

Explosive Safety Foundation Course ET01

Brian Wilson

Day 1

Course Admin

- Course timings - 2 days
- Day 1
 - Start 09:00
 - Morning Break 10:30
 - Lunch 12:00 – 13:00
 - Afternoon Break 14:10
 - End 15:55
- Day 2
 - Start 09:00
 - Morning Break 10:30
 - Lunch 12:00 – 13:00
 - Afternoon Break 14:30
 - Exam 14:50 – 15:50
 - End 16:00
- Mobile Phones
 - Please Switch OFF or on Silent
- Fire Alarms
- Toilets



Course Objectives – Day 1

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- | | |
|---|--|
| 1 | Explain the nature and characteristics of explosives |
|---|--|
-
- | | |
|---|---|
| 2 | Explain Hazard Divisions, Compatibility Groups and Hazard Types |
|---|---|
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- | | |
|---|--|
| 3 | Describe Explosion types and Basic Explosive Chemistry |
|---|--|
-
- | | |
|---|-----------------------------|
| 4 | Explain the Explosive Train |
|---|-----------------------------|
-
- | | |
|---|---|
| 5 | Be able to identify Explosives, Ammunition Markings and Basic Munition Design |
|---|---|
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- | | |
|---|--|
| 6 | Describe circumstances which can make Explosive Unsafe |
|---|--|
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- | | |
|---|--|
| 7 | Understand Lotting Batching, Bans Constraints and Safe Storage |
|---|--|
-
- | | |
|---|---------------------------------------|
| 8 | Understand fires involving Explosives |
|---|---------------------------------------|
-
- | | |
|---|--------------------------------------|
| 9 | Understand Explosive Disposal Safety |
|---|--------------------------------------|
-

Introduction

Introduce yourself

Team

Explain the team you work in, the size of the team and the team responsibilities

Your Role

Explain your individual role within the team

Your responsibilities

Explain your individual responsibilities and who/how you report activities and problems





Safety Moment

- Text

When it goes **WRONG**

United Kingdom

12 Aug 2018

An incident occurred in a flare manufacturing building at the Chemring Countermeasures (“CCM”) facility, near Salisbury.

1 PERSON KILLED

Romania

24 May 2004

EXPLOSION TRANSPORTING FERTILIZER

20 PEOPLE KILLED

TRUCK OVERTURNED DRIVER
TRIED TO EXTINGUISH FIRE
BUT COULD NOT

ASKED FOR HELP FROM
NEARBY VILLAGE

**CARS STOPPED AND CURIOUS
PEOPLE WATCHED THE FIRE**

A TV CREW ARRIVED

FIRE CREW ARRIVED

THE TRUCK EXPLODED!
KILLING 20
INCLUDING
7 MILITARY FIREFIGHTERS
2 JOURNALISTS
3 LOCAL PEOPLE
5 PEOPLE FROM CARS





When it goes **WRONG**

BUT

YOU TAKE THE
CORRECT ACTION

USA

August 2005

EXPLOSION TRANSPORTING EXPLOSIVES

0 PEOPLE KILLED

TRUCK CARRYING 16 000KG OF
EXPLOSIVES WENT OFF
THE ROAD

FIRE STARTED

DRIVER HELPED TO SAFETY

EXPLOSIVE PLACARDS AND THE DRIVER WARNED PEOPLE TO THE HAZARD SITE EVACUATED

**TRUCK EXPLODED AS PEOPLE
WERE IN THE PROCESS OF
MOVING AWAY**

**EXPLOSION CAUSED
SEVENTEEN MINOR INJURIES
TWO PEOPLE WERE HOSPITALISED**

EXPLOSION PRODUCED A CRATER 9M X 21M



REMEMBER
IT HAS HAPPENED

AND IT **WILL**
HAPPEN AGAIN

Explosives and pyrotechnics

Nature and characteristics



Explosives

- What is an explosive?
- Explosives are substances which contain their own oxygen to support the decomposition reaction and provided with the right stimulus will detonate
- It is illegal to own explosives.



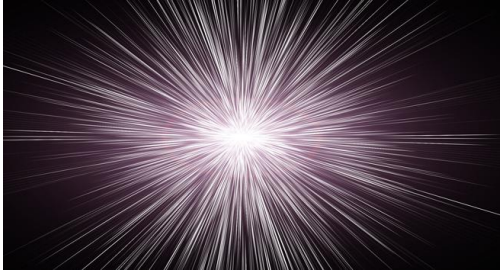
What is an explosion

- A violent expansion of gaseous matter
- Lightning hitting a tree
- A boiler exploding
- *Explosive substances replicate this by producing heat and gas virtually instantaneously*
- *Therefore an explosive is a substance which can react to produce an explosion*



Explosives produce

Light



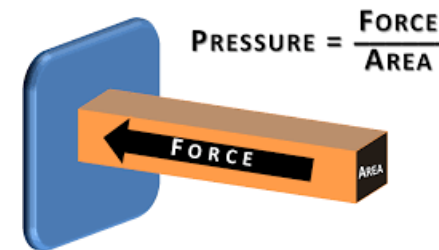
Heat



Sound



Pressure



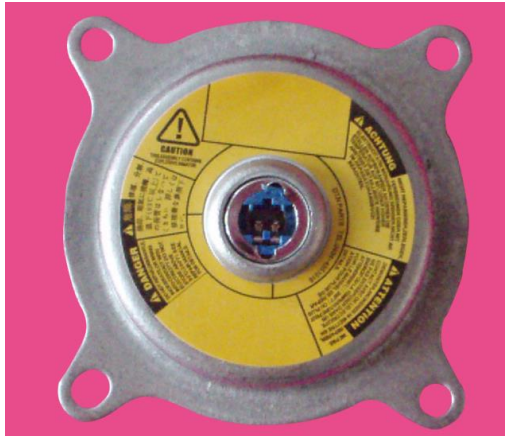
Definition of an explosive substance

An explosive substance is a substance capable by chemical reaction in itself of producing gas at such a temperature and pressure and at such a speed as could cause damage to surroundings



Pyrotechnics

- What is a pyrotechnic?
- Pyrotechnics are substances which are capable of undergoing a self-contained, self-sustained, exothermic chemical reaction
- Pyrotechnics are deregulated explosives available to the general public. For example your cars air bag



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Pyrotechnics produce

Heat



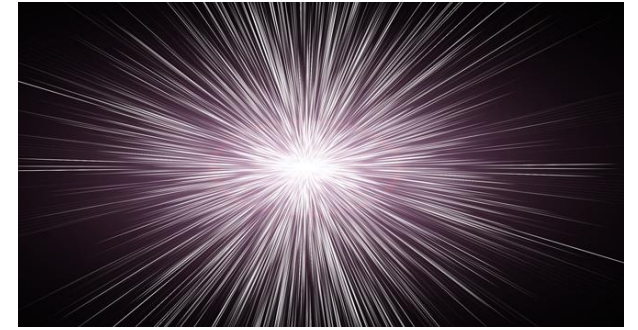
Noise

Flame



Smoke

Light



Gas

Definition of a pyrotechnic substance

A pyrotechnic substance is a substance designed to produce an effect by heat, light, sound, gas or smoke, or a combination of these as a result of a non-detonative, self-sustaining, exothermic chemical reaction.



Explosive reactions

Explosives produce two main effects:

- Deflagration
 - Burn less than speed of sound 340 m/s
 - Examples – propellants, power cartridges, fireworks
- Detonation
 - Shock wave travels between 2000 – 10000 m/s
 - Examples – Warheads – aircraft bombs -



Explosive reactions

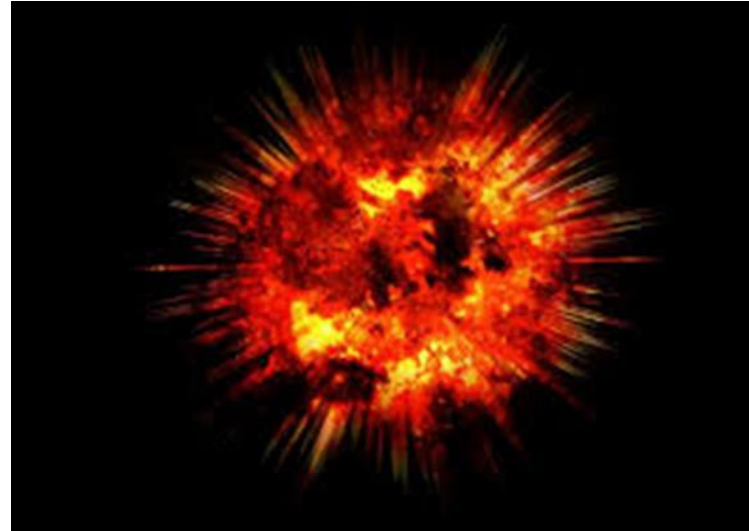
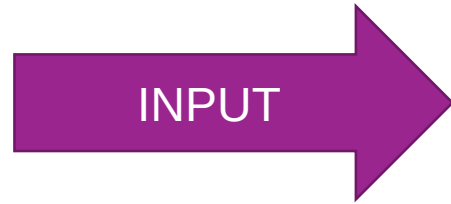
Explosive react to the input.



