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Field Risk Assessment (FRA)

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Contents

Contents ii
Foreword iii
Introduction 1
Field Risk Assessment (FRA) 2
1. Scope 2
2. References 2
3. Terms, definitions and abbreviations 2
4. General 2
5. Risk factors in the field 3
5.1. General 3
5.2. Human error 3
5.3. Procedural error 3
5.4. Hazards 4
5.5. Worksite Conditions 4
5.6. Technology failure 4
6. Assessing probability and consequences 5
6.1. Assessing the Probability of Detonation (PoD) 5
6.2. Assessing the Severity of Consequences (SoC) 5
6.3. Assessing the probability of leaving a hazard behind 5
6.4. Assessing the consequences of leaving a hazard behind 6
7. Field Risk Assessment (FRA) for a worksite 6
7.1. General FRA 6
7.2. Probability of Detonation (PoD) during varied procedures 7
7.3. Severity of Consequences (SoC) 8
7.4. Risk(s) added by the Worksite Conditions (WC) 8
7.5. Combining all relevant factors 10
7.6. Evaluating the Risk Numbers for each hazard and procedure 11
7.7. Comparing Risk Numbers 11
8. Re-evaluating risk in the event of an incident/accident 12
9. Explosive Ordnance Disposal (EOD) clearance sites 12
10. Responsibilities 13
10.1. General requirements 13
10.2. National Mine Action Authority 13
10.3. Demining Organizations 13
10.4. Employees' obligations 13
Annex A (Normative) References 14
Annex B (Informative) PoD and SoC data from the DDAS 15
Annex C (Informative) An Example of a Field Risk Assessment 17
Annex D (Informative) Templates for FRA 25
Amendment record 31

Foreword

Management practices and operational procedures for humanitarian mine action are constantly evolving. Improvements are made, and changes are required, to enhance safety and productivity. Changes may come from the introduction of new technology, in response to a new mine or ERW including cluster munitions hazards, and from field experiences and lessons learned in other mine action projects and programmes. This experience and lessons learned should be shared in a timely manner.

Technical Notes provide a forum to share experience and lessons learned by collecting, collating and publishing technical information on important, topical themes, particularly those relating to safety and productivity. Technical Notes complement the broader issues and principles addressed in International Mine Action Standards (IMAS).

Technical Notes are not formally staffed prior to publication. They draw on practical experience and publicly available information. Over time, some Technical Notes may be 'promoted' to become full IMAS standards, while others may be withdrawn if no longer relevant or if superseded by more up-to-date information.

Technical Notes are neither legal documents nor IMAS. There is no legal requirement to accept the advice provided in a Technical Note. They are purely advisory and are designed solely to supplement technical knowledge or to provide further guidance on the application of IMAS.

Technical Notes are compiled -at the request of the United Nations Mine Action Service (UNMAS) in support of the international mine action community. They are published on the IMAS website at www.mineactionstandards.org.

Introduction

Field Risk Assessment (FRA) is the process by which estimates of the risk involved in various field activities can be generated. The purpose of estimating risk is to allow the informed selection of a combination of procedures and tools that keep the risk to a tolerable level at any given worksite. This TN deals with the process of FRA for demining and BAC. The principles may also be applied to field risk assessments conducted for EOD tasks.

In this context, field risks are determined by assessing the probability of an unintended detonation occurring and the severity of the consequences of that event. The ultimate purpose of a FRA is not the reduction of risk, which may be very low anyway, but the assessment of the varied risks involved in various combinations of hazard, procedures and tools that may be at a worksite.

No human activities are risk-free, so risk cannot be totally eliminated. It is the responsibility of the employer to ensure that planning procedures are in place to ensue that the risk to employees and end-users is at a tolerable level. This requires decision-making tools that support the task planning process and provide a semi-qualitative method of FRA. Traditional technological risk analysis methods provide the framework for these tools, overlaid with field experience and evidence drawn from accident records. After detailed field risk assessments have been made, risk management decisions can be made.

The risks covered in a FRA are not only concerned with the Health and Safety risks to the employees. In humanitarian demining, the aim is to release suspected land, in an acceptable state, to the end users and so the primary risk that is to be kept to a tolerable level is the risk of leaving mines or ERW behind. The secondary risk, and that which is assessed here, is the risk of unintended detonations causing injury or death to employees. A third risk, which is not part of the risk assessment but should be considered at the risk management and task planning stage, is that of unnecessarily expending resources in areas where there are no mines or ERW.

This TN describes a process for evaluating relative risk for each combination of hazard and procedure at a particular worksite. For each combination, the result is a number than can be easily compared with the result for other combinations. A worked example of how to conduct a FRA is given in Annex C.

FRA uses the simple formula: *(PoD x SoC) + WC = RN (risk number)*

Where:

PoD: Probability of Detonation
SoC: Severity of Consequences
WC: Worksite Conditions

Risk can be assessed using a qualitative or quantitative approach. The model described here is "semi-quantitative". This means that, when possible, recorded data is used in the risk assessment model. While the recorded data can reliably show trends and generalisations, the conditions in which the data was gathered vary widely and the results will not apply in all circumstances so an intelligent qualitative overlay is always required.

Field Risk Assessment (FRA)

1. Scope

This TN provides specifications and guidance to National Mine Action Authorities (NMAA) and demining organisations on the minimum requirements of Field Risk Assessment (FRA) for use in demining activities during humanitarian mine action. It does not provide guidance on FRA for EOD tasks, although similar principles may be applied.

This TN does not cover the social, economic and political considerations that are a part of the prioritisation of tasks at national or international level and that may involve a separate primary risk assessment in which these, and other, considerations play a part.

2. References

A list of normative and informative references is given in Annex A. Normative and informative references are important documents to which reference is made in this standard and which form part of the provisions of this TN.

3. Terms, definitions and abbreviations

A complete glossary of all the terms, definitions and abbreviations used in the IMAS and TN series is given in IMAS 04.10.

In the TN series of standards, the words 'should', 'should' and 'may' are used to indicate the intended degree of compliance. This use is consistent with the language used in IMAS:

a) 'should' is used to indicate the preferred requirements, methods or specifications; and

b) 'may' is used to indicate a possible method or course of action.

The term 'National Mine Action Authority (NMAA)' refers to the government entity, often an inter-ministerial committee, in a mine-affected country charged with the responsibility for the regulation, management and coordination of mine action.

Note: In the absence of a NMAA, it may be necessary and appropriate for the UN, or some other recognised international body, to assume some or all of the responsibilities, and fulfil some or all the functions, of a MAC or, less frequently, an NMAA.

The term ‘Field Risk Assessment’ (FRA) refers to the process by which estimates of the risk involved in using various demining procedures can be generated and compared to ensure that the risks associated with the procedures at a given worksite are always tolerable.

4. General

Field risk assessments (FRAs) are made to control risk at a demining worksite. The first FRA at any worksite should be conducted before employees start work. The FRA is part of a combination of efforts to improve demining worksite safety that include:

1. ensuring that the deminers are sufficiently trained and competent;
2. ensuring that the tools and procedures used minimise the risk of an unplanned detonation and/or injury;
3. maintaining appropriate work and rest periods;
4. maintaining clear and unambiguous worksite marking;

5. maintaining appropriate levels of supervision;
6. wearing appropriate PPE; and
7. enforcing working distances appropriate to the remaining risk.

As work progresses at a worksite, the information on which the first FRA was based will be augmented with new data and the FRA should be reviewed on a regular basis to keep pace with these changes.

5. Risk factors in the field

5.1. General

FRAs take account of the following risk factors:

a) human error;

b) procedural error;

c) hazards;

d) worksite conditions; and

e) technology failure.

The potential for all but one of these factors occurring is covered in the FRA process described in Section 7. The exception is Technology failure. It is excluded because it is rare and should be minimised by the implementation of appropriate maintenance and testing regimes.

5.2. Human error

Human error may be deminer error, an error in training or in supervision, or any combination of these. It may be deliberate, through ignorance or curiosity or it may be accidental, through lack of attention, sickness or stress.

Most of the recorded demining accidents involve an element of error in training, supervision or the judgment of the employee(s).

Ensuring that training is appropriate and accessible, that supervisors are experienced and responsible, and that employees understand why they must work in the required manner can all reduce the risk of human error occurring. The behaviour of the employees is ultimately the responsibility of the managers who control the regime in which they work. Within the constraints of the appropriate employment laws, NMAAs can make employee control easier by accepting that the summary dismissal of employees may be essential for the effective control of risk and to promote safety.

5.3. Procedural error

Procedural error may occur because an inappropriate procedure is selected for use. It may also occur when there is a failing in the way an appropriate procedure is performed. The use of a large-loop ordnance detector in an area with minimum-metal mines is an example of the wrong procedure being used. The use of an appropriate metal detector while advancing the search head too quickly and thereby failing to ensure complete ground coverage is an example of a failure in the way that procedure is performed.

A significant number of recorded demining accidents involve an error in conducting a procedure that would not have caused an unintended detonation if it had been conducted in the correct manner.

