ANNEX A | CATEGORISATION OF DEMINING MACHINES

MECHANICAL DEMINING

MACHINES CATEGORY	COMMON MACHINE TASKS
MINE CLEARANCE MACHINES (light, medium and heavy systems) **Specifically designed** > Flails > Tillers > Combined systems flail & tiller > Dual capability flail or tiller **Adapted** > Earth movers/front-end loaders > Rotary sifter systems	> Area reduction > Cancellation > Inspection > Land release > Mechanical mine clearance > Quality control procedures Removal of metal contamination > Removal of buildings debris, boulders, rubble, defensive wire obstacles, etc. > Risk reduction > Road clearance > Road hazard (threat) reduction > Sifting of soil and debris > Soil loosening > Tripwire removal > Technical survey > Vegetation cutting > Vegetation clearance > Vegetation removal > Verification[1]
GROUND PREPARATION MACHINES (light, medium and heavy systems) **Multi-tools** (attachments to a tractor or excavator) > Flail head > Tiller head > Magnet > Roller > Tree excavator > Soil disrupter > Rotary mine comb > Lift and grab > Rotary systems > Constructional engineering equipment tools > Adapted farming implements	

[1] Verification is the act of establishing that a suspected hazardous area is mined, thus this could also be described as technical survey.

ANNEX A | CATEGORISATION OF DEMINING MACHINES

MECHANICAL DEMINING

MACHINES CATEGORY	COMMON MACHINE TASKS
GROUND PREPARATION MACHINES (light, medium and heavy systems) **Vegetation cutters** (attachments to a tractor or excavator) > Mower > Rotary mower > Reach mower > Brush cutter > Mulcher > Slasher > Flail > Tiller > Rock crushers > Sifters	
MINE-PROTECTED VEHICLES	> Inspection > Mine clearance > Risk reduction > Road hazard (threat) reduction > Road clearance

ANNEX B | GUIDELINES FOR MECHANICAL SAFETY

Here are a few guidelines that can easily be implemented for mechanical safety:

- Use ear defenders when working in noisy environments
- Use safety goggles/glasses when working in environments with risk of eye injury
- Use protective gloves overhauls that are flame resistant
- Use breathing respiratory protection when working in toxic environments
- Always use safety boots when working with heavy machinery and machine part
- Ensure that proper fire-fighting equipment is available in designated firepoints and that staff can operate this equipment
- Machines use high-pressure hydraulic systems; never work on the hydraulic system with the engine operating
- Always use a crane and lifting equipment above the specified weight of the item to be lifted. Never use crane or lifting equipment above weight limits specified by manufacturer
- Do not stand beneath or near to suspended/hanging loads
- Never use your fingers to align holes
- The demining machine operator should be aware of the location of the observers and other surrounding personnel at all times
- Never stand between the machine and static objects such as walls and houses when the machine is running
- It is crucial that no dirt or debris gets into hydraulic systems when connecting or disconnecting hydraulic pipes
- Clean all components when servicing the demining machine. When cleaning pay special attention to the engine compartment to minimize the fire hazard. Avoid using water when cleaning the machine if it is not already wet. Water will turn dust into mud that is difficult to remove, especially in a tight engine compartment

- When cleaning air filters with high pressure air this should be done blowing the air out of, and not into, the engine. When cleaning the filters it should be made sure that openings into the engine are sealed so that dust does not make its way into the engine during the cleaning. Many modern air filter elements have "micro fibres" that will be damaged if cleaned with compressed air. Clean the air filter by shaking it or knocking it, not to hard, against a solid object
- Always disconnect the battery before working on any electrical system
- Before any welding always clean the loader, disconnect the battery and the alternator (and any other dealer-specified connections), cover the rubber hoses and other inflammable parts. During grinding or welding of painted parts always ensure good ventilation
- Before refuelling stop the engine and let it cool down. Do not smoke during refuelling
- Ensure that all operators and mechanics wear all appropriate safety equipment provided
- Always conduct maintenance in accordance to manuals, instructions and training provided by the manufacturer
- The engine components and cooling system must be checked every day. If it is needed they should be cleaned to prevent fire risk or overheating
- Make sure that electric conductors and connections are functional and secure. Keep the battery terminals cleaned and tightened. Repair or replace any damaged parts. Apparently not damaged and fully functioning are not always the same when it comes to electric gadgets because they often "look okay"
- Check whether the fuel and hydraulic tubes, hoses and fittings are not damaged or leaking. When checking fluid leakage, never use the open fire or unprotected skin. Tighten or replace any leaky parts. Always clean the liquid stains. Do not use petrol or Diesel oil for cleaning parts. Use commercial non-flammable detergents

