CHAPTER 11
BLAST AND FRAGMENT PROTECTION

11-1. Introduction.

a. This chapter describes the blast and fragment protection requirements for unintentional and intentional detonations. These requirements should be addressed by the PDT when planning and conducting a munitions response. A checklist of planning considerations has been provided as Table B-8.

b. The MSD calculated to perform work at an MRA may include the MSD for unintentional detonations, intentional detonations, or both depending on the SOW. Preliminary site work performed at an MRA, such as surveying, laying out search lanes, and non-intrusive geophysical investigations, do not require the establishment of a MSD. The MSD requirements for intentional and unintentional detonations are discussed in paragraph 11-5.

11-2. DQOs. When evaluating the blast and fragment protection components of a munitions response project, the PDT should consider DQOs in the following areas:

a. Establishing MSDs IAW DOD 6055.9-STD.

b. Proper design and approval of any required engineering controls.

c. Procedures for reviewing government and contractor planning documentation.

11-3. Explosives Safety Considerations.

a. General. When developing the SOW for a munitions response project, the PDT will need to evaluate several resources to find information relating to the current characteristics of the project property, the type of munitions response project being proposed, the historical use of the project property, and the nature of the military munitions that were used at the location. These resources may include:

(1) INPR.

(2) SI Report.

(3) Historical records relating to the operation of the installation.

(4) Previous site investigation reports.

(5) Other historical or investigative reports that may give an indication of the current state of the project property.

b. Specific site characteristics that should be examined when reviewing these reports include:

(1) Project property layout.

(2) Land use of the project property and the surrounding area.

(3) Physical characteristics of the project property (e.g., topography, vegetation).

(4) Man-made structures at the project property (e.g., buildings, roads).

(5) Type of MEC present or suspected to be present.

c. Munitions Response. The type of munitions response proposed for a project property will influence the type and amount of blast and fragment protection requirements for a project. The PDT will need to consider the type of munitions response being proposed for the project property, such as:

(1) Anomaly Avoidance.

(2) Construction Support.

(3) RI or EE/CA.

(4) Remedial/Removal Action.

d. Probable Military Munitions Characteristics. The PDT will need to consider the type of MEC that could potentially be found at the project property. This information may be obtained from any archival information available on the project property or from any other reports that have previously been generated. Some of the elements to be considered in this category include:

(1) Conventional versus chemical MEC.

(2) MEC versus munition debris.

(3) The type and amount of MEC anticipated.

(4) The potential age, condition, and burial depth of MEC.

(5) The potential fuzing of the MEC.

e. MGFD. For all MRAs and MRSs, an MGFD will be determined. The MGFD is the munition that has the greatest fragmentation distance of the MEC items that are reasonably expected to be found at the MRA or MRS, based on research or site characterization. The PDT should select the correct MGFD for the project property based on the available historical information such as that listed in paragraph 11-3a.

f. Explosive Soils. For explosive soils, the MGFD concept does not apply. Instead, the concept of Maximum Credible Event (MCE) applies. For soil, the MCE is the concentration of explosives times the weight of the mix. For example, 1,000 pounds of soils containing 15 percent Trinitrotoluene (TNT) has an MCE of 150 pounds. When the concentration varies within the area, weighted averages or any other valid mathematical technique can be used, as long as the technique is explained and technically supported in the submission. Overpressure and soil ejecta radius will be considered when determining the Q-D for explosive soils. For additional information on explosive soils, contact the MM CX .

11-4. Explosive Effects.

a. A major component of the MM CX's involvement during a munitions response project is the calculation of MSDs for unintentional and intentional detonations of MEC items. A review of the explosive effect calculations that should be used by the PDT in the determination of MSDs is provided in this paragraph. This paragraph also provides the source documentation for these MSD calculations.

b. There are six factors of a MEC detonation that should be considered by the PDT when either siting an area for intentional MEC detonations (such as when setting up an OB/OD area) or when the possibility exists of an unintentional detonation during the course of a munitions response investigation. These six factors include:

(1) Fragmentation.

(2) Overpressure.

(3) Thermal flux.

(4) Ground shock.

(5) Noise.

(6) Ejected soil.

c. Controlling Factors. To determine the appropriate MSD, the PDT should use the explosion effect calculation that yields the greatest MSD, unless an engineering control will be used to limit the explosion effect. Typically, either fragmentation or overpressure is the controlling factor in determining the necessary MSD. However, thermal flux and soil ejecta may become controlling factors if a buried detonation is planned, as discussed in paragraph 11-4d.

