

LibMAS 09.50

Second Edition: January 2017

MECHANICAL DEMINING

Responsible National entity:

Libyan Mine Action Centre (LibMAC)
mandated by the Ministry of Defence (MOD)

Contact: LibMAC Deputy Director
quality.assurance@lmac.gov.ly



NOTE:

This document is current at the date shown on this page. The Libyan Mine Action Standards (LibMAS) are subject to regular revision, so users should ensure that they are using the latest version of each document in the standards. The most recent versions of LibMAS are the versions that are posted on the LibMAS pages of the LibMAC website www.lmac.gov.ly

Copyright notice

This document has been written with reference to the International Mine Action Standards (IMAS).

In its current form, this document is © **LibMAC Libya 2017** – All rights reserved.

Contents

1. Introduction.....	4
2. Use of Machines During Demining Operations.....	4
2.1 Mine Protected Vehicles (MPV).....	5
2.2 Detonating Machines.....	5
2.3 Ground Preparation Machines.....	7
2.4 Detection Machines.....	9
3. Mechanical Survey.....	10
4. Mechanical Support to Demining Operations.....	10
5. Systems Approach to Mechanical Demining.....	11
6. Mechanical Demining Operations - General Requirements.....	11
7. Testing and Evaluation (T&E) of Machines.....	12
7.1 Scope of T&E.....	13
7.2 Conduct of T&E.....	13
8. Mechanical SOPs.....	14
8.1 Management of Mechanical Demining Operations.....	14
8.2 Accident Response Plan.....	14
8.3 Machine Recovery Plan.....	15
8.4 Mines, ERW and Other Hazards.....	15
8.5 Inspecting Demining Machines.....	15
8.6 Machine Testing.....	16
8.7 Soil expansion.....	16
8.8 Communications.....	17
8.9 Mechanical Records.....	17
8.10 Maintenance and Servicing.....	17
8.11 Fire Precautions and Drills.....	18
8.12 Staff Requirements.....	18
9. Organisation and Responsibilities.....	19
10. Command and Control.....	20
11. Quality Assurance (QA) and Quality Control (QA).....	21
12. Environmental Considerations.....	22
12.1 General.....	22
12.2 Protection of Property and Infrastructure.....	22
12.3 Protecting the Archaeological Heritage.....	22
12.4 Protecting Artefacts.....	23
12.5 Protecting Human Remains.....	23
13. Responsibilities.....	23
13.1 Libyan Mine Action Centre (LibMAC).....	23
13.2 Mine Action Organisation.....	24
14. General References.....	25
15. Record of Amendments.....	25

Annexes

- A. Terms of Reference (TOR) for Mechanical Vegetation Cutter, Flail and Rotary Tiller On-site Assessment for Accreditation
- B. On-site assessment for Accreditation (Acceptance Test) form
- C. Mechanical Test and Evaluation (T&E) Pre-test Conditions

Foreword

Critical safety, control and quality elements of the International Mine Action Standards (IMAS) have been retained in the Libyan Mine Action Standards (LibMAS), so ensuring that they maintain the principles agreed in IMAS guidelines.

The work of preparing, reviewing and revising LibMAS is conducted by a technical committee with the support of international, governmental and non-governmental organisations in Libya. The latest version of each standard can be found at LibMAC website.

In all LibMAS the words “must”, “shall”, “should” and “may” are used in the following way. “Must” or “shall” is used to indicate a requirement, something that must be done in order to conform to the LibMAS. “Should” is used to indicate the preferred requirements, methods or specifications, but these may be varied when reasons for doing so are given. “May” is used to indicate a possible method or course of action that should be considered but need not be applied.

In this LibMAS:

- 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.
- The term “Mine Action Organisation” refers to any organisation (government, military, commercial or NGO/civil society) responsible for implementing mine action projects or tasks. The Mine Action Organisation may be a prime contractor, subcontractor, consultant or agent.

For the purpose of this standard, the words “Demining Organisation” and “Mine Action Organisation” are interchangeable and used to describe the same body.

1. Introduction

- a. This standard has been produced to provide guidelines and specifications that promote the safe, efficient and effective use of machines in demining operations in Libya. Machines have been used during demining operations for many years. Although their use has sometimes been controversial, they have demonstrated that their use can help to achieve some of the aims of humanitarian demining.
- b. No land can be recorded as “cleared” unless it has been processed in a manner that gives total confidence that the clearance requirements of LibMAS 09.10 have been achieved.
- c. The term ‘mechanical demining operations’ refers to the use of demining machines on demining operations and may involve a single demining machine employing one mechanical tool, a single demining machine employing a variety of tools or a number of machines employing a variety of tools.
- d. The term ‘demining machine’ refers to a unit of mechanical equipment used on demining operations.
- e. The term ‘mechanical tool’ refers to the working component(s) attached to a demining machine, such as flails, tillers, sifters, rollers, excavators, ploughs, magnets etc. A single demining machine may utilise a number of different tools, which may be fixed or interchangeable.
- f. Demining machines may be driven or operated by remote control.

2. Use of Machines During Demining Operations

- a. Machines used during demining operations in Libya are be divided into four general categories:
 - **Mine protected vehicles (MPV).**
 - **Detonating machines.**
 - **Ground preparation machines.**
 - **Detection machines.**
- b. Demining machines are generally not considered reliable to detonate or detect all the required mines and ERW in a suspect or confirmed hazardous area, although certain machines such as excavators used for ground preparation, may be assessed as capable of removing mine or ERW hazardous ground to the required depth. Normally this shall require follow-up demining using manual or MDD however based on pertinent test and evaluation (T&E), and on approval from the LibMAS, it may be decided that follow-up demining is not required.