Deflagration

Explosive reactions

Explosive react to the input.



Detonation.

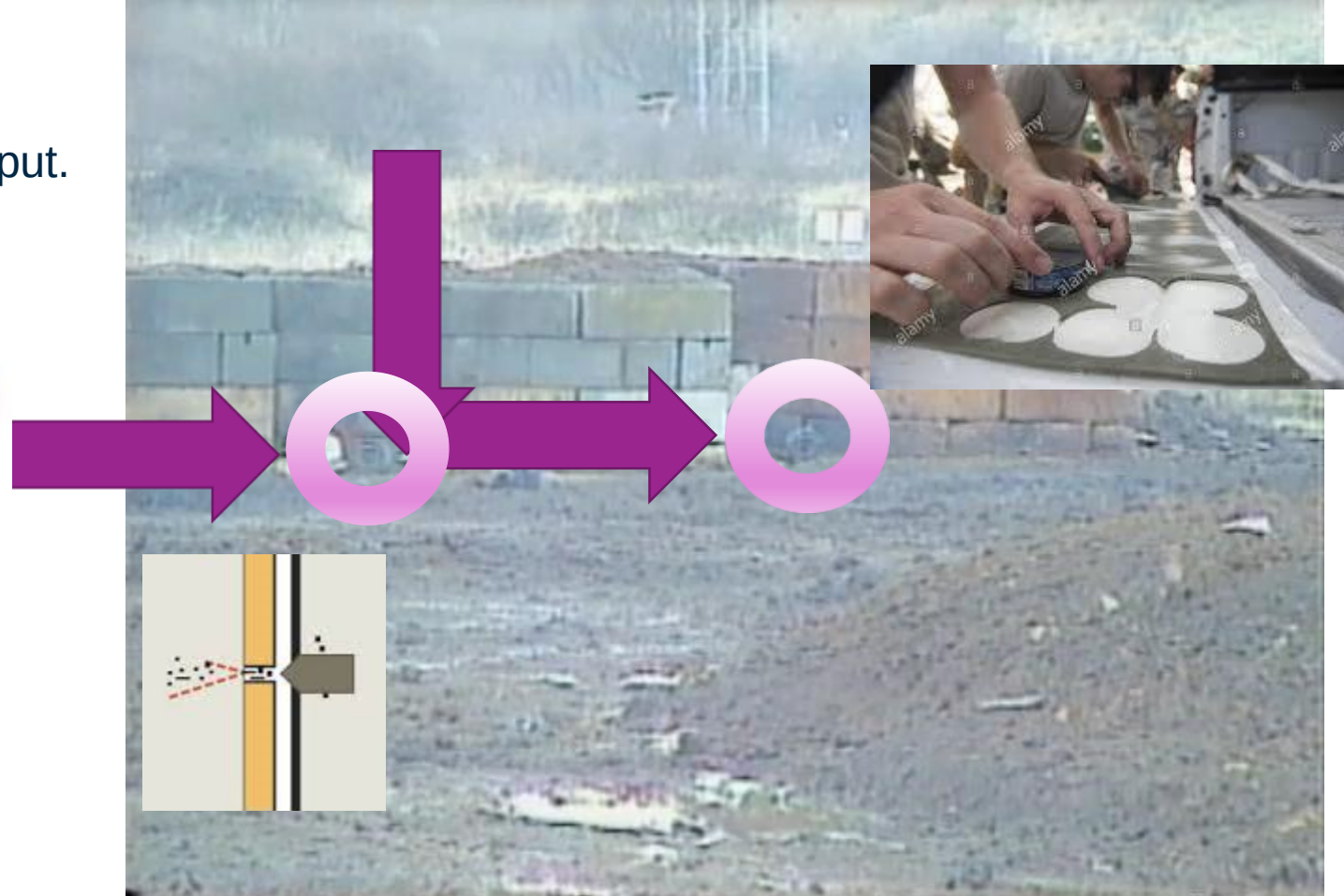
Class 1

The definition of explosives, the classification of explosives into Divisions and Compatibility Groups.

Explosives react to the input.



“Baldrick”
EOD Device



1000 lb HE
Bomb

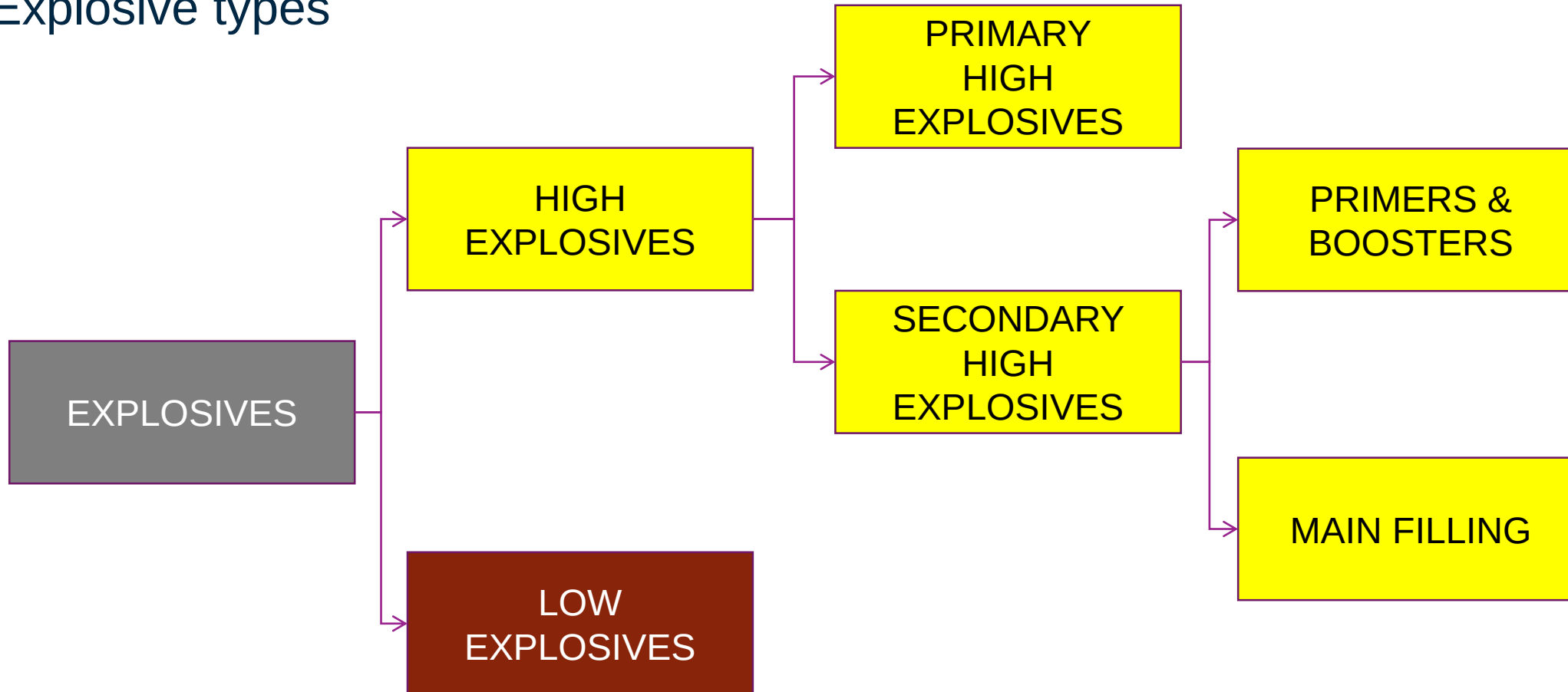


Class 1

Deflagrated bomb case



Explosive types



LOW EXPLOSIVES

- Flares



Propellants

Power Cartridges



HIGH
EXPLOSIVES

PRIMARY
HIGH
EXPLOSIVES

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- Detonators



HIGH
EXPLOSIVES

SECONDARY
HIGH
EXPLOSIVES

PRIMERS &
BOOSTERS

- Cartridge Primers



- Main Charge Boosters



HIGH
EXPLOSIVES

SECONDARY
HIGH
EXPLOSIVES

MAIN FILLING



- Aircraft Bomb





Explosive Hazard

Classification

Dangerous Goods – Class 1

Explosives



Dangerous Goods (DG)

Class 2 –Gases.

Liquefied gases.

Refrigerated liquefied gases.

Compressed gases.

Gases in solution.



LPG.



Liquefied Nitrogen.



Oxygen.



Acetylene.

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DG

Class 2 –Gases.



Under pressure.



Could explode.

DG.

Class 2 –Gases.



