much as it is no longer the target which does the triggering. Once abandoned, such a mine will normally become inactive.

GENERAL DEVELOPMENT OF MINES

Historical Development of Mines

Confederate Army mines in 1862 were artillery shells converted by hand Even so, they already exhibited all the characteristics of land-mines: casing, plus main charge, and a pressure-firing device (in the form of a copper dome, which would be squashed by the weight of the target) in place of the artillery fuse. The German antitank mines of 1918 were also made by greater or lesser alteration of other kinds of explosive device- mainly demolition charges, known as «mines», used for the sapping or undermining of enemy constructions.

● The **inter-war years** were those during which mines as we know them today made their appearance. A key-date in this development would be that of 1929, the year in which the Germans adopted the Tellermine 29, an antitank mine with a 4 or 5 kg explosive charge. Although this charge was adapted to the needs of antitank warfare, the Tellermine 29 could in fact be fitted with 3 different types of firing device: antitank pressure firing devices, antipersonnel pressure firing devices or antipersonnel trip-wire firing devices. The antipersonnel function was aimed at hindering the work of mine-clearance operators. This original model still underlies the design of many antitank mines today; its charge was excessive for antipersonnel applications.

● **At the outbreak of World War II** in 1939, antipersonnel mines were not common; the German Command, however, very quickly came to feel the need for them. Although Germany had been a very minor antipersonnel mine producer, the German Army, between 1939 and 1944, developed most of the various types of mine known: the stake-mine (or «Stockmine», in German), the bouncing mine («S» mine), the antipersonnel pressure mine (the wooden «Schumine» and the glass «Glasmine») and even air-to-land scatterable mines (the «SD2») and undetectable Bakelite models.

Both the Allies and the other Axis countries copied these German antipersonnel mines in large numbers, often indeed increasing their already formidable capacity: tanks remained the principle targets for land-mines Moreover, in most of the armies involved in the World War, mine-laying was confided to fairly big special units, which, operating as they did from lorries, were not troubled by the considerable weight of the devices (which tended to be of several kilos). During the '50s, the spread of plastic materials, originally employed in order to make mines undetectable, brought about a profound transformation in their production, enabling as it did the manufacture of smaller devices having a strictly antipersonnel purpose. The weight of these mines was much reduced, so that foot-soldiers were able to carry several of them without any real loss of mobility.

The whole attitude to mines was changed by these developments, and mines came to be part and parcel of all infantry combat units' supplies. The NATO antipersonnel mines (the American M14 and the French APDV 59) were smaller and with a much smaller charge than those of the Warsaw Pact forces (the Soviet PMN and the East German PPM).

● **The Vietnam War (1964-1975)** witnessed the putting into practice of two new concepts in the field of mine deployment: Their experience during the Korean War (1950-1954) led the Americans to develop a directional mine, the Claymore M18. First used in South East Asia during the War, it has since been very widely copied. These relatively heavy directional mines were first of all designed for the protection of posts; basically remote controlled, they were also often fitted with trip-wire firing devices.

In the South East Asia, the Americans also deployed scatterable mine systems- first using a copy of the German SD2, and then developing a completely new device, the little BLU 43 or «Dragon's Tooth», which the Soviet forces were to copy with their own PFM or «Butterfly mine», made wide scale use of in Afghanistan during the 1979-1988 war there. These mines could only be deployed by means of air-to-ground scattering.

● **In the early '70s**, there appeared the first antipersonnel mines which could be deployed either by automatic scattering or else by hand-laying (the Chinese «Type 72» or the Italian VS 50 / TS 50). These devices are compact, for container transportation, and reversible, so as to remain effective, and are of course easy to handle and low-cost (at 2 ECU per «Type 72») being as they are always sold in bulk lots. This modern kind of mine is very often difficult if not actually impossible to neutralize, their low cost making re-usable design superfluous. They also exist in an «anti-lift» version, outwardly indistinguishable from others

● **During the 1980s and '90s**, electronic firing firing devices and the progress in military electronics in general have made possible the development of new kinds of sensors for mine-activation, be it acoustic, seismic or magnetic. Current research in the mine development field has thus come to focus on the enhancement of target-data collection and analysis. The guarantee, or at least the hope, that the device might not be able to be set off by a non-military target such as a passing civilian, has led to the design of highly expensive «smart» systems which certain experts would distinguish from «dumb» mines. Such smart mines are not the preserve of the European theatre, they have already been deployed in Angola.