(1) Fragmentation. The method to be used to determine the separation distances due to fragmentation is identified in DDESB Technical Paper (TP) 16. This TP contains the methodology of calculations for determining fragmentation distances for many of the MEC items that have been encountered on past and present USACE project sites. These specific distances should be used for those specific MEC types in lieu of DOD 6055.9-STD. TP 16 also includes tables and charts to be used for determining the fragmentation distances when the item is unknown. Generally speaking, the maximum horizontal fragmentation distance is to be used for all unexploded ordnance (UXO) items as the MSD for all non-essential personnel for both intentional and unintentional detonations. This distance may be lessened when using authorized fragmentation reducing engineering controls, see DDESB TP 15 for a listing of all approved engineering controls for this purpose. All personnel will be located outside of the maximum horizontal fragmentation distance when intentional detonations are taking place. For MEC items, other than UXO, the use of the hazardous fragmentation distance (HFD) may be authorized during activities that may produce an unintentional detonation. The OE-CX will provide assistance to the USACE districts in determining when this is permissibile.

(2) Overpressure. The method to be used by the PDT in determining the MSD for overpressure is the same for both unintentional and intentional detonations. In both circumstances, the equation $D=KW^{1/3}$ is used. However, the safety factor 'K' differs depending on whether the circumstance is an unintentional or intentional detonation. For unintentional detonations a K value of 50 should be used, while for intentional detonations a K value of 328 should be applied. Generally speaking, the overpressure factor is used when the MEC item identified for the project site does not have a fragment producing effect, e.g., some practice bombs and munitions use black powder as signal indicator and the design of the MEC is to produce a visual effect such as a puff of smoke or a large sound report to enable the firing crew to see where the munition hit or landed. These types of munitions will usually use the K328 factor when determining the MSDs for the site activities. Normally the net explosive weight of the donor charge will be added to explosive weight of the MEC item to come up with a total explosive weight when figuring the K328 factor.

d. Secondary Factors. The following secondary factors are considered in calculating MSDs. These factors are typically not controlling factors in MSD determinations.

(1) Thermal Flux. Thermal flux will rarely be a controlling factor in MSD determinations. However, in some instances, the thermal flux generated from the exothermic

reactions that result from the detonation of certain MEC may generate a MSD greater than either the fragmentation or overpressure distance. The PDT should use the same method for determining the MSD based on thermal considerations for both unintentional and intentional detonations. The PDT should use the standards listed in DOD 6055.9-STD to determine the MSD due to thermal flux. If the MSD due to thermal flux listed in DOD 6055.9-STD cannot be met, then shields complying with MIL-STD-398 should be used to provide an acceptable level of thermal protection.

(2) Ejected Soil. The PDT should reference DDESB TP 16 to calculate the distance that soil may be ejected as a result of an intentional detonation. In addition to the hazards posed by ejected soil during a subsurface MEC detonation, the burial depth calculation may also assist in determining the amount of earth cover necessary to defeat the fragmentation generated during a MEC detonation. A computer model has been created to assist in determining the amount of earth cover necessary to mitigate the fragmentation hazard from a MEC detonation. The PDT should reference HNC-ED-CS-S-97-7, Revision 1, for additional details on the use of this computer model.

(3) Ground Shock. The PDT should use the same method for determining the MSD based on ground shock for both unintentional and intentional detonations. In those areas where vibration damage may occur due to a MEC detonation, the PDT should consult the requirements listed in TM 5-1300. In addition, state and local regulations may exist that are more stringent than the Federal regulations. As a result, local regulators should be contacted during the planning process to determine the level of ground shock allowed according to any local codes.

(4) Noise. The PDT should use the same method for determining the MSD based on noise for both unintentional and intentional detonations. The PDT should use the criteria presented in DA Pam 385-64. In addition, state and local regulators should be contacted during the planning process to determine if there are more stringent local regulations in regards to noise generated as a result of a MEC detonation.

11-5. MSDs.

a. The PDT should ensure the appropriate MSDs are used, as identified in DDESB TP 16 and DOD 6055.9-STD.