- When the flail/tiller unit is mounted and attached never start the engine without prior warning
- Never switch on the flail/tiller unit if it points to yourself, other persons, vehicles or other objects
- It is forbidden to clean the flail/tiller unit when the engine is running and the communication of remote control system is switched on
- When manipulating with the flail unit lifted to its maximal height follow instructions for high voltage safety zones
- Since hydraulic systems operate at hundreds, or even thousands, of Pounds per Square Inch (PSI) and temperatures are reaching very high temperatures, severe injuries and death can result from component failures. Care must always be taken when performing maintenance on hydraulic systems in demining machines. Hydraulic systems should be designed to protect personnel from surface temperatures that exceed touchable limits
- Drains and relief valves should be installed so that they do not allow ingress of air into the system and of a size that does not generate excessive back pressure. High-pressure relief valves must be installed so that the hazard to personnel is minimised.

ANNEX C | MINES AND UXO POSING A SERIOUS HAZARD TO DEMINING MACHINES

This table outlines examples of mines and UXO which can pose a serious hazard to demining machines. For more information on the protection of vehicles and plant equipment against mines and UXO see the GICHD 2004 *Study of Mechanical Application in Demining*, Chapter 5. This annex also comments briefly on UXO and their effect on demining machines.

AVMs and large items of ERW (although the detonation of most ERW as a result of mechanical action is not common) can damage or even destroy many light demining machines. It is essential to identify the type of ordnance to be encountered in clearance operations. For a non-exhaustive list of samples of mines that are considered "a serious hazard" to machines. AP blast mines have not been included since they do not pose a serious hazard to demining machines. It should be remembered though that an AP blast mine can cause serious damage to, for instance, a detector mounted on an MPV:

A PROM-1 bounding fragmentation mine

ANNEX C | MINES AND UXO POSING A SERIOUS HAZARD TO DEMINING MACHINES

Type of mine	Omni-Directional Anti-Personnel Fragmentation Mines	Directional Anti-Personnel Fragmentation Mines
Damage caused to demining machines and their operators	These mines rely on the shrapnel effect to incapacitate personnel. Can cause serious damage to the operator's cabin, hydraulic units, air filters, radiators, wheel tyres and other vulnerable components.	Can cause serious damage to the operator's cabin, hydraulic units, air filters, radiators, wheel tyres and other vulnerable components.
Brief description	They usually consist of a cylindrical metal sleeve that surrounds an explosive charge. The metal sleeve produces shrapnel with velocities up to 1500 m/s when the explosive charge is detonated and is lethal to personnel up to distances as far off as fifty meters. Two types are encountered. The first type is stake mounted on the surface and activated by pull-switch and tripwire. The other type is referred to as the "bounding mine". These mines are buried underneath the surface and activated by either pressure or tripwire. Activation of the fuse initiates a black powder charge that expels the mine from the ground to detonate at a height of approximately 1,5m to optimise the shrapnel effect against personnel.	These A/P type mines restrict the projection of shrapnel to a 40 to 60 degree arch in a band to the front of the mine. These mines are commonly used to initiate ambushes where they are command detonated (usually electrically) or for perimeter protection and early warning. They can also be initiated by trip-wire.
Examples	Examples of stake mounted mines: > POM-Z (Soviet) > PMR-2A (Yugoslavia) Examples of bounding mines: > PROM-1 (Yugoslavia) > Valmara No. 69 (Italy) > OZM-4 (Soviet) > OZM-72 (Soviet)	> MON-100 (Soviet) > MRUD (Yugoslavia)

ANNEX C | MINES AND UXO POSING A SERIOUS HAZARD TO DEMINING MACHINES

Anti-Vehicle Mines Blast

Can damage and/or destroy the demining machine depending of the size of the demining machine. Damage is usually confined to the tracks, the flail or the tiller. The shock effect transferred to the hull can cause injury to the operator. The effect from the mine will cause chains, hammers and bits to come off the demining machine.

These mines rely on blast effect. These mines can either be boosted with additional explosives placed underneath the mine, or more than one mine stacked on top of one another. This results in a main explosive charge of 15 - 20 kg that enhances the blast effect.