● **Mines of the Future:** For the very near future, the first anti-helicopter mines equipped with high precision sensors will soon be coming on to the market, promising a short-to-middle-term deployment of very sophisticated systems.

APPENDIX IV

MINES TRADE CIRCUITS

Producer	Affecred conflict area
Belgium**	Angola, Iraq, Mozambique, Namibia, Somalia
Brazil	Nicaragua
Bulgaria	Cambodia
Canada*	Iraq
Chile	Iraq (Kurdistan)
China	Afghanistan, Angola, Iraq, Cambodia, Mozambique, Namibia, Somalia
E. Germany	Cambodia, Mozambique, Namibia, Somalia
Egypt	Afghanistan, Nicaragua, Iraq
Ex-Czechoslovakia	Afghanistan, Angola, Cambodia, Mozambique, Namibia, Nicaragua, Somalia
Ex-U.S.S.R.	Afghanistan, Angola, Iraq, Cambodia, Mozambique, Namibia, Nicaragua, Somalia, Vietnam
Ex-Yugoslavia	Afghanistan, Cambodia, Mozambique, Namibia
France**	Iraq, Mozambique, Somalia
Hungary	Cambodia
Italy**	Angola, Iraq, Mozambique Somalia
Pakistan	Somalia
Romania	Irak (Kurdistan)
S Africa*	Angola, Mozambique, Namibia
Spain*	Iraq
U.K ***	Afghanistan, Mozambique, Somalia
Vietnam	Cambodia
W. Germany*	Angola
Zimbabwe (ex-S.Rhodesia)	Mozambique, Namibia

* Countries having since adopted a total moratorium on exportation of antipersonnel mines

** Already committed to exportation moratoria, Belgium, Italy and France have since forbidden the manufacuture of antipersonnel mines Belgium has gone farther, extending such a ban to cover deployment

*** Country having adopted a partial embargo on the exportation of antipersonnel mines (as has Russia).

APPENDIX V

SUB-MUNITIONS

• Sub-munitions and scatterable mines.

The distinction between sub-munitions and scatterable mines comes straight from their design features. unlike mines, sub-munitions are intended to explode on impact. Moreover, sub-munition cargoes carry many more devices than do the cargoes used in mine scattering. One American air-force bomb contains as many as 4,704 anti-tank submunitions.

Most cargo-bombs, it is true, carry smaller quantities, but still quite a lot 600 mini-bombs per cargo-bomb, or 50-odd sub-munitions in a 155 mm shell.

It is the unreliability of the firing systems involved which entails a pollution comparable to that of mines. In fact, as many as 15% of these sub-munitions turn out to be defective and fail to explode as and when intended. Such a similarity in their respective effects can sometimes lead to a certain confusion between these two quite distinct types of weapon. Their polluting effect is multiplied by their mass deployment: a single bomb can sow a hundred-odd lethal devices, which in itself constitutes the laying of a veritable minefield. Unexploded sub-munitions were responsible for many Allied casualties during the Gulf War.

• Manufacture of sub-munitions.

Unlike mines, sub-munitions, and especially their scatter systems, can only be produced and deployed by industrial nations. Since 1970, the U.S.A. alone have manufactured 750 million sub-munitions- i.e., in excess of the world-wide production figure for mines, whether antipersonnel or antitank; war-time deployment of all this could leave behind it a residual pollution of nearly 100 million devices.

There are also other stocks: South Africa, Germany, China, Spain, France, Greece, Israel, Poland, the U.K., Russia and part of the former Yugoslavia all manufacture this kind of sub-munition.

