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

Director,
United Nations Mine Action Service (UNMAS),
2 United Nations Plaza, DC2-0650
New York, NY 10017
USA

Email: mineaction@un.org
Telephone: (1 212) 963 1875
Fax: (1 212) 963 2498 Website:
www.mineactionstandards.org

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Director
United Nations Mine Action Service (UNMAS)
2 United Nations Plaza, DC2-0650
New York, NY 10017
USA

Email: mineaction@un.org
Telephone: (1 212) 963 1875
Fax: (1 212) 963 2498

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Foreword

International standards for humanitarian demining programmes were first proposed by working groups at an international technical conference in Denmark, in July 1996. Criteria were prescribed for all aspects of demining, 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 and the International Standards for Humanitarian Mine Clearance Operations were developed. A first edition was issued by the UN Mine Action Service (UNMAS) in March 1997.

The scope of these original standards has since been expanded to include the other components of mine action and to reflect changes to operational procedures, practices and norms. The standards were re-developed and renamed as International Mine Action Standards (IMAS) with the first edition produced in October 2001.

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, therefore, is the office within the United Nations responsible for the development and maintenance of IMAS. IMAS are produced with the assistance of the Geneva International Centre for Humanitarian Demining.

The work of preparing, reviewing and revising IMAS 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/>. Individual IMAS are 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 Explosive Remnants of War (ERW) 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 (QA) involves the establishment and monitoring of systems and operational procedures before and during the clearance process. Stage 2 Quality Control (QC) involves a process of inspection of cleared land. The inspection of cleared land supplements QA and provides additional confidence that clearance requirements have been met. If they are carried out, inspections form an important 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 (NMAA), 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.

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

1. Scope

This document provides guidance for the inspection of cleared land by sampling should such sampling be carried out. 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 ERW 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, definitions and abbreviations

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

In the IMAS series of standards, the words 'shall', '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) 'shall' is used to indicate requirements, methods or specifications that are to be applied in order to conform to the standard;
- b) 'should' is used to indicate the preferred requirements, methods or specifications; and
- c) 'may' is used to indicate a possible method or course of action.

The term 'National Mine Action Authority (NMAA)' 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 'NMAA'. 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 NMAA.

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 Detection Dogs (MDD)), 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 NMAA by applying random sampling procedures, or other appropriate and agreed methods of inspection.

4. Demining Quality Management (QM)

The aim of demining Quality Management (QM) is to provide confidence (to the beneficiary, the demining organisation and the NMAA) that clearance and quality requirements have been met and that cleared land is indeed safe for use. QM for demining comprises three complementary components.

4.1. Accreditation

Accreditation is the procedure by which a demining organisation is formally recognised as competent and able to plan, manage and operationally conduct demining safely, effectively and efficiently.

Accreditation is fundamental to the whole demining QM process. Having thorough and comprehensive accreditation procedures from the outset ensures that a demining organisation is established, staffed, equipped, and has the required systems, procedures and support structures in place prior to any work commencing. Furthermore, the accreditation process checks that the demining organisation is working in accordance with its documented systems and procedures and capable of achieving required standards. As a result of the accreditation process an accreditation agreement is reached with the demining organisation on the standards to which demining is to be carried out. This agreement then forms the basis for all follow-on monitoring activities.

4.2. Monitoring

Monitoring is the observation, inspection or assessment of worksites, facilities, equipment, activities, processes, procedures and documentation by suitability qualified personnel to confirm that a demining organisation is working in accordance with its accreditation agreement.

Monitoring is essentially a passive activity, however it may be acceptable to incorporate post clearance inspection into monitoring as a means of progressively checking the quality of clearance work. Consistently good reports from monitoring observation, inspections or assessments should provide confidence to the monitoring authority to be able to reduce the frequency of future inspection in the same way as reduced sampling can be applied in Post Clearance Sampling methods.

4.3. Post-clearance inspection

Post-clearance inspection is the process of measuring, examining, testing or otherwise comparing a sample of cleared land with the clearance requirements. Post clearance inspections supplement accreditation and monitoring and provide additional confidence that clearance requirements have been met.

Note: It may not be necessary for all the components of demining QM to be carried out to achieve the required level of confidence. If for example, thorough and comprehensive accreditation and monitoring Quality Assurance (QA) is carried out, it may not be necessary to carry out post clearance inspections (QC)

5. Application of post clearance inspections

IMAS 09.20 does not dictate that the sampling plan included in Annex C shall be followed (it is informative only). Clause 7 states that there are a number of alternative sampling methodologies that may be employed. However, the sampling plan detailed in Annex C does provide a statistically valid methodology that has been developed for demining operations.

