LibMAS 09.30 Annex A

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SAFETY MEASURES

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:
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Contents

1. Introduction

1.1 The Mine Action Organisation is responsible for ensuring that adequate safety measures are applied when conducting demolitions, which are to be detailed in their SOPs for approval by the LibMAC.

1.2 This annex details safety measures to be considered when conducting demolitions.

2. Explosive Hazards

2.1 The hazard to the general public from the demolitions of ERW and multi-item demolitions arises from three main causes, these being:

a. Blast (Shock wave). Blast is caused by the rapid expansion of gases during detonation and has two phases, a positive and negative phase. Blast will always take the route of least resistance. It can therefore be reflected, funnelled or shielded.

b. Ground (Earth) Shock. The blast is also transmitted through the ground, and can cause severe damage to underground utilities such as electric underground cables etc.

c. Fragmentation is the principle cause of casualties during an uncontrolled detonation. There are two types of fragmentation:

- **Primary** - Fragments formed by the weapon casing, which is projected at a high velocity from the seat of the explosion, fragmentation that was originally part of the ERW.
- **Secondary** - Fragments formed from brickwork, concrete, stones or anything else thrown loose and projected in the blast wave, fragmentation that was not originally part of the ERW.

2.2 Fragmentation is the main concern, as it is the main effect that can and will cause casualties. The Fragmentation Hazard Zone Distance is the distance that both primary and secondary fragments can travel; it will be the main contributing factor in establishing a Fragmentation Hazard Zone Distance. Where necessary, protective works, such as demolition pits, earth bunds or sandbag walling should be utilised to reduce the extent of the fragmentation.

2.3 Fragmentation Hazard Zone Distances are difficult to establish with any degree of accuracy owing to the various number of factors that have to be taken into account, factors such as:

- Type of ERW.
- Weight of ERW and explosive.
- ERW buried or unburied.

2.4 Unless adequate protective cover is available, the firing point should be located outside the evacuation areas. <u>If the firing point is to be located inside the evacuation area, it must provide full and effective overhead protection against fragmentation for personnel.</u>

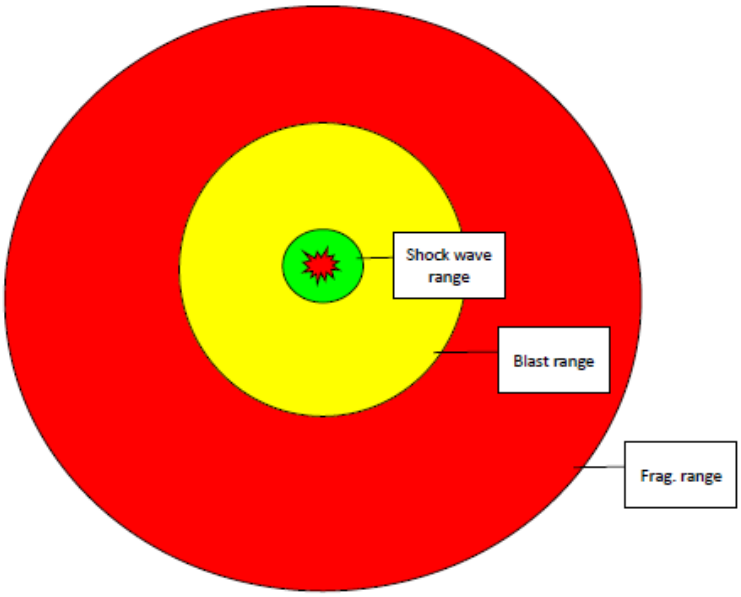

Figure 1: Explosive Hazards

3. Estimating Explosive Danger Areas

3.1 The following details examples of demolition safety distance calculations:

4. Multi-item Demolition Danger Area Estimation

4.1 The information below pertaining to the Multi-item Demolition Danger Area Estimation has been extracted from **IMAS TN 10.20/01** and the **examples** have been calculated in accordance with this information.

4.2 The net explosive content (NEC) has been used in conjunction with calculations detailed. The (NEC) of a munition or demolitions is the sum of the explosive contents of the munition (main charge, propellants, pyrotechnics etc.)