2.1
Flammable gas.



2.2
Non-flammable
non-toxic gas.



2.3
Toxic gas.

DG

Class 2.1 –Gases.



Gases that ignite in air.



May cause a fire, or contribute to another fire.

If heated, cylinder may BLEVE.



Boiling Liquid Expanding Vapour Explosion.

DG

Class 2.1 –Gases.



Most Aerosols.



Aerosols.



Propane.

Propane.

Acetylene.



Acetylene.

LPG.



LPG.



Butane.

Butane.

DG

Class 2.2 –Gases.



Asphyxiant.

Oxidising.



DG

Class 2.2 –Gases.



Oxygen.



Oxygen.



Carbon Dioxide.

Carbon Dioxide.

Nitrogen.



Helium.



Helium.



Aerosols.

Aerosol, Paste/Cream.

Nitrogen.

DG

Class 2.3 –Gases.



Toxic.

Not fitted with a safety relief valve.



DG.

Class 2.3 –Gases.



Chlorine.

Methyl Bromide.



Chlorine.



Methyl Bromide.

DG

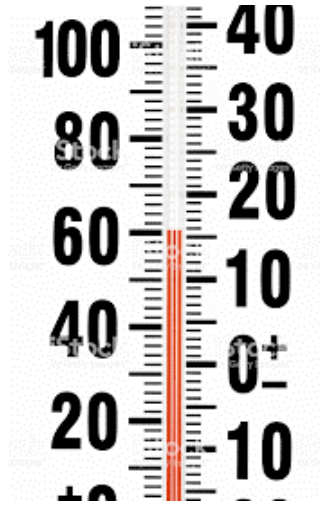
Class 3 –Flammable liquids.



Flash point $\leq 60^{\circ}$ Celsius.

A Flash Point refers to the lowest temperatures at which sufficient flammable vapours are released which will burn in air.

Some flammable liquids give off highly flammable vapours at ambient (current) temperatures.



DG

Class 3 –Flammable liquids.



Alcohol.



Alcohol.



Ether.

Paint.



Paint.

Kerosene.



Kerosene.

Petrol.



Petrol.

DG

Class 4.



4.1
Flammable solids.



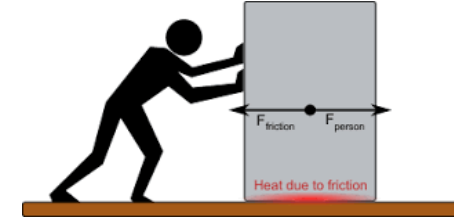
4.2
Substances liable to
spontaneous
combustion.



4.3
Substances which, in
contact with water,
emit flammable
gases.

DG.

Class 4.1 –Flammable solids.



Readily Combustible solids, may cause fire through friction.

Powder, granular or paste.



Metal powders – CO2 or Water can increase the hazard.



DG

Class 4.1 –Flammable solids.



Self-reacting substances – thermally unstable.

Thermal unstable substances which may undergo a strong chemical reaction that releases energy, even without Oxygen.



De-sensitized explosives are wetted to suppress their explosive properties.



DG.

Class 4.1 –Flammable solids.



Sulphur.

Magnesium.



Sulphur.



Magnesium.

Naphthalene.

Safety matches.



Naphthalene.



Safety Matches.



Solid Firelighters.

DG

Class 4.2.

Substances liable to
spontaneous combustion.



Pyrophoric Substances.

Self-heating substances.

Liable to catch fire without the application of an ignition
source.



DG

Class 4.2.

Substances liable to
spontaneous combustion.



Carbon.



Carbon.

Copra.



Copra.

White Phosphorus.



White
Phosphorous.

Zirconium.



Zirconium.

DG

Class 4.3.

Substances which,
in contact with water, emit flammable gases.



Emit flammable vapour, usually Hydrogen, when in
contact with water.



DG.

Class 4.3.

Substances which,
in contact with water, emit flammable gases.



Sodium.



Sodium.



Lithium.

Lithium.

Zinc Dust.



Zinc Dust.



Potassium.

Potassium.

DG

Class 5.



5.1
Oxidising substances.



5.2
Organic peroxides.

DG.

Class 5.1.

Oxidising substances.



Oxidising.



DG

Class 5.1.

Oxidising substances.



Aluminium Nitrate.



Aluminium Nitrate.



Barium Bromate.

Barium Bromate.

Bromine Pentafluoride.



Bromine
Pentafluoride.



Calcium Chlorate.

Calcium Chlorate.

DG.



Class 5.2.

Organic Peroxides.

An Organic Peroxide is any organic (carbon-containing) compound having two Oxygen atoms joined together.



DG

Class 5.2.

Organic Peroxides.



Exothermic decomposition.

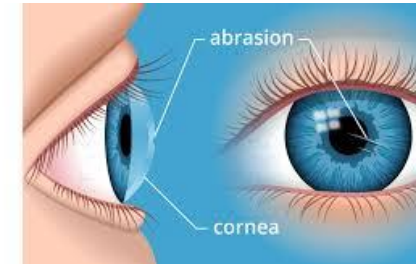
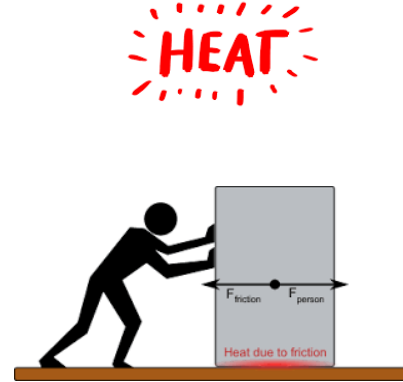
Harmful or flammable gases/vapours.



Temperature controlled.



Avoid contact with eyes.



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DG.

Class 5.2.

Organic Peroxides.



Methyl Ethyl Ketone Peroxide (MEKP).



DG

Class 6.



6.1
Toxic substances.



6.2
Infectious substances.

DG

Class 6.1.

Toxic Substances.



Relates to substances that can cause damage or death.

Two main factors used:

Dosage.



Route of exposure.



DG

Class 6.1.

Toxic Substances.



Route of exposure:

Orally – ingestion, eating/drinking.



Dermally – skin contact.



Inhalation – breathing in dusts and mists.



DG.

Class 6.1.

Toxic Substances.



Aluminium Phosphate Pesticide.



Aluminium phosphate
pesticide.

Ammonium Fluoride.



Ammonium
fluoride.

Arsenic.



Arsenic.

Barium Oxide.



Barium oxide.

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DG

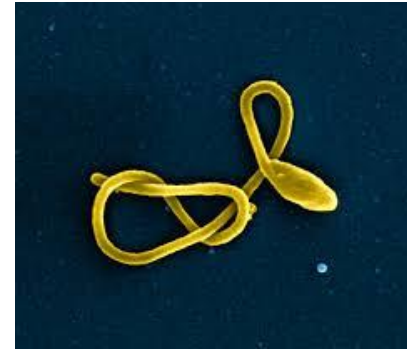
Class 6.2.

Infectious Substances.



Category A.

Capable of causing permanent disability, life-threatening or fatal diseases in humans or animals.



Ebola.



Lassa.

DG.

Class 6.2.

Infectious Substances.



Category B.

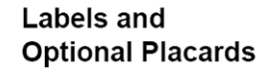
Biological substances.

Pathology samples.

Medical waste.



Class 7.



7

DG.

Class 8.

Corrosive substances.



Which can by chemical action attack and damage living tissue.

In the event of a leakage can damage or destroy other goods.



DG.

Class 8.

Corrosive substances.



Hydrofluoric acid.



Hydrofluoric acid.



Fluroboric acid.

Fluroboric acid.

Bromine.



Bromine.

Batteries, wet, filled with acid.



Batteries, wet,
filled with acid.

DG.

Class 9.

Miscellaneous dangerous
Substances and articles.



Substances and articles, which during carriage, present a danger not covered by the heading of other classes.

Carcinogens – cancer causing.

Irritants.

Elevated temperature substances.

Environmentally hazardous substances.



DG

- What do you consider to be the most hazardous class of DG?



SLZ20

Dangerous Goods – Class 5 – Oxidizing & Organic Peroxides

Class 5.1

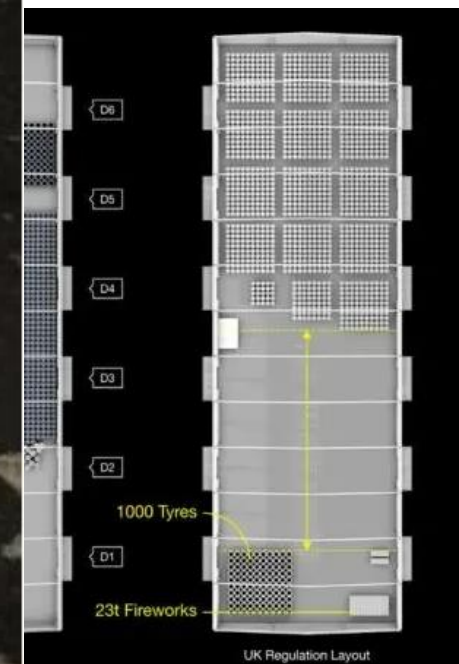
- Oxidizing substances



Ammonium Nitrate



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QINETIQ

Signage

The
Academy

EQUALITY & DIVERSITY



Equality is not about treating all people in the same way. It's about recognising and respecting diversity enough to adapt practice and procedure to suit all.



