

Assignment

by Finn Mallon

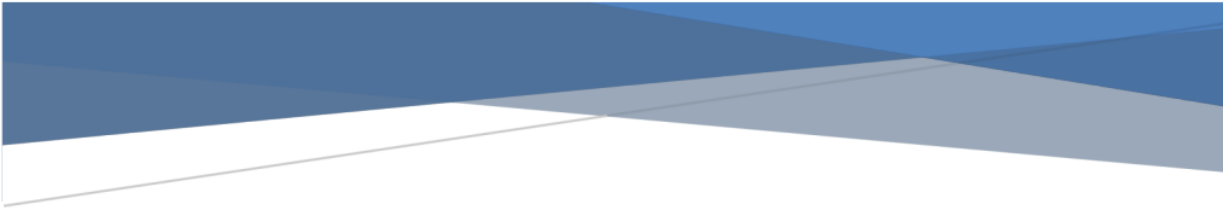
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OME ASSIGNMENT

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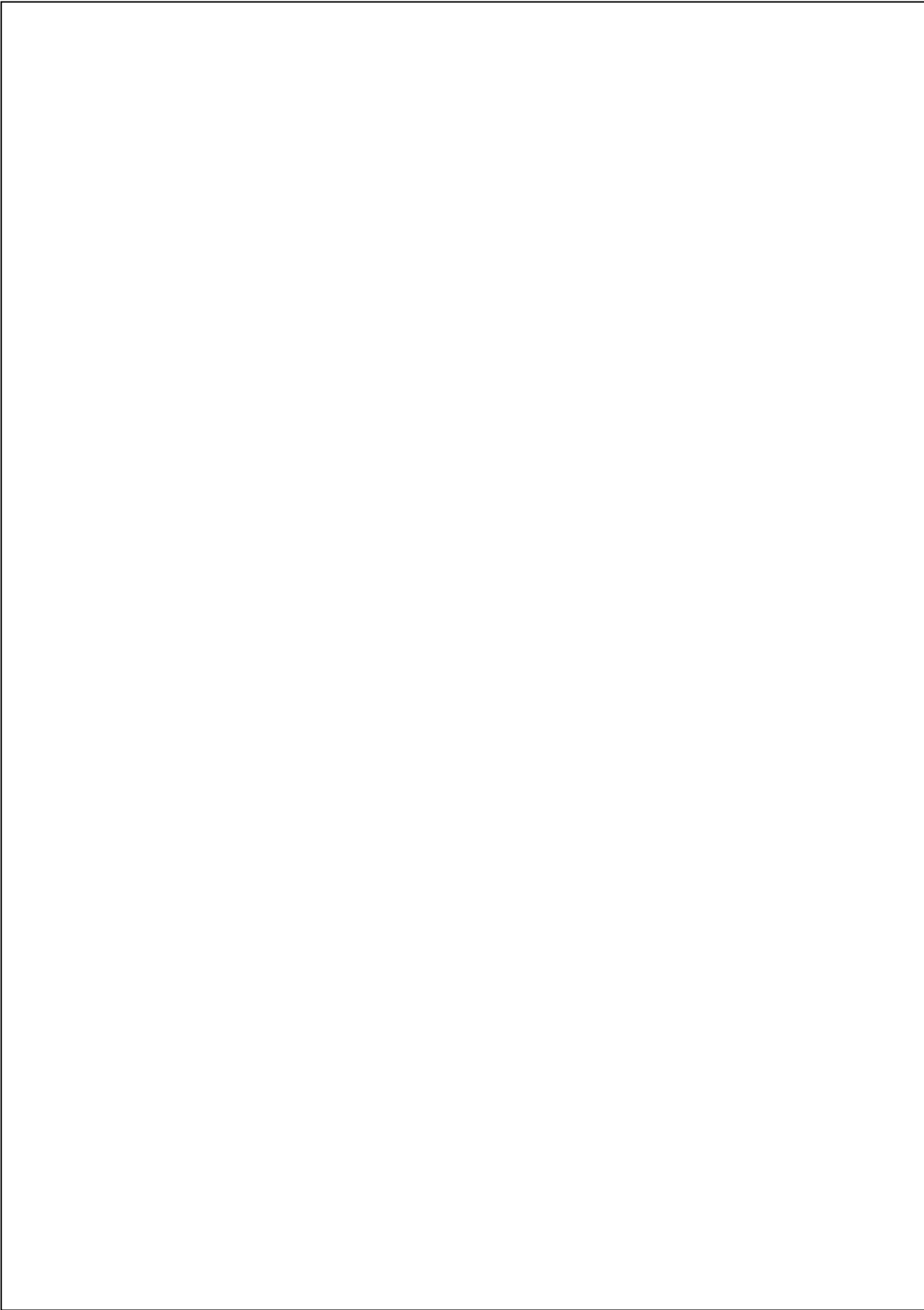
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1.0 Explosive Trains

Explosive trains are the triggering sequence that leads to an explosive detonation. There are two types of explosive train and they are Low and High. Both types have lots of risk associated with them and these safety considerations are made in the formulation, manufacture and use of the explosive. "Explosives must ever explode prematurely but always explode when desired". [1]

The initiation of explosives varies depending on the sensitivity of the munition. This classification of sensitivity is typically distributed between three different groups, Primary Secondary and Tertiary.