4.3 The all up weight (AUW) has been used in conjunction with calculations detailed. The AUW includes the Net Explosive Content (NEC) of the munitions, the weight of their casings and fuzing systems, and the weight of the donor explosive charges.

4.4 There are several sources of information pertaining to munitions types and specifications, i.e. “Jane’s” and “ORDATA”.

5. Danger Areas (public access)

5.1 It must be assumed that the local public will have access to most places outside sealed military camps. This means that the mine action management has a responsibility to ensure that the safety distances required to isolate the danger areas are strictly observed, and the rules for setting up demolitions contained in IMAS 10.30 are strictly adhered to, especially in the matters of warning the local villagers and of posting sentries to ensure no involuntary incursions by locals or their animals during demolitions.

5.2 Where the ground makes observation by sentries difficult, the explosive weights of individual demolitions may have to be reduced to reflect the practical capabilities of the village authorities and sentries to keep locals, especially children, out of hazard range.

5.3 For danger areas where the public have access to the immediate area:

$$R = 634 \times (AUW)^{1/6}$$

Where:

R = Range (m).

AUW = All Up Weight of Demolition (kg). The All Up Weight (AUW) includes the Net Explosive Content (NEC) of the munitions, the weight of their casings and fuzing systems and the weight of the donor explosive charges.

For example:

AUW = 20 kg

Sixth root of 20 ($\sqrt[6]{20}$) = 1.6475

Range (m) = 634 x 1.162 = 1044.515

Minimum safety distance = 1044.515 m (1045 rounded up)

6. Danger Areas (controlled access)

6.1 Controlled access can only be assumed if the mine action manager is convinced that there are no local people or animals in the area. If there is any doubt, the "public access" formula above should be used as a default solution.

6.2 For danger areas where it is certain that the public have NO access to the immediate area and only staff of the demining organisation are operating then the controlled then:

$$R = 444 \times (AUW)^{1/6}$$

Where:

R = Range (m)

AUW = All Up Weight of Demolition (kg).

For example:

AUW = 20 kg

Sixth root of 20 ($\sqrt[6]{20}$) = 1.6475

Range (m) = 444 x 1.6475 = 731.49

Minimum safety distance = 732 m (rounded up)

7. Condensed High Explosive Only

7.1 In practice, this kind of demolition will only be carried out if some stripping down of mines or munitions is undertaken, i.e. the removal of the explosive charge pellets from certain plastic or wood-cased anti-personnel mines, or the central charges from POMZ fragmentation mines. Some high-energy tank gun main armament separated charges should also be treated as high explosive.

7.2 For danger areas where no fragmentation hazard exists, the charge contains purely condensed high explosive, the distance at which no glass breakage can be expected can be estimated by:

$$\mathbf{R = 130 \times (NEC)^{1/3}}$$

Where:

R = Range (m).

NEC = Net Explosive Content (kg). The Net Explosive Content (NEC) of a munition or demolitions is the sum of the explosive contents of the munition (main charge, propellants, pyrotechnics etc.).

For example:

AUW = 20 kg

Cubed root of 20 ($\sqrt[3]{20}$) = 2.7144

Range (m) = 130 x 2.7144 = 352.872

Minimum safety distance = 353 m (rounded up)

Explosive Kg (AUW/NEC)	Public Access	Controlled Access	Condensed High Explosive
1	634	444	130
2	712	498	164
3	761	533	187
4	799	559	206
5	829	581	222
10	931	652	280
20	1045	732	353
30	1118	783	404
40	1172	821	445
50	1217	852	479
60	1254	879	509
70	1287	901	536
80	1316	922	560
90	1342	940	583
100	1366	957	603
150	1461	1023	691
200	1533	1074	760
250	1591	1114	819
300	1640	1149	870
350	1683	1179	916
400	1721	1205	958
450	1755	1229	996
500	1786	1251	1032
1000	2005	1404	1300
2000	2250	1576	1576
3000	2408	1686	1686
4000	2526	1769	1769
5000	2622	1836	1836
10000	2943	2061	2061
20000	3303	2313	2313

Figure 2: Pre-calculated Danger Area Distances

8. Central Demolitions (CDS) Site Explosive Limit

8.1 Explosive limits for demolition sites shall be calculated by a qualified EOD operator after taking the following into account:

a. Distances to inhabited buildings.

b. Distances to local Infrastructure;

c. Maximum visibility distances from the firing point to all areas around the CDS (sentry points).

d. Maximum safe workable distance from the CDS to the firing point. This should be close enough for the officer in charge disposals (or similar) to be able to hear partial detonations.

e. Any arrangements with relevant military/civilian authorities that may be deemed necessary.

