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The inspection of cleared land: guidelines for the use of sampling procedures

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Contents

Contents	iii
Foreword.....	iv
Introduction	v
Sampling procedures for the inspection of cleared land	1
1 Scope.....	1
2 References	1
3 Terms and definitions.....	1
4 General requirements and principles	1
5 Sampling plan	2
5.1 Method of inspection(s).....	2
5.1.1 Acceptance criteria	2
5.1.2 Corrective action.....	3
5.1.3 Re-inspection.....	3
5.1.4 Record of inspections and results	3
6 Responsibilities and obligations	3
6.1 UNMAS.....	3
6.2 National mine action authority.....	3
6.3 Inspection body.....	4
6.4 Demining organisation	4
Annex A (Normative) References.....	5
Annex B (Informative) Terms and definitions	6
Annex C (Informative) Sampling plan.....	8

Foreword

In July 1996, international standards for humanitarian mine clearance programmes were proposed by working groups at a conference in Denmark. Criteria were prescribed for all aspects of mine clearance, standards were recommended and a new universal definition of 'clearance' was agreed. In late 1996 the principles proposed in Denmark were developed by a UN-led working group into *International Standards for Humanitarian Mine Clearance Operations*. A first edition of these standards was issued by the UN Mine Action Service (UNMAS) in March 1997.

This IMAS reflects changes to operational procedures, practices and norms which have occurred over the past three years. The scope of these standards has been expanded to include the other components of mine action, in particular those of mine risk education, victim assistance and stockpile reduction.

The United Nations has a general responsibility for enabling and encouraging the effective management of mine action programmes, including the development and maintenance of standards. UNMAS is the office within the United Nations Secretariat responsible for the development and maintenance of international mine action standards (IMAS).

The work of preparing, reviewing and revising these standards is conducted by technical committees, with the support of international, governmental and non-governmental organisations. The latest version of each standard, together with information on the work of the technical committees, can be found at <http://www.mineactionstandards.org/>. IMAS will be reviewed at least every three years to reflect developing mine action norms and practices, and to incorporate changes to international regulations and requirements.

Introduction

The target of humanitarian demining is the identification and removal or destruction of all mine and UXO hazards from a specified area to a specified depth. The objective of this standard is to promote a culture where the demining community strives to achieve this target by developing and applying appropriate management procedures, by establishing and continuously improving the skills of managers and deminers, and by using safer, more effective and more efficient equipment.

The beneficiaries of humanitarian demining programmes must be confident that cleared land is safe for their use. This requires management systems and operational procedures which demonstrate the very highest levels of quality.

IMAS 09.10 specifies clearance quality by adopting a two-stage approach. Stage 1 (quality assurance) involves the establishment and monitoring of quality management systems and operational procedures before and during the clearance process. Stage 2 (quality control) involves a process of inspection of cleared land. The inspection of cleared land provides confidence that the clearance requirements have been met, and as such forms an essential part of the overall clearance process.

General principles and procedures for inspection and sampling have been developed by the International Organisation for Standardisation (ISO), and these approved principles and procedures are published in ISO 2859. The ISO inspection and sampling procedures provide rules which enable decisions to be taken on the quality of a product - in the case of demining the 'product' is cleared land.

The results of sampling are greatly influenced by the way in which a sample is selected. Rigorous procedures for sampling are therefore required. If procedures are not established and are not followed, then the inspections could be influenced by personal opinion and bias which would undermine the results - and in the case of demining will reduce confidence that the land is safe for its intended use.

This Guide provides one method of inspecting cleared land, and that is through selecting random samples. Other methods are possible, and may be developed to meet national and local needs and preferences. National mine action authorities, donors and other bodies developing and applying other inspection regimes should, however, ensure that such methods are statistically valid, and can be applied to the particular requirements of humanitarian demining in a consistent manner.

Sampling procedures for the inspection of cleared land

1 Scope

This document provides guidance for the inspection of cleared land by sampling. It defines terms, proposes a management system and procedures based on ISO 2859, and provides guidance on the implementation of these procedures.

This Guide is applicable to mine and UXO clearance tasks which have been conducted in accordance with the requirements of IMAS 09.10.

2 References

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

3 Terms and definitions

A list of terms and definitions used in this Guide is given in Annex B. A complete glossary of all the terms and definitions used in the IMAS series of standards is given in IMAS 04.10.

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

- a) 'should' is used to indicate the preferred requirements, methods or specifications.
- b) 'may' is used to indicate a possible method or course of action.