20 minute break

Class 1

The definition of explosives, the classification of explosives into Divisions and Compatibility Groups.

Class 1 classification.

Explosive substances, solid or liquid.

Pyrotechnic substances or mixtures.



Class 1

The definition of explosives, the classification of explosives into Divisions and Compatibility Groups.

Class 1 classification.

Explosive articles, containing one or more explosive or pyrotechnic substance.



Class 1

- Hazard Division is the term used by the UN for DG transportation and the MOD in relation to explosives which are packaged for transportation and storage and does not change.

Class 1 divisions.

Division 1.1 - Mass Explosion Hazard.

Substances and articles which have a mass explosion hazard.

A mass explosion is an explosion which affects almost the entire load virtually instantaneously.



Hazard Division 1

Plastic Explosive – Semtex

Semtex is a general-purpose plastic explosive containing RDX and PETN. It is used in commercial blasting, demolition, and in certain military applications.



Mass Explosion Hazard

Class 1

The definition of explosives, the classification of explosives into Divisions and Compatibility Groups.

Class 1 divisions.

Division 1.2 - Projection Hazard

Substances and articles which have a projection hazard but not a mass explosion hazard.



Hazard Division 2

CRV7 Rocket.

The CRV7, short for "Canadian Rocket Vehicle 7", is a 2.75-inch (70 mm) folding-fin ground attack rocket produced by Bristol Aerospace in Winnipeg



Projection Hazard

Class 1

The definition of explosives, the classification of explosives into Divisions and Compatibility Groups.

Class 1 divisions.

Division 1.3 - Fire Hazard

Substances and articles which have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard:

Combustion of which gives rise to considerable radiant heat; or

Which burn one after another, producing minor blast or projection effects or both.



Hazard Division 3

Charge Propelling M3 for 155 mm Howitzer

The M3 series propelling charges are green bag type designed for use in 155 mm howitzers for firing in Zones 1 through 5. The full charge consists of approximately 5.50 pounds of propellant including a base charge and four unequal increments loaded in cloth bags



Fire Hazard

Class 1

The definition of explosives, the classification of explosives into Divisions and Compatibility Groups.

Class 1 divisions.

Division 1.4 - Slight explosion risk

Substances and articles which present only a slight risk of explosion in the event of ignition or initiation during carriage or storage.

The effects are largely confined to the package and no projections of fragments of appreciable size or range is to be expected.

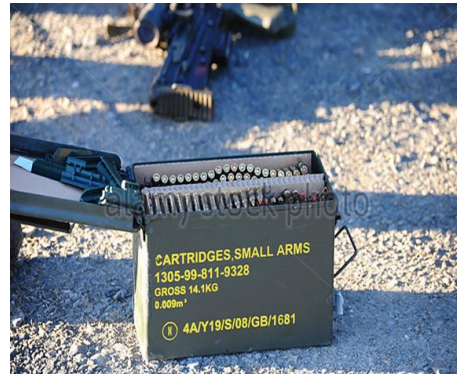
An external fire shall not cause virtually instantaneous explosion of almost the entire contents of the package.



Hazard Division 4

Cartridges Small Arms

An ammunition box with 5.56mm belted rounds inside



Slight explosion Hazard

1.4 S



1.4 S



Class 1

The definition of explosives, the classification of explosives into Divisions and Compatibility Groups.

Class 1 divisions.

Division 1.5 - Very insensitive substances

Very insensitive substances having a mass explosion hazard which are so insensitive that there is very little probability of initiation or transition from burning to detonation under normal conditions of carriage and storage.



Hazard Division 5

ANFO – Ammonium Nitrate/Fuel oil

ANFO is a widely used bulk industrial explosive used in coal mining, quarrying and civil construction.



Very insensitive substances

Class 1

The definition of explosives, the classification of explosives into Divisions and Compatibility Groups.

Class 1 divisions.

Division 1.6 - Extremely insensitive articles

Extremely insensitive articles which do not have a mass explosion hazard.

The articles predominantly contain extremely insensitive substances and demonstrate a negligible probability of accidental initiation or propagation.



Hazard Division 6

Underwater influence mine - BLOCKER

Underwater Influence Mine, BLOCKER system and its main charge (FOXIT) and booster (FPX R1) combination have proven to be insensitive enough to be classified to 1.6.



Extremely insensitive articles

Compatibility Groups

- To enable safe storage and transportation Class 1 is further classified by its Compatibility Group,
- Would not store Bleach with Fresh Fruit
- Would not Store Detonators with Plastic Explosive



Compatibility Groups

- A
 - Primary Explosive
- B
 - Article containing a primary explosive substance and not having two or more effective protective features
- C
 - Propellant explosive substance or other Deflagrating explosive substance or article containing such explosive substance
- D
 - Secondary Detonating explosive substance or black powder, or article containing a secondary detonating explosive substance, in each case without means of initiation and without a propelling charge, or article containing a primary explosive substance and containing two or more effective protective features
- E
 - Article containing a secondary detonating substance, without means of initiation, with propelling charge (other than on containing a flammable or hypergolic liquid)
- F
 - Article containing a secondary explosive substance with its own means of initiation and with a propelling charge (other than on containing a flammable or hypergolic liquid or without a propelling charge)
- G
 - Pyrotechnic substances, or article containing a pyrotechnic substance, or article containing both an explosive substance and illuminating, incendiary, lachrymatory, or smoke-producing substance (other than water-activated article or one containing white phosphorous, phosphide or flammable liquid or gel)

Compatibility Groups

- H
 - Article containing both an explosive substance and white phosphorous
- J
 - Article containing both and explosive substance and a flammable liquid or gel
- K
 - Article containing both an explosive substance and a toxic chemical agent
- L
 - Explosive substance or article containing an explosive substance presenting a special risk needing isolation of each type
- N
 - Articles containing only extremely insensitive detonating substances
- S
 - Substances or articles so packed or designed that any hazardous effects arising from accidental functioning are confined within the package unless the package has been degraded by fire, in which case all blast or projection effects are limited to the extent that they do not significantly hinder or prohibit fire-fighting or other emergency response efforts in the immediate vicinity of the package.

Compatibility Groups

CG	A	B	C	D	E	F	G	H	J	K	L	M	N
A													
B			2	2	2	2	2						
C		2				3	4						
D		2				3	4						
E		2				3	4						
F		2	3	3	3		3, 4						
G		2	4	4	4	3, 4							
H													
J													
K													
L													



6

[2] Articles of CG B are to be segregated in storage from other articles of CGs C, D, E, F and G by means which are effective in the prevention of propagation to those other articles, i.e. in a separate compartment, or by use of suitable traverses/barriers or simple distance separation. Fuzes of CG B may be stored with their parent explosive articles, but the NEQ must be aggregated and the whole treated as CG F.

The classification of explosives

- Hazard Classification Code (HCC)
- **Class 1** - Explosives.
- **HD 1** - Explosives which have a mass explosion hazard.
- **CG C** - Propellant explosive substance or other deflagrating explosive substance or article containing such explosive substance.