11-6. Unintentional Versus Intentional Detonation Minimum Separation Criteria. When the PDT or the UXO contractor determines the MSD to be used on a munitions response project, two sets of MSD criteria may need to be considered.

a. The first set of criteria has been established for unintentional detonations. An unintentional detonation is a detonation that is not planned in advance. Unintentional detonations are discussed in paragraph 11-7.

b. The second set of criteria has been established for intentional detonations of MEC. An intentional detonation is a planned, controlled detonation. Intentional detonations are discussed in paragraph 11-8.

11-7. Unintentional Detonations.

a. The MSD for unintentional detonations is the distance non-project personnel must maintain from intrusive operations, and they are:

(1) For UXO items, it is the maximum horizontal fragment distance, as identified in DDESB 16, for fragment producing munitions.

(2) For other MEC items that produce fragments, it may be permissible to use the hazardous fragment distance (HFD), contact the OE-CX for additional information.

(3) For MEC items that do not produce fragments (by design), but contain explosives, use the K328 distance of the item.

b. These distances may be reduced by using approved engineering controls.

c. Team Separation Distance (TSD). The TSD is the greater distance of:

(1) Overpressure value of K50, or

(2) 200 feet.

11-8. Intentional Detonations. The MSD for intentional detonations is the distance that both project personnel and the public will be from the intentional detonation. The MSD for intentional detonations is calculated by taking the greatest value of the following:

a. Overpressure at K value of 328. Ensure the explosive weight of the donor charge is added to the net explosive weight of the MEC item when making this calculation.

b. Maximum horizontal fragmentation distance as determined IAW DDESB TP 16, unless engineering controls are being employed. The item having the greatest fragment distance will become the MGFD for intentional detonations for a MRS.

11-9. Explosives Siting Plan.

a. General.

(1) The proposed MSDs for unintentional detonations, intentional detonations, and siting of critical project components are discussed in the Explosives Siting Plan, a component of the project Work Plan. The Explosives Siting Plan will be reviewed by the PDT to ensure that the appropriate minimum separation standards have been applied. The PDT should review the Explosives Siting Plan to ensure that it properly describes the MSDs and other safety criteria that will be employed during a munitions response. All ESPs must be reviewed and approved by the OE-CX, as delegated by HQUSACE. The OE-CX will provide the MACOM/Direct Reporting Unit (DRU) approval in accordance with the delegation authority. DOD 6055.9-STD requires all explosive safety plans to have a MACOM/DRU approval. The following explosives operations will be described in the plan and located on a map:

(a) MRSs.

(b) Explosives storage magazines.

(c) Planned or established demolition areas.

(2) The site map should be scaled at 1-inch equals 400 feet. However, a larger scale may be used if available and the map can be logistically included in the work plan. Also, a smaller scale is acceptable as long as the distances can be shown accurately. If an unscaled map is used, all relevant distances will be labeled.

(3) The MSDs calculated for the operation should be discussed in the text of the plan and Q-D arcs for the above-listed project elements drawn on the map.

b. Explosive Safety Quantity-Distance (ESQD) Requirements. DOD 6055.9-STD provides many tables, in Chapter 9, on this topic. Explosive Storage QD for the BATF Type II magazines, used predominantly on USACE MMRP locations, is normally derived from Table C9.T2 for hazard division (HD) 1.1 explosives. Select the Net Explosive Weight (NEW) you want to store, look to the right in the "Structure" column and that will be your ESQD arcs around your potential exposure site (PES) for, non-fragmenting, bulk high explosives or non-fragmenting MEC. If recovered, fragmenting MEC is being stored pending disposal, you must site the magazine using the same table but use the "Open" column distances. See DOD 6055.9-

STD for other storage configurations and PESs.If the PDT is going to establish an OB/OD area within the MRS, the provisions of EP 1110-1-17 apply.

c. MRSs. The PDT should confirm that the MSDs during intrusive operations are determined IAW the criteria discussed in paragraphs 11-7 and 11-8.

d. Explosives Storage Magazines. The PDT should ensure that the following items are discussed in the Explosives Siting Plan in regards to the Explosives Storage Magazine:

(1) Type of explosives storage magazine, (e.g., portable commercial, above ground, shed, and earth-covered).

(2) NEW and hazard division to be stored in each magazine, (generally, recovered MEC is considered to be Hazard Division 1.1).

(3) Q-D criteria used to site the magazine.