To prevent procedural errors occurring, the organisation must have an adequate knowledge base that is accessible to trainers and field supervisors. Technical, training and support documents should be clearly written and illustrated, should be translated into the language of the field employees and should be available in the field.

Ensuring that training is appropriate and accessible, that supervisors are experienced and responsible, and that employees understand why they must work in the required manner can all reduce the risk of procedural error occurring.

5.4. Hazards

The hazards are the mines and ERW at a site and their condition when they are found. All mines and ERW age to some extent and some decay quickly in harsh environments. Corrosion and other degradation can significantly alter the degree of risk faced when clearing a device.

Normally, it is the condition of the fuzing system that is of greatest concern, and the need to avoid initiating the firing train is paramount. However, parts of a munition other than the fuze may present the greatest hazard. For example, many UXO can be safely moved for destruction even when corroded. Most have a stable fuze system that is initiated by an impact greater than that which could occur during normal working procedures. However, if the casing of a white phosphorous incendiary is seriously corroded, the filling could be ignited by exposing the content to air as it is moved. These should be pulled from a safe distance to allow their condition to be assessed before any decision to move them is made. Similar precautions may be necessary when there is a risk of propellant leakage from a corroded munition.

Hazards should always be assessed by personnel with extensive relevant experience who have access to appropriate reference works.

5.5. Worksite Conditions

Worksite Conditions (WC) are unique to each worksite. WC that can affect the probability of unintended detonations can include such things as weather conditions, light levels and the type of ground in/on which the work is conducted (hard soil, soft sand, density of undergrowth etc.). They can affect the probability of an unintended detonation occurring with any of the range of demining procedures that may be used.

For example, if a worksite is covered with dense vegetation and the hazards include bounding fragmentation mines that are in a functional condition, there is a high risk of an unintended detonation during a manual vegetation removal procedure. Conversely, if the worksite is on an open hillside with sparse grasses and the hazards include bounding fragmentation mines in a functional condition, there is a low risk of an unintended detonation during a manual vegetation removal procedure. The selection of an appropriate procedure to use at a worksite can be dictated by the conditions that are present.

Extreme weather (hot, cold, wet) and light conditions should obviously to be avoided, and can be, as time is seldom the critical driving force for clearance operations. However, some conditions cannot be avoided and their effect on the probability of unintended detonations should be evaluated and are discussed below.

5.6. Technology failure

Technology failure is the failure of equipment and machines to perform as they were designed. This may include mechanical or electrical breakdown.

A breakdown may not cause an unintended detonation, but it can increase the risk of that occurring. For example, if a breakdown leaves machine operators stranded inside a hazardous area, or leaves a deminer searching the ground with an unreliable metal-detector, the risk of an unintended detonation is increased.

The failure of technology can be reduced by ensuring that testing and maintenance regimes are devised and implemented at intervals that:

a) reduce the incidence of failure to the minimum; and

b) ensure that any failure is most likely to occur outside a hazardous area.

The significance of technology failure can be reduced by including failure scenarios in training to ensure that all employees know how to respond safely when a failure is recognised.

When technology failure occurs, the appropriateness of the technology should be appraised, along with the training of those involved in maintenance and operation. In general, any technology that fails in a manner that increases risk should be avoided.

Technology failure is rare and is not covered in the FRA process described in Section 7.

6. Assessing probability and consequences

6.1. Assessing the Probability of Detonation (PoD)

The probability of (unintended) detonation depends on the characteristics of the identified hazards, the procedures that will be used to clear them and the context in which the work will be conducted.

The main obstacle to assessing risk objectively is the calculation of probability based on recorded previous experience. The Database of Demining Accidents provides records of unintended detonations from demining programmes around the world. The record is a representative sample spanning more than ten years. After excluding unique events, common features can be compared and trends identified with a degree of statistical reliability that exceeds decisions based on any individual, or employers', experience.

Formerly, health and safety risk assessment for demining has presumed that there is a risk of unintended detonation of the largest or most potentially dangerous device present. The accident record indicates that this is not always the case.

Assessing PoD is an integral part of the FRA process described in Section 7.

6.2. Assessing the Severity of Consequences (SoC)

An unintended detonation has often been presumed to cause either severe injury or death. On that basis, many risk control strategies have been designed to avoid all unintended detonations. When the combination of a hazard and the procedures used to clear it are such that the risk of severe injury from an unintended detonation is low, it can be acceptable for the risk of an unintended detonation to be higher. For example, even though the risk of an unintended detonation may be higher using long-handled excavation methods, they can be used when the hazards that may be initiated have a small explosive content and the risk of severe injury to the deminer if an unintended initiation should occur is tolerably low.

Assessing the SoC is an integral part of the FRA process described in Section 7.

6.3. Assessing the probability of leaving a hazard behind

The probability of leaving a hazard behind depends on the depth of the identified hazards, the procedures that are used to clear them and the context in which the work is conducted. As work progresses and mines and ERW are located, it may be found that the original depth of clearance was more or less than necessary. For example, when all mines are found close to the surface, it may not be necessary to process the ground to the originally anticipated depth. Conversely, when some mines or ERW are found deeper than anticipated, it may be necessary to process the ground to a greater depth than was originally anticipated.

When these circumstances occur, the FRA will be revised and any changes to the clearance plan discussed with the NMAA or its representatives as a matter or urgency. Generally, clearance depth may be increased without NMAA approval but should only be reduced after approval by the NMAA or its authorised representatives.

6.4. Assessing the consequences of leaving a hazard behind

The aim of humanitarian demining is to destroy or remove all mines and ERW in a defined area to a specified depth at a worksite. Procedures designed to achieve this should be conducted on any land that is released for productive use. No injuries to end-users of the land because of mines or ERW left in cleared areas within the working depth are acceptable. Mines or ERW concealed *beneath* the working depth and later discovered represent the “tolerable risk” for cleared land.

After work has begun it may become apparent that some hazards are at a depth greater than anticipated. After negotiation with the NMAA or other appropriate authorities, the clearance depth in appropriate parts of the worksite should be increased. The NMAA or its representatives should always be informed so that their future tasking can take note of possible variations in anticipated depth.

After work has begun it may become apparent that all hazards are at a depth that is shallower than the clearance requirement. In this case, when appropriate, the details of the task can be discussed with the NMAA or its representatives with a view to agreeing a shallower clearance depth for the worksite. The original depth of clearance should be maintained until agreement to vary the depth has been received in writing from the NMAA or its representatives.

When the condition of the hazard is such that it cannot function as designed, it may be that the risk of injury to the end-user of the land when an item is discovered is very low. In these circumstances, the time and cost required to clear every device must be balanced against the need for the demining assets to be deployed elsewhere. The details of the task should be discussed with the NMAA or its representatives with a view to agreeing whether it is acceptable to process the land in a manner that does not clear all mines and ERW but does give confidence that any residual risk is at a tolerable level. Land processed in this way should not be released as ‘cleared’. The definition of the term describing its release should include it having a residual risk that is acceptable at that time.

7. Field Risk Assessment (FRA) for a worksite

7.1. General FRA

The specified area to be cleared and the required depth of clearance should normally be presented to the demining organization by the NMAA in a site specific tasking order. When the demining organization is tasked to establish its own clearance depth, the depth of clearance should be established by a technical survey or from other reliable information. The required clearance depth may be adjusted as clearance work progresses. See IMAS 09.10 clearance requirement for more details. After the clearance depth has been determined to give confidence that any residual risks to the end-users of the land is tolerable, the risks to the employees at each worksite should be assessed. This can be achieved using either the process described below, or by an alternative process that considers at least the same range of risk factors.

FRA uses the simple formula: *(PoD x SoC) + WC = RN (risk number)*

Where:

PoD: Probability of Detonation
SoC: Severity of Consequences
WC: Worksite Conditions

A worked example of a FRA for an imaginary worksite is given in Annex C. No example can be broadly representational of all situations because each worksite is unique, but the application of the FRA process is relevant to all.

The degree of hazard presented by a type of mine or ERW expected to be encountered should be determined. This is achieved by reference to its original design and its present condition. Regardless of its explosive, incendiary or fragmentation content, the sensitivity of its firing train is usually the main factor when assessing the hazard it presents to employees.

For example, most AT mines require a force to be applied on their top surface in excess of the force applied by a deminer in the field, so they may present a very low risk of initiation during manual clearance. This is confirmed by reference to the accident record in which there are no clear instances of accidents occurring as a result of a deminer stepping on an AT mine. However, AT mines have been initiated by deminers using inappropriate tools to either uncover them or while attempting to disarm them.

Note: In some conflicts AT mines have been fitted with anti-lift devices, booby trapped, or laid with AP mines on top of them. If this may have occurred, the combined hazard presents a greater risk than the AT mines alone. The likelihood of this occurring should be assessed by personnel with relevant experience of the conflict.

Note: If an AT mine is designed so that its pressure plate is crushed as part of the firing train, it may be possible that the mine has been partly crushed in the past and might be later initiated with a lower pressure than its designers intended. When this occurs, the hazard implied by the design details found in reference works may be unreliable. The likelihood of this occurring should be assessed by personnel with relevant experience with reference to known or likely traffic over the area.

