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International Standards for Personal Protective Equipment

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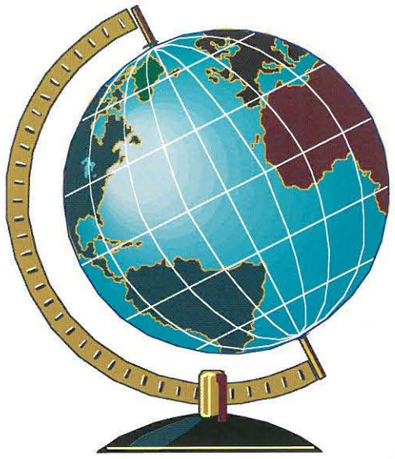


International Standards

for Personal Protective Equipment

by Colonel Alastair McAslan, GICHD, *and Keith Feigenbaum,* MAIC

Introduction

International Standards for Mine Action are being revised by the United Nations. As part of the revision process, a working group on personal protective equipment (WGPPE) has been established to examine the subject of safety in mine clearance operations, and to make recommendations on standards and guidelines for PPE. This paper is based on the WGPPE's report.

The concepts of safety, risk and risk management are not new to humanitarian mine clearance. Risk management involves the identification, analysis, assessment and removal (or at least reduction) of risk. The term implies dominance and control of the risk, and the application of agreed processes to achieve consistent results.

It is necessary to clarify the meaning of the term safe in respect to mine clearance. To say that a situation is safe implies a final judgement that the risk is in some sense acceptable or tolerable, or even nonexistent. However, the terms "acceptable" and "tolerable" imply human judgement of the situation and judgement may be tentative, transient and fallible.

A Systems Approach to the Problem

A recent international study of mine accidents and incidents carried out by Andy Smith on behalf of the U.S. Department of Defense (DoD) has revealed that in the vast majority of cases, victims either failed to wear PPE correctly or were engaged in activities which contravened local Standing Operating Procedures (SOPs). A simple statement of the blast and ballistic protection levels alone would be inadequate for international safety standards. A systems approach considering the threat, training, operating procedures, supervision, equipment capabilities, environmental factors and protection levels is needed to enable managers of mine clearance operations to decide appropriate local requirements for PPE.

Mine and UXO Threat

Though the term "threat" is not often found in general safety literature, it is frequently used in mine clearance to describe the extent of risk at a particular time in a particular country, province or district. Threat is a useful concept and we must establish a common understanding of its meaning and application.

Whereas "risk" refers to the probability and severity of a single occurrence of harm, the threat from mines and UXO refers to the sum of local risks in an area or theatre. In mine clearance, the probability of harm is a combination of the quantity of munitions with the potential to cause harm and the probability of failing to detect a single active mine/UXO. There seem to be three components of any threat within a given area: (1) The type of hazard (fragmentation, blast or incendiary), and the severity of physical harm which would result from its unintended detonation; (2) The detectability of mines and/or UXO; and (3) The quantity of mines and/or UXO within a given area.

Threat is dependent on time as well as area. In some mine-affected theaters it will *reduce* over time from demining and through effective mine awareness training. In other theaters it may *increase* over time from uncontrolled vegetation coverage, soil movements and the cumulative effects of weather.

The threat can be demonstrated graphically as shown in Table 1 below. This example, which uses data from Bosnia-Herzegovina, attempts to illustrate the antipersonnel (AP) mine threat in Sector MND(SW). In general, mines towards the top right of the table represent a greater threat than those towards the bottom left. The size of the circle is proportional to the quantity of mines.

Risk Management

In recent years, the concepts of risk, risk management and safety have received much attention from industry and academia. This attention can be explained in part by a moral imperative and by a growing sense of duty, but it is mainly driven by the impact of litigation. The International Organisation for Standardisation (ISO) has had to address these issues in the workplace. ISO guidelines for the development of safety standards are relevant, and the ISO approach has proved to be an appropriate model to guide the work of the WGPPE.

Notwithstanding the legal imperatives to reduce risk, humanitarian mine clearance imposes a moral duty of care that demands attention be given to the consequence of all actions, and also to the consequence of inaction. The latter is often overlooked, and is particularly relevant to those in positions of authority, supervision or of professional standing in humanitarian mine clearance.