Primary Explosives:

These are the most sensitive to a reaction involving some kind of heat source to start the explosive train. They can also be triggered by the use of shock, electrical sparks, friction or impact. These are typically high explosives like the fulminates and lead azide (typically with a small amount of lead styphnate too) that carry their own oxygen therefore find it a lot easier than Secondary explosives to detonate.

Secondary Explosives:

These explosives are less sensitive than primary and require much more energy to be initiated. They find it hard to go from deflagration to detonation and struggle to initiate electrostatically. This type include nitrocellulose and PETN (Pentaerythritol tetranitrate).

Tertiary Explosives:

These explosives are the most difficult to detonate by normal quantities of primary explosives and therefore require an explosive booster of secondary explosive. [2] These type of explosives contain extremely powerful high explosives such as RDX and HMX. [1]

1.1 How Ignition and Explosive Trains Work

The first component of the explosive train is triggered by some kind of external stimulus. This may be, impact on the target causing stabbing by a firing needle or by an electric current passed at a predetermined time by an electronic timing device or proximity sensor. The initiator can also be stimulated by heat or by a flame and its output which may be a flash or shock is passed onto the next component in the train until the working charge is initiated either by burning or shock.

The next stage of the explosive train will boost the initiator output. This could be enhancing the flash or flame depending on if the burning charge is supposed to burn or explode or they may also include a component that will burn to detonation itself if the working charge is designed to detonate.

The final stage of the explosive train is the working charge. This may be designed to detonate, explode or burn.

Figure 1 below shows the explosive train of a 105mm Shell fitted with a L106 PD fuze.

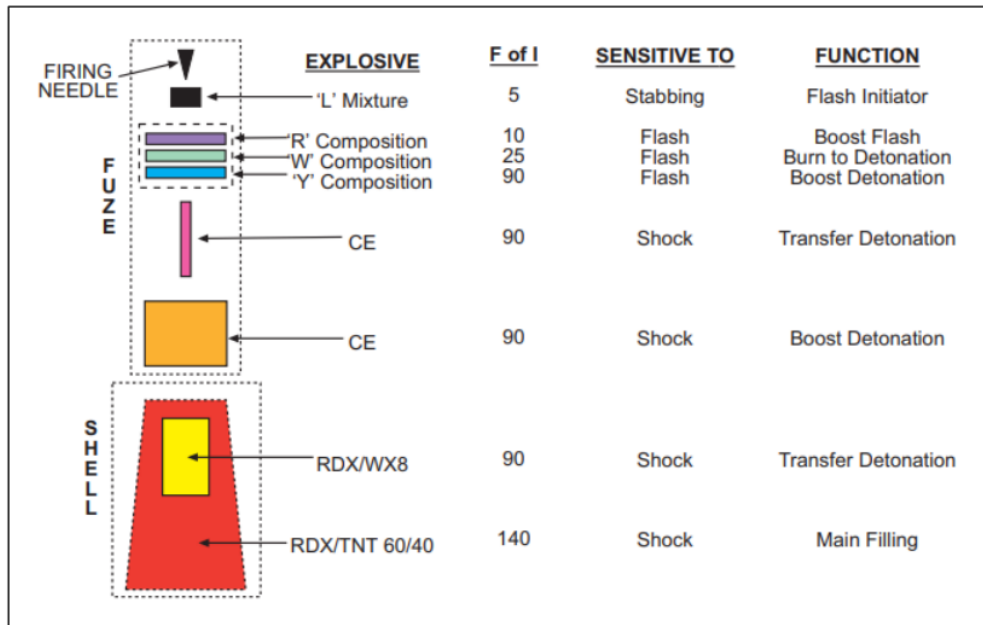


Figure 1 (Explosive Train) – [3]

2.0 Artillery Service Life

There are many factors that will affect serviceability of the artillery. Having the correct implications put in place will prevent said affects from causing damage. If ammunition is not correctly stored, transported and handled this will lead to deterioration of the ammunition causing them to eventually malfunction. This can be very dangerous for the users as the ammunition may function or partially function at the wrong time causing a serious hazard to friendly troops near the firing zone.