A few mines and ERW have very sensitive fuzes, initiation systems that are more readily triggered in one way than another, or their filling may present an alternative hazard. Knowing the anticipated devices, their hazardous content and the way they operate is essential in order to avoid approaching them in an inappropriate manner. To assess the hazard presented by the mines and ERW at a worksite, reliable mine and ERW reference works should be consulted to determine the hazardous content and design details of each device anticipated. The condition of the devices at the worksite should be estimated, and that estimate should be reviewed after examples have been found.

When a mine or ERW item has been damaged or decayed in such a way that the fuze mechanism is unstable or the hazardous content may be exposed, there may be a higher risk of initiation. To reduce the increased risk of injury that this implies, the use of demining procedures that increase the distance between the deminer and the hazard should be preferred.

Some mines and ERW feature in more accidents than others. The numbers may reflect how commonly the mine or ERW has been used rather than the relative hazard it represents. However, some general observations of value about the threat presented by mine types can be derived from the accident database: these are listed in Annex B.

After the hazards at a worksite have been identified and their condition is either known or has been estimated, the results should be assessed alongside the available demining procedures and worksite conditions. This allows a simple numerical comparison to be made between the relative risks associated with each procedure at that worksite.

7.2. Probability of Detonation (PoD) during varied procedures

For each demining procedure and for each hazard, a Probability of Detonation (PoD) should be estimated. In Table A below, the PoD is defined and given the number in the left column.

Table A: Probability of detonation (PoD) for a given hazard and procedure		
4	Frequent (high)	Could occur often with this procedure
3	Probable (medium)	Could occur if the procedure is used correctly
2	Occasional (low)	Could occur if the procedure is used incorrectly
1	Improbable (negligible)	Very unlikely to occur even if the procedure is used incorrectly

Table A: assigning a number to the Probability of a Detonation (PoD) occurring

A high PoD does not always mean that the procedure is inappropriate. If the likelihood of an injury occurring in an unplanned detonation is very low, a high probability of an unplanned detonation need not be significant.

7.3. Severity of Consequences (SoC)

To determine the significance of an unintended detonation, the Severity of the Consequences (SoC) must be estimated. To assess the SoC of a detonation, it is always presumed that the device is in a functional condition. The condition of the mine or ERW is not relevant to its SoC number. Whether the device is in good condition, unstable, or incapable of functioning, its condition is covered when estimating the probability of an unintended detonation occurring with each available procedure.

Using Table B below, the SoC for each hazard is estimated and given one of the numbers from the column on the left.

Table B: Severity of Consequences (SoC)		
4	Catastrophic	Death
3	Severe	Severe or disabling injury
2	Minor	Minor injury
1	Negligible	No injurious consequences

Table B: Severity of Consequence (SoC) definitions

Note: The SoC should be estimated presuming that PPE is worn in accordance with the requirements of IMAS 10.30 SOH PPE. When enhanced PPE would reduce the risk of injury, the use of enhanced PPE should be considered.

Note: The severity of secondary injuries that may occur should be estimated presuming that working distances in accordance with IMAS 10.20 SOH demining worksite safety, are in force. When increased distances would reduce the risk of secondary injury, the use of extended working distances should be considered.

Severity of Consequence (SoC)-numbers for common mines are listed in Annex B. These have been derived from the Database of Demining Accidents (DDAS) to provide a guide when relevant national data is not available. The most likely SoC number should be selected.

The risks added by the conditions at the worksite must then be evaluated.

7.4. Risk(s) added by the Worksite Conditions (WC)

The Worksite Conditions (WC) are a combination of the weather, light, terrain, ground conditions, vegetation and any other obstructions that are present at a worksite. WCs also include the marking system and command and control regime that will be used. The incline of the ground and the presence of vegetation, ditches and other obstructions all impact on ease of work and supervision. Some conditions also impact on the choice of worksite marking system. For example, the use of painted rocks to delineate cleared from uncleared areas may be appropriate on a bare hillside, while in dense undergrowth sticks and marking tape may be more appropriate.

Extreme weather (hot, cold, wet) and light conditions should obviously to be avoided, and can be, as time is seldom the critical driving force for clearance operations but some WCs will affect the choice of appropriate procedures and approaches, the deployment plan and the site supervision required.

The employer is responsible for ensuring that appropriate marking systems and field supervision are in place. The details of these may be dictated by the procedures and tools selected during the FRA process.

Note: Field supervision has been recorded as being inadequate in a high number of accidents. In many cases, this may have been because the supervision regime was not varied to suit the particular worksite.

Note: In some recorded accidents, the marking between cleared and uncleared land was not appropriate. In some cases the marking regime was inadequate. In others the marking regime was not adequately maintained.

WCs that have featured in recorded accidents and have increased the risk of severe injury during manual demining procedures are listed in Table C below.

Note: Each worksite is unique and Table C is a guide that should be extended by the inclusion of factors reported by experienced field personnel before it is used.

Table C is divided by hazard type (AP blast mines, AP fragmentation mines, etc) and presumes that the hazards are in functional condition. An additional risk number is listed on the left for each type of Worksite Condition. The number on the left should be used in the FRA unless the added risk can be reduced by adopting the risk reduction factor(s) in the third column. If the risk has been reduced the number in the column on the right should be used in the FRA.

Table C: Increased risk posed by the Worksite Conditions (WC)

Risk	Worksite Conditions (WC)	Factors to reduce risk of detonation and/or injury that have worked for others	Adjusted Risk
When searching for AP blast mines			
+2	Hard/rocky ground	Use of blast resistant and long handled tools, or the use of mechanical ground preparation.	+1
+1	Soft/wet ground	Allow to dry but not to harden too much.	0
+1	Leaf litter on ground	Use of long-handled leaf rakes and metal-detectors.	0
+1	Significant undergrowth	Cut carefully by hand until ground surface is visible and metal-detector search head can be moved very close to ground surface.	0
+1	Root mat on ground surface	Mechanical ground preparation.	0
+1	More than 7 metal pieces psm	Use of powerful magnets (where no magnetic influence fuzes are present).	0
+1	Steep incline	Conduct clearance uphill directly or obliquely and ensure employees have suitable slip-resistant footwear.	0
+1	Wire obstructions	Issue wire cutting and pulling tools and conduct training in their use at the worksite.	0
+1	Ditches, trenches or canals	Use clear marking, train in a similar situation and increase depth of search inside the obstruction. Use mechanical excavation and sifting when available.	0
+1	Presence of livestock	Community liaison officer to liaise with local owners to ensure the absence of livestock.	0
When searching for AP fragmentation mines (stake mounted)			
+1	Leaf litter on ground	Use metal-detectors before any other tool, then use again after leaf-litter is removed.	0
+2	Significant undergrowth	Use of mechanical vegetation cutting. If not available, cut vegetation from the top in short lengths, sweeping with metal detector after each cut. Use tripwire feeling procedure before each cut when tripwires may be present.	0
+1	More than 7 metal pieces psm	Use of powerful magnets (where no magnetic influence fuzes are present).	0
+1	Steep incline	Conduct clearance uphill directly or obliquely and ensure employees have suitable slip-resistant footwear.	0
+1	Wire obstructions	Issue cutting and pulling tools and conduct training. Pull using an armoured machine if tripwires or mines may be among the obstructions.	0
+1	Presence of livestock	Community liaison officer to liaise with local owners to ensure the absence of livestock.	0
When searching for AP bounding fragmentation mines			
+2	Leaf litter on ground	Use metal-detectors before any other tool.	0

+3	Significant undergrowth	Use mechanical vegetation cutting. If not available, cut vegetation from the top in short lengths, sweeping with metal detector after each cut. Use a tripwire feeling procedure before each cut when tripwires may be present.	0
+1	More than 7 metal pieces psm	Use of powerful magnets (where no magnetic influence fuzes are present).	0
+1	Steep incline	Conduct clearance uphill directly or obliquely and ensure employees have suitable slip-resistant footwear.	0
+1	Wire obstructions	Issue cutting and pulling tools and conduct training. Pull using an armoured machine if tripwires or mines may be among the obstructions.	0
+1	Ditches and canals	Use clear marking and train in a similar situation. Also increase depth of search inside canal/ditch.	0
+1	Presence of livestock	Community liaison officer to liaise with local owners to ensure the absence of livestock.	0
When searching for <u>AT mines</u>			
+1	Hard/rocky ground	Do not use heavy hand tools such as mattocks and picks.	0
+1	Presence of livestock	Community liaison officer to liaise with local owners to ensure the absence of livestock.	0
When searching for <u>ordnance</u>			
+2	Hard/Rocky ground	Use clear marking and metal detectors: do not rely solely on visual search.	+1
+2	Significant undergrowth	Cut vegetation from the top in short lengths, sweeping with metal detector after each cut.	0
+1	Steep incline	Conduct clearance uphill directly or obliquely and ensure employees have suitable slip-resistant footwear.	0
When searching for <u>submunitions</u>			
+2	Hard/Rocky ground	Use clear marking and metal detectors: do not rely solely on visual search.	0
+3	Soft/wet ground	Allow to dry and search to greater depth.	0
+2	Significant undergrowth	Conduct cautious visual search in vegetation from top down: cut vegetation from the top in short lengths, sweeping with metal detector after each cut.	0
+1	Steep incline	Conduct clearance uphill directly or obliquely and ensure employees have suitable slip-resistant footwear. Presume submunitions may have moved downhill.	0
+1	Leaf litter on ground	Use of long-handled leaf rakes and metal-detectors.	0
+1	Wire obstructions	Issue cutting and pulling tools and conduct training. Pull using a suitably armoured machine if submunitions may be among the wire obstruction(s).	0
+1	Ditches and canals	Use clear marking, train in a similar situation and increase depth of search inside the canal/ditch.	0
+1	Presence of livestock	Community liaison officer to liaise with local owners to ensure the absence of livestock.	0

Table C: Increased risk added by the Worksite Conditions (WC)

Any increased risk resulting from the conditions at the worksite should be added to the total for each hazard and procedure as shown in Table D below.