- PT Mi-Ba-III (Soviet)
- TM46 (Soviet)
- TMA-3 (Yugoslavia)
- Type 72 (China)
- Mk 7 (British)

Anti-Vehicle Mines Hollow charge

Can damage and/or destroy the demining machine depending of the size of the demining machine. The hollow charge will cause over pressure and send fragmentation into the hull and injure or kill the operator. Chances of survivability are low if the operator's cabin is penetrated.

These mines use the Munroe or "hollow charge" effect to penetrate steel in order to incapacitate vehicles, especially heavy armour. The mines use the hollow charge effect to penetrate armour and allow the blast and shock effect of the accompanying detonation to incapacitate the vehicle and its operator. The explosive charge is cone-shaped and provided with a metallic liner, (usually copper) with the open end of the cone pointed upwards towards the target. Upon detonation, this causes a focussed blast effect that turns the metallic liner into a high-speed copper jet capable of penetrating the armour due to its very high kinetic energy. A slug of molten metal follows the penetrating jet. Once the armour has been penetrated, the residual jet, fragments from the penetrated armour and the molten slug enter the vehicle interior and incapacitates the occupants.

- ATM-2000E (Austrian)
- TMK-2 (Soviet)
- Mk 7 (British)
- No. 8 (South African)
- TM-62 (Soviet)

Anti-Vehicle Mines Self Forming Fragment

The Miznay Shardin effect causes greater damage to the machine than the Munroe effect. The formed slug is bigger, with the result that greater damage is caused to the vehicle's hull. The ensuing hole in the hull is bigger, with the result that the blast effect entering the hull is considerably greater, causing more injury or death to the operator and damage to the interior of the machine.

The self forming fragment type mine relies on the or platter effect to incapacitate vehicles and its occupants. The mine contains a hollow dish-shaped metal liner facing towards the target. Upon detonation, this dish forms a high-speed metal slug that is projected towards the target at velocities up to 2500 m/s. This slug is capable of penetrating armoured steel, allowing the ensuing blast effect to enter the target vehicle and incapacitate the occupants and cause damage to the vehicle.

- TMRP-6 (Former Yugoslavia)

ANNEX C | MINES AND UXO POSING A SERIOUS HAZARD TO DEMINING MACHINES

POMZ 2M
stake-mounted
fragmentation mine

TM-46
anti-vehicle mine

TMRP-6
anti-vehicle mine

UXO

UXO can be classified as small, medium or large according to their explosive contents. While most UXO rely on a combination of blast and shrapnel effect to incapacitate personnel and demining machines, some more sophisticated UXO include hollow charge effects posing a greater threat to demining machines.

Small

Small UXO contain an explosive charge of less than 500 g and rely on a combination of blast and shrapnel effect to incapacitate personnel and vehicles. Examples include hand grenades, rifle grenades, 40 mm anti-aircraft rounds and aircraft bomblets.

A BLU-63 bomblet

ANNEX C | MINES AND UXO POSING A SERIOUS HAZARD TO DEMINING MACHINES

Medium

Medium UXO contain an explosive charge between 1 and 20 kg and rely on a combination of shrapnel and blast effect to incapacitate vehicles and personnel. Examples include artillery/mortar rounds up to 155 mm. These UXO can damage and/or destroy the demining machine depending of the size of the demining machine. Damage is usually confined to the tracks, the flail or the tiller. The shock effect through the hull can injure the operator.

Large

Large UXO consist mostly of aircraft bombs with explosive charges up to 500 kg. They rely mostly on their blast effect to incapacitate vehicles, equipment and personnel. These UXO will seriously damage or destroy the demining machine.

Definition of mine threat levels (MTL)

The hazard that mines and UXO pose to vehicles, plant equipment and their occupants is defined according to severity in the table below. These levels will be used to determine required protection levels to counter the threat.

MTL	DESCRIPTION	TYPICAL EXAMPLES
MTL-01	AP mine blast type	PMN, PMD-6, Type 72
MTL-02	AP mine shrapnel type UXO-small	POM-Z, OZM-4, OZM-72, PROM-1 Hand grenades, rifle grenades, bomblets
MTL-03	AVM blast type	TM46, TM57, TMA-3
MTL-03A	AVM blast under wheel	TM46, TM57, TMA-3
MTL-03B	AVM blast under hull	TM46, TM57, TMA-3
MTL-04	UXO medium size	60-120 mm mortar. Artillery rounds up to 155mm
MTL-05	AVM hollow charge	AT-4
MTL-06	AVM self forming fragment	TMRP-6, TMRP-7, TMK-2
MTL-07	UXO heavy size	250-500 kg a/c bombs

CHECKLIST 1 | A CHECKLIST FOR BUYING DEMINING MACHINES

This checklist has been assembled from several sources, including the experiences of the GICHD mechanical demining team, and is offered to help those thinking about buying or leasing a demining machine. This checklist has been further developed in the demining machine selection model, which can be found in this handbook.