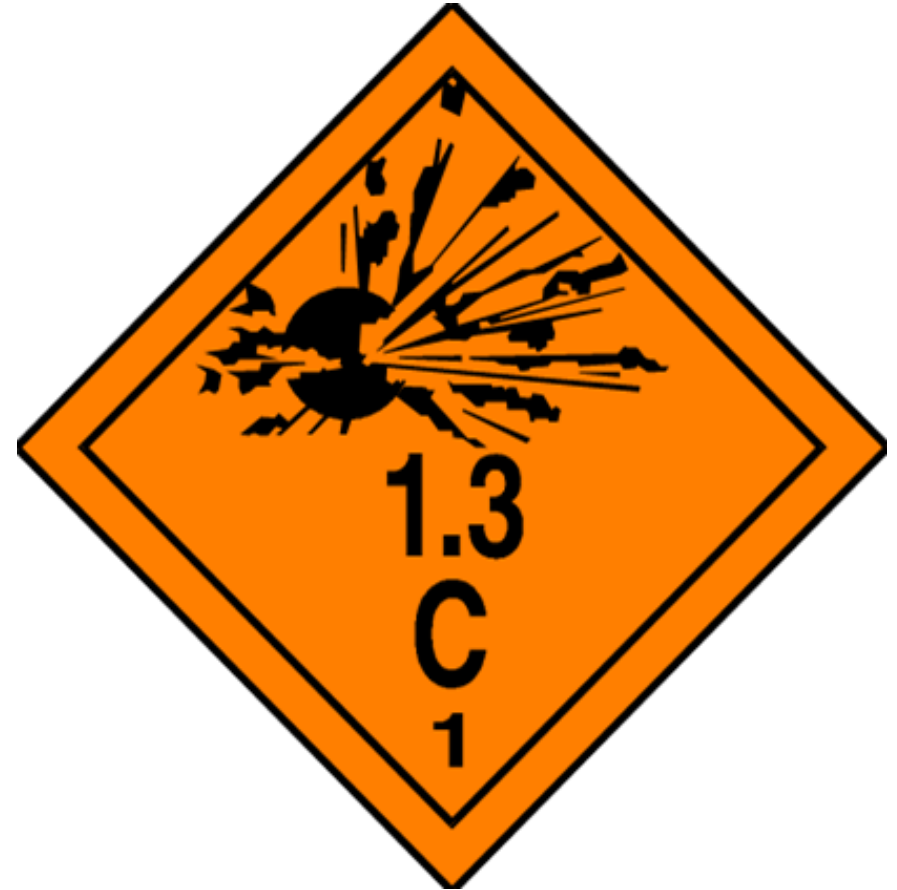
The classification of explosives

- Hazard Classification Code (HCC)
- **Class 1** - Explosives.
- **HD 2** - Explosives which have a projection hazard
- **CG B** - Article containing a primary explosive substance and not having two or more effective protective features.



The classification of explosives

- Hazard Classification Code (HCC)
- **Class 1** - Explosives.
- **HD 3** - Explosives which have a fire hazard
- **CG C** - Propellant explosive substance or other deflagrating explosive substance or article containing such explosive Substance.



The classification of explosives

- Hazard Classification Code (HCC)
- **Class 1** - Explosives.
- **HD 4** - Explosives which have no significant hazard.
- **CG S** - Substances or articles so packed or designed that any hazardous effects arising from accidental functioning are confined within the package unless the package has been degraded by fire, in which case all blast or projection effects are limited to the extent that they do not significantly hinder or prohibit fire-fighting or other emergency response efforts in the immediate vicinity of the package



Explosive Hazard Type

Signs are only used to show the numbers
HT DOES NOT HAVE ANY SIGNAGE

Hazard Type can change throughout the journey of the explosives through the supply and technical chain.

You must ensure you understand what the Hazard Type will be if you change the conditions.



Hazard Type 1

An explosive which, as a result of, or as a result of any effect of, conditions of its storage or process of manufacture, has a

mass explosion hazard



Explosive Hazard Type

**Signs are only used to show the numbers
HT DOES NOT HAVE ANY SIGNAGE**

Hazard Type can change throughout the journey of the explosives through the supply and technical chain.

You must ensure you understand what the Hazard Type will be if you change the conditions.



Hazard Type 2

An explosive which, as a result of, or as a result of any effect of, conditions of its storage or process of manufacture, has a

Serious projectile hazard but does not have a mass explosion hazard.



Explosive Hazard Type

**Signs are only used to show the numbers
HT DOES NOT HAVE ANY SIGNAGE**

Hazard Type can change throughout the journey of the explosives through the supply and technical chain.

You must ensure you understand what the Hazard Type will be if you change the conditions.



Hazard Type 3

An explosive which, as a result of, or as a result of any effect of, conditions of its storage or process of manufacture, has a

Fire hazard and either a minor blast hazard or a minor projectile hazard, or both, but does not have a mass explosion hazard.



Explosive Hazard Type

**Signs are only used to show the numbers
HT DOES NOT HAVE ANY SIGNAGE**

Hazard Type can change throughout the journey of the explosives through the supply and technical chain.

You must ensure you understand what the Hazard Type will be if you change the conditions.



Hazard Type 4

An explosive which, as a result of, or as a result of any effect of, conditions of its storage or process of manufacture, has a

Fire hazard or slight explosion hazard, or both, with local effect only.



Picture of Igniter Safety Fuze Electrical – an electric match

Explosive Hazard Type

**Signs are only used to show the numbers
HT DOES NOT HAVE ANY SIGNAGE**

Hazard Type can change throughout the journey of the explosives through the supply and technical chain.

You must ensure you understand what the Hazard Type will be if you change the conditions.



HD 5 would be treated as HT 1



HD 6 would be individually assessed

Explosive Hazard Type

Hazard Type can change throughout the journey of the explosives through the supply and technical chain.

You must ensure you understand what the Hazard Type will be if you change the conditions.



Contains Electric
Detonators



Represent the likely effects when subjected to an incident, i.e. Fire

Not how the explosives is designed to work

Explosive Hazard Type

Hazard Type can change throughout the journey of the explosives through the supply and technical chain.

You must ensure you understand what the Hazard Type will be if you change the conditions.



Explosive Hazard Type

Hazard Type can change throughout the journey of the explosives through the supply and technical chain.

You must ensure you understand what the the Hazard Type will be if you change the conditions.

Especially:

- When unpacking.
- After breakdown.



Explosive Hazard Type

Hazard Type can change throughout the journey of the explosives through the supply and technical chain.

You must ensure you understand what the Hazard Type will be if you change the conditions.

Especially:

- When unpacking.
- After breakdown.
- After assembly.
- During manufacture.
- During testing.



Net Explosive Quantity

- The Net Explosive Quantity (NEQ), also known as Net Explosive Content (NEC) or Net Explosive Weight (NEW), of a shipment of munitions, fireworks or similar products is the total mass of the contained explosive substances, without the packaging, casings, bullets etc
- Net Explosives Quantity (metric UK)
- Net Explosive Weight (imperial US)
- Net Explosives Content (usually used for individual articles within a multiple article munition)



Net Explosive Quantity

- NEQ is shown in Kg, sometimes organisations will round up the NEQ on the paperwork.
- An item has 5 g of explosives, how would this be shown as if the NEQ was rounded to 2 decimal places?
- 5 g = 0.005 kg
- 0.005 round to two decimal places = 0.01
- NEQ = 0.01 kg

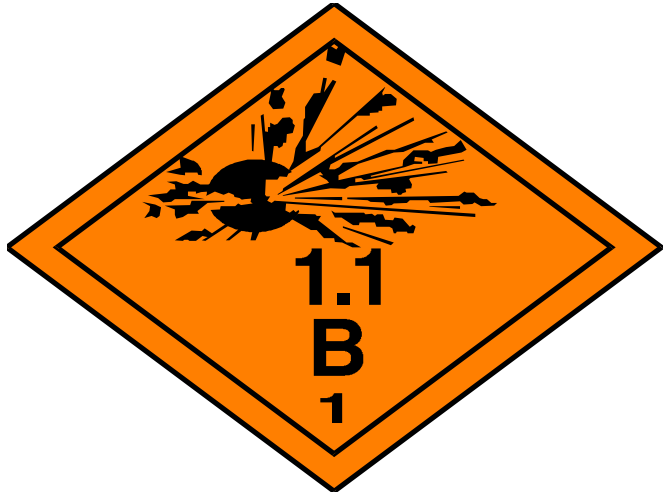


Signage



Signage

Hazard Division 1



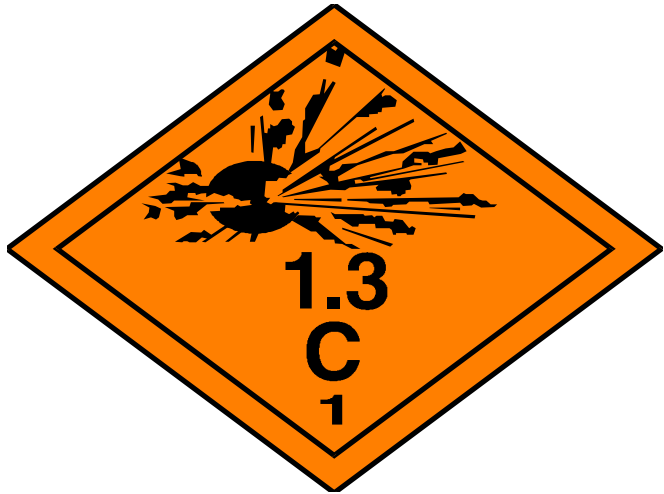
Signage

Hazard Division 2



Signage

Hazard Division 3



Signage

Hazard Division 4



Signage

Hazard Division 5



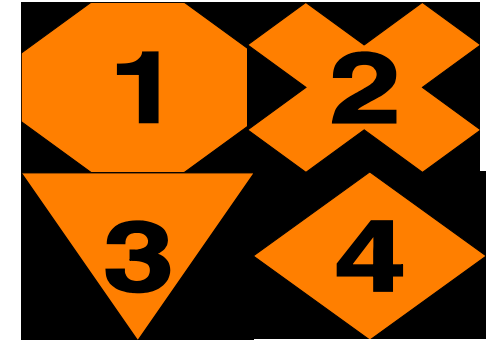
Signage

Hazard Division 6

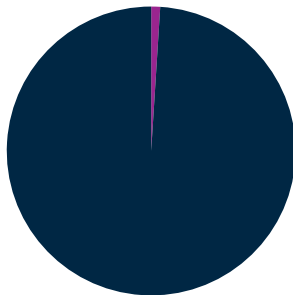


Signage

- What is the purpose of explosive building HD signs?
- They indicate a quantity of that HD is present



