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DDAS: Protection Needs in Humanitarian Demining, the Facts (2000)

Humanitarian Demining Accident and Incident Database
AID

Protection needs in HD - the facts (2000)
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[This paper was first published in the JMU Journal of Mine Action in April 2000. The number of recorded accidents in the DDAS has increased by a factor of 10 since this was written 15 years ago, but the general conclusions remain very similar. The only significant change has been in the number of deaths caused by ordnance and IEDs following recent conflict, usually involving devices that could not be realistically protected against with body armour.]

I have approached this subject by studying the risks that deminers really face and the injuries that result, then working out how to minimise risk and protect against any residual danger. I bore in mind that there was no point is prescribing an action or a garment that would not be used. This is not an approach widely endorsed in the protective equipment industry, which apparently prefers to base its assessment of risk on experimental data and a scale of injury borrowed from the automobile industry. If the injuries commonly predicted by them were accurate, most of the accident victims I have worked with would have been dead.

Anyone considering this matter objectively should bear in mind that demining accidents are rare. While I do not have all the relevant data, I believe that severe accidents occur at the rate of one per 25-30 man-years of actual demining. This statement ignores the facts that some groups have more accidents than others (perhaps working in more dangerous areas) and only serves to explain why it is that most actual deminers have not seen a serious accident and will not wear equipment that they believe is unnecessary.

The following paper draws on my five years of field research and my knowledge of the Database of Demining Incident Victims (DDIV). The DDIV covers all recorded explosive incidents that have occurred while demining in Angola, Mozambique, Cambodia, Bosnia Herzegovina, Laos and Zimbabwe. It also covers all the accidents that occurred in Afghanistan between 1997 and 1999 and those made available from Kosovo. It does not include details of civilian accidents and injuries. Often with considerable detail about the circumstances surrounding an accident, the records provide a reference for informed analysis.

The DDIV has been accepted as an authoritative resource by GICHD in its work advising on the revision of UN standards for HD. The DDIV is available on CD. Contact me for details. [The DDIV became the Database of Demining Accidents when it ecame a relational database in 2003.]

The first part of this paper gives facts in support of the discussion that follows.

1 The facts

1.1 Threat activities

There are many opinions of what constitutes the greatest threat in demining. Using the DDIV, genuine threat activities can be listed in terms of incident type and frequency.

The type of accident is followed by the number of recorded victims

Excavation	119
Missed-mine	85
Handling	32
Victim inattention	25
Detection/tripwire	18
Survey	16
Vegetation removal	12
Other	10
Demolition	7
Detection	6

[The activity titles are defined in full in the DDIV.]

1.2 Injuries sustained

In the DDIV, injuries likely to be life-threatening, to require surgery or to result in permanent disability are rated as “severe”. All others are rated as “minor”.

For the whole database the following injuries are recorded:

Body part	Severe /amp.	Minor

Eye	60	37
Face/head	41	139
Hand/finger	68	118
Arm	38	66
Leg	103	94
Foot/toes	27	10
Body	13	36
Chest	18	37
Genital	11	5

1.3 Devices involved

The following records the devices that are most commonly involved in recorded incidents.
The Blast mine threat in the various theatres can be summarised as:

> Afghanistan, Iraq, Mozambique – PMN (240g TNT).
> Angola – PPM-2 (110g TNT), PMN.
> Bosnia-Herzegovina – PMA-3 (35g Tetryl), PMA-2 (100g TNT).
> Cambodia – PMN-2, Type 72 (51g TNT), M14, MD82B (27/28g).
> Kosovo – PMA-2 (100g TNT).
> Zimbabwe – R2M2 (58g RDX/WAX).

The PMN represents the largest AP blast threat and is present in most theatres.
The fragmentation mine threat is far less common and can be summarised as:

> Afghanistan, Angola, Cambodia – POMZ (75g TNT)
> Bosnia-Herzegovina – PROM-1 (425g TNT).
> Iraq – the Valmara-69 (450g Comp B) and PROM-1 (425g TNT).
> Laos – a mortar features in the only recorded injury.
> Mozambique – OZM-4 (170g TNT).

The PROM-1 represents the greatest threat (in terms of numbers of accidents). The smallest fragmentation mine, the POMZ, is the most universal threat.