Need

- What is the identified need for a machine?
- Is there a large number of potential target sites for the machine?
- Will the machine speed the achievement of national objectives?
- What difference will a machine make?

Capabilities

- Is there an existing machine (or several variations of type) in the market with the right capabilities for the task required?
- What is the productivity of the machine?
- Will the machine be used in support of manual deminers or mine detection dogs (MDD), or will manual deminers and MDD be in support of the machine?
- What are the differences between the various manual, animal and mechanical capabilities?
- How many personnel will be needed to support/follow-on the work of the machine?
- What are the annual costs of balanced supporting/follow-on assets – manual deminers, MDD or other?
- What is the working life of the machine – 5 years, 10 years?
- What climatic factors will impact on the machine – heat, dust, rain, etc?
- What kind of terrain is the machine expected to work in?

Capital cost

- What is the purchase cost of the machine(s)?
- Will the machine need to be armoured?
- What are the costs of armouring the machine?
- Does the machine need to be adapted?
- Has the adaptation been done before?
- What is the cost of the adaptation?

Establishment and running costs

- Will a specialised operator be required?
- How much operator training will be required?
- What is the cost of operator training?
- What is the maintenance regime for the machine?
- Will an internationally qualified mechanic be required?
- What is the annual cost of a qualified mechanic?
- How many other supporting mechanics will be needed?
- What is the training requirement?
- What will be the annual salary costs for mechanics?
- What are the annual costs of maintenance and spares parts?
- How easily are spares sourced – is the machine built with common parts?
- Are there parts suppliers or maintenance facilities in the country?
- What spares package and support is the machine supplier offering?
- What is the warranty period for the machine and what does it cover?
- What are the annual fuel costs?
- Will machine maintenance schedules need to be adjusted because of climatic factors?

- What will be the annual costs of maintenance adjustments?
- Does the frequency range of remote controlled units interfere with other operators (e.g. military forces) in the area?

Further support costs

- Can fuel be purchased easily in the country or region?
- Will a fuel truck need to be purchased to support the machine in some parts of the country?
- Will a low-loader or lorry be required to transport the machine between sites?
- What are the maintenance and running costs of the fuel truck and low-loader?
- Will a mobile workshop be required?
- What is the cost of a mobile workshop vehicle and tools?
- What are the main maintenance and running costs of the workshop?
- What maintenance and training package does the manufacturer provide?
- Is the infrastructure (rail, road and bridges) of the country good enough to enable the machine to be transported between sites?
- Will additional operations planners be required?
- Will additional operations planning vehicles be required?
- What are the costs of additional operational planning?

Importation

- What rules govern importation of the machine or in-country purchase? (For example, can a machine be imported if it is second hand?)
- What will be the costs of shipping the machine to the operational theatre?
- What country of origin/manufacturer rules governs the export of the machine?
- What is the manufacture and delivery timeline?
- Will the delivery date coincide with the optimal season for machine use?

Quantity

- Will one machine be sufficient?
- Will two or more machines give measurable advantages and cost savings over the medium term?

Quality

- What test and evaluation needs to be done?
- How much will the evaluation process cost?
- Can it be done safely in-country?
- Has it been done before?

Funding

- Are funds available to purchase the machine(s)?
- Are funds available for the running and support costs associated with the machine?
- Is funding likely to be sustainable for a number of years?
- When does the breakeven point occur between machine use and the alternative of continued operations without a machine?

Other

- Is there a potential other use for the machine after its use in mine action?

If it is decided to obtain a machine, the following should be considered when negotiating the contract:

- What are the warranty conditions – and when does the period start?
- Can the machine be commissioned and delivered in-country (thus providing a guarantee from the manufacturer that the machine is working) and does the commissioning include a field trial?
- What spare parts package is included in the contract?
- Is delivery insurance for the machine included in the contract?

- Can the contract payment be in instalments (e.g. 30% on contract signature, 30% when the machine leaves the factory and 40% when commissioning/ acceptance is completed)?
- Are technical manuals and operators handbook available in the desired language?
- Can a penalty agreement for late delivery of the machine be included?
- What factory/manufacturer support will be available?
- What service agreement on major services is available?
- Can a training package for both mechanics and operators be provided by the manufacturer?
- What are the competency standards of manufacturer's personnel giving support in-country?