APPENDIX VI

THE LIMITS OF MAGNETIC DETECTION

While much research has been carried out in the area of mine manufacturing, the basic principles of detection equipment have not much evolved since World War II. The equipment consists mainly in magnetometers that are more or less accurate and that emit a signal in the presence of metal.
Interestingly, the concept of non-metal mines has evolved over time, and in parallel with the progress in metal detectors. Back in the 1950's, mines with a non-metal casing were considered as such, whereas they are nowadays considered as metal mines because some parts in their detonator do contain metal. Manufacturing non-metal detonators (especially the firing pin) proved more problematic than manufacturing non-metal outer casings: Bakelite, plastic, wood, etc...Moreover, the use of the detector involves a specific danger: contrary to the probes which are obviously inert, the detector is «active», since the magnetometer sends out radiations. Some sophisticated mines will react to such emissions.

• **The limits of common magnetic equipment:** Portable metal mine-detectors were part of the equipment in all troops throughout World War II. Although the appearance of metal detectors has not changed much since 1944, their magnetometers have been improved so that they are now able to locate just a few grams of metal (including aluminium).

Traditionally, mine detectors used a constant emission and analysed the return radiation. The German detectors METEX 4.125 (FORSTER) and the American detectors AN/PSS-11 still operate the same way Their magnetometers operate on direct current at low frequency/audio-frequency (in the case of the American AN/PSS-11) or at high frequency/radio frequency (in the case of the German METEX).

• **Modern metal detection systems:** Two types of improvements were recently brought about by two European firms to portable mine detectors:

One of them exploited a technology once exclusively used in «treasure hunting»: pulse emission enabled them to reach an outstanding accuracy level and therefore a great economical success. The SCHIEBEL AN/19-2 is now extensively used by the U.N. and the Swedish army, while the British, Dutch, German and American armies all have adopted it.

The other one specializes in non-destructive tests; it has developed a very sensitive device based on a double emission, both at low and high frequency: the MINEX 2FD. Unfortunately, this highly precise detector (localization between 2 and 20 cm depending on the mine) has a high price and weighs more than the average. It will therefore be used in particularly tedious cases.

• **The problem of false alarms:** Obviously, as the capacity of detectors to detect very small metal parts increases, so does the rate of false alarms (currently estimated at 15 for one mine). This is due to the presence in the ground of any battle field of small metal objects (shell splinters, projectiles, garbage or lost items). In Afghanistan, 1000 inoffensive objects are picked up for one single mine, against 129 in Cambodia. Obviously, only part of those objects are responsible for false alarms, but that is enough to dramatically impair the progression of mine-clearing teams. The depollution of mined areas is delayed by the impossibility to distinguish between mines and inoffensive items, thus increasing the number of victims.

This is the reason why today, only the probe will achieve the level of precision necessary to restore an inhabited area.

APPENDIX VII

THE EXAMPLE OF AFGHANISTAN

This is the oldest and most thorough mine-clearance programme. Although in accordance with the first two principles presented in § IV. 2., it is purely a UNO program, as the other sponsors, among which the EC is the most important, cannot claim any great participation in its development and implementation Today, many lessons can be drawn from this example. Over 4000 minefields were identified in 27 provinces out of 29 The total area of those mined zones is 500 km2. Approximately 45000 people have been moved within the country, while approximately 2.8 million refugees still remain in adjoining countries.

Afghanistan is one of the least developed, and **the most extensively mined** countries. in the world. Most infrastructures have been mined. Thousands of Afghan people were killed or amputated, and the refugees are reluctant to go through the minefields. The war against the Soviet Union began at Christmas in 1979 and ended in April 1988 thanks to the good offices of the U.N. But a civil war is still going on 10 million mines have been laid during that period of time. Most antipersonnel mines were laid by the Soviet forces, while antitank mines were being laid by the mujahedeens. The mine-clearing teams found numerous butterfly mines and booby-trap mines that were used to empty the towns and get control over movements of population. Since the outbreak of the civil war, the different parties have been laying more mines and as a result, very recently-laid mines can today be found

UNOCA (United Nations Co-ordinator for Humanitarian Assistance) undertook the first evaluation of mine-related risks in 1988, and prepared a mine-clearance programme designed to be completed in the short run, in relation with the reconstruction project. It became **UNOCHA** (Co-ordination of Humanitarian Assistance) in 1992. The first mine-clearing teams arrived from various countries in February 1986. The first objective of the U.N. was to train as many refugees as possible in the field of risk prevention. Since then, the number of expatriates has progressively decreased to make room for executives of Afghan origin

There has never been an official government in Afghanistan since the mine-fighting programme was initiated. «National» mine-clearance is currently under controlled by a specialized department, the **DMC** (Department of Mine Clearance), which is dependent on the Prime Minister and calls upon former soldiers. Due to the lack of means, this structure is not efficient. However UNOCHA maintains informal relations with the DMC as well as with local and regional authorities which often participate in the logistic support and safety of mine-clearing units. In the absence of an official government, UNOCHA is de facto regarded as the national organism for mine-clearance.