The term 'national mine action authority/authorities' refers to the government department(s), organisation(s) or institution(s) in each mine-affected country charged with the regulation, management and co-ordination of mine action. In most cases the national mine action centre (MAC) or its equivalent will act as, or on behalf of, the 'national mine action authority'. In certain situations and at certain times 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 of the functions, of a national mine action authority.

The term 'demining organisation' refers to any organisation (government, NGO or commercial entity) responsible for implementing demining projects or tasks. Demining organisations include headquarters and support elements, and comprise one or more sub-units (see below).

The term 'sub-unit' refers to a formed group of people, with equipment, supplies and other capabilities (such as mine detecting dogs), which apply approved procedures to carry out demining tasks such as survey, marking and clearance.

The term 'inspection body' refers to any organisation which conducts post-clearance inspection(s) on behalf of the national mine action authority by applying random sampling procedures, or other appropriate and agreed methods of inspection.

4 General requirements and principles

The inspection of cleared land should be done by inspection bodies, acting on behalf of national mine action authorities. This inspection forms part of a management process which aims to verify the quality of clearance, and to establish sufficient confidence that the demining organisation has removed and/or destroyed all mine and UXO hazards from the specified area to the specified depth, in accordance with its agreed contractual obligations.

Confidence can be objective or subjective. The term 'confidence' used in ISO 2859-0 and this standard refers to the objective mathematical probability of achieving the required level of clearance. Subjective confidence, which involves human factors such as perception, judgement and opinion, is not addressed in this Guide.

The effectiveness and validity of inspection by sampling requires the clearance process to be 'continuous and under control'. A 'continuous' process implies that each lot presented for inspection (see Clause 5.2 below) should include land which has been cleared under similar conditions; i.e. by sub-units with similar capabilities, using similar operational procedures and with similar equipment.

5 Sampling plan

There are a number of alternative sampling methodologies that may be employed. For the purpose of this IMAS, a statistically valid system has been developed. This is at Annex C as an informative note.

The minimum total area of land to be inspected after clearance should be calculated using figures derived from ISO 2859-0, of which an extract is at Appendix 1 to Annex C. If this methodology is adopted then, the individual units of land to be inspected shall be chosen by the inspection body at random. This IMAS provides one method of selecting random samples, but other methods may be developed to meet national and local needs and preferences, which should conform to the basic principles given in ISO 2859-0.

5.1 Method of inspection(s)

The procedures and equipment used by the inspection body to inspect the samples of cleared land should be approved by the national mine action authority, and should be agreed with the clearance organisation as part of the contract or agreement. Any major changes to sampling or inspection procedures (such as the introduction of mechanical or dog-assisted sampling) should be agreed between the national mine action authority and demining organisation prior to the start of inspection.

The national mine action authority and the demining organisation should agree a mutually acceptable time limit within which the sampling inspection must take place.

5.1.1 Acceptance criteria

A 'lot' should be considered as 'cleared' only if all the samples in the lot are found to be free of mines or UXO down to the depth specified in the contract. Where any sample in the lot is found to contain one or more mines or UXO, this will constitute a 'critical non-conformity', and the lot containing that sample should be declared to have failed the inspection.

Cleared land may contain other indicators of potential non-conformity, such as residual metal fragments following detection by metal mine detectors, or residual traces of explosives following detection by explosives detectors. Such cases could indicate a potential critical failure of the demining process (equipment, people or procedures), and again constitute a critical non-conformity. The conditions for acceptance or non-acceptance of all categories of non-conformity should be agreed between the national mine action authority and the demining organisation prior to the start of clearance.

An illustration of the extended definition of critical non-conformities involving residual metal fragments for use in a contract where the demining organisation has used metal mine detectors might include a requirement such as:

"The presence of 25g or more of scrap ferrous metal found in any 1.0 m² unit of land offered for inspection shall be considered as non-conforming. The identification of three or more separate sample units, in a single lot, each found to contain 25g or more of scrap metal shall be considered as a 'critical non-conformity'. In these circumstances the lot shall be rejected."

The definition of critical non-conformities must take into account the clearance methodology used by the demining organisation. For example, it would clearly be inappropriate to use residual metal fragments as a critical non-conformity if explosive detection methods were to be used as part of the primary clearance technology.

5.1.2 Corrective action

The national mine action authority should determine the corrective action to be taken on lots that are rejected. Guidance on corrective action should be provided in advance, should be based on national standards and guidelines, and should form part of the demining organisation's contract or agreement.

