International Standards for Personal Protective Equipment

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International Standards for Personal Protective Equipment

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 (WGPE) 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 WGPE'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.

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 WGPE.

Notwithstanding the legal imperatives to reduce risk, humanitarian mine clearance imposes a moral duty of care that demands attention be given to the consequences 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. However, 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 WGPE 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 WGPE's analysis and many of its conclusions on PPE have been derived from the Database of Demining Incidents Victims (DDIV) compiled by Smith. The database covers mine clearance incidents in Angola, Afghanistan, Cambodia, Bosnia-Herzegovina, Mozambique and Zimbabwe. 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, or on or near the surface. Since most are easily detectable, they constitute less of a hazard than mines. When the threat is from "advanced UXO" existing, 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 more common mines found in reported incidents. Most mines with larger charges (PROM-1, V99) 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 casings. DDIV analysis shows a high percentage of fatalities from fragmentation mines (52 percent of mine incidents involving 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 severe detonation. 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 handicap 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. All other injuries, and the majority of upper limb injuries were caused while excavating and from (mis)handling mines, whereas the majority of lower limb injuries were caused by mines or 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 makes it difficult to generalize about their impact on safety as a whole and on PPE in particular. Climatic extremes are a constant concern to mine clearance operators throughout 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 mine incidents involve a PMN, PMN-2 or PMM-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 best highly 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 was 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. Although international guidelines and national SOPs can provide advice on how this can be achieved, the responsibility for risk management lies principally with the employers by their national teams, demining NGOs or commercial contractors. This responsibility must be embedded in the management system and cooperation with all organisations 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 inappropriate "field control." Improved field discipline and control through education, training and supervision could reduce the risk to deminers. It would also increase the overall efficiency of clearance operations. An accident causes substantial disruption and delay in addition to the obvious injuries to the victim and to the socio-economic development of his family and communities. 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 could reduce the risk to deminers. It would also increase the overall efficiency of clearance operations. An accident causes substantial disruption and delay in addition to the obvious injuries to the victim and to the socio-economic development of his family and communities. Overall, the risk associated with the selection of hand protection and appropriate hand tools is particularly important and should be considered as an integral part of the PPE requirement.

Blasts: The explosive content of a PMN is "... just under the threshold for overwhelming 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 support the need to protect against overpressured blast 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.

Boosts: Blast-resistant boots which are designed with at least a 1cm 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 a tolerable 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...
worst at the hand of nature. The majority of the population lacks access to safe drinking water, food resources and medical facilities, and the floods have created a shortage of many essential items. In turn, this shortage has caused the prices of these items to skyrocket, which does not correlate with the restricted incomes of many Mozambicans.

Challenged not only with reconstructing their homes and communities, Mozambicans now face multiple physical ailments. UNICEF officials have emphasized the outbreak of diseases that typically occur after massive flooding to include malaria, diarreah, measles, meningitis, dysentery and respiratory infections. In a country where only 46 percent of the total population has regular access to safe drinking water, the majority of Mozambicans are now forced to subsist on contaminated rainfall, which can induce these severe diseases.

**Humanitarian Action**

To return the country to its previous economic status, the local population and humanitarian organizations must take action against the devastating effects Cyclone Eline left in its wake. President Joaquim Chissano of Mozambique has hesistated the international community to forgive its foreign debts. Prior to the flooding, Mozambique was experiencing a significant economic increase, as the economy was growing at an annual average of 10 percent. For a country whose reputation of poverty has dominated its existence, Mozambique appeared to be on the road to recovery when Cyclone Eline ravaged the countryside.

Because of the immediate need for villagers and farmers to return to their communities, the United Nations must redouble its Accelerated Demining Program (ADP) efforts originally begun in 1992. While landmine related fatalities were steadily decreasing since the program commenced, demining teams fear this number will again rise as people will be unaware of the location and counteraction to take against the stowed landmines. Indigenous populations inhabiting previously cleared areas must now remember and refrain the appropriate procedures when encountering a landmine. Therefore, increased moves must be allotted to fund mine awareness campaigns to educate Mozambicans of the dangers of landmines. Mozambique urgently requires monetary donations and equipment to prevent a 10-year economic set-back.

President Chissano also has implored humanitarian organizations, primarily the U.N. Development Program (UNDP), for monetary assistance to rebuild his devastated country. The UNDP estimated that a minimum of $450 million (U.S.) is needed to rebuild the homes, schools, hospitals and roads demolished by Cyclone Eline and Hulah. UNICEF has donated $1 million in educational and mine awareness supplies for the 30 schools Eline destroyed and has offered technical guidance in planning, monitoring and coordinating Mozambique's government agencies in re-building the nation's infrastructure.

The UNDP has indicated several categories of emphasis for a portion of the estimated $450 million. It has assigned $120 million to rebuild transportation systems, $65 million for agriculture, $26.6 million for administrative costs, $38.1 million for industry and $15 million for disaster control.

In addition to the monetary support, Mozambicans have found themselves in dire need of medical supplies. UNICEF is currently shipping essential medicine and safe drinking water in an effort to combat the outbreak of disease. They have also begun a national communication campaign aimed at preventing the spread of diseases.

**Conclusion**

The rippling aftereffects of Cyclone Eline and Hulah have been mercilessly at the heart of this devastated country. Only time and financial assistance can return it to its previous state. As displaced Mozambicans are slowly trickling back to their homes and communities, starting to rebuild their lives and towns, they must do so cautiously. The financial assistance and donated supplies Mozambique so desperately requires will enable Mozambique's demining efforts to continue, eventually ridding the country of its horrendous and life-threatening problem and returning it to a state of economic stability and growth.

International Standards... continued from page 51

**International Standards for Personal Protective Equipment**

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

**Requirements:** PPE is the final protective measure after all planning, training and procedural efforts to reduce risk have been taken. Deciding appropriateness of 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 munitions.

**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 NGOs 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 PPE:** Mine detonation during demining in a squattting/sitting position:

- Frontal protection, coverage appropriate to the capability of protecting against the effects of a 240g of TNT at 30cm from the closest point.
- Eye protection equal to that offered by 3mm of untreated polycarbonate, capable of withstanding the effects of 24g of TNT at 60cm, (providing full frontal coverage of face and throat in conjunction with jacket/strap).
- Hand protection integrated into the appropriate design of hand-tasks. 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 fragment-

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