(4) Design criteria for any proposed engineering controls if the Q-D criteria cannot be met.

(5) Designation of commercial explosives into a DOD Hazard Classification and Storage Compatibility Group by USATCES prior to being stored in a DOD facility. (See DA Pam 385-64 for procedure.)

(6) Lightning Protection.

(a) FUDS. Lightning protection is not required if the following criteria are met:

- The magazine is constructed of metal that is 3/16-inch steel or larger (reference Appendix L of National Fire Protection Association 780).
- The magazine is grounded (see Figure 11-1).
- The magazine is located at least 6-1/2 feet from the nearest fence.
- The grounding system will be inspected and tested IAW the requirements of DA Pam 385-64.

(b) BRAC and Active Installations. Lightning protection for BRAC and active installations will meet the appropriate requirements identified in the service regulations.

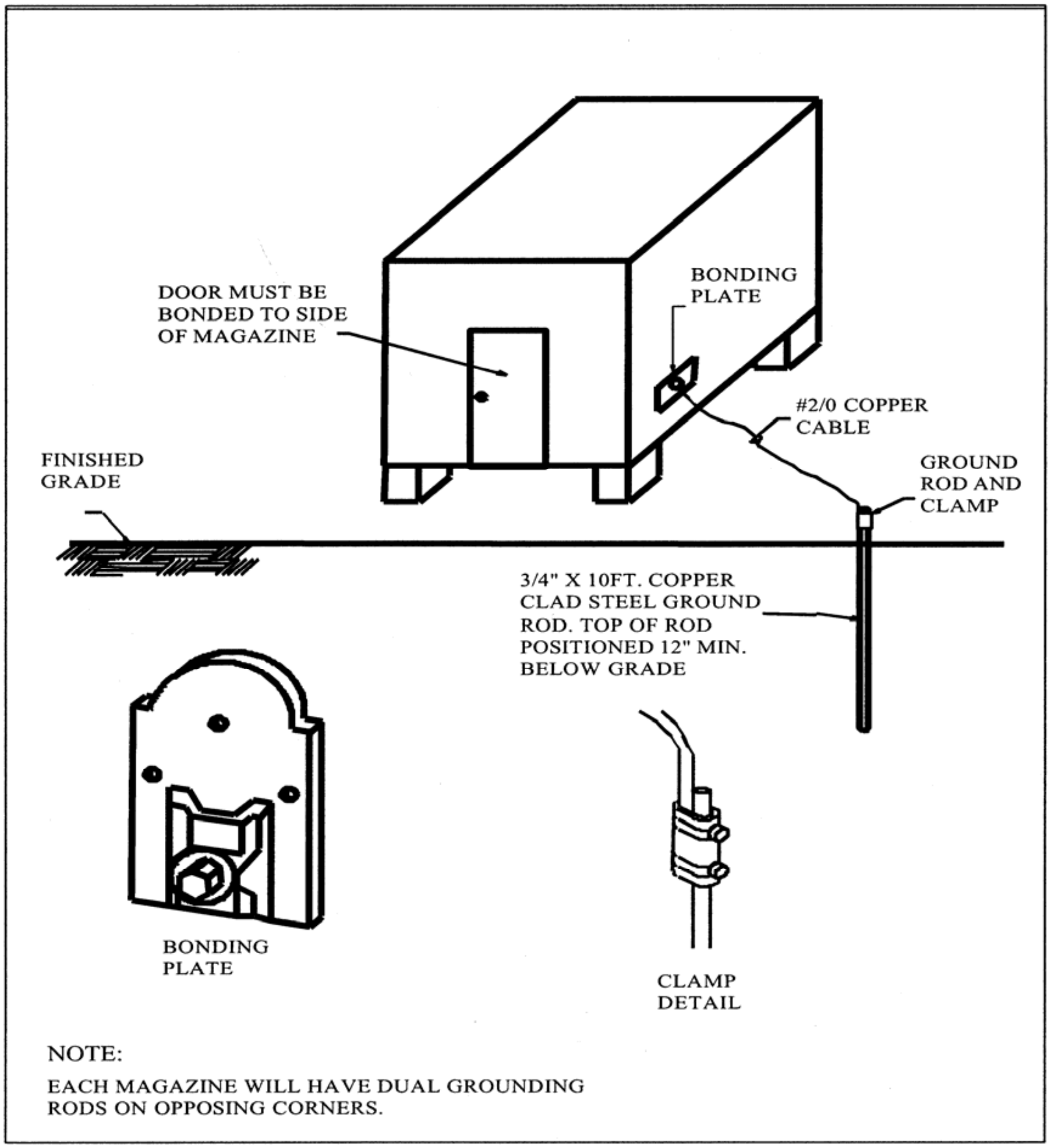

Figure 11-1. Magazine Grounding Detail

e. Planned or Established Demolition Areas. The PDT should confirm that the MSDs are established IAW the provisions of this chapter (this document).