The following factors that are known to cause the ammunition to become unserviceable and unable to be used are:

- Damp
- Heat
- Careless Handling
- Tampering or Unauthorised Use
- Transport

Damp –

Moisture is a major enemy of ammunition in the field. To protect from moisture, ammunition should be placed and stored on dunnage (brushwood mats) as a separation between the munition and the ground. With regards to charges, is to change the ballistic properties and eventually render them ineffective.

Also, projectiles will start to rust which makes them unsafe as at first the paint starts to chip and then stencil markings will start peeling off. These markings are essential for identification and are necessary on all projectiles. Untreated rust on the projectile can then lead to damaging other components when it comes to being fired. It will cause barrel wear and will make the projectile dangerous and could function earlier than designed to do.

Corrosion affects the fuzes on projectiles, depending on which material they are made from. This will also affect the explosive components and make them deteriorate to a dangerous/ unusable state. [3]

Heat –

Extreme heat conditions can cause rapid deterioration in explosives. The heat may separate out the more sensitive explosive from a mixture and exudation of the filling may occur. This will render the munition dangerous to handle and will become liable to premature on firing.

Very Low temperature are generally safer than high temperatures, however, explosives containing nitroglycerine may become dangerous at low temperatures whilst double base propellants in rocket motors becomes more brittle and more liable to crack.

Careless Handling –

Careless handling can cause the ammunition to become dented, cracked and start to break down however, many of the effects are not as obvious and can lead to dangerous situations.

Damage to packaging through careless handling presents a hazard to the ammunition inside. Splits or cracks allow water to enter and become trapped and ultimately reducing explosive effectiveness.

Ammo is designed to withstand normal handling and will remain in a safe condition however, it may not be necessarily functional. Ammunition goes through lots of different drop rattle and shake tests in manufacture however, ammunition that has been dropped may be safe to handle but not safe to fire. It is important to handle all ammunition very carefully to make sure no damage is caused allowing the artillery to perform at its maximum capability. Lifting aids can help to prevent careless handling as well as eliminating the chance of the munition being accidentally dropped from over working or straining as some ammunition can be heavy.

Tampering or Unauthorised use –

Tampering means any unauthorised modification or interference with the ammunition. Tampering can be extremely dangerous and is forbidden. It is also forbidden to fire any unauthorised ammunition or unauthorised combination of gun/projectile/fuze/charge/primer/tube.

Transport –

In transport the ammunition can bang about with reckless driving. Ammunition in transport must be sent following the correct transportation conditions. In order to have ammunition transported there are certain rules and regulations that need to be followed in order for this to happen. Ammunition must be kept secure at all times in transportation to prevent tampering.

3.0 TNT Physical Properties

TNT is a constituent of most modern HE shell fillings and is a solid at normal temperatures. Its chemical formula ($C_7H_5N_3O_6$) shows that for every seven units of Carbon (C), there are five units of Hydrogen (H), three units of Nitrogen (N), and six units of Oxygen (O). [3]

TNT has a melting point of 82°C and does not explode at any temperature below 240°C . It is relatively insensitive to shock and cannot be exploded without a detonator. For these reasons it is the most favoured chemical explosive, extensively used in munitions and for demolitions.

TNT has been as an explosive since 1902 showing that it is one of the best fillings for artillery shells there is.

4.0 Additives in Propellants

Many additives are used in propellants. Those of particular interest in field artillery propellants are:

- Stabilisers.
- Plasticisers and Coolants.
- Flash Inhibitors.

Stabilisers –

NC and NG decompose steadily at normal temperatures, thus degrading performance and reducing storage life. There is eventually the possibility of auto-ignition. Mineral Jelly (Vaseline) was used in the early cordites, whereas Diphenyl Amine is used in some current single base propellants. Picrite is the stabiliser and is a natural explosive ingredient of modern triple base.

Plasticisers and Coolants –

Plasticisers are required to convert NC fibre to a gel so that it can be extruded into the appropriate shape. Plasticisers tend also to act as coolants. There are several suitable plasticisers, of which Carbamate is the most common, in British Land Service propellants.

Flash Inhibitors –

Muzzle flash is undesirable as it gives away the gun position and causes loss of night vision. The flash is caused by the re-ignition of the products of combustion when they mix with atmospheric oxygen outside the gun. Carbon monoxide and hydrogen are the main gases concerned. They combine explosively with atmospheric oxygen to form Carbon Dioxide and water vapour. Picrite, or the addition of metallic salts, usually potassium, help to reduce flash by inhibiting the re-ignition reaction.