8.2 A CDS Explosive Limit shall be calculated using an approved explosive danger area distances (or similar).

8.3 Once an appropriate area has been identified and surveyed, a map should be drawn (explosive safety trace – EST), showing the following:

a. Bench Mark.

b. Control Point / Command Post (CP).

c. The Demolitions Pit/s.

d. Firing Point (FP).

e. Sentry Points (SP).

f. Areas of concern e.g. populated areas, roads, structures, electric power lines / antennas etc.

8.4 The shortest distance to any of the areas of concern should be the governing factor and is to be used to calculate explosive limit;

8.5 Once this distance is confirmed and in conjunction with the relevant danger area

calculation, it is possible to calculate the CDS Explosive Limit.

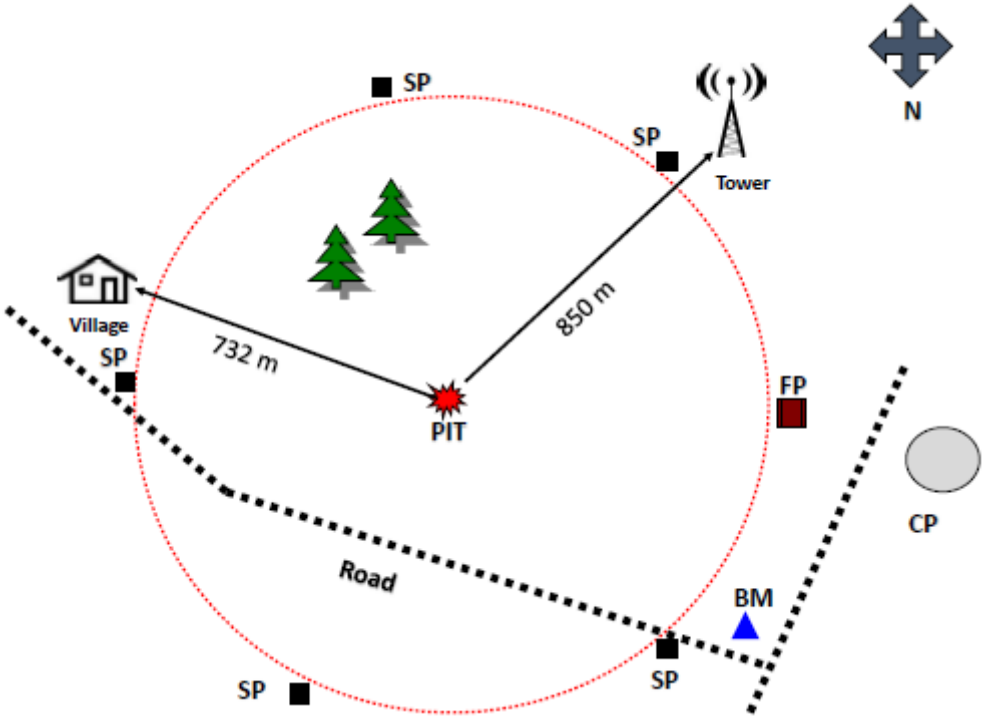

Figure 3: Example – CDS Safety Trace Map

8.6 In the above example (figure 3) the governing factor is the village at 732 metres, therefore, by using the Explosive Danger Area calculation for Controlled Areas, the CDS Explosive Limit (Kg) can be established:

Formula for Controlled Areas: $R = 444 \times (AUW)^{1/6}$

Example:

Distance from Demolition Pit to Village = 732 m

732 m ÷ 444 (R) = 1.648

$1.648^6 = 20.032$ (Kg)

CDS Explosive Limit = 20 m (rounded down)

9. Sandbag Protective Works

9.1 Sandbag protective works are normally used to reduce the distance that blast and fragmentation travels and/or to protect (i.e. personnel, equipment, property) from the effects of blast and fragmentation.