- c. In general, mechanical demining is only one part of a combination of procedures that must be used in an area before it can be recorded as “cleared”. Mechanical demining must be integrated with other demining assets (manual mine clearance or MDD) whenever “clearance is necessary”, unless the machine is assessed as capable of clearance, and on approval by the LibMAS.
- d. Based on a risk assessment, suspect hazardous areas processed by demining machines may require a degree of follow-up clearance (i.e. manual mine clearance or MDD) prior to declaring the areas as having ‘no known risk’ and released.
- e. Confirmed hazardous area processed by machines shall require a degree of follow-up clearance (i.e. manual mine clearance or MDD) prior to declaring the areas as having ‘no known risk’ and released.
- f. Suspected or confirmed hazardous areas released after mechanical demining only shall be recorded as technical survey areas unless the machines used are approved for clearance.
- g. Depending on the type of machine used for mechanical demining, it must be capable of detonating, destroying, detecting or removing the types of mines or ERW expected in areas where they are intended to be deployed.
- h. The number of passes required by the machine over the same ground shall be determined by test and evaluation (T&E) and detailed in the Mine Action Organisation’s SOP and/or site Implementation Plan (IP). The machine should be used to process the same ground in two different directions.
- i. ‘Skip’ areas where the machine has not processed the ground as required shall be marked (when possible), recorded, and if suspected or confirmed as hazardous, shall require further demining using machines, manual or MDD procedures
- j. **Note:** The LibMAS may authorise the use of battle area clearance procedures in areas processed by machines, based on an assessment that there are **no** anti-personnel mines or other explosive ordnance requiring mine clearance procedures.

2.1 Mine Protected Vehicles (MPV)

- a. MPV are designed to protect any occupants and equipment from the effects of a mine detonation. MPV with people on board are commonly used during non-technical survey when there is a need to drive on un-surveyed routes in post conflict areas and technical survey, with the relevant apparatus mounted or attached for detonation, ground preparation and detection operations.
- b. The degree of protection on the machine may vary depending on its type, role and safety requirements. MPV are often used to transport Mine Action Organisation and other agency personnel safely in areas of conflict or where there other security considerations.

2.2 Detonating Machines

- a. Detonating machines are those machines that are generally designed to detonate or destroy mines rather than ERW, i.e. flails, tillers and rollers.

- b. Machines designed for this purpose have been used for minefield breaching by armed forces for many years and have been extremely useful in a combat scenario when they are deployed in a minefield to provide a safer passage to military personnel, equipment and possibly vehicles.
- c. In humanitarian demining, detonating machines are not considered reliable to detonate all pressure mines and generally do not detonate mines with pin-pull or “overpressure resistant” fuses.
- d. Due to the aforementioned, detonating machines shall require follow-up demining such as manual mine clearance or MDD, to declare an area as ‘cleared’.
- e. Detonating machines such as flails and tillers must be capable of penetrating the ground to the required search depth, that mines are expected to be located. This must be confirmed through test and evaluation (T&E).
- f. Machines used to detonate or destroy mines through the application of pressure to the surface of the ground include rollers (pushed or pulled by the machine), detonation trailers and steel wheels.
- g. Some machines may have the ability to detonate mines removed from the ground such as machines fitted an ‘ALLU’ screener crusher attachment (or similar).
- h. The ability to detonate the types of mines located where the machines shall be used must be confirmed through T&E.

2.2.1 Using Detonating Machines before Clearance

- a. Detonating Machines are primarily used for technical survey (TS) to confirm the presence or absence of mines.
- b. In areas where there is no evidence indicating the presence of mines however people are unwilling to use the land due to a suspicion of mines, then detonating machines may be used to install confidence. If there are no detonations or other evidence of mines then the land may be declared as having ‘no known risk’ and released.
- c. **Note:** Consideration must be made when deploying machines using tools which are known to move or “throw” mines and ERW outside its path as this may increase the area that needs to be cleared when the machine has finished.
- d. In general, machines designed to detonate mines may sustain damage, particularly from large detonations. That damage may be cumulative and very expensive to repair. Machines should be withdrawn and alternative procedures conducted such as manual mine clearance or MDD (if possible) in the proximity of the detonation. Only machines designed to withstand the effects of sustained mine detonations should be used to deliberately detonate numerous mines.

2.2.2 Using Detonating Machines after Clearance

- a. When a mine is located during clearance, (i.e. manual or MDD), it is necessary to clear beyond the last mine found in order to be certain that the mined area does not continue.

The extent of this clearance (buffer zone) depends on the particular site, however not less than ten metres in all directions, unless it is not physically possible or a reduction is authorised by the LibMAC.

- b. If no mines are located within the cleared buffer zone then there may be no requirement for further clearance. If a mine is located during clearance of the buffer zone then it shall continue for at least a further 10 metres from the mine. The buffer zone distance shall only be reduced on authorisation from the LibMAC.
- c. It may be decided to conduct technical survey outside the cleared buffer zone using detonating machines prior to assessing the land as having 'no known risk' for release. If however mines are detonated or there is visible evidence of mines, the machines shall be withdrawn and clearance conducted.
- d. Detonating machines with any history of throwing mines and ERW aside or behind as they work must not be used unless followed by manual or MDD clearance procedures that extend over the full area into which devices may have been thrown and the 10 metre buffer zone.
- e. **Note:** It may be possible to use accredited ground preparation machines such as excavators to conduct clearance of mines or ERW with or without the requirement for follow-up demining, based on pertinent T&E and on authorisation from the LibMAC.



Figure 1: Armoured Front-end Loader with AP Mine Rollers (*Reference: IMAS TN 09.50/01*)

2.3 Ground Preparation Machines

- a. Ground preparation machines are used to improve the efficiency of demining operations by reducing or removing obstacles, mines / ERW or hazardous materials. Ground preparation machines may be fitted with or supported by tools for excavating, mine / ERW hazardous ground or cutters for the removal of vegetation. Hazardous ground removed by ground preparation machines shall require processing, for example, by mechanical detection (i.e. sifters), and/or mechanical detonation (i.e. crushers), and/or clearance by manual or MDD.