The demining organisation should investigate every critical non-conformity, shall provide the inspection body with reasons for each critical non-conformity, and shall provide a programme of corrective action. If a lot fails re-inspection following corrective action, the inspection body may require the lot to be cleared again using a different sub-unit using different operational procedures and with different equipment, if these alternate methods exist.

If no acceptable reason is given for a critical non-conformity, either by the clearance organisation or by the inspection body, the inspection body should require the lot to be marked and fenced until the reasons for the non-conformity can be established.

5.1.3 Re-inspection

Lots should not be offered for re-inspection until the demining organisation has taken corrective action as agreed with the inspection body in accordance with national standards.

The inspection body should specify whether normal or tightened inspection (see Clause 5.3.3 above) shall be used for re-inspection. This shall be based on guidance provided by the national mine action authority.

5.1.4 Record of inspections and results

The sample plan, the methods used for inspection, and the results should be recorded by the inspection body, including the location, depth, types of hazard and other non-conformities specified in the contract such as metal fragments or explosive residue. Details of all corrective action shall also be recorded. All records shall be passed to the national mine action authority.

6 Responsibilities and obligations

6.1 UNMAS

UNMAS, or an organisation appointed to act on its behalf, should:

- a) monitor the effectiveness of the sampling procedures, including the suitability of the Specified Quality Limit (which is currently set at 0.35%), and propose changes to the standard as required; and
- b) provide assistance and expert advice to national mine action authorities, inspection bodies and demining organisations on the application of ISO 2859 and other relevant international standards and guidelines.

Note: See Annexes B and C for detailed explanation of the Standard Quality Limit.

6.2 National mine action authority

The national mine action authority should:

- a) specify the area to be cleared and depth of clearance in contracts and agreements;

- b) specify criteria, (if applicable to the sampling methodology), for applying levels of land use (LU1, LU2 and LU3) to national demining programmes;
- c) if necessary, specify categories of critical non-conformities other than mine and UXO hazards.
- d) provide guidance on any specific corrective action to be taken by demining organisations, (in addition to re-clearing the failed area), following an inspection which finds a critical non-conformity;
- e) specify the standards to be applied for the documentation of inspections, results and corrective action
- f) maintain the documentation for all inspected land; and
- g) establish an inspection body as part of the national mine action authority, or accredit an organisation to perform the duties of an inspection body.

6.3 Inspection body

The inspection body should:

- a) gain accreditation to operate as an inspection body.
- b) apply the national mine action standard for the inspection of clearance tasks. In the absence of a national standard, the inspection body shall apply this IMAS standard, or other standards as are specified in the contract; and
- c) maintain and make available documentation including the sampling plan, methods of inspection and the results of inspections as specified by the national mine action authority.

6.4 Demining organisation

The organisation undertaking clearance should:

- a) gain accreditation and the licenses needed to operate as a clearance organisation;
- b) apply the national mine action standards for clearance and inspection of clearance standards. In the absence of national standards, the demining organisation shall apply IMAS standards, or other standards as specified in the contract;
- c) investigate every critical non-conformity, provide the inspection body with reasons for every critical non-conformity, and provide a programme of corrective action; and
- d) maintain and make available documentation of clearance and, if necessary, re-clearance as specified by the national mine action authority.

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 2859-0:1995. Sampling procedures for inspection by attributes - Part 0. Introduction to the BS 6001 attribute sampling system;
- b) ISO 2859-1: 1989. Sampling procedures for inspection by attributes - Part 1. Specification for sampling plans indexed by acceptable quality level (AQL) for lot by lot inspection; and
- c) ISO/IEC Compendium – Conformity assessment – Guides and Standards, 4th Edition.

The latest version/edition of these references should be used. GICHHD hold copies of all references used in this standard. A register of the latest version/edition of the IMAS standards, guides and references is maintained by GICHHD, and can be read on the IMAS website (www.mineclearancestandards.org). National mine action authorities, employers and other interested bodies and organisations should obtain copies before commencing mine action programmes.

Annex B **(Informative)** **Terms and definitions**

B.1.1

Specified Quality Limit (SQL)

an indication of the quality required from clearance operations.

Note: For acceptance sampling purposes, the SQL is a specified borderline between what can be considered reasonable as a process average and what can not. It has to be attainable by the producer (demining organisation) but tolerable to the consumer (national mine action authority or contracting agency).

Note: The SQL reflects the average contamination (in terms of non-conforming items per square metre) following a lengthy and steady clearance operation. The table in Annex C has been produced assuming a nominal SQL of 0.35% for cleared land.