f. The contained detonation chamber will have a DDESB-approved siting plan prior to operation at an MRA.

g. Footprint Areas. The PDT will ensure that the following footprint areas are addressed in the Explosives Siting Plan. These areas, however, do not have to be shown on the map:

(1) Blow-in-Place Areas. MSDs for all personnel should be determined using the requirements for intentional detonations discussed in paragraph 11-7.

(2) Collection Points. Collection points, if used, should have the same MSD as that identified for unintentional detonations, as discussed in paragraph 11-8.

(3) In-Grid Consolidated Shots. MSDs for all personnel should be determined using the requirements for intentional detonations, as discussed in DOD 6055.9-STD. The procedures for in-grid consolidated shots are presented in the USAESCH document titled Procedures for Demolition of Multiple Rounds (Consolidated Shots) on Ordnance and Explosives Sites. This document and the corresponding DDESB approval letter will be available on-site.

11-10. Engineering Controls. Engineering controls are used to mitigate the effects of unintentional or intentional explosions if the calculated MSD for the MEC to be destroyed cannot be met. The primary goals of using engineering controls are to improve personnel safety and/or to reduce the exclusion zone. This section discusses engineering controls that can be used by the PDT for either an unintentional or intentional explosion scenario. DDESB TP 15 contains a listing of the approved engineering controls that can be used on USACE MMRP locations.

a. Engineering Controls for Unintentional Detonations. Engineering controls used for unintentional detonations include various barricades. The PDT should design barricades IAW approved DOD standards. To implement a barricade that has been previously-approved by DDESB, the PDT should contact the MM CX. If a barricade has not been previously approved, a complete structural design package will be submitted to the MM CX as part of the Explosives Siting Plan/ESS. The structural design package will include design drawings, design details, calculations, drawings, and relevant testing details. The design will show how fragmentation is captured and overpressure is reduced. The design package, as part of the Explosives Siting Plan/ESS, is forwarded through appropriate channels to DDESB for approval.

b. Engineering Controls for Intentional Detonations. The most common engineering controls used during intentional detonations are either soil cover or sandbags. If controls are required for intentional explosions, the MM DC should be contacted to arrange for the preparation of a design (or the review of a design already prepared) with the MM CX.

(1) Soil Cover. If soil is proposed to be used over a to-be-detonated MEC item, the PDT may use one of several computerized models to determine the required thickness of soil cover necessary for the intentional detonation of MEC (see 8-5d(2)). The Buried Explosion Module is one such computerized model. The methodology used in this software is documented in HNC-ED-CS-S-97-7, Revision 1 and DDESB TP 16. The use of soil as an engineering control reduces the fragment and soil ejecta distances.

(2) Sandbags. Sandbags may be used for MEC no larger than 155 mm. If sandbags are proposed to be used as an engineering control to mitigate the fragmentation and overpressures generated during an intentional MEC detonation, the PDT should refer to HNC-ED-CS-S-98-7.

(3) Barricades. There are a number of approved barricades that may be used for the mitigation of fragments, such as the open front barricade, enclosed barricade, and the miniature open front barricade. A comparison, siting, and selection procedure for various barricades can be found in HNC-ED-CS-S-96-8, Revision 1.

(4) Water Barriers. In some instances it may be necessary to use water as a mitigating agent for the control of blast effect and fragment containment resulting from the intentional detonation of munitions. HNC-ED-CS-S-00-3 contains the requirements necessary when using water as a mitigating agent.

(5) Contained Detonation Chambers. Another engineering control that may be proposed for the intentional detonation of MEC is a Contained Detonation Chamber (CDC). CDCs are designed to capture all fragmentation from the detonated MEC and will be approved by DDESB for the intentional detonation of MEC.

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