Machines with magnets attached may be authorised for the removal of scrap metal in hazardous areas.

- b. Designated areas shall be marked for the searching and clearance of hazardous soil or debris removed by ground preparation machines.
- c. Ground preparation tasks may include:
 - Vegetation cutting and clearing;
 - Removal of tripwires;
 - Loosening the soil;
 - Removal of metal contamination; and
 - Removal of building debris, boulders, rubble, defensive wire obstacles etc.
 - Processing of soil and debris.
- d. Ground preparation may or may not involve the detonation, destruction or removal of mines and ERW.



Figure 2: Armoured Front-end Loader removing rubble (*Reference: IMAS TN 09.50/01*)



Figure 3: Armoured Tractor fitted with Vegetation Cutter (*Reference: IMAS TN 09.50/01*)

2.4 Detection Machines

- a. Machines designed to detect mine and ERW in suspect or confirmed hazardous areas may do so physically, as with sifting machines and rollers, or by carrying a detection technology such as metal-detector array or vapour sampling devices. Some physical detection methods may involve detonating some hazards during the detection process
- b. Detection machines are those machines that are designed to locate the position or presence of mines or ERW. Machines designed for this purpose have been used in humanitarian demining for many years.
- c. Detection machines include those designed to:
 - Sift ground or debris removed from the hazardous area and expose mines or ERW;
 - Carry metal, UXO and ground penetrating radar (GPR) detectors; and
 - Carry vapour sampling devices – remote explosive scent tracing (REST).
- d. The use of detection machines should not involve the intended detonation of mines and ERW.
- e. When machines are used for detection operations, the information that they provide must be followed up appropriately.
- f. Detection machines for use in mechanical demining operations must undergo pertinent T&E to confirm their capability to perform their role as intended.
- g. When using machines with mounted detector systems, relevant indications are usually instantly marked and the coordinates recorded (i.e. using a DGPS or GPS). The indications are either investigated immediately the machine is at a safe distance away or, i.e. using manual mine clearance, battle area clearance, or MDD procedures.
- h. Depending on the type of mines/ERW, the detector systems used on a particular machine, and the demining task, demining using detection machines may involve the use of similar

or different machines over the same area.

- i. Vapour samples taken during mechanical detection operations require analysis at approved testing facilities and therefore the area where the samples were taken is recorded (i.e. using a DGPS or GPS) and may be marked. Depending on the test results (i.e. positive or negative indication of explosives) and type of ordnance (i.e. mines or ERW), the recorded area where the samples were taken may require clearance using manual mine clearance, battle area clearance or MDD procedures.
- j. Hazardous ground or debris sifted by machines shall be searched for mines and/or ERW. The search process may only require a visual inspection, or demining procedures such as manual mine clearance, battle area clearance or MDD. Alternative techniques for searching such as the use of mechanical or hand held rakes may be authorised. Other equipment such as magnets may be authorised for use in the search process.
- k. Designated areas shall be marked for the sifting, searching and clearance of hazardous soil or debris.

3. Mechanical Survey

- a. Machines may be used to transport non-technical survey (NTS) personnel, and as a component or for sole implementation of technical survey (TS). In the TS role machines are used in suspected hazardous areas to confirm the presence or absence of mines/ERW or explosives (i.e. REST) for additional TS, clearance, or release.
- b. Information gathered during the NTS such as geography, weather, threat, scope of the hazardous area, should assist in determining the mechanical TS requirements, i.e. number of machines, type, role and support. In general, the less NTS information available, the more TS may be required.

4. Mechanical Support to Demining Operations

- a. As previously mentioned, machines such as MPV may be used to transport Mine Action Organisation or other agency personnel. Ground preparation type machines are often used in support of demining operations in tasks such as preparing non-hazardous tracks to permit access into areas for demining operations, and administration areas at demining sites, i.e. levelling ground, removing vegetation and obstacles.
- b. The activities of all Mine Action Organisation machines which are contracted for demining or in support of demining operations must be recorded and reported.
- c. When machines are used in a non-demining role then these activities shall not be recorded demining and areas processed not recorded as surveyed or cleared.

5. Systems Approach to Mechanical Demining

- a. While there are many varieties of demining machines and tools designed to detonate devices available for use in mechanical demining, these are rarely able to defeat all mine types and are very unlikely to detonate all ERW
- b. This has led to a need for a '**systems approach**' whereby machines with a combination of tools, a combination of machines with different tools, or non-mechanical demining procedures are applied at different stages during the demining process. All demining machines may be used in a systems approach.
- c. The systems approach is about the use of demining machines being integrated with other demining assets (manual or MDD) to ensure that the most effective outcome is achieved.
- d. Below is an example of the steps involved in a systems approach leading to the selection of appropriate demining machines to use in a hazardous area.

Step 1 - Identify what the mechanical demining systems **can** consistently achieve when used in the hazardous area.

Step 2 - Identify what the mechanical demining systems **cannot** achieve when used in the hazardous area.

Step 3 - Identify the further work that will need to be completed before the land can be released.

6. Mechanical Demining Operations - General Requirements

Demining machines must conform to the following general requirements:

- a. Each machine must be Tested and Evaluated (T&E) to determine its suitability for the task(s) it is expected to carry out in the conditions in which it will work;
- b. The operation of each machine must be assessed and confirmed as safe for the operator and any other person at the worksite. The protection necessary to protect against the mines and ERW anticipated at a task must be in place;
- c. Detailed Standing Operating Procedures (SOPs) must be written and approved for each machine, and each tool that will be used; and.
- d. All machines that disturb the ground surface must be operated in accordance with the constraints of LibMAS 07.51 Conservation of the environment and heritage.
- e. Each machine must be accredited for use in demining operations in accordance with LibMAS 07.30 Accreditation and this standard.
- f. A detailed analysis of the mine/ERW threat (i.e. type and depth) in an area shall be conducted before using a mechanical demining machine. Other considerations such as the terrain (i.e. vegetation, rocks, slopes), and the purpose of machines (i.e. ground preparation, technical survey) must be taken into account.