CHECKLIST 2 | A CHECKLIST FOR LOCAL CONSTRUCTION OF DEMINING MACHINES

This checklist has been assembled from several sources, including the experiences of the GICHD mechanical demining team, and is offered to help those thinking about constructing demining machines locally. This checklist needs to be read and used together with the parts of Checklist 1 as applicable.

- What kind of machine will be constructed?
- Can the programme afford to purchase the machine and cover the running costs for the machine following the delivery of the same?
- Is there a firm in country that can construct the machine?
- Does the firm have any previous experience from similar projects?
- Is it cost effective to construct the machine locally compared to purchase from overseas?
- How and by whom will the specifications be prepared?
- How and who will monitor that the construction activities are proceeding in accordance with the specifications and the contract?

- If the machines are to be constructed under a contract, how will the contract be awarded? Will there be a competitive process and what is the timeline for this process? How will the invitation to bid be prepared and what documents do the bidders have to provide? What is the time line for the invitation to bid and responses to the same?
- How will the contract be prepared?
- How will payments be done? Will payments be done with an initial instalment, monthly payments and a final payment or in another way?
- What is the timeline for the contract? Will the contract be divided into phases with partial deliveries (i.e. a number of machines will be delivered after a certain period to be followed by another delivery of machines at a later stage)?
- What actions will be taken if the firm fails to deliver in accordance with the contract and how will this be regulated in the contract?
- What kind of support elements are needed once the machine is operationally deployed, i.e. mobile workshop etc, and can the firm deliver this as a part of the contract?
- Will the machines be delivered with spare parts?
- When will the firm be able to deliver the machine under the contract?
- Will the firm be able to purchase items such as armour plates and glass when constructing the machine? Will these items need to be imported and is there a risk that this will delay the delivery of the machines?
- Can the firm provide after delivery service?
- Will the machine be accompanied by a guarantee/warranty?
- What will the reporting requirements be under the contract? Will reporting be done weekly, monthly, following each phase or a combination of the three? Will the firm be required to provide a final report for the final payment?
- How will the reports be reviewed and approved?
- Will the firm provide manuals in the local language?

- Does the machine need to be registered and insured following the delivery and what is the timeline for this?
- What are the support requirements once the machine has been delivered?
- Are there facilities for maintenance of the machines or will this have to be contracted?
- Can a training package for both mechanics and operators be provided by the manufacturer?
- How will the machine be tested following the delivery of the same?

CHECKLIST 3 | A TASK ASSESSMENT CHECKLIST

A task assessment of a mechanical demining site should, as a minimum, include the following elements:

Review of survey documents including:

- Survey protocols
- IMSMA reports
- Minefield records
- Maps
- Photos
- Clearance reports
- Victim reports.

A hazard assessment including the following considerations:

- Types of mines that is expected to be encountered in the area
- The likeliness of encountering other types of ammunition in the area
- Other hazards
- Can the machine work in the environment of the hazard?

Establish local points of contact such as:

- Local leaders
- Police
- Military
- Hospitals and medical facilities
- Civil defence.

An environmental assessment should be undertaken on site before mechanical demining operations begin. This should include such considerations as:

- What are the ground water levels and will they be affected in any way by the clearance?
- Are there appropriate locations for refuelling in relation to water sources?
- When is the right season for mechanical demining in the area?
- Is the region/area prone to heavy rains?
- Will the site be exposed to a rainy season while being cleared?
- Is the proposed mechanical demining site on a slope and is there an increased risk for erosion?
- Is the area prone to high winds?
- Is there any local evidence of erosion in local agricultural areas?
- Which tools are appropriate for the ground conditions prevailing and the land use following the clearance?
- Will the proposed activity involve the disruption of plant root systems and the loosening of topsoil?
- What kind of vegetation is in the location and can all vegetation be removed?
- Will the proposed activity result in the loss of rain-sheltering vegetation – trees, bushes, etc?

- Is the vegetation cover on the area sparse/ limited – does it look fragile?
- Do beneficiaries have tools and seeds available in order to use the site?
- Will root-pulling livestock (such as goats) be grazed on the cleared site?
- What is the depth of clearance?
- How can the topsoil be preserved?
- Are there any activities required after clearance, are there areas where special caution is required?
- Has sufficient care been taken to ensure that adequate measures are in place to mitigate or repair environmental damage?