As indicated in clause 4 above there are various options in the application of post clearance inspections. These include:

- a) incorporating post clearance inspections into monitoring so that progressive inspections are carried out. If this was to occur following the sampling plan in Annex

C, the total sample inspected for the entire task would still need to be determined using the criteria in IMAS 09.20, i.e. lot size (this may have to be estimated initially), land use and inspection levels. Samples would also have to be randomly selected, cover the entire area cleared and acceptance criteria (and corrective/preventative action) would have to be clearly specified;

- b) conducting post clearance inspections only on the areas confirmed as hazardous and cleared during technical survey or clearance operations. Areas with no obvious indication of risk may be cancelled; and
- c) waiving post clearance inspections completely because thorough and comprehensive QA, combined with other factors already provides the NMAA with the required level of confidence in the quality of clearance. This option would have to be applied judiciously and may only apply to demining organisations that have a proven record.

The most important factor in any decision on the application of post clearance inspections is that the NMAA must have confidence in the quality of clearance. It is the NMAA that normally accepts the land on behalf of the user during the task handover process and this is the mitigation of liability point for the demining organisation (see clause 4 of IMAS 08.30). The NMAA then becomes responsible to the land user for the safety of that land.

Any decision on whether post clearance inspections are necessary or not, or how they are carried out normally rests with NMAA's (see note below). The procedures and responsibilities for post clearance inspections, including the justification, conditions and provisions for waiving or adjusting such inspections should be clearly laid down in national standards.

Note: There may be situations where donors or commercial clients direct that post clearance inspections, in accordance with IMAS 09.20, shall be carried out as part of funding agreements or commercial contracts.

6. Post clearance inspection general requirements and principles

The inspection of cleared land should be done by inspection bodies, acting on behalf of NMAAs. 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 or destroyed all mine and ERW hazards from the specified area to the specified depth, in accordance with its agreed contractual obligations. Post clearance inspections should also inspect the accuracy of post clearance marking and survey as indicated in completion reports.

Confidence can be objective or subjective. The term 'confidence' used in ISO 2859-0 and this IMAS 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 here.

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 Annex C clause C.2.) 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.

7. Sampling plan

For the purpose of this IMAS, a statistically valid system has been developed. This is at Annex C as an informative note. There may be alternative methodologies that can be employed, but alternative methodologies should be shown to be statistically valid and that they can be applied to the particular requirements of humanitarian demining in a consistent manner.

The minimum total area of land to be inspected after clearance should be calculated using figures derived from ISO 2859-0, of which an example is shown 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. Methods of selecting random samples may be developed to meet national and local needs and preferences, but should conform to the basic principles given in ISO 2859-0.

7.1. 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 NMAA, 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 MDD assisted sampling) should be agreed between the NMAA and demining organisation prior to the start of inspection.

The NMAA and the demining organisation should agree on a mutually acceptable time limit within which the sampling inspection must take place. However, in the event of a task being completed, post-clearance inspection and sampling should be completed within one week of task completion.

7.1.1. 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 ERW down to the depth specified in the contract. Where any sample in the lot is found to contain one or more mines or ERW, 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 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 NMAA 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 detectors might include a requirement such as:

"The presence of one or more pieces of scrap ferrous metal, with a weight equal to or greater than the ferrous metal content of the mine with the least ferrous metal content (as determined by technical survey or risk assessment for the site), 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 pieces of scrap ferrous metal equal to or greater than the ferrous metal content of the mine with the least ferrous metal content, shall be considered as a 'critical non-conformity'. In these circumstances the lot shall be declared to have failed the inspection"

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.

7.1.2. Preventative and corrective action

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 shall investigate every critical non-conformity, shall provide the NMAA, through the inspection body, with reasons for each critical non-conformity, and shall provide a programme of preventative action followed by corrective action. The NMAA should

agree on the preventative and corrective action to be taken on lots that have failed an inspection.

The demining organisation shall be required to re-clear the failed lot as part of the corrective action if the critical non-conformity is a mine or ERW or if the procedures used by the demining organisation indicate a less than required quality of clearance. The demining organisation may also be required to re-clear a wider group of lots as a result of critical non-conformities in only one or a few of the lots if it is realised that the non-conformity has appeared as a result of inadequate procedures that have also been used in the wider group of lots.