- g. Many machines are only designed to withstand detonations from anti-personnel mines and shall be severely damaged by anti-tank mines or large ERW. If it is likely that a machine shall encounter mines/ERW larger than it is designed to withstand, an alternative demining procedure shall be conducted.
- h. The purpose, method and any requirements shall be included in the Task Dossier and Implementation Plan (IP). Any deviation to this must be approved by the LibMAC
- i. The particular demining procedure adopted shall be mainly dependant on the type of machine, threat and terrain, and following the use of machines there may be a requirement for additional technical survey or clearance using additional machines or alternative demining procedures.
- j. When deploying machines into suspected or confirmed hazardous areas there shall be a minimum of 50 cm overlap outside the area processed by the machines. The Mine Action Organisation shall increase this distance if necessary (i.e. when deploying machines with large attachments for processing the ground), and on request by the LibMAS.
- k. The machine demining lanes should be as straight as possible to ensure a more precise overlap of the lanes. If the machine is unable to work in straight lines, then there may be a requirement to increase the overlap distance to ensure that the minimum overlap is achieved.
- l. When there is a required for a machines to penetrate the ground to a minimum depth (i.e. flails, tillers, excavators) the machines shall start the process at a sufficient distance to ensure that the minimum depth required is achieved at least 50 cm before the suspected or confirmed hazardous area. This distance shall be included in the site implementation plan (IP) and agreed with the LibMAS prior to the commencement of demining operations.
- m. Mine Action Organisations conducting mechanical demining shall ensure that all pertinent information is recorded such as mine/ERW detonations, visible mine/ERW (and parts), mine/ERW craters, other mine/ERW evidence. This shall provide valuable technical information regarding the type, location, and pattern of mines/ERW, and reduced areas.

7. Testing and Evaluation (T&E) of Machines

- a. T&E of machines is carried out to ensure that a machine is suitable for its intended use in the conditions in which it will work.
- b. T&E should be conducted prior to the machines arrival in Libya and shall be conducted prior to deployment in mechanical demining operations in Libya.
- c. As a minimum, the following shall be considered when determining the degree of T&E required for each machine:
 - The type of machine and its role.
 - Results from previous machine tests and evaluations.
 - The machine's history; use in demining operations.
 - The age and serviceability of the machine.

7.1 Scope of T&E

- a. T&E regimes for machines should be designed, developed and conducted in order to:
- Identify the parameters within which a machine is able to be employed in its intended operating environments.
 - Identify the optimal operating conditions for the machine in its intended operating environments.
 - To identify the effectiveness of machines in disrupting, destroying, detonating or otherwise removing different types of mines or ERW from hazardous areas in different operating environments. This should only occur for mines or ERW that a machine has been designed and developed to combat in accordance with the manufacturer's specifications.
 - For individual demining machines, or a number of machines or tools to be used as part of a systems approach, identify the residual risk remaining from each mine or ERW type to be targeted in the operating environments in which the machine(s) will work.
 - Identify any limitations in the employment of a machine (e.g. environmental conditions such as inclines, wet soil, hard ground, temperatures etc., or certain explosive hazards).
 - Assess and confirm the safety of the machine for the operator and any other person on a mechanical demining worksite.
 - Identify the operating procedures required to ensure that a machine is capable of achieving specified standards.
- a. Where there is evidence that a machine has been completed T&E and/or is proven safe and effective through use in other locations, in the interests of operational efficiency, the LibMAC may agree to exclude some of the T&E, however an in-country Acceptance Test for Operational Accreditation shall be conducted for all machines for use in demining operations in Libya.
- b. Internal and external monitoring of demining machines shall be conducted to confirm that they are able to perform as required, and in circumstances where it is determined that they are not then they shall be suspended pending corrective action and T&E.
- c. Records of machines T&E, monitoring and mechanical demining operations shall be maintained by the Mine Action Organisations and LibMAS.

7.2 Conduct of T&E

- a. The following tests shall be conducted prior to a machines employment in demining operations in Libya. The degree of testing of machines in Libya shall be determined by the LibMAC and shall be conducted in accordance to this LibMAS with reference to IMAS 03.40 Test and Evaluation of Mine Action Equipment, where necessary:

- **Performance test.** A test to establish whether the machine and its tool(s) is capable of performing the role for which it is intended under comparable and repeatable conditions and to evaluate the manufacturer's specifications.
 - **Survivability test.** A test to verify that the machine survives the explosive forces used as design criteria. **Note:** consideration shall also be given to the survivability of personnel operating machines.
 - **Acceptance test.** A test to ensure that a machine is able to work in the environment where it is intended to be used.
- b. T&E shall only be conducted in a safe and controlled environment and on authorisation from the LibMAC.
- c. **Annex A** details the Terms of Reference (TOR) for mechanical vegetation cutter, flail and rotary tiller On-site Assessment for Accreditation, **Annex B** details the On-site assessment for Accreditation (Acceptance Test) form, and **Annex C** details the mechanical T&E pre-test conditions.

8. Mechanical SOPs

- a. Machines can only be used within the limits of the SOPs submitted for Operational Accreditation and approved by LibMAC. Mine Action Organisations must ensure that the mechanical demining SOPs that submit for Operational Accreditation detail the procedures for using each different type of machine and tool, any cover the topics detailed in the headings below:

8.1 Management of Mechanical Demining Operations

- a. Management of mechanical demining operations must be carried out in a manner that ensures the operations are conducted in accordance with the Mine Action Organisation's SOPs, implementation plan (IP), and that adequate supervision is in place to ensure that operations are safe, efficient, effective, and that the ground is processed to the required standard.