7.5. Combining all relevant factors

The calculations for each hazard and procedure are combined for the worksite as shown in Table D below.

When both probability and severity of consequences (Tables A and B) have been estimated for a procedure, the numbers generated are multiplied together and the additional risks posed by Worksite Conditions (Table C) are added. This gives Risk Numbers for procedures that can be easily compared.

Table D: Calculating a Risk Number		
Table A: Probability of Detonation (PoD)		
4	Frequent	Could occur often with this procedure
3	Probable	Could occur when the procedure is used correctly
2	Occasional	Could occur if the procedure is used incorrectly
1	Improbable	Very unlikely to occur even if the procedure is used incorrectly
Table B: Severity of Consequences (SoC)		
4	Catastrophic	Death
3	Severe	Severe or disabling injury
2	Minor	Minor injury
1	Negligible	No consequence
Table C: Increased risk in varied Worksite Conditions (WC)		
?	The total increased risk from Table C should be added.	
Total		

Table D. calculating a Risk Number for a particular hazard and procedure at a worksite

For each hazard and procedure, the PoD number and the SoC number in Table D are multiplied together, and then the total increased risk number from the WC in Table D is added. The total will be a number between 1 and 26 which is the Risk Number for that hazard and that procedure at that worksite.

7.6. Evaluating the Risk Numbers for each hazard and procedure

The Risk Number calculated for a particular hazard and specific procedure at a worksite should then be evaluated using Table E below.

Table E: Tolerable and unacceptable Risk Numbers		
10-26	Not acceptable	This represents an intolerable risk: alternative procedures to reduce risk should be used.
9	Tolerable, but undesirable	Should only be accepted if no alternative procedures can be used.
5-7	Tolerable	The level of risk means that an unintended detonation may occur but a severe injury or fatality is unlikely
1-4	Normal	The level of risk means that any injury or fatality is very unlikely.

Table E: Tolerable and unacceptable Risk Numbers

Generally, procedures with a Risk Number lower than 10 should be selected for the worksite unless the NMAA advises that another number should be used to indicate the extent of the tolerable risk.

If a procedure has a risk number of 10 or above, ways should be found to reduce the risk of injury before the procedure is conducted. This may be achieved by protecting employees with enhanced PPE, armour or distance. Procedures with a Risk Number of 10 or more should only be used after the risk of severe injury or death has been reduced to a tolerable level.

7.7. Comparing Risk Numbers

The Risk Numbers for all the different procedures and hazards at the worksite should be calculated to allow the selection of a demining procedure(s) that result in a tolerable or normal risk. The selected procedure(s) may not always be the procedure(s) with the lowest Risk Number because working efficiency and the experience of the workforce should also be considered. When the lowest Risk Number is not selected, the reason for using the procedure that is preferred should be recorded so that the record can be reviewed if events in the field show that mistakes have been made. FRA is not an exact discipline and mistakes will sometimes be made. It is essential to identify the reasoning that led to the mistake(s) so that appropriate corrections can be made in a timely manner.

Note: FRAs should be reviewed and their content updated as new information becomes available. The need for revision is unavoidable and does not imply any failing in those carrying out the assessment as long as the revision is made as soon as possible.

For a worked example of a FRA, see Annex C. For template forms to use during a FRA, see Annex D.

8. Re-evaluating risk in the event of an incident/accident

After every incident or accident, the FRA should be reviewed in order to determine whether the qualitative and quantitative elements of the risk assessment require revision in the light of the new data surrounding the accident/incident. Changes in procedures and tools may be required in order to prevent the repetition of the circumstances surrounding that particular accident/incident. Remedial action should be required if the procedures or tools that were used made an unintended detonation more likely than anticipated. Remedial action may involve retraining or the adoption of alternative procedures and tools at the worksite, or part of the worksite, where the accident/incident occurred.

If an unintended detonation results in injury, or death, all work should stop until the review of the FRA has been conducted and the accident has been investigated in accordance with the requirements of IMAS 10.60 reporting and investigation of demining incidents and the organisation's internal reporting requirements.

Available data implies that, in a worst-case scenario, an injurious demining accident may be expected to occur one in every 33 person-years of work. A severely disabling or fatal accident may be expected to occur once in 50 person-years of work. An accident once in every 33 years means that for a team of 33 deminers, one injurious accident a year might be expected. This is a generalisation and cannot be applied directly to all scenarios. It represents a worst-case situation and so can be presumed to include a margin of error that overstates the risk rather than underestimating it. It should be possible for all demining agencies to achieve a lower ratio of explosive accidents to person-years of work than this figure.

The probability of a demining accident occurring once in 33 years of work and a severely injurious or fatal accident occurring once in 50 person years of work provides a baseline probability that should not be exceeded. If a demining organisation has accidents with greater frequency in any one year (measured in months leading up to the latest accident), remedial action should be taken. If a demining organisation has accidents with a frequency approaching the baseline, remedial action should be considered with the aim of preventing the baseline being approached.

9. Explosive Ordnance Disposal (EOD) clearance sites

When engaged in the clearance of EOD clearance sites, the principles involved in making a FRA should be followed. These are:

1) identify the anticipated hazards and the condition they are likely to be in;
2) quantify the risk of severe injury from the unintended detonation of each hazard or combination of hazards;
3) identify procedures that may be used in clearance;
4) quantify the risks of an unintended detonation when using the available procedures; and
5) select a procedure or combination of procedures in which the risks are tolerable.

10. Responsibilities

10.1. General requirements

NMAA and demining organization should establish and maintain policy, standards and guidelines covering the concept of tolerable risk for use in different situations in national mine action programmes. These should distinguish between the obligations and responsibilities at the national level, and those of the employer and employee as set out below.

10.2. National Mine Action Authority

The NMAA should:

a) establish a clear definition of tolerable risk to be used in FRAs. When the NMAA adopts the FRA procedure in Section 7, their definition of tolerable risk should include numerical indicators of what constitute tolerable and intolerable risk;

a) monitor the application of standards; and

b) undertake periodic reviews of the national definition of tolerable risk.

c) Ensure FRA is part of demining organizations training for field staff.

10.3. Demining Organizations

Demining organisations should:

a) apply the documented NMAA definition of tolerable risk to be used in FRAs;

b) use demining procedures that ensure that intolerable risks are not taken;

c) provide training and supervision in making and recording FRAs;

d) establish and maintain SOPs covering FRAs;

e) establish and maintain documented SOPs to undertake periodic reviews of the accuracy of FRAs and the criteria used in making them, making adjustments as appropriate.

In the absence of a NMAA or authorities, the demining organisation should assume additional responsibilities. These include, but are not restricted to:

a) issue, maintain and update their own standards to be applied for FRA;

b) cooperate with other employers in the same country to ensure consistency of standards in FRA; and

c) assist the host nation, during the establishment of a NMAA, in framing national standards for FRA and the definition of tolerable risk.

10.4. Employees' obligations

Employees of demining organisations should:

a) use procedures in accordance with the demining organisation's SOPs;

b) use PPE in accordance with the demining organisation's SOPs; and

c) report to the employer any new information that may affect the accuracy of the FRA as soon as it becomes known.

Annex A
(Normative)
References

The following normative documents contain provisions, which, through reference in this text, constitute provisions of this part of the standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of the standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid ISO or EN:

a) ISO Guide 51 Safety aspects – Guidelines for their inclusion in standards;

b) IMAS 04.10 Glossary of terms, definitions and abbreviations

c) IMAS 09.10 Clearance requirements

d) IMAS 10.10 S&OH - General requirements;

e) IMAS 10.20 S&OH – Demining worksite safety;

f) IMAS10.30 S&OH - PPE

g) IMAS 10.60 S&OH reporting and investigation of demining incidents

h) HANDBOOK - Reclamation of Land Contaminated by Munitions-Related Activity, Part 2 - Risk Assessment: Western European Armament Organisation (WEAO) research & development programme (EUCLID); TNO; NIRAS DEMEX, SARICON and FRAUNHOFER ICT. (Informative);

The following are Informative References

a) HANDBOOK - Reclamation of Land Contaminated by Munitions-Related Activity, Part 2 - Risk Assessment: Western European Armament Organisation (WEAO) research & development programme (EUCLID); TNO; NIRAS DEMEX, SARICON and FRAUNHOFER ICT;

b) Database of Demining Accidents, www.ddasonline.com and

c) Jane's Mines and Mine Clearance, www.jmmc.janes.com.