If a lot has been re-cleared by the demining organisation and fails re-inspection, the NMAA 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. Alternatively, a different organisation may be asked to re-clear the lot. The NMAA may then decide to withdraw the accreditation for the demining team (or organisation) that carried out the initial clearance and re-clearance for shorter or longer periods while the requirements for more extensive corrective action are identified and addressed.

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

7.1.3. Re-inspection

Failed lots should not be offered for re-inspection until the demining organisation has taken preventative and corrective action as agreed with the NMAA, through the inspection body, in accordance with national standards. Re-inspection of lots should only take place if the lot has been re-cleared or if other action has been carried out to remove non-conformities that would be present as a result of the same error that caused the initial non-conformity(eis).

The NMAA should specify whether, normal or tightened inspection (see Annex C clause C.6.) shall be used for re-inspection. This shall be based on guidance provided by the inspection body.

7.1.4. Cost of post clearance inspection

There is always a cost associated with re-clearance and re-inspection of re-cleared lots. The cost issues should be clearly articulated in the clearance contract between NMAA and the clearance organization. The NMAA may ask the clearance organization to cover the costs of re-clearance and re-inspection as appropriate.

7.1.5. 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 NMAA for inclusion in the completion report for the cleared land. Once the cleared land has been handed over the NMAA should be the custodian of all completion reports, handover certificates and supporting information.

8. Inspection body

The inspection of cleared land should be done by inspection bodies accredited and appointed by the NMAA to carry out inspections on its behalf. Any inspection body appointed by the NMAA shall be adequately staffed, equipped and trained to carry out inspections of cleared land in a safe and effective manner.

The inspection body shall have the necessary documentation that describes its management system (including its internal QM system), methods of inspection, equipment and procedures to be used in the inspection process.

In some cases, the NMAA may appoint the same staff to act as the monitoring body and the inspection body, but the two activities are separate. Where the inspection body also acts as a national accreditation body and/or a monitoring body, the relationship between its functions shall be clearly defined.

9. Responsibilities

9.1. 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 (SQL) (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 explanations of the SQL.

9.2. National Mine Action Authority (NMAA)

The NMAA 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 ERW hazards;
- d) provide direction on any specific corrective action to be taken by demining organisations 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) Specify a cost recovery policy if applicable.
- g) maintain the documentation for all inspected land;
- h) establish an inspection body as part of the NMAA, or accredit an organisation to perform the duties of an inspection body;
- i) monitor the work of the inspection body; and
- j) conduct periodic external QA audits on the inspection body.

9.3. Inspection body

The inspection body should:

- a) gain (from the NMAA) 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 NMAA.

9.4. Demining organisation

The organisation undertaking clearance should:

- a) gain the accreditation needed to operate as a clearance organisation;
- b) apply the national mine action standards for clearance. 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 preventative and corrective action; and
- d) maintain and make available documentation of clearance and, if necessary, re-clearance as specified by the NMAA.

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. GICHD 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 GICHD, and can be read on the IMAS website (www.mineclearancestandards.org). NMAA, employers and other interested bodies and organisations should obtain copies before commencing mine action programmes.

Annex B (Informative) Terms, definitions and abbreviations

B.1.

Note: audit

a timely process or system inspection to ensure that specifications conform to documented quality standards. An audit highlights discrepancies between the documented standards and the standards followed and might also show how well or how badly the documented standards support the processes currently followed.

B.2.

critical 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 ERW; and
- b) other critical non conformities as defined by NMAA's.

B.3.

demining organisation

refers to any organisation (government, NGO or commercial entity) responsible for implementing demining projects or tasks. The demining organisation may be a prime contractor, subcontractor, consultant or agent.

B.4.

demining sub-unit

an element of a demining organisation, however named, which is operationally accredited to conduct one or more prescribed demining activities, such as technical surveys, manual clearance, EOD or the use of MDD teams.

B.5.

Explosive Remnants of War (ERW)

Unexploded Ordnance (UXO) and Abandoned Explosive Ordnance (AXO). (CCW protocol V).

B.6.

inspection

the observation, measurement, examination, testing, evaluation or gauging of one or more components of a product or service and comparing these with specified requirements to determine conformity.

B.7.

inspection body

any organisation which conducts post-clearance QC on behalf of the NMAA by applying random sampling procedures, or other appropriate and agreed methods of inspection.