8.2 Accident Response Plan

- a. No mechanical demining operations shall be conducted without sufficient medical support, in accordance with LibMAS 10.40 Medical Support to Demining.
- b. A practical accident response plan (or similar) must be written before a machine is deployed to work in a suspected or confirmed hazardous area. The accident response plan for a mechanical operation must include procedures for the safe, efficient and effective extraction of a casualty from inside any machine that is not remotely controlled.
- c. Detailed procedures for accident response and machine recovery must be included in the SOPs for mechanical demining that are submitted for Operational Accreditation.
- d. When conducting mechanical demining operations the accident response must be

practised regularly in accordance with the requirements details in LibMAS 10.40 Medical Support to Demining. These practices shall be conducted in clear areas at the demining site, however should as realistic as possible. They shall be recorded in the demining site documentation and be made available to QA monitors.

8.3 Machine Recovery Plan

- a. A practical machine recovery plan must be written before a machine is deployed to work in a suspected or confirmed hazardous area. The recovery plan must describe a procedure that ensures the safe, efficient and effective recovery of the machine.
- b. Machine recovery practice (using all options detailed in the Mine Action Organisation's SOP) shall be conducted at least once at each site prior to deploying the machine into the suspected or confirmed hazardous area, and at least once every 3 months at the demining site over the duration of the operations at the site.
- c. Practices shall be conducted in clear areas at the demining site and scenarios must be as realistic as possible. Machine recovery practice must be conducted during breaks in mechanical demining operations of more than one month. They shall be recorded in the demining site documentation and machine logs (or similar), and be made available to QA monitors.
- d. If there is a requirement to deploy other machines to assist with the recovery or to clear up to an incapacitated machine then these assets must be accredited in accordance with the role and procedures they are intending to conduct.

8.4 Mines, ERW and Other Hazards

- a. Demining machines are designed to withstand the detonation of specified devices. These must be specified in the SOPs submitted for Operational Accreditation. If an unanticipated mine or ERW is found during operations, the threat it presents to the machine must be assessed. When the machine was not designed (or accredited) for use against this mine or ERW, the mechanical demining must stop and a review of the procedures used at the site must be carried out. A pertinent risk assessment shall be conducted, which may result in an amendment to procedures, the implementation plan or further T&E of the machine. Mechanical demining operations shall only resume on authorisation from the LibMAC.

8.5 Inspecting Demining Machines

- a. Whenever a machine is withdrawn from a suspected or confirmed hazardous area, it must be inspected at a designated safe 'Machine Inspection Area(s)'. The inspection must confirm that no mines, ERW or hazardous components remain in or on any part of the machine and its tool(s). Detailed procedures for machine inspection must be included in the SOPs for mechanical demining that are submitted for Operational Accreditation.

- b. When working at demining sites the following shall be adhered to when inspecting machines for mines/ERW:
- c. A designated machine inspection area must be marked and recorded at the site. The area must be clear from mines/ERW prior to use.
- d. Personnel who are not wearing PPE or not afforded sufficient protection, i.e. natural or man-made wall, shall be located at a minimum distance of 100 metres from the machine during the inspection process.
- e. Demining working and demining safety distances for mechanical demining shall be in accordance with LibMAS 10.20 Demining Worksite Safety, Table 3.
- f. The inspection of machines for mines/ERW shall only be conducted by accredited demining personnel who are able to identify the pertinent mines/ERW anticipated at the demining site. The person conducting the inspection shall wear PPE in accordance with LibMAS 10.30.
- g. The inspection process is normally 'visual' and in circumstances where there is a requirement to move the machine and/or tool to remove soil or other obstacles to facilitate the inspection, then the person conducting the inspection shall be at a safe distance.
- h. Any mine/ERW or hazardous components are located on or near the machine then these shall be marked and reported to supervisory staff at the site. Only qualified EOD operators (or similar) shall move, neutralise, disarm or destroy located mines/ERW.
- i. Before conducting the inspection process, the machine shall be driven (manually or remotely) into the inspection area and the engine shall be shut down. For manually operated machines, the operator shall remain inside the machine during the inspection and until the "all clear" has been given for him/her to disembark or drive the machine.
- j. Consideration shall also be given to the route taken between the hazardous area and inspection area. This shall be marked and should be as short as possible. The machine shall be monitored while moving between the two areas for any mines/ERW which may fall from the machine. If mines/ERW are observed then they shall be marked, reported and dealt with.

8.6 Machine Testing

- a. There shall be a Machine Testing Area(s) at the site when conducting mechanical demining operations. The testing area shall be used to confirm the performance of the machine prior to its use each day, i.e. to detect the required mines/ERW and process the ground to the required depth. The requirements for marking and siting the machine testing area(s) shall be in accordance with those detailed for the Machine Inspection Area. The ground conditions in the testing area must be similar to those where the machine will work.
- b. If a machine fails to achieve the required standard during the testing then it shall not be used in suspected or confirmed hazardous areas at the site, until proven capable.

8.7 Soil expansion

- a. Soil expansion is the increase in volume of soil mixed with air that occurs during mechanical ground processing. The extent of soil expansion varies according to the ground being processed. Soil expansion must be known when planning follow-up demining so the depth of mechanical processing must be recorded with reference to the original undisturbed ground surface.
- b. Detailed procedures for measuring and recording soil expansion must be included in the SOPs for mechanical demining that are submitted for Operational Accreditation.