Note: 0.35% was selected as the SQL figure after benchmarking against other critical non-compliances. The example provided by Cranfield University was that it is similar to the risk of death or severe injury as a result of contamination from the Aids/HIV/Hepatitis threat in Africa due to surgical glove failure. This is a comparatively strong SQL and is also similar to that used in other "hazardous" industries such as the nuclear reprocessing industry.

Note: The SQL shall be regularly reviewed by UNMAS as part of the standards review.

Note: A SQL of 0.35% does NOT equate to a "99.65% clearance standard".

B.1.2

demining organisation

any organisation (government, NGO or commercial entity) responsible for implementing demining projects or tasks. Demining organisations include headquarters and support elements, and comprise one or more sub-units.

B.1.3

inspection

the process of measuring, examining testing or otherwise comparing a sample of cleared land with the clearance requirements

B.1.4

inspection body

any organisation which conducts post-clearance inspection(s) on behalf of the national mine action authority by applying random sampling procedures, or other appropriate and agreed methods of inspection.

B.1.5

lot size

an area (comprising a number of 1.0m² units of cleared land) offered for inspection.

B.1.6

national mine action authority

the government department(s), organisation(s) or institution(s) in each mine-affected country charged with the regulation, management and co-ordination of mine action.

Note: In most cases the national mine action centre (MAC) or its equivalent will act as, or on behalf of, the 'national mine action authority'.

Note: In certain situations and at certain times 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 of the functions, of a national mine action authority.

B.1.7

non-conformity

the failure of a 1.0m² unit of land during inspection to meet the stated clearance requirements. IMAS identifies two types of critical non-conformities:

- a) the discovery of a mine or UXO; and
- b) other critical non conformities.

B.1.8
sample

one or more 1.0m² units of land drawn at random from a lot.

B.1.9
sample size

the number of 1.0m² units of land in the sample.

B.1.10
sampling plan

a specific plan that indicates the number of 1.0m² units of land from each lot which are to inspected (sample size or series of sample sizes) and the associated criteria for determining the acceptability of the lot (acceptance and rejection numbers).

B.1.11
sub-unit

a formed group of people, equipment, supplies and other capabilities (such as mine detecting dogs) which apply approved procedures to carry out demining tasks such as survey, marking and clearance.

Annex C (Informative) Sampling plan

C.1 Cleared area

The area to be cleared and the depth of clearance should be determined in advance by a technical survey, or from other reliable information which establishes the extent of the mine and UXO hazard area, and should normally be defined in a contract or some other formal arrangement. (Clearance requirements are covered in detail in IMAS 09.10.)

C.2 Area to be inspected

The cleared area may be divided up for inspection into one or more 'lots' of land. The size of each lot will depend on many factors, including the total mined area to be cleared, and whether the area consists of a single large minefield or a series of small mined areas.

For statistical reasons, the sampling requirement (i.e. the area to be inspected) reduces proportionally as the size of lot increases. Therefore, as clearance work progresses satisfactorily, it will usually be more efficient to select larger lots for inspection.

For example: several groups of small minefields are to be cleared by the same organisation in the same way, and the total area is three hectares (30,000 m²). This might be divided into five lots of 2,000 m² during the initial stages of the clearance, rising to four lots of 5,000 m² as the clearance progresses. This would ensure that the sampling could be completed by the inspection body within days of completion of the mine clearance.

C.3 Sample size

The sample size (i.e. the area of land to be inspected in each lot) depends on four factors:

- the lot size. (See Clause 5.3.1 below)
- the intended use of the land. (See Clause 5.3.2 below)
- the experience and effectiveness of the demining organisation. (See Clause 5.3.3 below)
- the sampling methodology. (See Clause 5.4 below)