Health and Safety

The International Labour Organisation (ILO) is a specialist agency of the United Nations, which seeks the promotion of human and labor rights. The ILO formulates international standards in the form of Conventions and Recommendations by setting minimum norms, including basic standards regulating conditions of work and the workplace. In 1981, the ILO adopted a Convention (C155) and related Recommendation (R164) on Occupational Safety and Health.

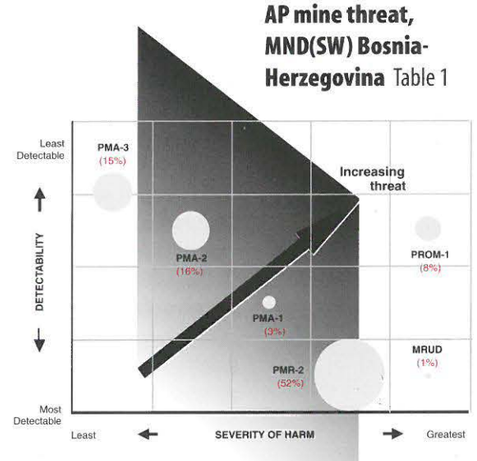
Precedent and norms already exist at international level to provide guidance for the development of new international standards for safety in mine clearance. The concept of responsibility included in ISO and ILO documents implies the need for accountability. In particular, the responsibilities and obligations of the national authorities, mine action centers, the employers and employees, as required by the ILO, should be applied to the management of mine clearance and be included in the revised safety standards.

Mine Incidents and Accidents

Risk reduction involves a combination of safe operating procedures, education, training, effective supervision and PPE. In adopting a systems approach, the WGPPE considered it necessary to analyze and evaluate the relationships between these factors before deciding whether the residual risk to deminers is "tolerable." This conforms to the approach taken by ISO in developing safety standards.

Much of the WGPPE's analysis and many of its conclusions on PPE have been derived from the Database of Demining Incident Victims (DDIV) compiled by Smith. The database covers mine clearance incidents in Angola, Afghanistan, Cambodia, Bosnia-Herzegovina, Mozambique and Zimbabwe.

AP mine threat, MND(SW) Bosnia-Herzegovina Table 1



The DDIV is a record of explosive incidents involving deminers. The victims were employed by NGOs, commercial demining companies, national agencies and, in some cases, the military. The current release (Version 1) of the database contains the records of 319 victims and 249 incidents.

Mine and UXO Hazards

AP blast mines are the most abundant mines encountered in humanitarian mine clearance and cause the greatest number of injuries. At close quarters, AP fragmentation mines overmatch the PPE currently available. Due to the area effect of such mines, they also have the potential to effect secondary victims. AT mines normally require significant pressure

to detonate and are less hazardous to manual deminers unless employed in a non-conventional manner. Effective PPE against AT mines is not available.

In general, when UXO munitions are encountered in mine clearance operations, they have already malfunctioned, though some are specifically designed as area denial weapons. They are usually high in metal content, on or near the surface. Since most are easily detectable, they constitute less of a hazard than mines. When the threat from "advanced UXO" exists, specialist EOD teams should be used. The varied nature of UXO means that the hazard is best dealt with procedurally, rather than relying on PPE designed primarily for humanitarian mine clearance.

The effect of blast is roughly proportional to the explosive content, though it can vary according to the mine's construction. The PMN (240g) is an appropriate level to protect against, as it is one of the most common mines found in reported incidents. Most mines with larger charges (PROM-1, V69) are fragmentation mines, and the lethality of their fragmentation effects is more significant than blast.

Fragment sizes and velocities vary greatly, even from mines of the same type with grooved/notched casing. DDIV analysis shows a high percentage of fatalities from fragmentation mines (52 percent of bounding fragmentation mine incidents and 22 percent of fragmentation mine incidents); survivors were usually secondary victims. Current PPE levels do not protect against close proximity fragmentation mines but may protect secondary victims.

There is also a fragmentation hazard from the casing and inner components of some AP blast mines. Furthermore, AP blast mines buried in scree, gravel roads and tracks and in soil containing a high percentage of stones represent a particular challenge for PPE.

Harmful Activities

The most common mine clearance activities which led to harm were excavation (36 percent) and missed-mine incidents (26 percent). Excavation includes digging with any tool or investigating a previously located mine; a missed-mine incident occurs when a victim initiates a device which the deminer or any other member of the demining unit has failed to locate. While excavating, almost all deminers were injured in the squatting or kneeling position.