8.8 Communications

- a. There must be adequate communications in order to conduct mechanical demining operations. Mine Action Organisations shall establish and maintain communications system between the demining site and operational base (or similar) and at the demining site, between supervisory personnel, medical support staff and machine operators.
- b. Machines operator manually must include suitable communications inside enabling the operator to transmit and receive clear messages.
- c. A radio log (or similar) must be maintained at the demining site to record all relevant communications, particularly in the event of an accident or other significant events.
- d. Details of the required communications must be included in the SOPs for mechanical demining that are submitted for Operational Accreditation.

8.9 Mechanical Records

- a. The Mine Action Organisation operating demining machines must maintain detailed records of their mechanical operations, including recording the areas processed accurately.
- b. Reporting on hours worked, land area processed, mines and ERW found, breakdowns and problems is essential in order to gather statistical records that allow the value of the machine to be assessed. Reporting on non-operational time, such as mechanical breakdowns, transport between sites and logistical delays, is also essential to that assessment.
- c. Such information may for example, facilitate the release of land after mechanical demining without follow-up demining if statistical data proves sufficiently, that the residual risk posed by remaining hazards is tolerable.
- d. Demining organisations must record pertinent mechanical operational information on a daily basis and regular progress reports shall be sent to the LibMAC, these are normally at the end of each working week however the Mine Action Organisation's shall be informed of reporting requirements by the LibMAC. Mine Action Organisation's must include details of daily and other regular reporting requirements in their SOPs submitted for Operational Accreditation.

8.10 Maintenance and Servicing

- a. To appropriately maintain a demining machine it must be operated in accordance with the manufacturer's guidelines, Mine Action Organisation's SOP and Accreditation agreement, according to its role and capability. Demining machine operators must be suitably qualified and accredited to confirm their knowledge, skills and aptitude to competently operate all machines they are proposed to operate in demining operations.
- b. Accreditation for machine operators shall include their responsibilities in the event of a

mechanical breakdown, machine recovery, accident, and for testing and inspecting machines. Machine operators may be required to conduct maintenance and/or servicing of machines, or this may be the responsibility of mechanical support staff, however it is expected that machine operators shall be able to perform 'first' and 'last' parade basic daily checks on machines they are operating.

- c. Mine Action Organisations must make adequate provisions for the maintenance and servicing of machines. These provisions must ensure that:
 - Routine checks are made on the working components of machines and where working components necessary for the effective operation of a machine are damaged or lost, these components must be repaired or replaced before further work continues;
 - Routine inspections of safety features of machines must be carried out and where damage is identified, that damage must be repaired before further work continues; and
 - Whenever a machine is subject to a detonation that may have affected the safety of the operation, the machine must be immediately withdrawn to a safe area and inspected. If there is damage that may reduce the machine's effectiveness or place staff in danger, the machine should not be used until the damage is repaired.
- d. Mine Action Organisations must include detailed service and maintenance procedures in the SOPs for mechanical demining that are submitted for Operational Accreditation.

8.11 Fire Precautions and Drills

- a. Written procedures to be followed in the event of a fire on a machine must be on site whenever a demining machine is used in a suspected or confirmed hazardous area. These procedures must describe the immediate actions to be taken to ensure the safe extraction of occupants and their transfer to a safe area. Whenever a machine has any people on board, the machine must be fitted with fire extinguisher or fire suppressing systems.
- b. Mine Action personnel must not be allowed to enter a suspected or confirmed hazardous area to fight a fire on a burning machine, unless as a last resort to rescue demining personnel (i.e. machine operator) who's life is in danger, and only if the procedure has been approved and Accredited by the LibMAC.
- c. Firefighting equipment must also be available at demining sites where remote controlled machines are operating, and at all places where refuelling of machines is carried out.
- d. Mine Action Organisations must include emergency fire procedures in the SOPs for mechanical demining that are submitted for Operational Accreditation.

8.12 Staff Requirements

- a. While the machine is used inside a suspected hazardous area, mechanical demining task sites must have enough qualified people on site to ensure that:
 - Standards for operations are maintained;

- The effective integration with other demining operations is achieved; and
 - The necessary support is provided in an emergency.
- b. Details of all staff in the mechanical team and their responsibilities must be included in the SOPS for mechanical demining that are submitted for Operational Accreditation.

9. Organisation and Responsibilities

- a. The structure of a mechanical demining unit and job titles may vary between Mine Action Organisations and although, the quantity of qualified personnel may differ, there shall be a sufficient amount to conduct safe, efficient and effective demining operations.
- b. Each person shall be qualified and accredited in mechanical demining operations pertaining to their position and responsibilities.
- c. When demining operations are conducted involving more than one demining activity, i.e. mechanical demining and manual mine clearance, or MDD, or BAC, then there shall be sufficient supervisory and support personnel, in accordance with LibMAS. Demining personnel may be qualified and accredited to supervise, conduct and/or support a number of demining activities.
- d. The structure for a mechanical demining unit may vary between Mine Action Organisations, however for the purpose of this Standard, a mechanical demining 'unit' refers to a 'squad', 'section' or 'team' comprising one or more demining machine and operator.
- e. A demining site may comprise one or more units and the minimum distance between each operating machine shall be in accordance with LibMAS 10.20 Demining Worksite Safety, Table 3.
- f. During mechanical demining operations there shall be sufficient operational personnel at site to manage, implement and support the operations, particularly in the event of an accident.
- g. The minimum requirement to facilitate safe, efficient and effective manual mine clearance operations including a casualty evacuation (CASEVAC) at the site is as follows:

Site Supervisor (minimum 2)

- Two (2) Site Supervisors (or person with equivalent mechanical demining qualifications) shall be located within five (5) minutes travel time, have reliable communications, and shall be capable of supervising operations at the site.
- Each Site Supervisor shall be able to manage an emergency at the site and at least one (1) shall be capable of briefing visitors.
- One (1) Site Supervisor may manage up to three (3) mechanical demining sites comprising a maximum of three (3) demining machines, providing that adequate additional supervision is in place for the all sites and teams, i.e. at least one (1) Site Supervisor located at each operational site.