The latest version/edition of these references should be used.

GICHD hold copies of all normative references used in this Technical Note. A register of the latest version/edition of the IMAS standards, guides and references is maintained by GICHD, and can be read on the IMAS website at www.mineactionstandards.org. National mine action authority, employers and other interested bodies and organisations should obtain copies before starting mine action programmes.

Annex B
(Informative)
PoD and SoC data from the DDAS

B.1. General

Some generalisations and observations of value about the threat presented by types of mines and ERW to employees can be derived from the Database of Demining Accidents (DDAS) www.ddasonline.com.

The content of the DDAS is constantly changing as new records are added so statistics derived from the database can become rapidly out of date. To avoid a need for frequent updates, the use of precise statistics is avoided in this Annex.

B.2. Mine and ERW types involved in demining accidents

More than 2/3rds of all demining accidents involve AP blast mines. The remaining 1/3rd involve mines and ordnance that are listed below in order of frequency, starting with the most frequent.

1. AP blast mines
2. AP bounding fragmentation mines
3. AT mines
4. Submunitions
5. Fuzes (unidentified)
6. AP fragmentation mines (stake mounted)
7. Other ordnance
8. Grenades (hand)
9. IED
10. Mortar bombs (HE)
11. Phosphorous
12. Propellant

B.3. Identifying procedures with the most risk

Accidents can happen at any time but they are more likely to happen at some times than others. With the exception of 'missed mine' accidents, the activity at the time of the accident can be relevant to the FRA.

The order of frequency shown below starts with the most frequent activity at the time of an accident.

Excavation accidents (covering signal investigation and area excavation)
Handling accident (moving, defusing or rendering safe)
Vegetation removal accident (with cutting tools in hand)
Detection accident (with metal detector in hand)
Demolition accident (before, during or after a planned demolition)

There are more than twice as many recorded accidents while excavating as the total of all the others combined.

B.4. Severity of Consequence (SoC) numbers

In a FRA numbers in the column on the left of the table below are SoC numbers.

Table C1: Severity of Consequence (SoC) numbers

4	Catastrophic	Death
3	Severe	Severe or disabling injury
2	Minor	Minor injury
1	Negligible	No injurious consequences

Table C1: Severity of Consequence (SoC) definitions

To assess the SoC of a detonation, it is always presumed that the device is in a functional condition.

Table C2 below suggests *SoC* numbers for mines and ERW commonly involved in recorded accidents. Based on evidence from recorded accidents, the SoC numbers reflect the consequences that might be expected when an unintended detonation occurs.

Note: The SoC number presumes that appropriate medical treatment is immediately available. It is not based on the most common outcome of recorded accidents with a device type, which is not necessarily the worst recorded outcome.

The hazards in the table are listed in alphabetical order. When a hazard is not listed, the SoC number for a hazard with similar properties should be used.

Table C2: Severity of Consequence (SoC) numbers for common mines and ERW			
Hazard: Mine/ERW	**Recommended *severity of consequence* number**	**Hazard: Mine/ERW**	**Recommended *severity of consequence* number**
AUPS AP Blast and frag.	4	**PMA-1 AP blast**	3
BLU-26 submunition	4	**PMA-2 AP blast**	3
BLU-61 A/B submunition	4	**PMA-3 AP blast**	3
BLU-97 submunition	4	**PMD-6 AP blast**	3
DPICM submunitions (M42, M77, KB1)	4	**PMN AP blast**	3
Fuzes (separated)	3	**PMN-2 AP blast**	3
Grenade (hand)	4	**POMZ-2 AP frag**	3
IED	4	**POMZ-2M AP frag**	3
M14 AP blast	3	**PPM-2 AP blast**	3
M15 AT blast	4	**PRB-M35 AP blast**	2
M19 AT blast	4	**Phosphorus**	3
M969 AP blast	3	**Pt Mi Ba III At blast**	4
MAI-75 AP blast	3	**PROM-1/2 AP b/frag**	4
MD-82B AP blast	3	**R2M1/2 AP blast**	3
Mortar HE (various)	4	**SA No.8 AT blast**	4
MRUD AP direct/frag	4	**TC/6 AT blast**	4
MS3 AP blast	3	**TM-46 AT blast**	4
No.10 AP blast	3	**TM-57 AT blast**	4
No.4 AP blast	3	**TMM-1 AT blast**	4
NR409 AP blast	3	**TS-50 AP blast**	3
OZM 3 / 4 AP b/frag	4	**Type 72(a) AP blast**	3
OZM 72 b/frag	4	**Valmara 69 AP b/frag**	4
P2Mk2/P4Mk1 AP blast	3	**VS 1.6 AT blast**	4
P2MK-2 AT mine	4	**VS-50 AP blast**	3

Table C2: Severity of Consequence (SoC) numbers for common mines and ERW

The Table illustrates a general trend that is usually applicable when assigning SoC numbers to mines and ERW that are not listed. The generalisation in Table C3 should be applied unless information to the contrary is available. If uncertain, always use a higher SoC number.

Table C3: general rule for SoC numbers	
Small AP blast mines	2 or 3
Large AP blast mines	3
All AP frag mines	3 or 4
All AT mines	4
All separate fuzes	3
All submunitions	4
All other ordnance	3 or 4

Table C3: general rule for SoC numbers

Annex C
(Informative)
An Example of a Field Risk Assessment

C.1. General

This annex is a worked example on a fictional/hypothetical worksite. It should not be used as a template solution for a real worksite and does not relate to any real area or situation. It is included to illustrate, or to help to understand, the way to conduct an FRA.

C.2. Field risk assessment

At worksite XXXXX it has been agreed to clear to the national clearance depth of 12 centimetres. This is subject to review if mines and ERW are all found closer to the surface or some are found deeper in the ground.

The FRA involves the following:

1. Assess each of the anticipated hazards, its design and its condition;
2. Listing each of the available procedures that may be used at the worksite;
3. Assessing the PoD with each hazard and each of the available procedures;
4. Assessing the SoC of an unintended detonation;
5. Assessing any additional risk presented by worksite conditions (WC);
6. Calculating Risk Numbers; and
7. Comparing Risk Numbers and selecting the appropriate procedures to use.

C.3. Hazard(s)

Fighting in the area around worksite XXXXX ended 15 years before. There is no minefield record but the types of mine and ERW that may be present can be reliably inferred from the record of what has been found in minefields laid by the same fighting faction in the same area.

The area surrounds high ground where the remains of trenches and a defended position are visible. Local people use one side of the hillside and a nomadic family camp among the remaining earthworks at the top each summer. There is a reliable report that a cow lost a leg in the mined area five years before. Despite this, the goats belonging to the nomadic family have been seen in the mined area.

The hazards anticipated are:

- PMN AP mines
- POMZ-2 stake mounted fragmentation mines
- PKMK-2 AT mines
- 72 mm mortar bombs

The degree of hazard that they represent is assessed below.

C.3.1 PMN AP mines

Three staggered rows of erratically placed PMN AP mines are anticipated. The PMN AP mines are believed to be functional and laid within three centimetres of the ground surface. This is presumed for the following reasons:

- Unintended detonations of these mines by deminers, civilians and heavy livestock (camels) have occurred regularly and recently in similar mined areas.
- Experience in similar minefields indicates that the mines are shallow buried.

The demining accident record shows that most accidents involving these mines occur while exposing them in hard ground. The PMN occurs in more recorded demining accidents than any other mine and can inflict severe injury on persons within a three metre radius.

These mines have a large metal signature and are considered easy to find to the required depth using the Ground Compensating (GC) metal-detectors available.

It is presumed that these mines are functional and will detonate if stepped on or exposed using a procedure that exerts a force exceeding 7 kg on the pressure plate. The design of the mine is such that less force may be required on the edge of the pressure plate to initiate the mine.

C.3.2 POMZ-2 fragmentation mines

The POMZ-2 stake mounted fragmentation mines are believed to be non-functional. This decision has been made for the following reasons:

- In minefields of the same age in the district, the wooden stakes of the POMZ-2 have decayed. The POMZ-2 mines have fallen over and usually separated from their MUV fuzes. The MUV fuzes have corroded such that the firing pin cannot be easily withdrawn.
- In similar minefields, parts of tripwires remain, but no intact tripwires have been found.
- There is no visible evidence of the mines, stakes or tripwires.
- Goats move over the mined area without incident, which implies that tripwires are no longer functional.

The demining accident record indicates that these mines are very rarely initiated during demining and that no special procedures are required for their safe clearance. Deminers should be trained to recognise separated fuzes and should understand that the fuze on its own is a hazard that should not be separated by inexperienced employees.