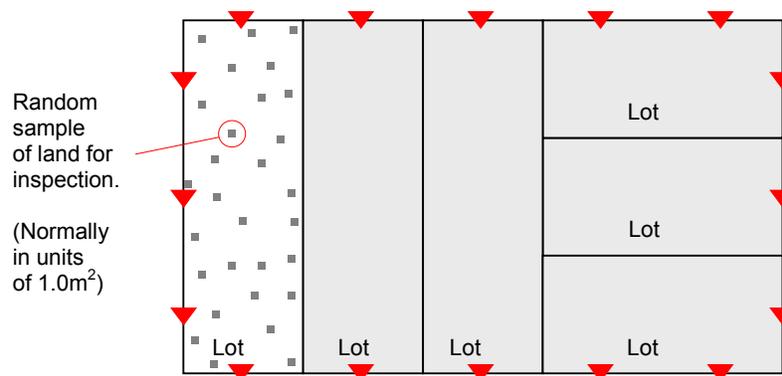


Figure 1: Illustration of cleared area, lots and samples of land for inspection

C.4 Lot size

As stated in Clause C.2 above, the required sample size is not directly proportional to the lot size. It is derived from the equation at Clause 4 of Appendix 3. For ease of application, examples of the relationship between the sample size and lot size are summarised in the table in Appendix 1. It can be seen that a smaller lot size requires a proportionally larger sample.

C.5 Land use

The sample size may be increased if additional confidence is needed on the quality of clearance. This will depend on the use to which the land is to be put, and the amount of human and animal traffic it will receive. Certain categories of land, for example tracks and footpaths, and areas around wells, housing and schools, will require higher levels of confidence (LU1), whereas land of little agricultural use and poorly frequented may only require a lower level (LU3). Three levels of land use (LU1, LU2 and LU3) are provided to represent the required confidence levels. The category of land use, and subsequent confidence levels, should be decided by the national mine action authority in accordance with national policy, and should be included in the clearance contract or some other formal agreement. If no level is specified, the highest confidence level, LU1, should be applied.

The target of humanitarian mine clearance remains the removal or destruction of ALL mines and UXO from the specified area to the specified depth. This is the responsibility of the clearance organisation, BUT the national mine action authority has a responsibility to ensure the quality of this work. The use of LU1, LU2 or LU3 is therefore not an indication of the level of clearance achieved, but rather an indication of the required confidence level in the organisation conducting the clearance.

The use of LU1 produces a sample size approximately double that of LU2 and therefore allows the national mine action authority to have a correspondingly higher level of confidence (10%) in the quality of that particular clearance operations.

The national mine action authority will decide on the LU category to be used. They may choose to use LU1 for all land, but this would probably not be the most efficient use of scarce resources if the demining organisations have had an excellent track record of success. It certainly goes against the principles of quality management and risk management on which IMAS is based.

It is recognised that this is initially a complex area; however, it is important to recognise that the use of LU3 during the sampling process does NOT equate to a lower standard of clearance.

C.5.1 Inspection levels

The sampling procedures established in ISO 2859-0 for the inspection of critical non-conformities include four levels of inspection. The inspection levels reflect the proven effectiveness and capabilities of the demining organisation. They provide an incentive to improve performance. For the inspection of cleared land:

- a) the 'normal' level of inspection defines the average size of sample which will achieve sufficient confidence that the demining organisation has removed and/or destroyed all mine and UXO hazards from the specified area to the specified depth.
- b) the 'tightened' level of inspection should be applied at the start of a contract and at the start of each clearance task when the demining organisation has yet to establish a record of effective and efficient clearance. The 'tightened' level may also be applied to a successful demining organisation on the introduction of new and unproven operational procedures or new and unproven equipment.

- c) the 'reduced' level of inspection gives credit to successful organisations with a proven record of safety and effective clearance.
- d) 'skip inspections' can be applied to demining organisations that have a consistent record of safe and effective clearance.

The switching procedures and rules which enable demining organisations to move between different levels of inspection are described in Annex D. National mine action authorities should seek expert advice before modifying the switching procedures and rules.

Example: A lot presented for inspection has a total area of 7,000m². It comprises grazing land which is deemed (by the national mine action authority) to require the medium level of confidence (LU2). A demining organisation with a proven track record is being used, and the contract has been in progress long enough for the organisation to have gained the confidence of the national mine action authority. This allows a reduced sampling regime to be adopted. If these criteria are applied to the table in Annex C (see extract at Figure 2 below), a sample size of 445m² would, if proved clear, achieve sufficient confidence that the entire lot has been cleared and is safe.

		Inspection Levels		
Cleared Area (m ²)	Land Use	Reduced (m ²)	Normal (m ²)	Tightened (m ²)
5,001 – 8,000	LU 1	640	785	1,175
	LU 2	445	510	590
	LU 3	260	375	420

Figure 2: Required sample size (extract from Annex C)

Once a demining organisation has demonstrated a consistent record of safe and effective clearance, and has an effective and efficient system of quality assurance, then the national mine action authority may consider allowing that demining organisation to conduct self-sampling for quality control. The self-sampling must, however, use the sampling methodology in use by the national mine action authority.