HD Present

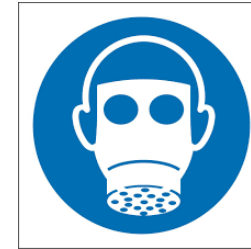


Signage – Supplementary signs

Radiological hazard



Breathing apparatus to be worn



Protective clothing to be worn



No water to be used



Explosion Types



Explosion Types

- Types of explosions
- Physical Explosion
- High pressure boiler
- Pressurised gas cylinders



Explosion Types

- Types of explosions
- Nuclear Explosion
- Fission or fusion



Explosion Types

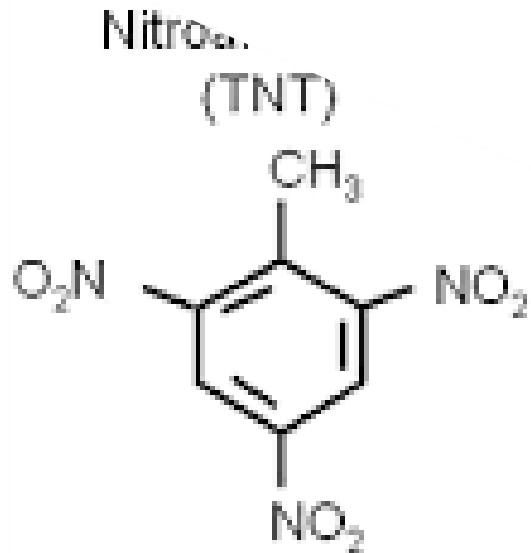
- Types of explosions
- Chemical Explosion
- Exothermic oxidation which produces flame or smoke



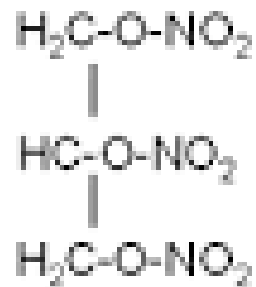
Lunch – Back at 13:00

Explosive Principles

Basic explosive chemistry



Nitrate Esters
(NG)



Explosive Principles

- Black Powder
- A mixture of potassium nitrate, charcoal, and sulphur, black powder undergoes a highly reactive combustion which produces large quantities of heat and gas in the process.



Potassium Nitrate
 KNO_3 75%



Charcoal
C 15%

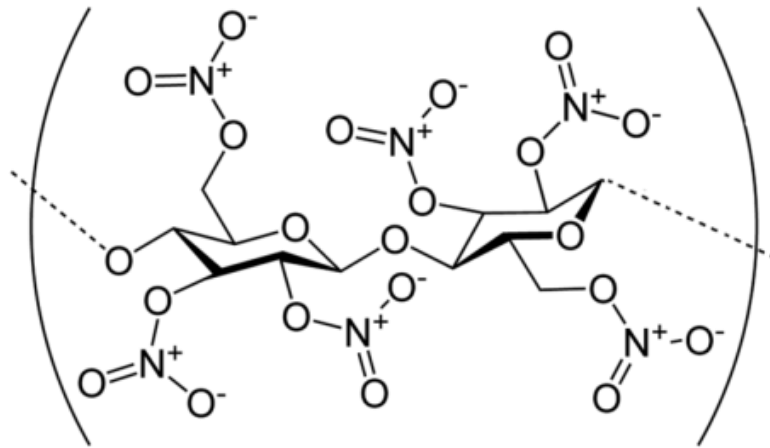


Sulphur
S 10%



Explosive Principles

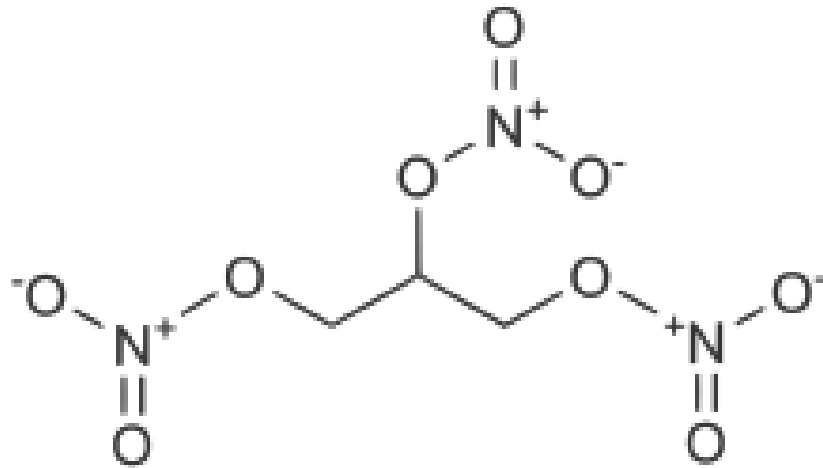
- Nitrocellulose – Gun Cotton
- Nitrocellulose has a simple structure and is aptly named; the compound consists only of cellulose with nitro-groups attached via the oxygen in cellulose.



Nitrocellulose is considered to deflagrate rather than detonate.

Explosive Principles

- Nitroglycerin
- Nitroglycerin's molecular make up allows it to exothermically decompose into gases without an external oxygen source; rather than deflagrating, nitroglycerin detonates.



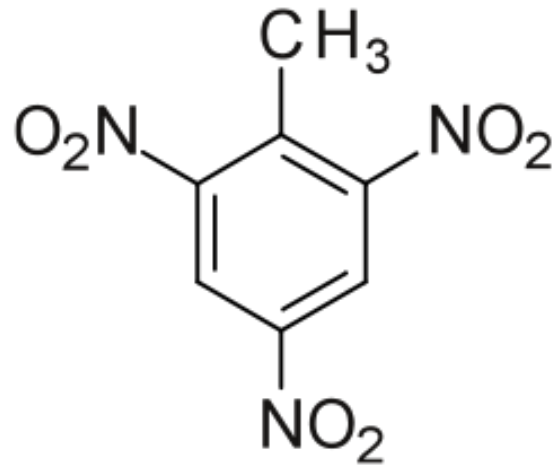
Explosive Principles

- Dynamite
- The chemical marvel of dynamite lies not in its reaction (it is still nitroglycerin), but in its successful use of absorbents to stabilize nitroglycerin.
- Alfred Nobel used the stabilizer, diatomaceous earth.



Explosive Principles

- Trinitrotoluene (TNT)
- Unlike nitroglycerin, the detonation of TNT has an unusually high activation energy barrier. Its stability makes the transportation of TNT safe, with little chance of accidental detonation.

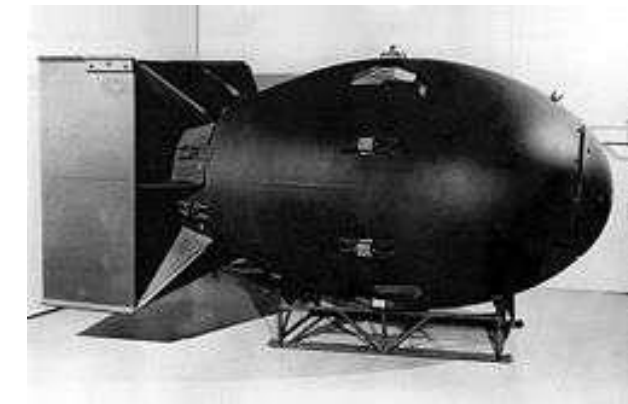


Explosive Principles

- TNT equivalent (TNTe)
- The relative effectiveness factor (RE factor), relates an explosive's demolition power to that of TNT – NEQ can be expressed as TNTe

Explosive	Velocity of Detonation m/s	RE factor
Black Powder	600	0.55
ANFO	5270	0.74
TNT	6900	1
Nitrocellulose	6400	1.10
Dynamite	7200	1.25
C4	8040	1.34