The high metal content of the mine body and the MUV style fuzes mean that they are easy to find to the required clearance depth using the available GC metal-detectors.

It is presumed that these mines are non-functional and that their tripwires are no longer intact, so they represent a low, or no, hazard.

C.3.3 P2MK-2 AT mine

The P2MK-2 AT mines may have been placed between the un-surfaced route at the bottom of the hill and the rising incline. There have been no recorded accidents or incidents involving AT mines in this area but it is believed that they may be present because these mines have been found in similar situations. They have been found buried up to 30 centimetres deep in the ground and sometimes with a large rock placed on top. The rock is believed to be a warning for friendly forces.

The normal operating pressure for these plastic cased mines is greater than 180 kg. Exposed examples of these mines are degraded by sunlight and the pressure plate may have crumbled. The mine is initiated by an AP mine beneath the pressure plate. When the pressure plate has been damaged, the mine could be initiated by the pressure of an employee walking over it, but this has not occurred in any recorded accidents so it is considered very unlikely.

P2MK-2 AT mines of a similar age have detonated in two mine accidents involving civilian vehicles over the past five years so they are presumed to be functional.

The low metal content of the P2MK-2 mine makes it impossible to find reliably at depths below 12cm with the available GC metal-detectors. The risk of leaving mines behind must be countered by ensuring that the suspect part of the worksite is searched to a greater depth because the level land at the base of the hill may be used to park vehicles or for agriculture in future. If mines are concealed at a depth greater than 12 cm, it is presumed that the mine has not been exposed to sunlight and so remains in good condition. This means that it may be stepped on by employees searching with a metal-detector to a limited depth. Subsequent procedures will either remove the top-soil and search again with a metal-detector, or search the area using appropriately trained EDDs able to detect the mines at the anticipated depth.

C.3.4 72 mm HE mortar bombs

Unexploded 72 mm HE mortar bombs have been located in similar defensive positions, so are anticipated at the worksite.

The force required to initiate the firing train is not known but is believed to greatly exceed any force that could be accidentally applied during manual demining procedures. The demining accident record implies that they represent a very low risk and no special procedures are required to limit risk to employees.

The high metal content of the mortar bombs mean that they are easy to find to the required clearance depth using the available GC metal-detectors.

The 72 mm HE mortar bombs that may be at the worksite present a low, or no, hazard during manual demining procedures.

C.4. Procedures available

The demining procedures available to the employer are:

1. manual demining using GC metal-detectors and signal investigation;
2. manual demining using area excavation techniques;
3. mechanical preparation using a shared backhoe asset; and
4. use of shared EDD assets (with manual investigation of signals).

Shared assets are in heavy demand and may not be available when required. This means that their use may reduce efficiency if there is downtime waiting for them to be available.

C.5. Probability of Detonation (PoD) during varied procedures

For each demining procedure and for each hazard, a Probability of Detonation (PoD) is estimated in Table A below. The probability of detonation is assessed and given a number from the following list.

4	Frequent	Could occur often with this procedure
3	Probable	Could occur if the procedure is used correctly
2	Occasional	Could occur if the procedure is used incorrectly
1	Improbable	Very unlikely to occur even if the procedure is used incorrectly

Annex C, Table A. Probability of Detonation (PoD) during available procedures		
Hazard: PMN AP mine (assessed as in normal functional condition)		
Procedure 1: Manual demining using GC metal-detectors and signal investigation		
2	Occasional	Could occur if the procedure is used incorrectly
Procedure 2: Manual demining using area excavation techniques		
3	Probable	Could occur if the procedure is used correctly
Procedure 3: Mechanical preparation using a shared backhoe asset		
4	Frequent	Could occur often with this procedure
Procedure 4: Use of shared EDD assets (and manual investigation of signals)		
2	Occasional	Could occur if the manual or EDD procedure is used incorrectly.
Hazard: POMZ-2 AP mine (assessed as non-functional)		
Procedure 1: Manual demining using GC metal-detectors and signal investigation		
1	Improbable	Very unlikely to occur even if the procedure is used incorrectly

Procedure 2: Manual demining using area excavation techniques		
1	Improbable	Very unlikely to occur even if the procedure is used incorrectly
Procedure 3: Mechanical preparation using a shared backhoe asset		
1	Improbable	Very unlikely to occur even if the procedure is used incorrectly
Procedure 4: Use of shared EDD assets (and manual investigation of signals)		
1	Improbable	Very unlikely to occur even if the procedure is used incorrectly
Hazard: P2MK-2 AT mine (assessed as in normal functional condition)		
Procedure 1: Manual demining using GC metal-detectors and signal investigation		
1	Improbable	Very unlikely to occur even if the procedure is used incorrectly
Procedure 2: Manual demining using area excavation techniques		
2	Occasional	Could occur if the procedure is used incorrectly
Procedure 3: Mechanical preparation using a shared backhoe asset		
3	Probable	Could occur if the procedure is used correctly
Procedure 4: Use of shared EDD assets (and manual investigation of signals)		
1	Improbable	Very unlikely to occur even if the procedure is used incorrectly
Hazard: 72 mm mortar bombs (assessed as in normal functional condition)		
Procedure 1: Manual demining using GC metal-detectors and signal investigation		
1	Improbable	Very unlikely to occur even if the procedure is used incorrectly
Procedure 2: Manual demining using area excavation techniques		
1	Improbable	Very unlikely to occur even if the procedure is used incorrectly
Procedure 3: Mechanical preparation using a shared backhoe asset		
1	Improbable	Very unlikely to occur even if the procedure is used incorrectly
Procedure 4: Use of shared EDD assets (and manual investigation of signals)		
1	Improbable	Very unlikely to occur even if the procedure is used incorrectly

Annex C, Table A: assigning a number to the Probability of a Detonation (PoD) occurring

To determine the significance of an unintended detonation, the Severity of the Consequences (SoC) is estimated for each hazard. Using Table B below, the severity of consequences is estimated and given one of the numbers from the column on the left.

Annex C, Table B: Severity of Consequences (SoC)		
4	Catastrophic	Death
3	Severe	Severe or disabling injury
2	Minor	Minor injury
1	Negligible	No injurious consequences
Severity of consequences for the detonation of each hazard		
PMN AP mine		
3	Severe	Severe or disabling injury
POMZ-2 AP mine		
3	Severe	Severe or disabling injury
P2MK-2 AT mine		
4	Catastrophic	Death
72 mm HE mortar bombs		

4	Catastrophic	Death

Annex C, Table B: Assigning a number to the severity of possible injuries

When assessing the SoC of a detonation, it has been presumed that the device is in a functional condition. The most likely SoC has been selected.

C.6. Risk(s) added by the Worksite Conditions (WC)

The employer is satisfied that normal supervision and marking procedures will be used at the worksite. This is possible because the conditions at the worksite are similar to the normal work environment.

The WCs that are relevant to this worksite are listed in the table below.

Annex C, Table C: Increased risk presented by the Worksite Conditions (WC)			
Risk	**Worksite Conditions (WC)**	**Factors to reduce risk of detonation and/or injury**	**Adjusted Risk**
When searching for <u>AP blast mines</u>			
+2	Hard/rocky ground	Blast resistant and long handled tools are available. Mechanical ground preparation is impractical because of the incline.	+1
+1	More than 7 metal pieces psm	Metal contamination is not known. Powerful magnets are available.	0
+1	Steep incline	Clearance will be conducted uphill directly or obliquely and employees have suitable footwear.	0
+1	Presence of animals	Community liaison officer has arranged for goats not to be free on the worksite.	0
When searching for <u>AP fragmentation mines</u> (stake mounted)			
+1	Leaf litter on ground	Use metal-detectors before any other tool.	0
+3	Undergrowth	Light grass and scattered small bushes will be cut carefully by hand.	0
+1	More than 7 metal pieces psm	Metal contamination is not known. Powerful magnets are available.	0
+1	Steep incline	Clearance will be conducted uphill directly or obliquely and employees have suitable footwear.	0
+1	Presence of animals	Community liaison officer has arranged for goats not to be free on the worksite.	0
When searching for <u>AT mines</u>			
+1	Hard/rocky ground	The deminers will not use heavy hand tools.	0
+1	Presence of animals	Community liaison officer has arranged for goats not to be free on the worksite.	0
When searching for <u>ordnance</u>			
+2	Hard/Rocky ground	Metal detectors will be used.	+1
+1	Steep incline	Clearance will be conducted uphill directly or obliquely and employees have suitable footwear.	0

Annex C, Table C: Increased risk presented by the Worksite Conditions (WC)

Increased risk presented by the conditions at the worksite are added to the total for each hazard and procedure as shown in Annex C, Table D below.

C.7. Combining all relevant factors

For each hazard and procedure, the results of Table A and Table B are multiplied together, then the total additional risk added by WCs, Table C, is added. The total is a number between 1 and 26 which is the Risk Number assigned to that hazard and that procedure at that worksite.

The results for this example are shown in Annex C, Table D below.