B.8.

lot size

in the context of humanitarian demining, the term refers to an area (comprising a number of 1.0m² units of cleared land) offered for inspection.

B.9.

National Mine Action Authority (NMAA)

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 MAC or its equivalent will act as, or on behalf of, the NMAA.

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 NMAA.

B.10.

post clearance inspection

in the context of humanitarian demining, the term refers to ...the process of measuring, examining, testing or otherwise comparing a sample of cleared land with the clearance requirements.

B.11.

sample

in the context of humanitarian demining, the term refers to one or more 1.0m² units of land drawn at random from a lot.

B.12.

sample size

in the context of humanitarian demining, the term refers to the number of 1.0m² units of land in the sample.

B.13.

sampling plan

in the context of humanitarian demining, the term refers to 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.14.

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 (NMAA 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 Aids/HIV/Hepatitis 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'.

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 ERW 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 hazardous area to be cleared, and whether the area consists of a single large hazardous area or a series of small hazardous 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 hazardous areas 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 clearance.

C.3. Sample size

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

- the lot size (see clause C.4. below);
- the intended use of the land (see clause C.5. below);
- the experience and effectiveness of the demining organisation (see clause C.6. below).

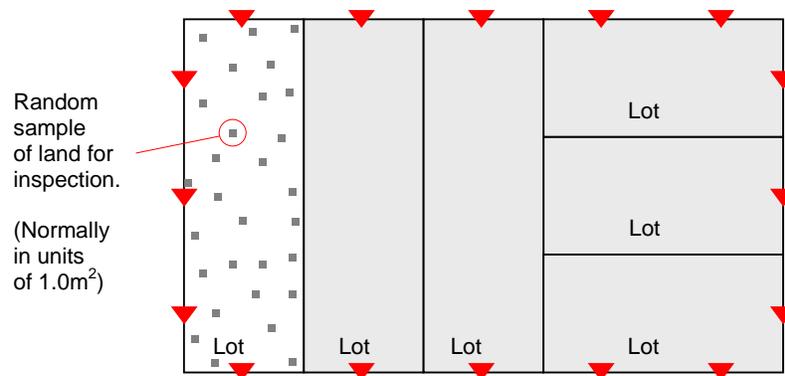


Figure C.1: Illustration of cleared area, lots and samples of land for inspection

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 C.3.4 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 in 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 NMAA 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 ERW from the specified area to the specified depth. This is the responsibility of the clearance organisation, BUT the NMAA 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 NMAA to have a correspondingly higher level of confidence (10%) in the quality of that particular clearance operations.

The NMAA 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 QM 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.6. 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 ERW 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; and

- 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 Appendix 2. NMAA should seek expert advice before modifying the switching procedures and rules.

Example: A lot presented for inspection has a total area of 8,000m². It comprises grazing land which is deemed (by the NMAA) to require the medium level of confidence (LU2). A demining organisation with a proven work record is being used, and the contract has been in progress long enough for the organisation to have gained the confidence of the NMAA. This allows a reduced sampling regime to be adopted. If these criteria are applied to the table in Appendix 1 (see extract at Figure C.2 below), a sample size of 444m² would, if proved clear, achieve sufficient confidence that the entire lot has been cleared and is safe.

Lot Size (Cleared Area) (m ²)	Land Use	Inspection Levels		
		Reduced (m ²)	Normal (m ²)	Tightened (m ²)
8,000	LU 1	636	784	1,173
	LU 2	444	506	585
	LU 3	334	373	418

Figure C.2: Example: sample sizes for various lot sizes (extract from Appendix 1)

Once a demining organisation has demonstrated a consistent record of safe and effective clearance, and has an effective and efficient system of QA, then the NMAA may consider allowing that demining organisation to conduct self-sampling for QC. The self-sampling must however, use the sampling methodology in use by the NMAA.

C.7. 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. in the main text 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 (Informative)

Example: Sample sizes for post clearance inspections

Lot Size (Cleared Area) (m ²)	Land Use	Inspection Levels		
		<i>Reduced</i> (m ²)	<i>Normal</i> (m ²)	<i>Tightened</i> (m ²)
500	LU 1	291	331	406
	LU 2	226	249	275
	LU 3	181	198	216
1,500	LU 1	479	570	781
	LU 2	349	392	446
	LU 3	269	298	331
3,000	LU 1	566	687	988
	LU 2	403	455	523
	LU 3	306	340	380
5,000	LU 1	609	746	1,100
	LU 2	429	486	561
	LU 3	323	360	404
8,000	LU 1	636	784	1,173
	LU 2	444	506	585
	LU 3	334	373	418
15,000	LU 1	659	815	1,235
	LU 2	458	522	605
	LU 3	342	383	430
40,000	LU 1	676	839	1,283
	LU 2	468	534	620
	LU 3	349	391	440
200,000	LU 1	685	851	1,307
	LU 2	472	540	628
	LU 3	352	394	444