5.0 Alternatives to TNT

There are many alternatives to just using TNT some of the possible alternatives are listed below:

Bis-oxadiazole –

Bis-oxadiazole is a new compound containing Nitrogen. The company Chavez has been developing high-nitrogen explosives compounds for a long time with emphasis on low explosive sensitivity whilst always bearing in mind good environmental properties. Bis-oxadiazole has 1.5 times performance capabilities of TNT. Another reason Bis-oxadiazole is better than TNT in my opinion is that TNT has been listed as a possible carcinogen and with exposure to the material has been linked with blood disorders whereas Bis-oxadiazole has not.

RDX –

RDX (Research Department Explosive) which used to be known as cyclotrimethylenetrinitramine, is a powerful explosive that is safe and inexpensive to manufacture.

It is a hard crystalline solid that is white in colour, insoluble in water and in some other solvents. It is often mixed with other substances to decrease sensitivity.

It was first used in WW2 and is often mixed with TNT in a 60/40 ratio.

It has a melting point of 205.5°C and a density of 1.806g/cm³.

[4]

PETN –

PETN is an explosive material it is also a nitrate ester of pentaerythritol and has a similar structure to nitroglycerine. PETN is a very powerful explosive material with a relative effectiveness factor of 1.66. If it is mixed with a plasticizer it will form a plastic explosive. PETN as well as RDX are the main ingredients of Semtex and C4.

PETN has melting point of 141.3°C and a density of 1.77g/cm³.

PETN is more difficult to detonate than primary explosives, therefore, dropping it or igniting it will typically not cause an explosion. It is difficult to ignite at atmospheric pressure however, it is more sensitive to shock and friction than most other secondary explosives. Under specific conditions a deflagration to detonation can happen.

[5]

TATB-

TATB is very powerful explosive, less than RDX but more than TNT. It is extremely insensitive to shock, vibration fire or and impact. It is very difficult to detonate by accident and is the proffered option when extreme safety conditions are necessary. This may be explosives that are used in nuclear weapons.

It has a melting point of 350°C and a density of 1.93g/cm³. [6]

HMX –

HMX is a nitroamine and is a quite powerful and relatively insensitive explosive. It is similar to RDX with a chemically related structure.

It is mixed with TNT in melt-castable explosives. Additionally, polymer-bonded explosive compositions containing HMX are used in the manufacture of missile warheads and armor-piercing shaped charges

It has a melting point of 276°C-286°C and a density of 1.91g/cm³. [7]

6.0 Conclusion

I feel that bis-oxadiazole is the best alternative for TNT. The reason for this is because TNT has an explosive energy of approximately 4000 Joules and Bis-oxiadazole has 1.5 times performance capabilities. Another reason Bis-oxiadazole is better than TNT in my opinion is that TNT has been listed as a possible carcinogen and with exposure to the material has been linked with blood disorders whereas Bis-oxiadazole has not. I feel Bis-oxiadazole has much more benefits than TNT and in my opinion it is the future of explosives.

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Assignment

GRADEMARK REPORT

FINAL GRADE

41 / 100

GENERAL COMMENTS

Instructor

Finn, the first thing to mention is thinking more about the structure of the paper you propose to submit. It would be useful to have an introduction into a topic like this, rather than go straight into the topic.

Overall, I am concerned that you may not completely understand the aspects of explosives, specifically the types and their initiation mechanisms. This is evident from your examination result too, and I think we may need to consider what additional tuition may be required. The terminology you use at the 'principles of OME' level is also very vague. Examples:

working charge,

some kind of external stimulus, detonate, explode (is this not detonation or deflagration?) or burn.....

bang about

how can you put an implication in place?

I do like figure 1, which shows the sequencing of an explosive train. If you had discussed your thoughts around this you would have done very well I believe.

The two types of explosive train are igniferous and detonative. The types of explosive are low and high. This is an important learning point for you to understand.

Lead azide has the formula $\text{Pb}(\text{N}_3)_2$. There is no oxygen in it. Mercury fulminate does have oxygen ($\text{Hg}(\text{ONC})_2$). So, not all explosives have oxygen so your statement is incorrect.

Your comments on tertiary explosives are incorrect. RDX and HMX are secondary explosives. Tertiary explosives are the likes of ammonium nitrate and NTO for example.

Your section on service life is good.

I do not learn much about the problem at all from the section on TNT physical properties. How is this a problem during service life and use? Remember the Cumbrian Pie video.

Nitroguanidine (picrite) is not a stabiliser. It is an explosive that is 'energy poor' and contains a large amount of nitrogen. As a result it lowers flame temperature to reduce barrel erosion and also quenches muzzle flash. It is insensitive as an explosive because its energy is low, but detonation velocity and density high.

Your comments on PETN are also incorrect. PETN sits on the borderline between primary and secondary explosive. It would be a more sensitive selection than TNT as the explosive filling.

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