The ordnance threat (crudely defined as explosive devices that are not classed as mines) in the various theatres can be summarised as “fuzes”. There have been very few UXO accidents, almost all of which have involved fuzes and been minor.

2 Reducing risk

There are two obvious ways to reduce the risk of injury in an accident. The first is to avoid the accident. The second is to provide effective protective equipment.

Avoiding risk can be achieved by revising operating procedures, or by enforcing the application of safe operating procedures. The DDIV records 272 injuries where the primary cause was a management inadequacy at some level. This was generally either the failure to provide appropriate equipment or training or the failure to ensure that deminers worked as trained. Clearly, improving controls at all levels could be a very effective way of reducing accident numbers – and it would take another paper to explain how I would approach that.

When everything has been done to avoid an accident, provision must be made to protect against residual risk.
For brevity I only discuss protection needs in the four most common accident types in the following. The other accident types were rare and my conclusions are similar to those expressed for others.

Excavation of a suspect mine is the most common accident activity. This is an activity that must be carried out and accidents have occurred when no “mistake” was attributed to the victim. The “duty of care” of an employer requires that a deminer be protected appropriately when working as directed on a required task.

Missed-mine accidents are the second most common and indicate that clearance has not been effective. Some time-served groups have not had any missed-mine accidents: others have had many. This implies that it is possible to work in a way that avoids them. (Incidentally, there is no evidence that there is a greater risk of missing a mine when demining in areas with minimum-metal mines). The evidence in the DDIV suggests that the best defence against the “missed-mine” risk is to avoid it by using proven working methods that are adequately supervised.

Handling is the next most common accident and occurs when a device or part of a device explodes in the hand. In several accidents the victim did not recognise the risk, which could have been avoided with appropriate training. Some groups seek to avoid the risk altogether by not allowing devices to be handled (these groups have still suffered these accidents). Practical protection is impossible, so avoidance is the only way to reduce injuries.

Victim inattention is the next most common accident and covers deminers behaving in a thoughtless manner. While close supervision and rigorous training might have prevented some accidents, it has to be accepted that moments of inattention occur. Given that it is impossible to predict the nature of these accidents, the only practical protection seems to be that used for other accidents.

The only kind of accident that occurs despite a deminer acting properly in accordance with his training and instructions is "excavation" – which is also the most common accident. This is why I believe it should provide the benchmark for protection needs (an opinion shared by many field workers).

3 Protection while excavating

To protect a deminer against accidents that occur when excavating we must know the position he is in and the injuries he risks.

The data in the DDIV clearly illustrates that almost all deminers excavate in a kneeling or squatting position (whatever their SOP). This is good news for the deminer because he avoids the whiplash acceleration injuries that might have been associated with having his head within a few centimetres of a blast while his body remained stationary. The exploding device is almost invariably directly in front of and below his body and head. Often his hand is above or alongside the device.

The following lists the number of severe (disabling) injuries recorded while excavating.

Face & neck	54
Upper limb	51
Lower limb	7
Trunk	10

The low number of lower limb injuries illustrates the way that a fragment cone rises from a seat of initiation and its core often misses the legs (minor leg injuries were more common - 36). The low number of trunk/body injuries illustrates how the main torso is not threatened as much as the upper limbs and the head. (Half of the severe body injuries were caused by parts of the victim's hand-tool.)

3.1 Face and neck protection

Despite the fact that some form of eye protection was issued, it was not worn in almost half the recorded blast accidents and more than one in three victims suffered eye injury.

Eye protection issued varies from industrial safety spectacles to 5mm polycarbonate visors. Visors made from 5mm polycarbonate have been used by the most responsible groups for some years and their use is spreading (MAG, HALO Trust, NPA, MgM, Koch MineSafe, MineTech, INAROEE, most Bosnian and Croatian groups, etc). Some of these are short and attach to helmets –

usually leaving the wearer's throat exposed. Others are long and worn without helmets. These offer some protection to the throat when kneeling and looking down.

I have tested 5mm polycarbonate visors in over 40 tests using mines. In one test, the visor was penetrated by a steel fragment in the earth covering the mine. In several further tests against POMZ fragmentation mines, the visor was not penetrated at all. One 5mm visor broke in two in a recorded incident. These facts illustrate the unpredictability of mines, but also shows that even 5mm polycarbonate does not guarantee protection to a deminer excavating an AP blast mine. It is, however, light enough for sustained wear (thousands of deminers do so) and is the best available option until a lighter, stronger material is developed.