For further environmental considerations see the checklist in Annex D (Informative) to IMAS 10.70, *Environmental Management Checklist for Temporary Support Facilities*.

Other aspects of the demining operation such as:

- What is the aim of using the demining machine?
- Will use of the demining machine enable the objective to be achieved faster?
- What will the result of demining machine use be?
- What are the topographical and vegetative features of the site?
- What other methods (if any) must compliment the machine?
- What security measures are required?
- Will a field maintenance unit be required – what size?
- What routine maintenance spares will be needed over the course of work at the site?
- What route will be used for logistical re-supply?
- What are the running costs for the site? – salaries, fuel, food, water, accommodation and other?
- How will proposed actions be described and explained to beneficiaries?
- What quantity of complimentary assets must be available to ensure maximum machine productivity?

- What is the residual risk?
- What quality assurance methods can be used at the site?
- What quality control regime should be established?
- What will the required follow-on and where, how and by who will this be carried out?
- How will the work be mapped?
- How will the site be marked – ongoing work, QA and QC activities?
- How will the site be handed over to the national authority, and to beneficiaries?
- How will productivity be recorded?
- How will productivity be reported?
- How and where will work be explained and briefed to visitors?
- Where will site management locations be?
- What safety distances will be applied between assets, machines, dogs, manual deminers and what is the rationale for those safety distances?
- How will products of the process be managed – vegetation debris, soil mounds, windrows, etc?

Logistical aspects of the mechanical demining operation such as:

- Can the machine reach the site and does the road infrastructure allow transportation of the machine?
- What mechanical recovery assets may be required?
- How much time will be required for the machine to complete the task?
- What specific logistical support will need to be in place to support the operation – fuel, water, paint, marking stores, camping stores, etc?
- How frequent will logistical re-supply have to be over the life of the work at the site – e.g. how much fuel will be needed per week?
- How many vehicles will be required to support work at the site – transport, safety, logistical?
- What medical support is required and available?

CHECKLIST 4 | A CHECKLIST FOR ROAD CLEARANCE

- What are the requirements for road clearance on the country level and/or the local level and is road clearance a part of the countries national mine action strategy?
- Is road clearance linked with the development goals for the country, as well as for the regional aims?
- What is the social, economic and environmental impact from landmines laid on roads?
- What are the purpose of the road clearance on the country and regional level?
- Are the roads to be cleared prioritised and selected by all involved mine action stakeholders, including affected communities on the country and regional level?
- Are funds available for the road clearance required?
- Are there NMAS for road clearance?
- Are there SOPs for road clearance?
- Is there a specific accreditation process related to road clearance methodologies and the demining assets required for the road clearance?
- How and when will the accreditation for the road clearance operations be carried out?
- Will a contractor be used and what are the contractual arrangements for road clearance?
- What are the timelines if a contract will be issued for the road clearance?
- Are appropriate contractors (mine clearance operators) for road clearance available in-country or will external contractors be required?
- If external contractors are to be used, which contractors are capable of carrying out the road clearance required?
- Has road clearance been carried out previously in the country and how was this done?
- If machines were used for road clearance, which machines were used?

- Will machines be tested, and if so, how will the machines be tested?
- What are the information requirements for clearance during the survey phase?
- Are rules and regulations for land release established in country? If technical survey was undertaken and no evidence of landmines and ERW was found, what are the status or clearance requirements for those roads?
- What activities will follow road clearance and what are the requirements in terms of width and depth?
- Should the clearance operator only operate during certain seasons of the year?
- It the operator is deploying from overseas, what aspects need to be planned in terms of necessary permissions and more?
- Does the operator a need permissions and clearances to be able to work and move freely in the country?
- What are the appropriate assets for detection, removal or destruction of all mine and ERW hazards considering the future use of the road?
- Will several different types of machine be needed during the road clearance?
- Are rules and regulations for QA established for the planning, preparation and clearance processes?
- If the road will be rehabilitated after clearance, how is liaison with the rehabilitation contractor ensured?
- What are the recording and reporting requirements?
- Are rules and regulations for QC established, and is there capacity to undertake the QC?
- Are the land release procedures after clearance activities established, and how will the handover documentation be prepared?
- Are there rules and regulations for conducting a post-project review?