The Afghan example therefore gave birth to the concept of national **integrated mine-clearance programme**. This is the main function of the **DHA**. This strategy was successfully implemented by the U N in Mozambique in 1994, in spite of some violent hurry due to the accumulation of great delays. Within 6 months, 30 teams of Mozambican mine-clearing operators, which represents over 450 men, were trained, fully equipped and deployed. They Have destroyed over 3000 mines.

Organisation of UNOCHA
(responsible for fund collection, administrative and accounting management)

↓

staff headquarters of the mine-clearance programme (in Islamabad, Pakistan)
a programme director
a small team of U.N. experts
development of the programmes
definition of the priorities
definition of the courses of action
relations with NGO and Commercial Companies
equipment
health and insurance
updating of minefield surveys
participation in all coordination meetings between agencies of the U.N.

↓

three regional officers
regional director
daily coordination
registration of new requests for mine-clearance
training
supervision of the worksites
investigation following accidents
liaison with administrations and local associates
and the NGO on the field

↓

There are 8 mine-clearance NGO (7 Afghan ones plus HALO Trust). They have approximately 3000 interveners on the field and carry out projects related to all four basic areas of the fight against mines.

***Note: The priorities:** UNOCHA has defined 5 types of priority worksites: roads, chanels, residencial areas, agricultural fields and pastures.*

APPENDIX VIII

RESEARCH AND DEVELOPMENT AND MINE CLEARANCE

MINES DETECTION

• **Application of nuclear physics:** Since the 40's, several institutions specializing in nuclear research have been investigating methods based upon the clear differences between the ground and the explosive in terms of their atomic numbers (respectively 5 to 7 and 11 to 12), or other abnormalities in magnetic or paramagnetic resonance and such. In spite of the theoretical success of such methods, the cost of their application still appears as prohibitive.

As a reminder, the atomic number of any body is the number of particles (neutrons plus protons) in the nucleus of its atom.

• **Detection of Abnormalities related to the presence of mines in the ground:** Examination of the ground could reveal certain abnormalities typical for the presence of mines: the shape of the outer casing (flat or curved), the dielectric characteristics of the ground, traces left by digging, the observation of all suspicious items etc...

Many experimental technologies permit the detection of such clues. For their development, budgets from various origins have been used, either private or public (mostly Defense) and those technologies have achieved different stages of development. Two of them specifically already appear as applicable «on the field», they are: infrared research and penetration radars. Other detection systems not based upon the detection of explosive compounds have been thoroughly tested on «training grounds».

• **Infrared detection:** This method is based upon disturbances caused by burial of the mine Digging alters the consistency of the ground, and normal conditions will not be restored for several decades after the ground was dug. This characteristic will affect heat circulation (especially solar heat) for long periods of time, and this disruption is the kind of signal that infrared sensors will detect. However, this disruption varies with temperature throughout the day.
Many manufacturers of optical or optronic components have modified their systems to different extents in order to adapt them to the fight against mines. Today, this technology is used in conjunction with air-transported video cameras to detect suspicious lines (minefields). Unfortunately, this method is well suited for the localization of anti-tank mines but not so much of antipersonnel ones, due to their small size.

• **Other abnormalities** can turn up as the opposing characteristics between dug soil and compact ground as follows:
- Polarization and reflection of light (method using visible wavelengths)
- Detection on the surface of bacteria usually found underground (method using ultraviolet rays)
- Differences in acoustic impedance (acoustic or seismic methods)
- Other methods...

Note: Feasibility studies have not yet been completed for most of these methods.