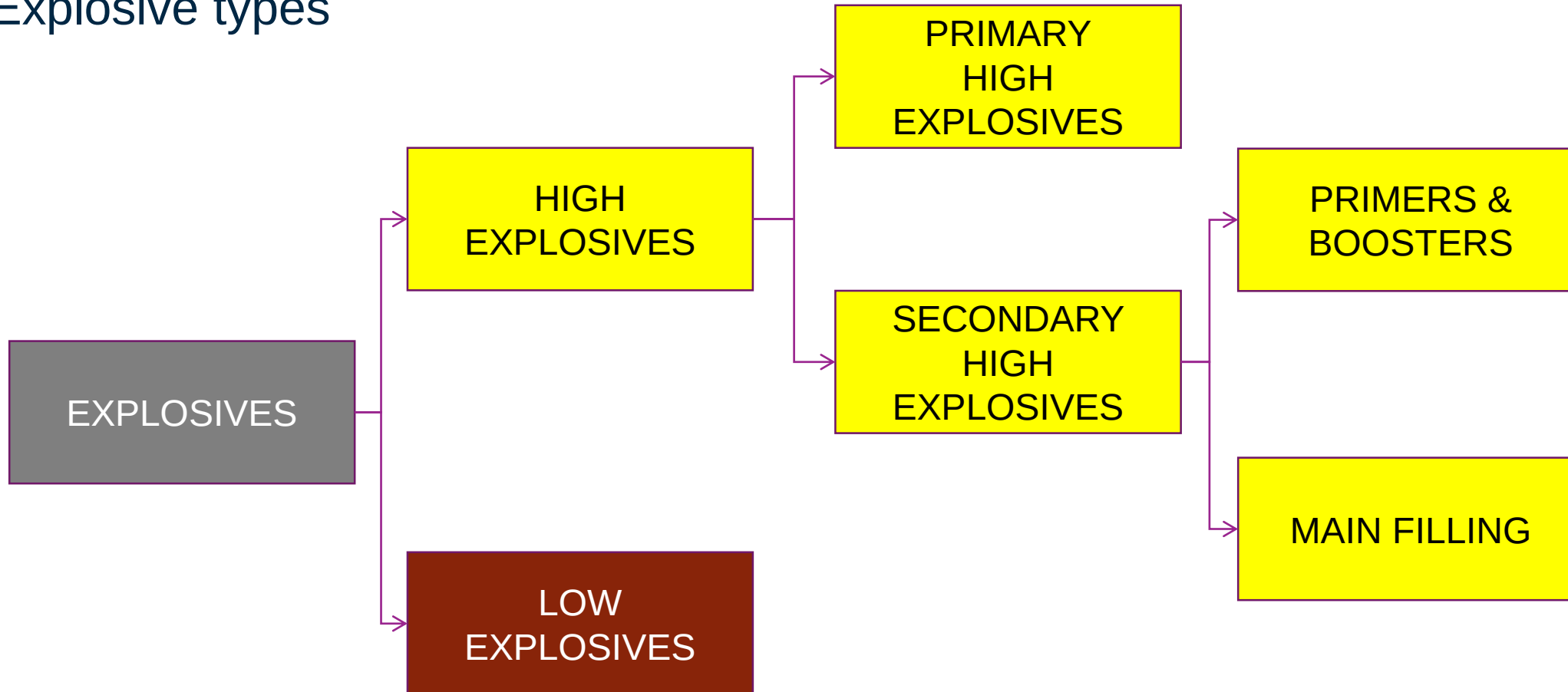
Weapon	Kilotons of TNT	RE Factor
'Fat Man' Nagasaki A-Bomb	20	4500