9.2 In cases where property is likely to be damaged, the EOD operator must gain approval for the demolition (in writing) from the owner (and possibly the local authorities and LibMAC), examine the building, and assess the condition before and after any the disposal takes place.

9.3 Examples of sandbag protective works are a 'backstop' and 'surround'.

9.4 Sandbag Backstop

9.4.1 This is a simple sandbag wall which should be constructed on the opposite side of the explosive donor charge to arrest fragmentation and blast.

9.4.2 Ideally it should be horseshoe shaped for maximum effectiveness.

Figures 4 and 5: Example of a Sandbag Backstop before and after demolition
(Reference: google website)

9.5 Sandbag Surround

9.5.1 Normally used for protection from Explosive Ordnance up to 2.5 kg:

a. Thirty two (32) sandbags - Fragmentation only.

b. Eighty (80) sandbags - Blast and Fragmentation.

9.5.2 **Thirty two Sandbags Surround**

a. Where a number of small UXO have to be dealt with quickly and there is the possibility of an explosion occurring inadvertently, it may be advisable to provide each item of UXO with a 32 bag surround.

b. The 32 bag surround gives reasonable protection against fragmentation but is not so efficient in absorbing blast. The bags are likely to be shattered by the explosion and may be thrown up to 4m from the UXO.

9.5.3 **Eighty Sandbags Surround**

a. A square surround consisting of 80 sandbags gives almost complete protection against fragmentation and blast.

b. The surround is created by initially constructing a 32 bag surround (1 sandbag thick) and increasing the surround by placing a second layer around the outside.

c. The bags must be carefully laid and tightly packed, with no gaps through which blast or fragments could pass.

d. The bags may be thrown up to 3m from this surround and fragments will be thrown into the air unless boards are laid over the top covered with a layer of sandbags (Igloo).

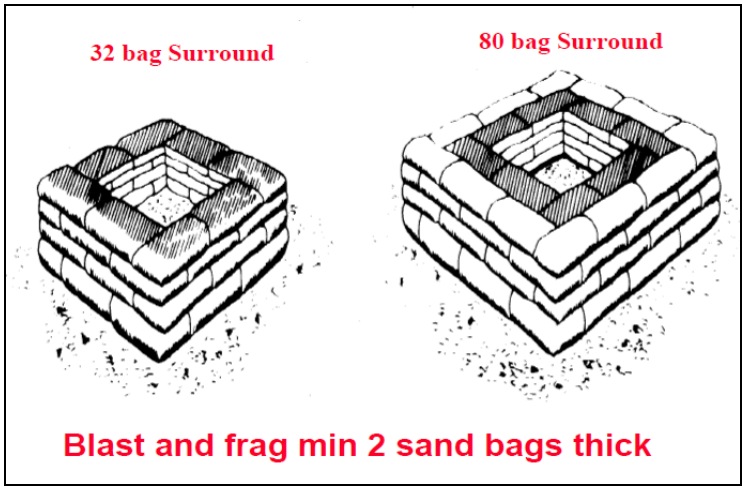

Figure 6: Example of a sandbag surround

10. Example for Calculating the Sandbag Requirement

10.1 When calculating the quantity of sandbags required for a safe disposal operation the NEQ of both the EO and donor charge shall be determined.

10.2 The examples below detail the minimum sandbags required for a demolition of explosive ordnance (EO), on the surface of the ground and sub-surface.

10.3 The LibMAS shall stipulate what constitutes surface and sub-surface (i.e. distance below ground level).

10.4 The number of sandbags shall be calculated for the explosive content of the EO (NEC) and donor explosives, therefore additional sandbags may be required to take into consideration the EO casing and fuzing system.

Surface EO

Requires 20 sandbags per 0.5 kg of explosives, therefore:

40 x sandbags per 1 kg

4 x sandbags per 0.1 kg

Sub-surface EO (greater than 0.75cm below the surface)

Requires 10 sandbags per 0.5 kg total NEQ, therefore:

20 x sandbags per 1 kg

2 x sandbags per 0.1 kg