C.6 Sampling scheme

The individual units of land to be inspected (normally in units of 1.0m²) should be chosen in a random fashion. Any attempt to move away from random samples by applying assumptions and judgement could undermine the validity of the inspection process by introducing bias, and should therefore be discouraged.

Sampling units of 1.0m² may be grouped into clusters for ease of inspection. All units inside each cluster shall be inspected. For the application of this IMAS, clusters shall be no larger than 30 m² in size. Clusters may be of any shape including, for example a circle, a square or a strip, but they shall be the same size in any single lot of land presented for inspection.

Small areas of land may be grouped into a single lot, and submitted as a single lot for inspection – so long as all the areas have been cleared by the same demining organisation under similar conditions (see Clause 4 above). All areas, regardless of size, shall be inspected – the sampling effort shall be in proportion to the size of each area. This process is known as 'stratification'.

Example: A demining organisation has been contracted to clear four gardens in the same area (three are 1,000 m² and one is 2,000 m²). The organisation has been authorised to group the gardens as a single lot and to submit that lot for inspection. The inspection body should stratify the sample by allocating 40% of the sampling effort to the bigger garden and 20% to each of the three smaller gardens.

Appendix 1 to Annex C (Normative) Required sample sizes for post clearance inspection

Cleared Area (m ²)	Land Use	Inspection Levels		
		Reduced (m ²)	Normal (m ²)	Tightened (m ²)
0 – 500	LU 1	349	387	449
	LU 2	281	306	333
	LU 3	230	249	270
501 – 1,500	LU 1	495	588	802
	LU 2	362	405	460
	LU 3	279	308	342
1,501 – 3,000	LU 1	588	714	1024
	LU 2	419	474	544
	LU 3	318	354	396
3,001 – 5,000	LU 1	625	765	1,126
	LU 2	439	499	576
	LU 3	331	369	414
5,001 – 8,000	LU 1	636	783	1,172
	LU 2	444	505	585
	LU 3	333	372	418
8,001 – 15,000	LU 1	665	822	1,246
	LU 2	461	526	610
	LU 3	345	386	434
15,001 – 40,000	LU 1	676	839	1,283
	LU 2	467	533	620
	LU 3	349	390	439
40,001 – 200,000	LU 1	684	851	1,307
	LU 2	472	539	627
	LU 3	352	394	443

Figure C1: Required sample size (derived from ISO 2859-0 using the equation at Clause 4 of Annex E)

Notes.

(1) The inspection levels reflect the proven effectiveness and capabilities of the demining organisation. They provide an incentive to improve performance. Switching rules which enable demining organisations to move between different inspection levels are provided in Appendix 2.

(2) LU1 refers to the most sensitive category of land and LU3 to the least sensitive. The required level of land use shall be decided by the national mine action authority in accordance with national policy, and should be included in the contract.

(3) The sample size represents the number of individual one square metre units of land that need to be inspected.

Example:

A lot presented for inspection has a total area of 7,000m². It comprises grazing land which is deemed (by the national mine action authority) to require the medium level of confidence (LU2). A demining organisation with a proven track record is being used, and the contract has been in progress long enough for the organisation to have gained the confidence of the national mine action authority. This allows a reduced sampling regime to be adopted. If these criteria are applied to the table above, a sample size of 445m² would, if proved clear, achieve sufficient confidence that within that lot the specified area has been cleared to the specified depth.

Appendix 2 to Annex C (Normative) Switching procedures

C.2.1 General requirements

Switching procedures shall be applied to the inspection of a series of lots offered for inspection. Selection of an inspection plan should include consideration of the lots offered for inspection and the application of the qualifications and experience of staff and the successful application of an acceptable quality management system. The flow chart in Figure D1 shows the application of switching procedures to a demining sub- unit.