CHECKLIST 5 | A CHECKLIST FOR EXCAVATION TASKS

- Will the existing terrain stand up to the passage of a machine?
- How far do individual machines need to move on or off the site to carry out specified actions?
- How much time does each of these actions take?
- Is there sufficient capacity to carry out the planned processing efficiently?
- Is there sufficient space to carry out the planned processing efficiently?
- Can the operation be carried out without cross-contaminating areas?
- If more than one machine is involved - can the machines work in front, behind and beside each other – i.e. have the machines got the right configuration of armour? If not, will the lack of armour on one machine force it to stop working while another machine is working in front or near it?
- Can the inspection process deal with the volume of excavated material in a timely fashion?
- Can inspected spoil be returned to the approximate area it was excavated from in a timely manner? What time is reasonable to consider as "timely" – one day, two days, one week?
- If layers of soil are being cut from a site, will those layers be processed and returned in the right order to maintain the integrity of the fertility of the soil?

ANNEX E | EXAMPLE OF WEEKLY REPORT FORMAT FOR A MECHANICAL DEMINING UNIT

Example of a daily maintenance log sheet for demining machines

(available on the attached cd)

Organisation						Reporting Period Start:			
Machine ID						Reporting Period End:			
Supervisor									
	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Total	Remarks
Area cleared/prepared (m^2)									
AP blast mines detonated (qty)									
AP frag mines detonated (qty)									
AT mines detonated (qty)									
ERW detonated (qty)									
Working depth (cm)									
Fuel consumption (L)									
Machine h ours meter reading									
Operational time (hrs)									
Maintenance time (hrs)									
Inactive time: Transport to site (hrs)									
Inactive time: Breakdown, repairs (hrs)									
Inactive time: Breakdown, no spares (hrs)									
Inactive time: Waiting for task (hrs)									
Inactive time: Waiting for transport (hrs)									
Inactive time: No operator/mechanic (hrs)									
Inactive time: No support personnel (hrs)									
Inactive time: No fuel, oil, lubricants (hrs)									
Inactive time: Weather constraints (hrs)									
Inactive time: Security constraints (hrs)									
Inactive time: Other - specify (hrs)									
Total (hours)									

ANNEX F | EXAMPLE OF A DAILY MAINTENANCE LOG SHEET FOR DEMINING MACHINES

Example of a daily maintenance log sheet for demining machines

(available on the attached cd)

Daily maintenance log sheet

Machine Hours		Date Time	

	ITEM	CHECKED/COMPLETED	HOURS TILL SERVICES
1	Clean air pre-cleaner bowls		
2	Clean and change oil in cleaners		
3	Check engine oil level		
4	Clean _____		
5	Check and clean engine air and air intake panels		
6	Clean radiator and coolers		
7	Check coolant level		
8	Grease _____		
9	Grease _____		
10	Clean cab air filters		
11	Check flail chains and bolts		
12	Inspect carrier gearbox		
13	Inspect flail/tillerhead		
14	Check for leaking lines and connections		
15	Check tyre/track wear		
16	Inspect safety equipment and PPE		
17	Check communications equipment		

ADDITIONAL WORK UNDERTAKEN

ADDITIONAL WORK REQUIRED

SPARE PARTS REQUIRED				Spare part in stock		Spare part ordered	
	Spare part name	Spare part no	Pieces	Yes	No	Yes (date)	No
1							
2							
3							
4							

NAME

SIGNATURE

Additional comments/observations

ANNEX G | VEGETATION CLASSIFICATION

For classification of vegetation during mechanical demining operations the following classifications can be used for guidance. The information has been extracted from the CEN Workshop Agreement 15044:2004.

LIST OF CODES FOR VEGETATION

Codes for vegetation
Tall trees
Medium trees
Short trees
Tall bushes
Medium bushes
Short bushes
Tall grass (above 15 cm)
Medium grass (5 cm to 15 cm)
Short grass (below 5 cm)

In addition, other information about vegetation, such as vegetation density can be recorded using the below classification system:

CLASSIFICATION OF VEGETATION DENSITY (SURFACE COVERED BY VEGETATION)

Surface covered by vegetation	Class of vegetation density
%	%
0	None
0 to 5	Few
5 to 15	Common
15 to 40	Many
Above 40	Abundant

ANNEX H | AN INDEX FOR MECHANICAL DEMINING SOPS

Below is a non-exhaustive index of items to include in mechanical demining SOPs. It must be remembered that SOPs are to be adjusted to local conditions and be in compliance with NMAS and IMAS.