- One (1) Site Supervisor shall be located at or as close to the Working Area as possible during operations. He/she shall be located at a minimum distance in accordance with LibMAS 10.20 Demining Worksite Safety, Table 3, with the ability to walk to the Working Area of the machine(s) within two (2) minutes.
- One (1) Site Supervisor is allowed to supervise a maximum of three (3) working machines (equivalent to 1 unit), if safe to do so, and if located in accordance with the point d. above.
- **Note:** if there are different demining procedures being conducted at a site simultaneously, i.e. mechanical, manual mine clearance, MDD, or BAC, then each procedure must have sufficient personnel to supervise, implement and support for the site, in accordance with the relevant LibMAS for that procedure. Working distances for manual mine clearance and BAC are detailed LibMAS 10.20 Demining Worksite Safety.

Deminer (minimum 3)

- Three (3) Deminers qualified in manual mine clearance and/or BAC, depending on the threat, shall be located at the operational site, and able to walk to the Working area of the machine(s) within five (5) minutes. Note, the Deminers may be conducting demining.
- Two (2) of the Deminers shall be able to walk to the Working Area of the machine(s) within two (2) minutes.
- Three (3) Deminers may be located at up to three (3) operational sites **only** if in accordance with the above points.

Medic (minimum 1)

- One (1) Medic may support up to three (3) operational sites.
- One (1) Medic able to travel to the medical treatment point within (five) 5 minutes for each operational site he/she is supporting.
- For additional details see LibMAS 09.10 Medical Support to Demining.

10. Command and Control

- a. It is the responsibility of the Site Supervisor to ensure that there is sufficient command and control during demining operations.
- b. Command and control may become more problematic particularly in urban areas, populated, adjacent to roads, and depending on the terrain. Consideration should therefore be given to the overall task and threat posed, with an appropriate response thought-out. The optimum type and number of machines should be deployed to achieve safe, efficient and effective technical survey or clearance.
- c. The number of machines and personnel conducting demining operations at the Site simultaneously and the distance between them shall be dictated by certain factors including the clearance methodology, threat, nature of the ground, climatic conditions and the ability of supervisory personnel, however shall be in accordance with 8. Organisation and Responsibilities, above and LibMAS 10.20 Demining Worksite Safety, Table 3.
- d. Where possible, the person supervising should ensure that he/she is in a position to watch all machines and people under his/her responsibility simultaneously however, as a minimum requirement he/she shall diligently observe each machine and person under his/her responsibility at least once during each working shift.
- e. The person supervising shall ensure that they are aware of the activities of all machines and personnel under his/her responsibility and that they are working safely, efficiently and effectively.

- f. The working shift when conducting mechanical demining shall be a maximum of 60 minutes duration followed by a minimum of 10 minutes rest. Consideration shall at all times be given to the safety and therefore the Mine Action Organisation shall reduce the working shift duration and/or increase the rest period, in circumstances where it is considered unsafe, i.e. arduous conditions or extreme temperatures.
- g. The rest period may be reduced from 10 minutes to a minimum of 5 minutes however **only** if the working shift duration is 30 minutes or less.
- h. For additional safety requirements during manual mine clearance and battle area clearance operations refer to LibMAS 10.20 Demining Worksite Safety, Tables 1 and 2.

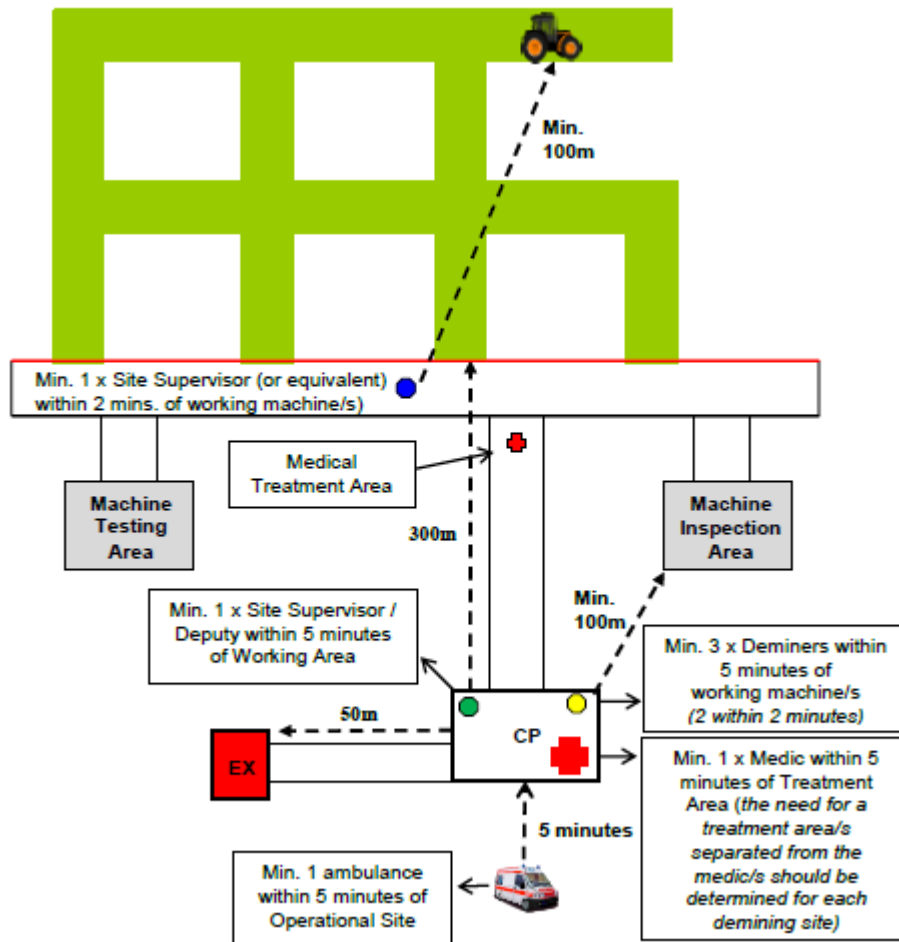


Figure 1: Example of Command and Control (minimum requirements)

11. Quality Assurance (QA) and Quality Control (QA)

- a. The level of Internal and External QA monitoring shall be dependent of the requirements of the LibMAC, and as detailed in the Mine Action Organisations SOP.
- b. The following are the minimum QC requirements for mechanical demining operations, and reference shall be made to LibMAS 07.40 Quality Management:
 - A minimum of 10% "internal" QC shall be conducted of the ground where technical survey and clearance is conducted during mechanical demining operations to confirm the standard of demining.