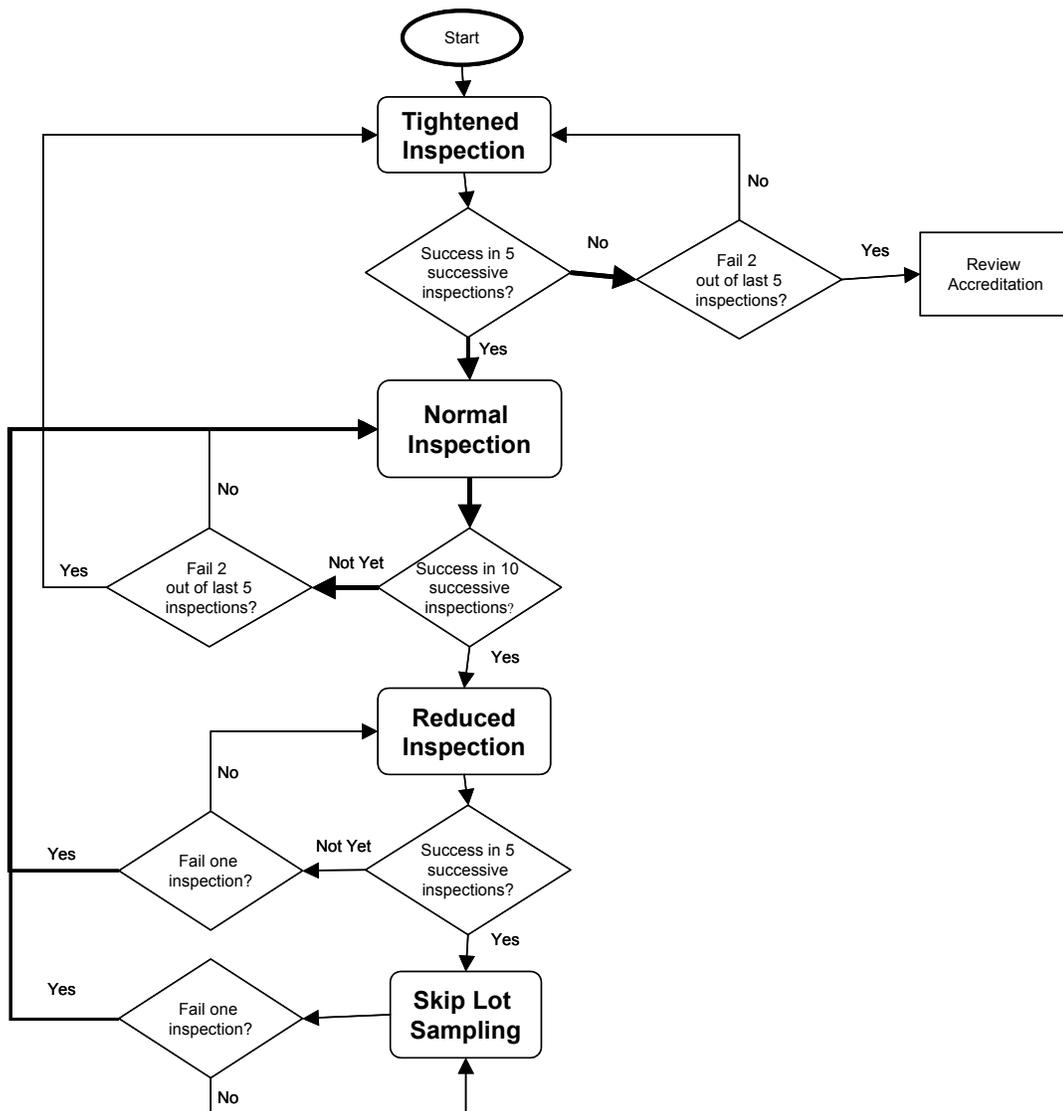


Figure D1: Flow chart of switching rules

C.2.2 Guidelines for switching between inspection levels

C.2.2.1 General principles

Tightened inspection levels shall be carried out at the start of the inspection process, or when inspecting the first lot of cleared land in any contract or agreement, unless otherwise specified by the national mine action authority.

Tightened, normal, reduced or skip-lot inspection shall continue on successive lots, except where the switching procedures require change in accordance with the following criteria.

C.2.2.2 Normal to tightened level

When two of the last five or less consecutive lots failed to meet the clearance criteria, and have required corrective action.

C.2.2.3 Tightened to normal level

When five consecutive lots have been presented for inspection and all have been accepted.

C.2.2.4 Normal to reduced level

When the following considerations are satisfied:

- a) the preceding ten lots have been presented for normal inspection and all have been accepted; and
- b) the clearance effort has been steady, there have been no long breaks or interruptions, and there have been no significant changes to operational procedures or equipment.

C.2.2.5 Reduced to normal level

When any of the following occur:

- a) a single lot is not accepted and requires corrective action; or
- b) clearance becomes irregular or delayed due to bad weather or other external or internal factors; or
- c) other conditions warrant reversion to normal inspection, such a change in key staff, operational procedures or equipment..

C.2.2.6 Reduced to tightened level

When an incident occurs which indicates a deviation from operational procedures or inadequate on-site supervision.