Areas of the Body at Risk Table 2

	Severe	*Minor*	*Total*
Head and neck:	94	148	242
Upper Limb:	92	142	234
Lower Limb:	109	98	207
Trunk:	40	77	117

Less than 10 percent of incidents involved deminers (mis)handling or holding the mine during examination or disarming. Nearly seven percent of incidents involved behavior considered dangerous or careless, such as stepping outside a cleared and well-marked area.

Only two percent of all incidents involved an accident *during* detection. It should be noted, however, that this low figure may disguise the practice of "detection by excavation," which is sometimes applied.

Areas of the Body at Risk

The DDIV classifies non-fatal injuries as severe if they were likely to be life threatening, to require surgery or to result in permanent disability. All other injuries are classified as minor. The distinction is not intended to reflect the suffering and/or hardship associated with any injury. The areas of the body at risk are summarized in Table 2 below.

The risk of severe injuries to the head and to the limbs (both upper and lower) is similar, but the risk to the trunk is not as severe. The majority of head and upper limb injuries were caused while excavating and from (mis)handling incidents, whereas the majority of lower limb injuries were caused by missed-mine incidents.

(Note: The lower number of injuries to the trunk cannot be explained by the provision of PPE since the DDIV suggests that in the majority of cases the victims were not wearing any body protection).

Environment

The diversity of environmental factors make it difficult to generalize about their impact on safety as a whole and on PPE in particular. Climatic extremes are a constant concern in some theaters through high temperature, humidity or cold. In addition, there may be local environmental problems which demand use of specialized PPE or life support equipment.

Analysis and Discussion

Perception(s): It is often assumed that minimum metal mines represent the greatest risk to deminers, as they are, at least in theory, the most difficult to detect. However, this assumption is not confirmed by the number of reported injuries. The majority of missed mine incidents involve a PMN, PMN 2 or PPM-2 and all have significant metal content. There may be a psychological "risk adjustment," which causes deminers to operate with greater caution in areas where minimal metal mines are expected.

Fatalities: Incidents resulting in death show a disproportionate number resulting from bounding fragmentation mines. AP blast mines account for the next greatest number followed by larger mines. Vegetation clearance produced the highest number of deminer fatalities. Handling or manipulating mines (some during the process of disarming) proved to be the second highest readily identifiable activity at the time of death.

Injuries: Evidence suggests that AP blast mines were the most common cause of deminer injury (62 percent), of which the PMN and PMN-2 series caused 38 percent of the incidents.

Protection: A fragmentation jacket or apron of some kind was issued to under a third of the victims recorded in the DDIV. It was worn in only half of those cases, and visors were temporarily discarded or raised by 56 percent of the victims issued with them. The thickest visors commonly worn were 5mm thick. These appeared to provide adequate protection against blast and were considered wearable by deminers. There was also evidence of severe hand injuries resulting (at least in part) from the use of inappropriate hand-tools during manual demining.

Risk Reduction

Risk Management: Risk reduction involves a combination of factors, including safe operating procedures, education, training, PPE and effective supervision. Though international guidelines and national SOPs can provide advice on how this can be achieved, the responsibility for risk management lies principally with the employers be they national teams, demining NGOs or commercial contractors. This responsibility must be embedded in the management culture and practices of all organizations involved in the planning and prosecution of humanitarian mine clearance operations.

Control and supervision: There is much room for improvement in the control and supervision of humanitarian mine clearance operations. Over 50 percent of the injuries recorded in the DDIV were apparently caused by inadequate "field control." Improved field discipline and control through education, training and supervision would reduce the risk to deminers. It would also increase the overall efficiency of clearance operations. An accident causes substantial dislocation and delay in addition to the obvious injuries to the victim and to the socio-economic impact on his family and community.

Reports and Investigations: There is significant variation in the quality and timeliness of reports and post-incident investigations. Consideration should be given to the development of an international standard for reporting and for the conduct of investigations and inquiries. Though local requirements may vary, there is a need to maintain objectivity and impartiality and to facilitate lessons learned about risk and safety issues.

PPE Requirements

Human Factors: The frequency with which deminers fail to wear PPE suggests that equipment and clothing is either inappropriate or is already at or beyond the "wearable" limits of weight and mobility, though some improvements could be achieved through better field discipline. Any assessment of PPE requirements must recognize the limits of acceptability by addressing the human factors, including environmental conditions and ergonomics.

Associated Equipment: The systems approach to risk reduction includes an understanding of the interface between the deminer and his/her associated equipment. In this respect, the selection and use of hand-protection and appropriate hand-tools is particularly important and should be considered as an integral part of the PPE requirement.