**Figure C.1.1: Example: Sample sizes for various lot sizes
(derived from ISO 2859-0 using the equation at clause C.3.4. of Appendix 3)**

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 NMAA 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.
- (4) A simple computer programme that allows organisations to more accurately calculate the sampling requirement than the examples given in this Annex, is included on the IMAS website www.mineactionstandards.org or on the IMAS CD ROM

Example:

A lot presented for inspection has a total area of 8,000m². It comprises grazing land which is deemed (by the NMAA) 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 NMAA. This allows a reduced sampling regime to be adopted. If these criteria are applied to the table above, a sample size of 444m² 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 (Informative) 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 QM system. The flow chart in Figure C.2.1 below shows the application of switching procedures to a demining sub-unit.

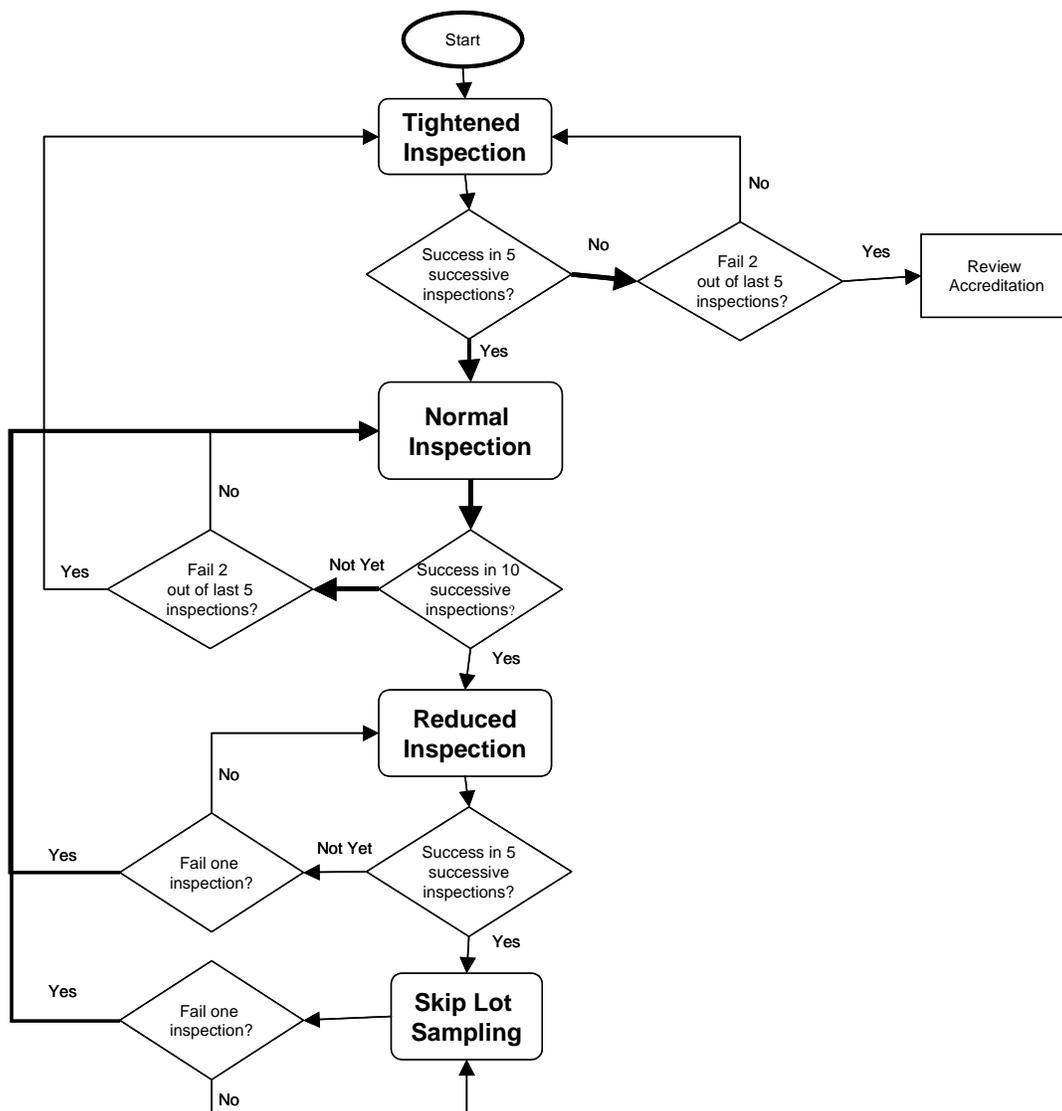


Figure C.2.1: Flow chart of switching rules

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 NMAA.