Annex C, Table D: Generating Risk Numbers							
Hazard: PMN AP mine	**Probability of detonation (from Table A)**		**Severity of consequences (from Table B)**		**Increased worksite risk (from Table C)**		**Total risk number**
Procedure 1: Manual demining using GC metal-detectors and signal investigation	2	x	3	+	1	=	7
Procedure 2: Manual demining using area excavation techniques	3	x	3	+	1	=	10
Procedure 3: Mechanical preparation using a shared backhoe asset	4	x	3	+	1	=	13
Procedure 4: Use of shared EDD assets (and manual investigation of signals)	2	x	3	+	1	=	7
Hazard: POMZ-2 mine	**Probability of detonation (from Table A)**		**Severity of consequences (from Table B)**		**Increased worksite risk (from Table C)**		**Total risk number**
Procedure 1: Manual demining using GC metal-detectors and signal investigation	1	x	3	+	0	=	3
Procedure 2: Manual demining using area excavation techniques	1	x	3	+	0	=	3
Procedure 3: Mechanical preparation using a shared backhoe asset	3	x	3	+	0	=	9
Procedure 4: Using shared EDD assets (and manual investigation of signals)	1	x	3	+	0	=	3
Hazard: P2MK2 AT mine	**Probability of detonation (from Table A)**		**Severity of consequences (from Table B)**		**Increased worksite risk (from Table C)**		**Total risk number**
Procedure 1: Manual demining using GC metal-detectors and signal investigation	1	x	4	+	0	=	4
Procedure 2: Manual demining using area excavation techniques	2	x	4	+	0	=	8
Procedure 3: Mechanical preparation using a shared backhoe asset	3	x	4	+	0	=	12
Procedure 4: Using shared EDD assets (and manual investigation of signals)	1	x	4	+	0	=	4
Hazard: 72mm HE mortar	**Probability of detonation (from**		**Severity of consequences**		**Increased worksite risk**		**Total risk number**

	Table A)		(from Table B)		(from Table C)		
Procedure 1: Manual demining using GC metal-detectors and signal investigation	1	x	4	+	1	=	5
Procedure 2: Manual demining using area excavation techniques	1	x	4	+	1	=	5
Procedure 3: Mechanical preparation using a shared backhoe asset	1	x	4	+	1	=	5
Procedure 4: Using shared EDD assets (and manual investigation of signals)	1	x	4	+	0	=	5

Annex C, Table D: generating Risk Numbers

C.8. Evaluating the risk calculation for each hazard and procedure

The Risk Number calculated for each hazard and specific procedure at a worksite is evaluated using Table E below.

Annex C, Table E: Tolerable and unacceptable Risk Numbers		
10-26	Not acceptable	This represents an intolerable risk: alternative procedures to reduce risk should be adopted unless personnel are protected by distance or other means.
9	Tolerable, but undesirable	Should only be accepted if no alternative procedures can be deployed.
5-7	Tolerable	The level of risk means that an unintended detonation may occur but a severe injury or fatality is unlikely
1-4	Normal	The level of risk means that any injury or fatality is very unlikely.

Annex C, Table E: tolerable and unacceptable Risk Numbers

C.8.1 Comparing risks

To compare the risks, the procedures and the Risk Numbers for each threat are combined in a single table and the unacceptable risks highlighted.

Annex C, Table G: Comparing Risk Numbers				
Procedure	**PMN AP mine**	**POMZ-2 AP mine**	**P2MK2 AT mine**	**72mm HE mortar**
Procedure 1: Manual demining using GC metal-detectors and signal investigation	7	3	4	5
Procedure 2: Manual demining using area excavation techniques	**10**	3	8	5
Procedure 3: Mechanical preparation using a shared backhoe asset	**13**	9	**12**	5
Procedure 4: Using shared EDD assets (and manual investigation of signals)	7	3	4	5

Annex C, Table G: Comparing Risk Numbers

There are three Risk Numbers greater than nine. These are generally unacceptable unless the risk can be reduced by enhanced PPE, armour or distance can be arranged.

Two of the three unacceptable risk numbers occur during **Procedure 3: mechanical preparation using a backhoe**. As long as the operator is securely protected against the threat with appropriate armour and other employees maintain an appropriate distance, the procedure can still be used in areas where the PMN is anticipated. However, protecting the employee against the detonation of an AT mine may not be possible and the machine would certainly be damaged, so the backhoe should not be used where the P2MK2 AT mines are anticipated.

The remaining unacceptable risk number occurs for **Procedure 2: Manual demining using area excavation techniques** in areas where PMN mines are anticipated. This will be avoided.

C.8.2 Selected procedures

The procedure used at the worksite will be manual demining using metal-detectors. It is possible that a metal-detector search will miss deeply buried P2MK2 AT mines. When the task has been completed, the situation will be assessed. If required, any area where deep P2MK2 AT mines may remain will be subsequently searched using shared EDD assets that have been trained to find P2MK2 mines at a depth up to 30cm.

Annex D
(Informative)
Templates for FRA

FRA Table A: Probability of Detonation (PoD) during available procedures

For each demining procedure and for each hazard, a Probability of Detonation (PoD) is estimated in FRA Table A below. The condition of the anticipated hazards is considered when estimating the probability of detonation. The probability of detonation is given a number from the following list.

4	Frequent	Could occur often with this procedure
3	Probable	Could occur if the procedure is used correctly
2	Occasional	Could occur if the procedure is used incorrectly
1	Improbable	Very unlikely to occur even if the procedure is used incorrectly

FRA Table A. Probability of Detonation (PoD) during available procedures		
Hazard: *[Name of hazard]*		
Procedure 1: *[describe procedure]*		
[No.]		
Procedure 2: *[describe procedure]*		
[No.]		
Procedure 3: *[describe procedure]*		
[No.]		
Procedure 4: *[describe procedure]*		
[No.]		
Hazard: *[Name of hazard]*		
Procedure 1: *[describe procedure]*		
[No.]		
Procedure 2: *[describe procedure]*		
[No.]		
Procedure 3: *[describe procedure]*		
[No.]		
Procedure 4: *[describe procedure]*		
[No.]		
Hazard: *[Name of hazard]*		
Procedure 1: *[describe procedure]*		
[No.]		
Procedure 2: *[describe procedure]*		
[No.]		
Procedure 3: *[describe procedure]*		
[No.]		
Procedure 4: *[describe procedure]*		
[No.]		
Hazard: *[Name of hazard]*		
Procedure 1: *[describe procedure]*		
[No.]		
Procedure 2: *[describe procedure]*		
[No.]		
Procedure 3: *[describe procedure]*		
[No.]		
Procedure 4: *[describe procedure]*		
[No.]		

FRA Table A. assessing Probability of Detonation (PoD) during available procedures.

FRA Table B: Severity of Consequences (SoC) number

The SoC is estimated for each hazard using FRA Table B below The severity of consequences is estimated and given one of the numbers from the column on the left.

To assess the severity of the consequences of a detonation, it is always presumed that the device is in a functional condition.

FRA Table B: Severity of Consequences (SoC)		
4	Catastrophic	Death
3	Severe	Severe or disabling injury
2	Minor	Minor injury
1	Negligible	No injurious consequences
SoC for the detonation of each hazard *[Extend the table for a greater number of anticipated hazards]*		
[Name of hazard]		
[No.]		
[Name of hazard]		
[No.]		
[Name of hazard]		
[No.]		
[Name of hazard]		
[No.]		
[Name of hazard]		
[No.]		
[Name of hazard]		
[No.]		
[Name of hazard]		
[No.]		
[Name of hazard]		
[No.]		

FRA Table B: Assigning a SoC number to the severity of possible injuries

FRA Table C: Risk(s) added by the Worksite Conditions (WC)

Worksite Conditions (WC) are unique at each worksite so the content of FRA Table C should be adjusted to suit the worksite. Some listed conditions should be removed and new conditions added when appropriate.