C.2.2.7 Reduced level to skip-lot sampling

Skip lot sampling may be used when a series of lots has been regularly proven to be considerably better than the Specified Quality Level (see Clause 1 of Annex E). Skip lot sampling permits one in three lots to be chosen at random for inspection.

When reduced inspection is being carried out, skip-lot inspection may be put into operation provided that the following considerations are satisfied.

- a) the preceding five lots have been presented for reduced inspection and have all been accepted on original inspection;
- b) the clearance rate has been steady, there have been no long breaks or interruptions, and there have been no significant changes to operational procedures or equipment;
- c) the demining organisation's management system is deemed to be acceptable; and

- d) skip-lot inspection is considered acceptable by the national mine action authority.

C.2.2.8 Skip-lot to normal level

When any of the following occur on the original inspection:

- a) a lot is not accepted; or
- b) production becomes irregular or delayed; or
- c) other conditions warrant reversion to normal inspection, such as a change in key staff, operational procedures or equipment, or when lots offered for inspection are not markedly better than the specified SQL. This criterion is applied to acceptance rules for 'other non-conformities'.

Appendix 3 to Annex C (informative) Supplementary guidance on sampling

C.3.1 Specified Quality Limit

The Specified Quality Limit (SQL) provides an indication of the quality required of clearance operations. For acceptance sampling purposes, the SQL indicates the borderline between what can be considered reasonable over time. It has to be attainable by the demining organisation, but tolerable to the national mine action authority – representing the interests of individuals and communities who will make use of the cleared land.

In the case of mine clearance, the SQL reflects the average contamination (in terms of non-conforming items per square metre) following a lengthy and steady process run. The table in Annex C has been produced assuming a nominal SQL of 0.35% for cleared land.

The SQL shall be regularly reviewed by UNMAS.

C.3.2 Land Use

The sample size may be increased if additional confidence is needed on the clearance quality for certain categories of land, for example tracks and footpaths, and areas around clinics, schools and housing. Three levels (LU1, LU2 and LU3) are provided to produce this additional confidence. The required level of land use shall be decided by the national mine action authority in accordance with national policy, and should be included in the contract. If no level is specified, LU1 shall be applied as a default. (Refer to Annex C, Clause C5).

The table below shows the confidence levels that have been used in producing this standard. The interpretation is as follows:

Following a Normal inspection at LU 1 there is at least 95% confidence that the quality of clearance is better than the SQL.

Land Use	Reduced	Normal	Tightened
LU 1	91%	95%	99%
LU 2	81%	85%	89%
LU 3	71%	75%	79%

Table E1: Confidence of clearance quality

C.3.3 Lot size

The area to be cleared and the depth of clearance should be determined in advance by a technical survey, or from other reliable information which establishes the extent of the mine and UXO hazard area. The clearance requirements shall be in accordance with IMAS 09.10, and should normally be defined in a contract or some other formal arrangement.

The cleared area may be presented for inspection in one or more 'lots' of land. The size of each lot shall acknowledge the need to ensure a 'continuous process'. The size of each lot of land should be agreed in advance between the demining organisation and the inspection body

The sample size (see Clause 4 below) and Annex C encourages the use of larger lots. Larger lots require proportionally less sampling to achieve the same level of confidence. But larger lots create management risks that need to be balanced against sampling costs. The failure of a larger lot costs more to correct than the failure of a smaller lot.

The combination of several small cleared areas into one lot for the purpose of saving sampling costs requires a continuous and steady clearance process, and this may not be possible in practice. The optimum size of lots will be determined from experience and from local circumstances.

C.4.4 Sample size

The determination of the sample size to be inspected is calculated by entering the necessary parameters (inspection level, minefield size, confidence level) in the table at Annex C.

The method of inspection for critical non-conformities developed in ISO 2859-0 obtains the sample size by applying the formula shown below.

$$n = (N-d/2)(1 - B^{1/(d+1)})$$

where:

n	sample size – rounded up to nearest integer (i.e. whole number)
N	lot size in m ²
B	probability of failing to find at least 1 mine; i.e. the level of confidence
p	maximum fraction of contaminated land; i.e. the quality of clearance
d	maximum number of non-conforming items allowed in the lot - rounded down to nearest integer (d = N x p)

A simple computer programme that allows the demining organisation to more accurately calculate the sampling requirement than the examples given in Annex C accompanies this IMAS. The programme is Windows[®] based, and uses the above formula as the basis for its calculations.