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 SQL (see clause C.3.1 of Appendix 3). 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 NMAA.

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'.

Note: If an organisation on a skip-lot inspection regime has a lot that is not accepted, consideration should be given to inspecting previously skipped lots.

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

C.3.1. Specified Quality Limit (SQL)

The 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 NMAA – representing the interests of individuals and communities who will make use of the cleared land.

In the case of mine and ERW 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 Appendix 1 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 NMAA 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 C.3.1: 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 ERW 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 C.3.4 below) 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.3.4. Sample size

The determination of the sample size to be inspected is calculated by entering the necessary parameters, lot size, land use confidence levels and inspection level. See the example in Figure C.1.1 at Appendix 1.

A simple computer programme that allows organisations to more accurately calculate the sampling requirement than the examples given in this Annex, is included on the IMAS website www.mineactionstandards.org or on the IMAS CD ROM. The programme is Windows[®] based, and uses the formula below as the basis for its calculations.

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 m²
- B probability of failing to find at least 1 mine/item of ERW; 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)

Amendment record

Management of IMAS amendments

The IMAS series of standards are subject to formal review on a three-yearly basis, however this does not preclude amendments being made within these three-year periods for reasons of operational safety and efficiency or for editorial purposes.

As amendments are made to this IMAS 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 IMAS by the inclusion under the edition date of the phrase *'incorporating amendment number(s) 1 etc.'*

As the formal reviews of each IMAS are completed new editions may be issued. Amendments up to the date of the new edition will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

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

Number	Date	Amendment Details
1	1 Dec 2004	<ol style="list-style-type: none"> 1. Formatting changes. 2. Minor text editing changes. 3. Changes to terms, definitions and abbreviations where necessary to ensure that this IMAS is consistent with IMAS 04.10. 4. Substantive changes: <ol style="list-style-type: none"> a) Clause 4. New sentence added. b) Clause 5.1.1. Change to the example shown in italics. c) Clause 5.1.2. Changes to the heading and text including changing 'inspection body' to 'NMAA' x 3. d) Clause 5.1.3. Changes to the text including changing 'inspection body' to 'NMAA' x 2 and 'national mine action authority' to 'inspection body'. e) Clause 5.1.4. Changes to the last sentence. f) Clause 6. New clause. g) Clause 7.2, previously 6.2. Change to sub clause 'd'. New sub clauses 'h' and 'i'. h) Clause 7.4, previously 6.4. Change to sub clause 'c'. i) Annex C, clause C.3, removal of sub clause 'd'. j) Appendix 1 to Annex C, figure C.1.1. Lot sizes (in left column) changed to show just one lot size, instead of a range as shown previously. Sample sizes changed where necessary to show the correct sample size for the lot size, land use and inspection level.
2	23 Jul 2005	<ol style="list-style-type: none"> 1. Clause 5.1.1, second and third paragraphs, removal of the word 'mine' from the term 'metal mine detectors' (twice).
3	24 Jan 07	<ol style="list-style-type: none"> 1. Minor changes/additions to the first and second paragraph of the foreword. 2. Introduction, text changes to the third paragraph. 3. Clause 1, text changes to 'Scope'. 4. Inclusion of a new clause 4 concerning 'Demining QM'. 5. Inclusion of a new clause 5 on the 'Application of post clearance inspections'. 6. Addition to the first paragraph of clause 7 sampling plan. 7. Addition to the 4th paragraph and inclusion of 5th and 6th paragraphs to clause 7.1.2 preventative and corrective action. 8. Text changes to clause 7.1.3 re-inspection. 9. Inclusion of new clause 7.1.4 cost of post clearance inspection. 10. Inclusion of new bullet "f" to clause 9.2 National Mine action Authority (NMAA). 11. Inclusion of the term 'mines and ERW'. 12. Removal of the term 'threat' from throughout the IMAS.