FRA Table C: Risk(s) added by the Worksite Conditions (WC)			
Risk	**Worksite Conditions (WC)**	**Factors to reduce risk of detonation and/or injury that have worked for others**	**Adjusted Risk**
When searching for AP blast mines			
+2	Hard/rocky ground	Use of blast resistant and long handled tools, or the use of mechanical ground preparation.	+1
+1	Soft/wet ground	Allow to dry.	0
+1	Leaf litter on ground	Use of long-handled leaf rakes and metal-detectors.	0
+1	Significant undergrowth	Cut carefully by hand until ground surface is visible and metal-detector search head can be moved very close to ground surface.	0
+1	Root mat on ground surface	Mechanical ground preparation.	0
+1	More than 7 metal pieces psm	Use of powerful magnets (where no magnetic influence fuzes are present).	0
+1	Steep incline	Conduct clearance uphill directly or obliquely and ensure employees have suitable slip-resistant footwear.	0
+1	Wire obstructions	Issue wire cutting and pulling tools and conduct training in their use at the worksite.	0
+1	Ditches, trenches or canals	Use clear marking, train in a similar situation and increase depth of search inside the obstruction. Use mechanical excavation and sifting when available.	0
+1	Presence of livestock	Community liaison officer to liaise with local owners to ensure the absence of livestock.	0
When searching for AP fragmentation mines (stake mounted)			
+1	Leaf litter on ground	Use metal-detectors before any other tool, then use again after leaf-litter is removed.	0
+2	Significant undergrowth	Use of mechanical vegetation cutting. If not available, cut vegetation from the top in short lengths, sweeping with metal detector after each cut. Use tripwire feeling procedure before each cut when tripwires may be present.	0
+1	More than 7 metal pieces psm	Use of powerful magnets (where no magnetic influence fuzes are present).	0
+1	Steep incline	Conduct clearance uphill directly or obliquely and ensure employees have suitable slip-resistant footwear.	0
+1	Wire obstructions	Issue cutting and pulling tools and conduct training. Pull using an armoured machine if tripwires or mines may be among the obstructions.	0
+1	Presence of livestock	Community liaison officer to liaise with local owners to ensure the absence of livestock.	0
When searching for AP bounding fragmentation mines			
+2	Leaf litter on ground	Use metal-detectors before any other tool.	0
+3	Significant undergrowth	Use mechanical vegetation cutting. If not available, cut vegetation from the top in short lengths, sweeping with metal detector after each cut. Use a tripwire feeling procedure before each cut when tripwires may be	0

		present.	
+1	More than 7 metal pieces psm	Use of powerful magnets (where no magnetic influence fuzes are present).	0
+1	Steep incline	Conduct clearance uphill directly or obliquely and ensure employees have suitable slip-resistant footwear.	0
+1	Wire obstructions	Issue cutting and pulling tools and conduct training. Pull using an armoured machine if tripwires or mines may be among the obstructions.	0
+1	Ditches and canals	Use clear marking and train in a similar situation. Also increase depth of search inside canal/ditch.	0
+1	Presence of livestock	Community liaison officer to liaise with local owners to ensure the absence of livestock.	0
When searching for <u>AT mines</u>			
+1	Hard/rocky ground	Do not use heavy hand tools such as mattocks and picks.	0
+1	Presence of livestock	Community liaison officer to liaise with local owners to ensure the absence of livestock.	0
When searching for <u>ordnance</u>			
+2	Hard/Rocky ground	Use clear marking and metal detectors: do not rely solely on visual search.	+1
+2	Significant undergrowth	Cut vegetation from the top in short lengths, sweeping with metal detector after each cut.	0
+1	Steep incline	Conduct clearance uphill directly or obliquely and ensure employees have suitable slip-resistant footwear.	0
When searching for <u>submunitions</u>			
+2	Hard/Rocky ground	Use clear marking and metal detectors: do not rely solely on visual search.	0
+3	Soft/wet ground	Allow to dry and search to greater depth.	0
+2	Significant undergrowth	Conduct cautious visual search in vegetation from top down: cut vegetation from the top in short lengths, sweeping with metal detector after each cut.	0
+1	Steep incline	Conduct clearance uphill directly or obliquely and ensure employees have suitable slip-resistant footwear. Presume submunitions may have moved downhill.	0
+1	Leaf litter on ground	Use of long-handled leaf rakes and metal-detectors.	0
+1	Wire obstructions	Issue cutting and pulling tools and conduct training. Pull using a suitably armoured machine if submunitions may be among the wire obstruction(s).	0
+1	Ditches and canals	Use clear marking, train in a similar situation and increase depth of search inside the canal/ditch.	0
+1	Presence of livestock	Community liaison officer to liaise with local owners to ensure the absence of livestock.	0

FRA Table C: assessing risk(s) added by the Worksite Conditions (WC)

The number in the left hand column should be used unless the factors to reduce risk of detonation and/or injury that have worked for others is used. When the factors to reduce risk are used, the number in the right hand column should be used.

FRA Table D: Combining factors to generate Risk Numbers

The calculations for each hazard and procedure for the worksite are calculated using the formula: <u>*(PoD x SoC) + WC = Risk number*</u>

This becomes: *(Table A x Table B) + Table C = Risk Number*

The total is a number between 1 and 26 which is the Risk Number assigned to that hazard and that procedure at that worksite.

FRA Table D: Generating Risk Numbers *[Extend the table for more than five procedures and more than four hazards]*							
Hazard: *[Name of hazard]*	**Probability of detonation (from Table A)**		**Severity of consequences (from Table B)**		**Increased worksite risk (from Table C)**		**Total Risk Number**
Procedure 1: *[Describe procedure]*		x		+		=	
Procedure 2: *[Describe procedure]*		x		+		=	
Procedure 3: *[Describe procedure]*		x		+		=	
Procedure 4: *[Describe procedure]*		x		+		=	
Procedure 5: *[Describe procedure]*							
Hazard: *[Name of hazard]*	**Probability of detonation (from Table A)**		**Severity of consequences (from Table B)**		**Increased worksite risk (from Table C)**		**Total Risk Number**
Procedure 1: *[Describe procedure]*		x		+		=	
Procedure 2: *[Describe procedure]*		x		+		=	
Procedure 3: *[Describe procedure]*		x		+		=	
Procedure 4: *[Describe procedure]*		x		+		=	
Procedure 5: *[Describe procedure]*							
Hazard: *[Name of hazard]*	**Probability of detonation (from Table A)**		**Severity of consequences (from Table B)**		**Increased worksite risk (from Table C)**		**Total Risk Number**
Procedure 1: *[Describe procedure]*		x		+		=	
Procedure 2: *[Describe procedure]*		x		+		=	
Procedure 3: *[Describe procedure]*		x		+		=	
Procedure 4: *[Describe procedure]*		x		+		=	
Procedure 5: *[Describe procedure]*							
Hazard: *[Name of hazard]*	**Probability of detonation (from Table A)**		**Severity of consequences (from Table B)**		**Increased worksite risk (from Table C)**		**Total Risk Number**
Procedure 1: *[Describe procedure]*		x		+		=	
Procedure 2: *[Describe procedure]*		x		+		=	
Procedure 3: *[Describe procedure]*		x		+		=	
Procedure 4: *[Describe procedure]*		x		+		=	
Procedure 5: *[Describe procedure]*							

FRA Table D: combining factors to generate Risk Numbers

FRA Table E: Comparing and evaluating Risk Numbers

To compare and evaluate the relative risks, the procedures and the Risk Numbers for each hazard can be combined in a single table and the unacceptable numbers highlighted.

FRA Table E: Comparing Risk Numbers

Numerical level of risk		
10-26	Not acceptable	This represents an intolerable risk: alternative procedures to reduce risk should be adopted unless personnel are protected by distance or other means.
9	Tolerable, but undesirable	Should only be accepted if no alternative procedures can be deployed.
5-7	Tolerable	The level of risk means that an unintended detonation may occur but a severe injury or fatality is unlikely
1-4	Normal	The level of risk means that any injury or fatality is very unlikely.

[Extend the table for more than five possible procedures and more than four hazards.]

Procedure	*[Hazard name 1]*	*[Hazard name 2]*	*[Hazard name 3]*	*[Hazard name 4]*
Procedure 1: *[Describe procedure]*	*[Enter Risk number from Table D]*	*[Enter Risk number from Table D]*	*[Enter Risk number from Table D]*	*[Enter Risk number from Table D]*
Procedure 2: *[Describe procedure]*	*[Enter Risk number from Table D]*	*[Enter Risk number from Table D]*	*[Enter Risk number from Table D]*	*[Enter Risk number from Table D]*
Procedure 3: *[Describe procedure]*	*[Enter Risk number from Table D]*	*[Enter Risk number from Table D]*	*[Enter Risk number from Table D]*	*[Enter Risk number from Table D]*
Procedure 4: *[Describe procedure]*	*[Enter Risk number from Table D]*	*[Enter Risk number from Table D]*	*[Enter Risk number from Table D]*	*[Enter Risk number from Table D]*
Procedure 5: *[Describe procedure]*	*[Enter Risk number from Table D]*	*[Enter Risk number from Table D]*	*[Enter Risk number from Table D]*	*[Enter Risk number from Table D]*

FRA Table E: Comparing Risk Numbers

Generally, procedures with a risk number lower than 10 should be selected.

Amendment record

Management of Technical Notes amendments

Technical Notes (TN) are subject to review on an 'as required' basis. As amendments are made to this TN they will be given a number, and the date and general details of the amendment shown in the table below. The amendment will also be shown on the cover page of the TN by the inclusion under the version date of the phrase *'incorporating amendment number(s) 1 etc.'*

As reviews of TN are made new versions may be issued. Amendments up to the date of the new version will be incorporated into the new version and the amendment record table cleared. Recording of amendments will then start again until a further version is produced.

The most recently amended TN will be the versions that are posted on the IMAS website at www.mineactionstandards.org.

Number	Date	Amendment Details
1	01 July 2013	1. Inclusion of amendment No, date on the title and header. 2. Minor text changes thorough the TN. 3. Removal of Annex B. 4. Relabelled Annexes C,D, E and F 5. Inclusion of amendment record