• **Close detection by penetration radars:** This method emerges from technologies extensively exploited in other areas, especially in archaeological research (excavation of objects) and civil engineering (detection of various pipes and cables). Like other types of radars (Radio Detection and Ranging), penetration radars detect the presence of objects (by wave return) and determine the distance at which it is located (length of time between the emission of the wave and the echo. The latter measurement might pose problems of standardization, but is of lesser importance when working with mines anyway. Penetration radars installed on all-road vehicles seem best adapted to fighting against antipersonnel mines although years of research are still needed.
Besides, it is likely that this technology will have to be used in conjunction with one or more others, all based upon various concepts, as these new methods still develop a false alarm rate well above the acceptable with respect to the type of object concerned..

• **Pluri-disciplinary approach of the problem**
Based upon the analysis of all experiences conducted, a pluri-disciplinary approach, meaning an approach combining several technologies, seems best advisable. This is the kind of approach currently developed by the American Army in the ASTAMIDs project. Such an approach underlines the complexity of the process and the limits in the reliability of each individual method.

The objectives of NATO (ONST programme) are to provide all fifteen Allied armies with faster and safer mine-clearing means by the year 2005. The broad lines also imply the use of pluri-disciplinary approaches. One starting point of the programme (a broader, more ambitious project, but less advanced than ASTAMIDs) is the observation that today's devices are «blind», meaning that they work in the same way, no matter whether the field is mined or not. NATO is hoping to get equipped with «intelligent» devices that would combine detection functions with neutralization / destruction functions.

MINE IDENTIFICATION

Mine identification should also benefit from technological progress, particularly computer systems with the possibility to refer to data banks available either on computer or on paper. Several computer data banks have been set up and there is even dedicated software able to analyse an image transmitted to it by the mine-clearance team. Improvement in and generalization of this kind of system is no doubt an effective way of making headway in the fight against mines.

APPENDIX IX

International Workshop and Study on the State of Knowledge for the

LOCALISATION AND IDENTIFICATION OF ANTIPERSONNEL MINES

carried out for the
Federal Ministry for Education, Science, Research and Technology (BMBF)
of the Federal Republic of Germany

Code Number : ISP 9501

Study Manager
Dr. habil. Alois J. Sieber
Head of the Advanced Techniques Unit
of the Institute for Remote Sensing Applications

JOINT RESEARCH CENTRE

EUROPEAN COMMISSION

GLOSSARY

ANGLAIS	ESPAGNOL	FRANÇAIS
A		
activation	**activacion**	excitation
antipersonnel mine	**mina contra personal**	mine anti personnel
antitank mine	**mina contra tanque**	mine anti-char
B		
black powder	**polvera negra**	poudre noire
blast effect	**efecto de la explosion**	effet de souffle
blast	**explosion**	blast
brisance	**poder de expansion**	brisance
bomb	**bomba**	bombe
bombing	**bombardéo**	bombardement
booby trap	**trampa explosiva**	piège
booster	**embujador**	relais, booster
bullet	**bala, proyectil**	balle
C		
caliber	**calibre**	calibre
canister	**bote de metralla**	boite a mitraille
cannon	**pieja de artilleria**	canon
cannon ball	**bala de canon**	boulet
case	**funda**	douille
charge	**carga**	charge
chain explosive train	**cadena de explosivo en secuencia**	chaine pyrotechnique
chemical	**substancia quimica**	substances chimiques
chemical warfare	**guerra quimica**	guerre chimique
confinement	**encerramiento**	confinement
crater	**crater**	entonnoir
D		
decontaminate	**decontaminar**	décontaminer
defensive position	**posicion de resistencia**	position de défense
deflagration	**deflagracion**	déflagration
delay	**explosivo de retardo**	retard pyrotechnique
demilitarization	**desmilitarizacion**	demilitarisation
demolition	**demolicion**	démolition
destruction	**destrucion**	destruction
detonation	**detonacion**	détonation
detonation capacity	**capacidad de detonacion**	aptitude à la détonation
detonation velocity	**velocidad de detonacion**	vitesse de détonation
detonation wave	**efectos de detonación**	onde de détonation
detonator	**detonator**	amorce détonateur
disconnect	**desembragar**	déconnecter
distanse	**distancia**	distance
dynamite	**dinamita**	dynamite
E		
excitation	**excitacion**	excitation
explosive factory	**fabrico de explosivos**	poudrière
F		
field artillery	**artilliera de campana**	artillerie de campagne
filling	**cargar**	chargement
firearm	**arma de fuego**	arme à feu
firing	**disparar**	mise à feu
firing pin	**percutor**	percuteur
flare	**illama**	fusée éclairante
fortification	**fortificacion**	fortification
fragmentation	**fragmentacion**	fragmentation
fuel	**combustible**	combustible
fulminating composition	**fulminanto de composicion**	composition fulminante