Blast: The explosive content of a PMN is "... just under the threshold for overpressure injuries." Larger explosive content is generally confined to fragmentation mines where the lethality of fragmentation is more significant than blast. The DDIV provides no evidence to suggest the need to protect against overpressure from AP blast mines, yet tests conducted by Canadian Defence Research Establishment Suffield (DRES) suggest the possibility in certain cases of "... severe, critical or unsurvivable injury."

Fragmentation: Current accepted levels of PPE provide inadequate protection against fragmentation mines at close quarters, and procedures/processes must be applied (with conviction) to reduce the risk to a tolerable level. PPE should continue to be designed to protect "secondary victims" against fragmentation mines.

Boots: Blast-resistant boots which are designed with at least a 10cm stand-off may reduce injuries when stepping on small blast mines, but they impair mobility and are unlikely to be accepted for general use though they may have some specialist application. There is no clear evidence to suggest that blast-resistant mine boots, without any stand-off, would reduce injury to an acceptable level. Indeed, some evidence suggests that such boots may actually worsen the severity of leg and groin injuries when stepping on a PMN. Further evidence from study and independent

continued on page 77

International Standards...

continued from page 51

tests is required to determine the efficacy of blast-resistant mine boots and to judge their place in humanitarian demining operations.

Requirement(s): PPE is the final protective measure after all planning, training and procedural efforts to reduce risk have been taken. Deciding appropriate PPE depends heavily on local SOPs and should be the subject of an iterative risk reduction exercise using a formal process as set out in ISO Guide 51. A realistic minimum standard for PPE is that capable of withstanding the effects of blast and fragmentation mines.

Formal Evaluation: There is a need to encourage the formal trials of PPE available for use in humanitarian mine clearance programs. Such a trial should be conducted under strictly controlled and repeatable conditions using criteria that agrees with the field user community. Ideally, this trial should be conducted with U.N. approval and taken as a priority project by the recently formed International Test and Evaluation Programme (ITEP). The results should be made available to MACs and demining entities in the form of a consumer report.

User Trials: User trials complement formal testing and evaluation. They serve two purposes. First, they provide a means of testing *locally* manufactured or locally modified PPE against *local* threats without involving the cost and complexity of a formal international trial. Second, they provide *local* demining entities with immediate and sometimes more appropriate results under *local* test conditions. They encourage *local* confidence in the effectiveness of PPE.

Blast: PMN mine detonating during demining in a squatting/kneeling position:

- Frontal protection, coverage appropriate to the activity, capable of protecting against the effects of a 240g of TNT at 30cm from the closest part.
- Eye protection equal to that offered by 5mm of untreated polycarbonate, capable of retaining integrity against the effects of 240g of TNT at 60cm, (providing full frontal coverage of face and throat in conjunction with jacket/apron).
- Hand protection integrated into the appropriate design of hand-tools. The tools should be designed to be used at a low angle to the ground, provide at least 30cm stand-off from an anticipated point of detonation, and be constructed in such a way that their separation or fragmentation in a blast is reduced to a minimum and include a hand-shield whenever possible.

Fragmentation: Ballistic protection of "secondary victims" must be provided against the local fragmentation mine threat. It is generally acknowledged that tests for ballistic protection do not realistically replicate mine effects. Until an accepted alternative is developed as an international standard, the effects of a fragmentation hazard should continue to be evaluated by the STANAG 450 m/s V50 test or by independently verified user trials (involving at least three articles of equipment) tested at the safe working distances defined in local SOPs.

Conclusion

In examining the vital demining issue of PPE and its effectiveness, it's crucial not to overlook outside factors. While the study of PPE certainly must focus on its adherence to international standards, durability in the field and proper usage by deminers, through efforts like those of the WGPPE, these factors are integrated with other vital forces. These forces include environment, threat and supervision, among others. When all factors are considered, the most efficient and, above all, safe approach toward reducing risk is revealed. Also, not to be overlooked are industry practices outside the realm of demining. If SOPs are to be improved, the demining community may need to look no further than other successful risk-laden industries. The end result of an intelligent and comprehensive study of PPE and its surrounding influences will inherently address issues such as the effects of primary and secondary fragmentation, threats from lesser detectable mines and areas of the body most at risk. But only through examination of the broader picture can those issues that hit home the hardest be understood and corrected. ■

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