

**TECHNICAL UPDATE #3
MATHEMATICAL EQUATIONS AND CALCULATIONS
FOR MEC OPERATIONS**

1. FOR DEMOLITION SHOTS:

1. To obtain the net explosive weight (NEW) for the calculations for the MSD for intentional detonations for those munitions that are not fragment producing, use the following process:

a. To determine the combined NEW of the munition and the donor charge - obtain the NEW of both the munition and the donor charge and the TNT equivalent of both explosives. The TNT equivalent for most of the explosives encountered on MEC projects is identified in DDESB TP 16. Multiply each explosive weight by their respective TNT equivalent, add these together and multiply by a safety factor of 1.2. The resulting value becomes W in the equation $D=328W^{1/3}$.

b. For example, consider the M38 100 pound practice bomb with the M1A1 spotting charge (3 pounds of black powder) being destroyed with a 1 pound PETN donor. The TNT equivalent for black powder is 0.4 (**this number is not in TP 16**) and for PETN is 1.27. The total NEW is:

$$W = 1.2 \times (0.4 \times 3 + 1.27 \times 1) = 1.2 \times (1.2 + 1.27) = 1.2 \times (2.47) = 2.964 \text{ lbs}$$

The K328 distance for blast overpressure is:

$$D = 328 \times (2.964)^{1/3} = 471 \text{ ft}$$

2. FOR CONSOLIDATED DEMOLITION SHOTS:

a. For fragmenting rounds, the K328 overpressure for the shot may not exceed the maximum fragment distance for the MGF. To calculate the total allowable NEW of the consolidated shot divide the maximum fragment distance for the MGF by 328 and cube (not the cube root) the result and divide this by 1.2. This will result in the total allowable TNT equivalent explosive weight for the shot. For example, suppose the MGF is the 105mm M1 high explosive projectile with a maximum fragment distance of 1939 feet. To calculate the total allowable TNT equivalent explosive weight:

$$NEW_{TNT} = [(1939/328)^3]/1.2 = 172 \text{ lbs}$$

b. If perforators are used to initiate the munitions, the perforators' NEW are small enough compared to that of the 105mm that they can be neglected. The 105mm has 5.07 lbs of Comp B in it and the TNT equivalent of Comp B is 1.20. So each 105mm has a TNT equivalent of:

$$1.2 \times 5.07 = 6.08 \text{ lbs}$$

Therefore, the total number of 105mm projectiles that can be destroyed in one consolidated shot are:

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in accordance with *Procedures for Demolition of Multiple Rounds (Consolidated Shots) on Ordnance and Explosives (OE) Sites*.

$$172/6.08 = 28 \text{ projectiles}$$

c. If multiple types of ordnance are to be destroyed in one consolidated shot, then the TNT equivalent in each item must be calculated as well as the TNT equivalent of each donor charge. Multiply each of these by a 1.2 safety factor and add all of them together to compute the total TNT equivalent NEW of the shot. Calculate the K328 overpressure distance for this total TNT equivalent NEW. This K328 overpressure distance shall not exceed the maximum fragment distance for the MGF. For example, if the consolidated shot is intended to destroy the following items:

- Four 37mm MkII projectiles (0.053 lbs black powder each)
- One Mk II hand grenade (0.125 lbs TNT each)
- Three 2.36-in M6A1 rockets (0.5 lbs pentolite each)
- Six 105mm M1 projectiles (5.07 lbs Comp B each)
- ¼ pound PETN block donor charges (one per item for a total of 14 blocks)

d. Calculate total TNT equivalent NEW:

$$\begin{aligned} 37\text{mm MkII} &- 4 \times 1.2 \times 0.4 \times 0.053 = 0.10 \text{ lbs} \\ \text{Mk II grenade} &- 1 \times 1.2 \times 1.0 \times 0.125 = 0.15 \text{ lbs} \\ 2.36'' \text{ M6A1} &- 3 \times 1.2 \times 1.38 \times 0.5 = 1.73 \text{ lbs} \\ 105\text{mm M1} &- 6 \times 1.2 \times 1.2 \times 5.07 = 43.80 \text{ lbs} \\ \frac{1}{4} \text{ lb PETN} &- 14 \times 1.2 \times 1.27 \times 0.25 = 5.33 \text{ lbs} \end{aligned}$$

$$\text{Total TNT equivalent NEW} = 0.10 + 0.15 + 1.73 + 43.8 + 5.33 = 51.11 \text{ lbs}$$

$$\text{K328 overpressure distance} = 328 \times (51.11)^{1/3} = 1217 \text{ ft} < 1939 \text{ ft (max frag distance for MGF)}$$

Therefore, one consolidated shot may be used to destroy these 14 items in accordance with *Procedures for Demolition of Multiple Rounds (Consolidated Shots) on Ordnance and Explosives (OE) Sites*. (Note: The referenced document details restrictions on the layout of the consolidated shot.)

3. TNT EQUIVALENT WEIGHTS

1. Table A-2, DDESB Technical Paper 16 identifies the factor to be used to determine the TNT equivalent of explosive fillers used in MEC. For determining overpressure distances (K Factors) use the "Average Equivalent Weight (pressure)" column.
2. Black powder fillers will use a TNT equivalency of 0.40.

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4. SAFETY FACTORS

USACE uses a safety factor of 1.2 in all mathematical equations for MEC. This safety factor has been incorporated into the calculations in DDESB TP 16. What this means is once you have determined what the TNT equivalent weight is, multiply that number by 1.2 before figuring the applicable K factor for determining distances.

5. K Factors

- K6 Barricaded Aboveground Intermagazine Distance (IMD)
- K9 Barricaded Intraline Distance (ILD)
- K11 Unbarricaded Aboveground IMD
- K18 Unbarricaded ILD
- K24 Public Traffic Route Distance (PTRD) <100,000 lbs
- K24 Separation Distance to be used for essential personnel in mechanized MEC Processes
- K40 MSD for unintentional detonations with a non-fragmenting MGFD during MEC activities
- K40 Team Separation Distance
- K328 Minimum Separation Distance for non-fragmenting munitions for intentional detonations

6. Miscellaneous

Explosive storage magazines can not be sited within K11 distance of the MGFD for intrusive operations in and around the magazine.

Explosive magazines can not be sited closer than Inhabited Building Distance (IBD) from non-essential personnel.

There is no MSD established for essential personnel from explosives magazines.