ANGLAIS	ESPAGNOL	FRANÇAIS
F		
fuse train interrupter	**interruptor de fusible en secuencia**	interrupteur de chaîne pyrotechnique
fuze	**espoleta**	fusée
G		
gas	**gas**	gaz
gun	**arma de fuego, canon**	arme à feu
gun barrel	**canon**	canon
gun tube	**anima del canon**	tube de canon
H		
hand arms	**armas portatiles**	armes portatives
hand grenade	**grenada de mano**	grenade à main
helmet	**casco**	casque
homogeneous powder	**polvera homogenea**	poudre homogène
howitzer	**obus**	obusier
I		
ignite	**enconder**	initier, amorcer
igniter	**encondedor**	inflammateur
ignition	**ignicion incendido**	allumage
illuminating composition	**composicion de iluminacion**	composition éclairante
implosion	**estallido interno**	implosion
inactivate	**desactivar**	inactive
incendiary	**incendiario**	incendiaire
inert	**inerte**	inerte
individual weapons	**armas individuales**	armes individuelles
initiator	**fulminante**	amorce
initiation	**iniciacion**	initiation, amorçage
L		
launcher (grenade)	**lanzagranadas**	lance-grenades
launcher (rocket)	**lanzacohetes**	lance-roquettes
lid	**tapadera, cobertor**	opercule
line fire	**linea de fuego**	ligne de tir
linearshaped charge	**carga de forma lineal flexible prefabricada**	charge coupante
liner	**lineal**	assiette
liner	**envoltorio, envolver**	revêtement
liquid explosive	**explosivo liquido**	explosif liquide
load	**carga**	charge
lockened	**cerrado, encerrado**	armé
M		
machine gun (light)	**ametralladora (ligera**	mitrailleuse légère
machine gun (heavy)	**ametralladora (pesada)**	mitrailleuse lourde
magazine	**cargador, almacen**	chargeur
magnetic base	**basa magnetica**	base magnétique
mercury fulminate	**fulminate de mercurio**	fulminate de mercure
mild detonating fuze	**fulminate detonate liviano**	cordeau (transmission)
mine (antitank)	**mina antitanque**	mine antichar
mine (anti personnal)	**mina contra personal**	mine antipersonnel
mine (naval)	**mina naval**	mine sous-marine
minefield	**campo de minas, campo minado**	champ de mines
missile	**misil, proyectil**	missile
mortar	**mostero**	mortier
munition	**municiones**	munitions