1. PLANNING

1.1 Community liaison
1.2 Deployment
1.3 Sweeping operations
1.4 Concept of operations
1.5 Tasking
1.6 Coordination with other mine clearance assets
1.7 Task assessment
1.8 Terrain categories
1.9 Soil categories
1.10 Environmental assessment
1.11 Site preparations
1.12 Site layout and set up

2. OPERATIONS

2.1 Site safety
2.2 Daily briefings
2.3 Visitors
2.4 Site log
2.5 Pre-start checks and other checks
2.6 On site testing
2.7 Operator safety
2.8 Medical support and
2.9 MEDEVAC
2.10 Extraction procedures
2.11 Recovery procedures
2.12 Obstacles
2.13 Mechanical clearance
2.14 Area clearance

2. OPERATIONS

2.15 Area reduction using demining machines
2.16 Vegetation cutting using demining machines
2.17 Technical survey using demining machines
2.18 Road clearance using demining machines

3. REPORTING AND COMPLETION

3.1 Missed mines procedures
3.2 Mechanical after works
3.3 Follow-on requirements Marking and fencing
3.4 Reporting requirements
3.5 Handover and post-clearance procedures

ANNEX I | CONVERSION TABLE FOR LAND AREAS

This table can be used for conversions when calculating the area to be cleared.

Unit	Conversion	Example of lot a size
One hectare is	10,000 square metres	Equal to 100 by 100 metres
One acre is	4,046.86 square metres	Equal to 63.61 by 63.61 metres
1,000 square metres is	0.247 acres	Equal to 31.62 by 31.62 metres
5,000 square metres is	1.23 acres	Equal to 70.71 by 70.71 metres
10,000 square metres is	2.47 acres	Equal to 100 by 100 metres and 10,000 square metres, one hectare and 0.01 square kilometres.
One square kilometre is	247.1 acres	Equal to 1,000 by 1,000 metres, 1,000,000 square metres and 100 hectares.
Ten square kilometres is	2471 acres	Equal to 3,162.28 by 3,162.28 metres and 10,000,000 square metres.
One square mile is	640 acres or 2.59 square kilometres	Equal to 1,609.34 by 1,609.34 metres

ANNEX J | GLOSSARY OF ACRONYMS AND ABBREVIATIONS

APM Anti-personnel mine

AVM Anti-vehicle mine

CEMOD Cost-effectiveness model

CEN European Committee for Standardization

DRDC Defence Research and Development Canada

ELS European Landmine Solutions

EOD Explosive ordnance disposal

ERW Explosive remnants of war

FAO Food and Agriculture Organization

GMAA General mine action assessment

IMAS International Mine Action Standards

ITEP International Test and Evaluation Programme

MAC Mine Action Centre

MACC Mine Action Coordination Centre

MAG Mines Advisory Group

MDD Mine detection dog

MPV Mine-protected vehicle

MTL Mine threat level

NMAS National Mine Action Standards

NMAA National Mine Action Authority

PPE Personal protective equipment

QA Quality assurance

QC Quality control

SOP Standard operating procedures

MSB Swedish Civil Contingencies Agency

SWEDEC Swedish Explosive Ordnance Disposal and Demining Centre

UN United Nations

UXO Unexploded ordnance

The Geneva International Centre for Humanitarian Demining (GICHD) works for the elimination of anti-personnel mines and for the reduction of the humanitarian impact of other landmines and explosive remnants of war. To this end, the GICHD, in partnership with others, provides operational assistance, creates and disseminates knowledge, improves quality management and standards and supports instruments of international law, all aimed at increasing the performance and professionalism of mine action.

A Handbook of Mechanical Demining, GICHD, Geneva, July 2009.

ISBN 2-940369-25-9

Acknowledgements
The GICHD would like to thank the Governments of Norway and Sweden and the Canadian Global Peace and Security Programme for their financial support; and those individuals who contributed to this handbook: Håvard Bach, Geoffrey Coley, Al Carruthers, Theodor Friedrich, Tekimiti Gilbert, Alexander Griffiths, Josef Kienzle, Klaus Koppetsch, Pehr Lodhammar, Alan Macdonald, Stuart Maslen, Erik Tollefsen and Åsa Wessel.

The key contact point for this publication is Pehr Lodhammar | Mechanical Project Officer p.lodhammar@gichd.org

Photo credits
Photographs are copyright GICHD except those supplied by companies and organisations operating in this field and the following individuals: Peter Holmström, Bonnie Docherty, Josef Kienzle, Jean Louis Blanche, Masakazu Kashio, Colin King and Simon Conway. We would like to thank them for their contribution to this publication.