- QC shall be conducted using a different machine or another demining asset (i.e. manual mine clearance, MDD or battle area clearance) with the ability to perform at least to the same standard as the machine used for the technical survey or clearance.
- When conducting QC of ground which has been excavated below the required clearance depth for the relevant mines and/or ERW, then based on a risk assessment, the LibMAC may approve a visual inspection, and confirmation of the dimensions of the area (i.e. trench) is sufficient QC, to ensure that it is in accordance with clearance requirements.
- A pertinent mine and/or ERW located during QC of a mechanically cleared area should constitute a non-conformity.

12. Environmental Considerations

12.1 General

- a. Land that is subjected to mechanical processing must be left in a state that is suitable for its eventual use.
- b. Where mechanical operations involve the removal of vegetation, or the processing of ground, demining organisations must ensure that the constraints detailed in LibMAS 07.51 Conservation of the environment and heritage are applied.
- c. The operation, repair, maintenance and servicing of demining machines just be carried out in a way that ensures that no ground or watercourse contamination from fuel, oil and lubricants is permitted.

12.2 Protection of Property and Infrastructure

- a. Planning for any mechanical operations must take into account any possible damage to property or infrastructure. Where damage to property or infrastructure is possible, the property owners or local authorities must be consulted and the consequences of any damage agreed before the machine is used.

12.3 Protecting the Archaeological Heritage

- a. Machines may not be used in any area when it is known, or becomes apparent, that the area may have archaeological significance. No machine can be permitted to process ground within 25 metres of shaped stones or parts of architectural artefacts of unknown origin until permission has been granted by the relevant department of museums and/or antiquities.
- b. When the use of a machine uncovers shaped stones or parts of architectural artefacts of

unknown origin, the machine must be immediately withdrawn. The Mine Action Organisation must notify LibMAC of the discovery and ask LibMAC to report the find to the appropriate authorities. Manual mine clearance, battle area clearance and MDD demining procedures may be conducted in the area radiating to 25 metres from the extremity of the discovery.

- c. If portable artefacts are discovered during Manual mine clearance, battle area clearance and MDD demining procedures, those artefacts must be collected and delivered to LibMAC as soon as possible. No artefacts, no matter how modern in origin, may be kept by the Mine Action Organisation's operator(s).

12.4 Protecting Artefacts

- a. Portable artefacts that are discovered during mine action activity in Libya remain the property of the Government of Libya. Machines may not be used in any area when it is known, or becomes apparent, that the area contains artefacts of historical interest or value.
- b. The procedures that must be used when artefacts are discovered are described in LibMAS 07.51.

12.5 Protecting Human Remains

- a. Machines may not be used in any area when it is known, or becomes apparent, that the area may contain human remains. No machine can be permitted to process ground within 25 metres of human bones or bodies. The area must be processed using other approved demining procedures.
- b. The procedures that must be used when human remains are discovered are described in LibMAS 07.51.

13. Responsibilities

13.1 Libyan Mine Action Centre (LibMAC)

LMAC will:

- a. Consider the SOPs for machine use for Operational Accreditation in accordance with the requirements of LibMAS;
- b. Implement a QA and QC system that ensures that the accredited SOPs of the Mine Action Organisation are applied; and
- c. Provide advice to prospective machine users.

LibMAC should also:

- a. Establish a Testing and Evaluation (T&E) regime so be used before a machine can be accredited; and
- b. Establish reporting systems to gather data on machine performance.

13.2 Mine Action Organisation

The Mine Action Organisation using demining machines must:

- a. Support the LibMAC with the testing and evaluation of their machines when required;
- b. Establish SOPs that ensure that their demining machines operate effectively, are properly maintained and ensure the safety of all staff;
- c. Obtain LMAC Operational Accreditation for each different mechanical procedure to be used in demining operations;
- d. Comply with the LMAS for the use of demining machines;
- e. Apply management practices and operational procedures in an approved way; and
- f. Establish and maintain reporting systems and make the information required by LibMAC available in a timely manner.

14. General References

- a. International Mine Action Standards (IMAS), in particular, 09.50 Mechanical Demining, and for pictures IMAS TN 09.50/01 Guide to Mechanical Mine Clearance / Ground Preparation using Commercial Tractors and Front Loaders.
- b. LibMAS 10.20 Demining Worksite Safety and 10.20/1 Demining Site Marking Systems and 10.40 Medical Support to Demining.

15. Record of Amendments

Ser.	Date: D/M/Y	Standard	Section / Paragraph	Amended by: Name / Position / Org.	Comments
1	16/11/15	09.50 Mechanical Demining	All	Doug Ware, Chief of Ops/QA, UNMAS	Revised and add. details to existing Standard.
2	16/11/15	09.50 Annex A	All	Doug Ware, Chief of Ops/QA, UNMAS	New Standard.
3	16/11/15	09.50 Annex B	All	Doug Ware, Chief of Ops/QA, UNMAS	New Standard.
4	16/11/15	09.50 Annex C	All	Doug Ware, Chief of Ops/QA, UNMAS	New Standard.