ANGLAIS	ESPAGNOL	FRANÇAIS
N		
napalm	napalm	napalm
neutralize	neutralizar	neutraliser
nitroglycerin	nitroglicerina	nitroglycérine
nozzle	escape de cohetes, misiles	tuyere
O		
ordnance	material de guerra	matériel de guerre
oxidizing agent	agente quimico	comburant
P		
pentaerythrol-tetranitrate	pentariltetranitrato	pentrite
pentolite	pentolito	pentolite
penetration	penetracion	pénetration
phlegmatize	disminucion de poder explosivo	flegmatiser
phlegmatiser	disminucion quimica	flegmatisant
picric acid	acido picrito	mélinite
plastic explosive	explosivo plastico pegado	explosif plastique
powder	polvera, polvo	poudre
power	poder	puissance
primary explosive	explosivo primario	explosif primaire
priming composition	composicion preparada	composition d'amorçage
propellant	impulsador	propergol
propeller	propulsar	propulseur
pyrotechnics	pirotecnia	pyrotechnique
pyrotechnic area	area pirotecnica	zone pyrotechnique
pyrotechnic component	componente pirotecnico	composant pyrotechnique
pyrotechnic device	aparato pirotecnico	dispositif pyrotechnique
pyrotechnic train	tren pirotecnico	atelier pyrotechnique
pyrotechnics	pirotecnicos	pyrotechnie
R		
rate of fire	cadena de tiro	cadence de tir
rear effects	effectos posteriores	effets secondaires
reconnaissance	reconocimiento	reconnaissance
rifle	fusil	fusil
rifle grenade	granada de fusil	grenade à fusil
rocket	cohete	roquette
rocket launcher	lanzacohetes	lance-roquette
ROX/Wax/aluminium	ROX/Céra/aluminio	Hexal
S		
sabotage	sabotaje	sabotage
safety	seguridad proteccion	sécurité
safety instructions	instrucciones de seguridad	consignes de sécurité
security	seguridad	sécurite

ANGLAIS	ESPAGNOL	FRANÇAIS
S		
secondary instructions	explosion secundaria	explosif secondaire
self-forging fragment	fragmento auto-formado	assiette deformable
sensitivity	sensitividad	sensibilite
shaped charge	carga formado	charge creuse
sheath / fuze well	orificio para colocar un fusible en un proyectil	gaine
linear shaped change	carga de forma lineal	cordeau decoupeur
sheel explosive	lamina explosiva	explosif en plaque
shelter	refugio, protector, abrigo	abri
shock	choque	choc
shock pressure	presion de choque	pression de choc
shock wave	onda de choque	onde de choc
shotfirer	disparador	boutefeu
slurry exp liquid exp	explosivo liquido	explosif en bouillie
signalling composition	composicion de senalizacion	composition de signalisation
signalling rocket	coheto senalizacion	fusee de signalisation
slow fuze	mecha lenta	mèche lente
slow match	cerillo lento	mèche lente
shell	granada	obus
small arms	armas portabiles	armes portatives
smoke	humo	fumée
smoke composition	composicion de humo	composition fumigène
smokeless powder	polvera sin humo	poudre sans fumée
solid propellant	impulsador solido	poudre
sound composition	composicion de sonido	composition sonore
squip	encendedor	initiateur
stability	estabilidad	stabilité
stabilize	estabilizar	stabiliser
stricker	percutor	percuteur
T		
tamper	encerramiento	confinement
target	blanco, objectivo	cible
target range	campo de tir	champ de tir
team	equipo	équipe
terrain	terreno	terrain
tetracene	tetril	tetrazene
thermal protection	proteccion termica	protection thermique
tracer composition	composicion trazadora	composition traçante
trinitrotoluene	trinito-tolueno	tolite
time fuze	espoleta de tiempos	fusee à temps
tracer (Ammunition)	municion trajadora	munition traçante
trench	trinchera	tranchée
trip-wire	alambra de tropiejo	fil de piegeage fil de trébuchement
W		
weapons	armas	armes

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ACRONYMS

STANAG :	Standard agreement (NATO). accord de standardisation (OTAN)
FAE :	Fuel Air Explosive: Explosif par Aérosol.
MAP :	Mine Awareness Programme. Programme de mise en garde de la population.
MAE :	Mine Awareness Education: Formation aux techniques de mise en garde contre les mines.
NMS :	Nationwide Mine Survey: Programme National d'identification et de marquage des champs de mines.
DHA :	Department of Humanitarian Action - NY (O.N U) Département de l'Action Humanitaire
NPA :	Norvegian People Aid (ONG). Secours Populaire Norvégien.
UNOCHA :	Coordination of humanitarian assistance - Afghanistan (U.N). Coordination de l'Assitance Humanitaire (N.U.)
OEA :	Organisation des Etats Américains (Organization of American States).
UXO :	Unexploded Ordnance. (munitions non explosées).
EOD :	Explosive Ordnance Disposal. Traitement des munitions, et des explosifs, (qualification Grande-Bretagne)
NEDEX :	Neutralisation, Elimination et Destruction des Explosifs, (qualification Française)

COMMENTS :