The evidence suggests that 5mm polycarbonate visors that are fixed in the "down" position should be provided for deminers excavating AP blast mines.

3.2 Upper limb protection

The DDIV records 51 severe upper-limb injuries from blast mine detonations (including 14 amputations of fingers and hands, and 10 of arms). The injuries were worst when the tool was short and used vertically. When the tool broke up, deminers were struck in the chest, upper arm and face. At least five deminers died after their hand-tool fragmented in a blast.

The DDIV also provides evidence that tools which stay in one piece do not injure the user.

Demining hand-tools should be designed so that they:

- are easiest to use a low angle to the ground;
- stay in one piece;
- are long enough to keep the user's hand at least 30cm from the blast;
- incorporate a flexible blast shield whenever possible without reducing utility.

Examples of such tools exist and are available on the commercial market.

3.3 Body protection against fragmentation

Protection designed to reach a STANAG V50 of 450m/s (current UN standard) has proved less than adequate against bounding fragmentation mines. Deminers who let one off at close quarters invariably die even when wearing protection. However, bounding fragmentation mine incidents occur rarely outside Europe and there are no records of a bounding fragmentation mine incident having occurred while excavating (although I have anecdotal evidence of one such incident in Kuwait). Protection against the close quarter detonation of a bounding fragmentation mine would involve such a weight of body armour that it is not practical, but the use of an angled steel shield when setting charges on such devices might be practical.

3.4 Body protection against blast

In the recorded excavation accidents where body armour was worn, it did not fail, illustrating the fact that the current STANAG 450m/s standard of body protection is sufficient (or more than sufficient) against the largest AP blast-mine threat.

But a fragmentation V50 of 450m/s is no measure of blast protection. Blast is a significantly different threat and the materials used to protect against it may lack fragmentation resistance while being highly effective against blast.
In an attempt to use more practical armour, there has been a general move away from flak-jackets to the use of frontal "aprons". Some have a V50 as low as 380m/s, others over 500m/s. The only sort to have failed in my tests had the higher V50 but was made up of discrete panels that the blast separated. A one-piece apron with a 380m/s V50 has performed well in 7 tests and in at least 15 real incidents.

The evidence shows that the need for body protection may not be a high priority, but it is desirable, especially when it is comfortable enough for a deminer to wear. Simple, frontal blast aprons have proven capable of protecting an excavating deminer – and are comfortable enough to be worn without protest.

The evidence suggests that deminers should be issued with frontal blast protection (240g TNT at 30cm) for use when excavating.

3.5 No protection because no proven risk

There are a number of products available that offer protection against risks that the facts suggest are not real. There is, for example, no evidence of over-pressure internal injuries from any AP blast mine. There is also no evidence to suggest that blast-proof boots would have significantly reduced injury (most occurred with mines far larger than those used in "successful" boot trials). There is no evidence that wearing a helmet or an armour back-panel has ever significantly reduced injury.

Protection against hearing damage is sometimes suggested. There were many claims of hearing damage in Afghanistan during a period when compensation was paid for small, unverifiable hearing loss.

Excluding Afghanistan, there is only one claim of severe hearing damage resulting from a single blast in the DDIV (the claimant was in close proximity to a very large ambush device). The risk is, at worst, very low.

4 Wrapping it up

As I see it, there are two practical approaches to meeting deminer protection needs. These are:

a) Reducing the number of accidents that occur.
b) Reducing the severity of injury when an accident occurs.

The first can be pursued via changes to working methods and improved supervision – and is likely to have most effect. The second can be pursued via the provision of PPE appropriate for use at times when risk cannot be avoided.

The practical personal protective equipment I recommend is:

- Fixed eye protection with a blast performance and fragmentation protection equal to that offered by untreated 5mm polycarbonate.
- Hand-tools that are fit for purpose and that are designed to minimise the risk of adding to injury.
- Comfortable frontal blast protection (against 240g TNT at 30cm/12”) for use when excavating. The inclusion of a collar that overlaps the visor and closes any access to the throat from below is desirable.

Some groups already do most of the above. A few have done so for many years. This provides evidence that my suggestions are practical, and the DDIV provides evidence that they are needed.

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