Explosive Train



Explosive types



Explosive train

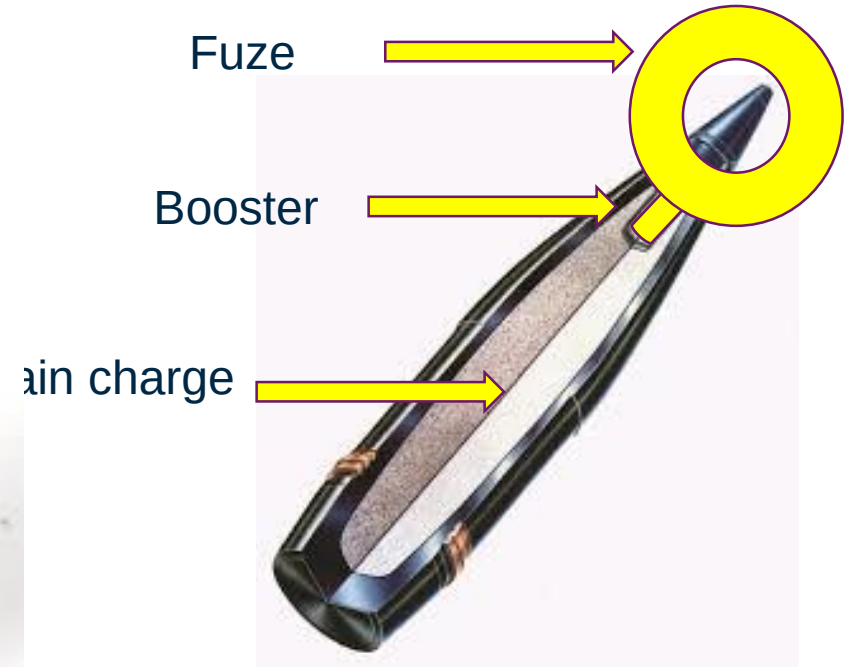


155 mm HE

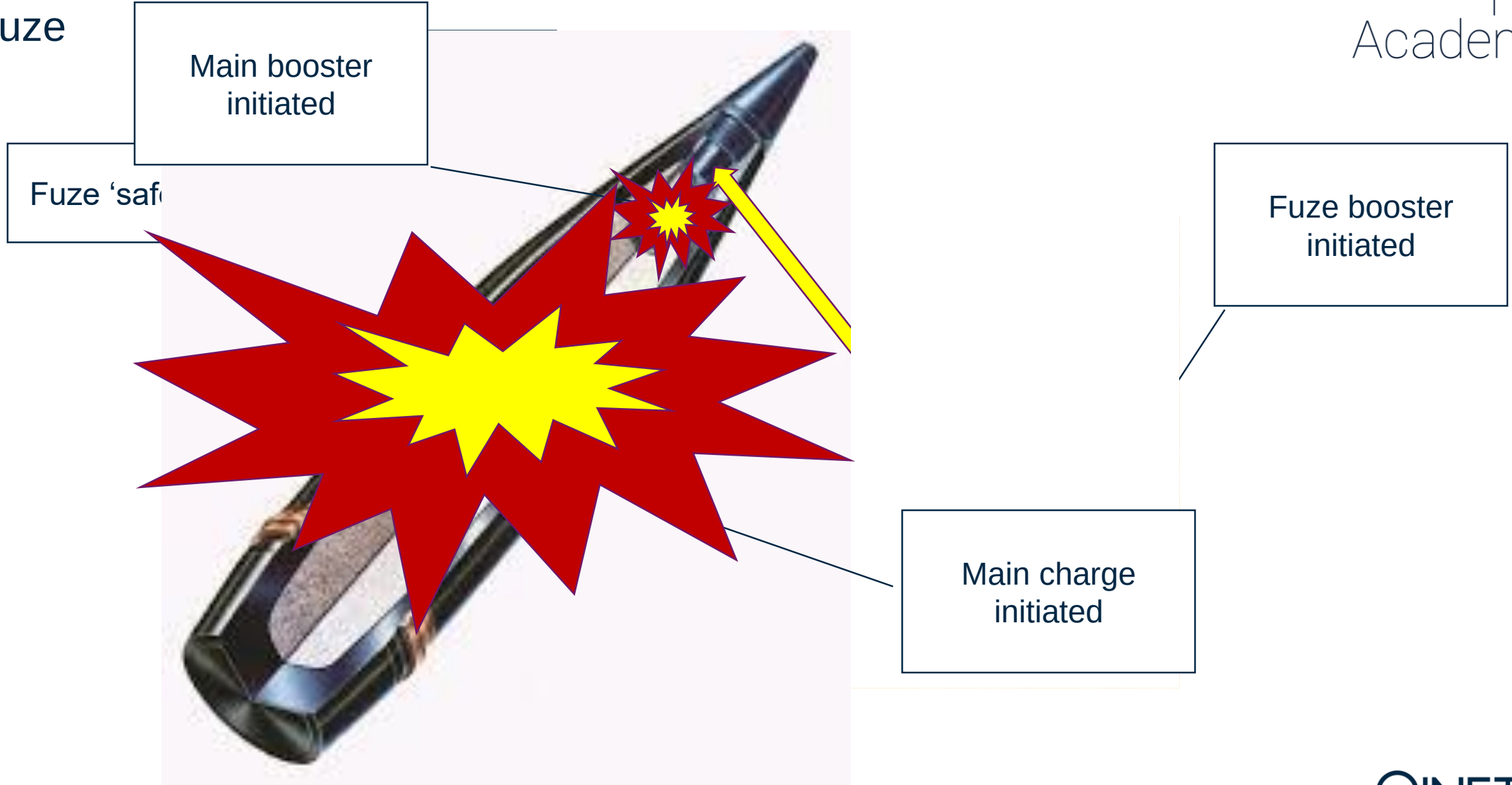
Primary
Explosive



Booster



Fuze



Explosive Train

- HE Primary – Initiator
- HE Booster



The
Academy

Explosive Train

- 155 mm
- Plug Representing Fuze (PRF)
- Plug



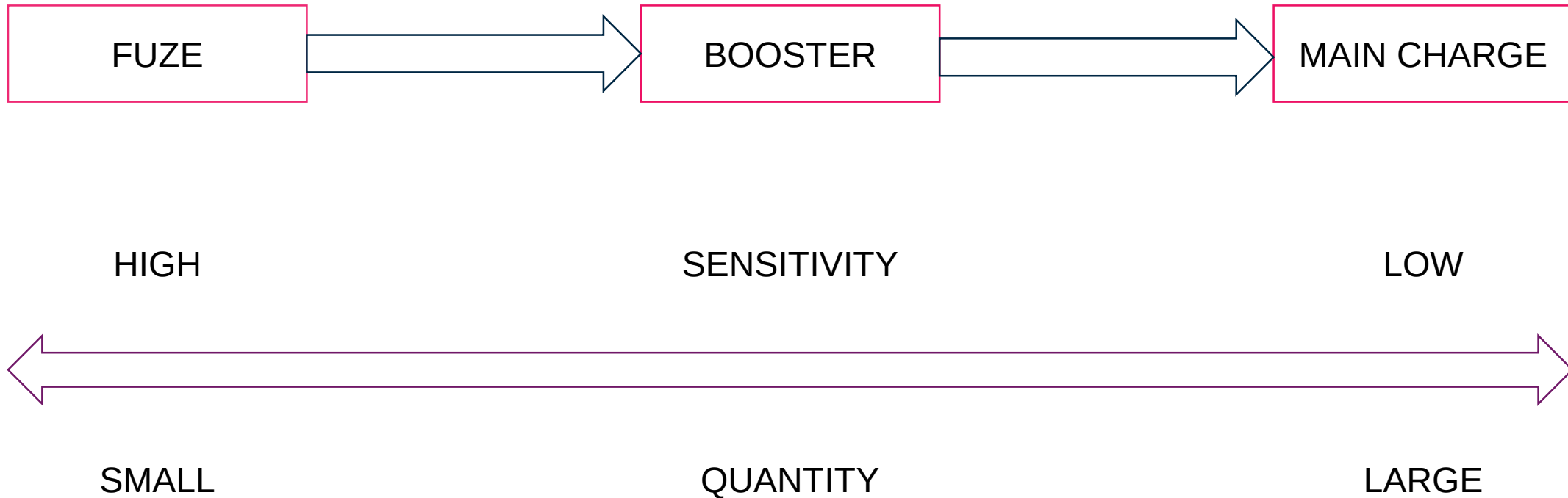
Explosive Train

- Sequence of energetic materials beginning with priming or initiating material (Primer or Fuze), through boosting material, and finally to the main charge



Explosive Train

- Sequence is typically a small quantity of low-yielding, but very sensitive material (Primary Explosive) to a large quantity of high-yielding but not as sensitive material High Explosive.



Explosive Train



Explosives

Identification



Ammunition under 20 mm

Colour is applied to the tip of the bullet



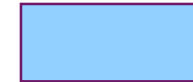
Colours used



BLACK – Armour-piercing



SILVER – Armour-piercing incendiary



BLUE - Incendiary



YELLOW - Observing



RED - Tracer

Ammunition over 20 mm

Overall colour Role



Coloured bands explosive Hazard



Colours used

YELLOW – High Explosive



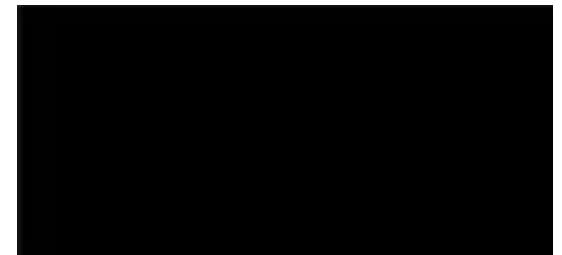
SILVER - Countermeasures

BROWN – Low Explosive



RED - Incendiary

BLACK – Armour defeating



LIGHT GREEN - Smoke

Colours used

PRACTICE



DRILL



Practice

Practice.

Can contain explosive



3 kg Practice Bomb



CRV 7 Practice

Drill

Drill

Will not contain explosive



Drill Hellfire Missile



Drill Blowpipe

Ammunition markings.



Ammunition markings

Ammunition is marked according to the

Defence Standard (DEF Stan)

00 – 810 Marking of Ammunition and Associated Packages.



Ministry of Defence
Defence Standard 00-810 Part 1

Issue 1 Publication Date 24 July 2006



**Marking of Ammunition and
Associated Packages**

Ammunition markings

The purpose of ammunition and packaging markings is:

- Identification and management purposes.
- Enable the correct nature and type of ammunition to be issued to the user.
- Enable the ammunition to be correctly identified by the user under all conditions of service.
- To provide sufficient information to enable the ammunition to be stored handled and transported correctly.
- To assist in the tracing of ammunition and aid investigation into ammunition incidents.



Ammunition markings

The principles to be observed are:

Clarity:

Markings necessary for item identification shall be made more prominent in size and position than those required for detailed identification.

Uniformity:

Uniformity in marking shall be maintained wherever practicable for groups of stores having similar characteristics.

Simplicity:

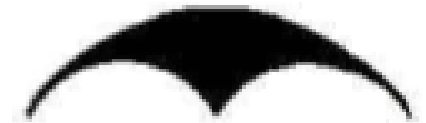
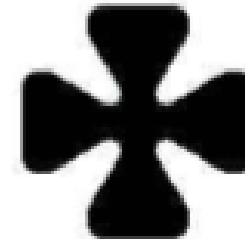
Complicated symbols and superimposed colours shall be avoided wherever possible



Ammunition markings

Special Feature Markings

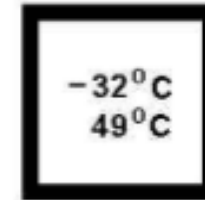
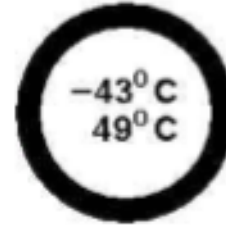
- NATO Design Mark.
- NATO Symbol of Interchangeability
- Parachute Symbol



Ammunition markings

Special Feature Markings

- Temperature limitation Symbol.
Safety limits for user e.g. firing.
- Temperature limitation Symbol.
For storage and transit.
- Tracer Symbol.

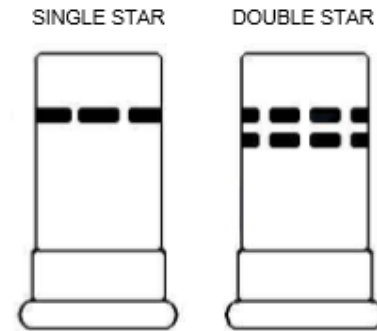
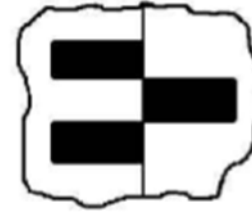


T

Ammunition markings

Special Feature Markings

- Alignment symbol.
- Broken Coloured Bands.
Bands denoting coloured effects
- Centre of gravity Symbol.



Ammunition markings

Approved Abbreviations

Term	Abbreviation
Acquisition	ACQN
Aluminium Powder	AL
Anti-riot	AR
Anti-personnel	APERS
Armour-piercing	AP
Bandolier	BDR
Calibre	CAL
Charge	CHGE
High Explosive Dual Purpose	HEDP
Torpex	TX
Target Practice	TP

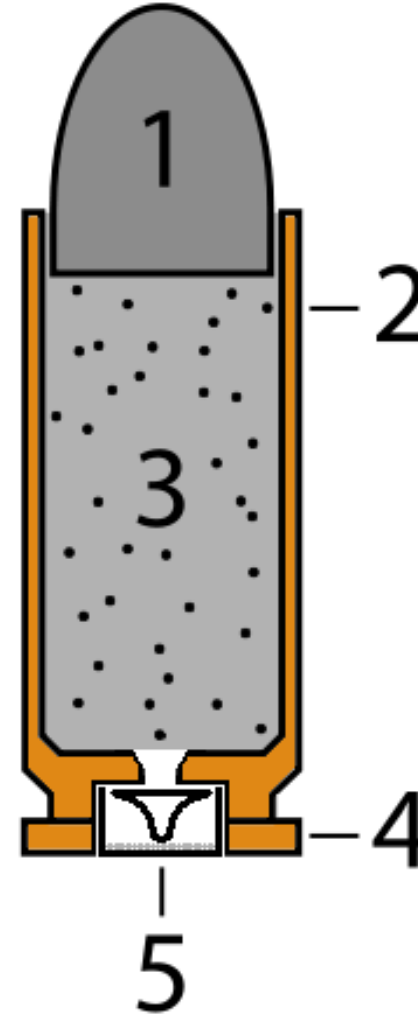
Explosive Principles

Basic munition design for simple and complex systems



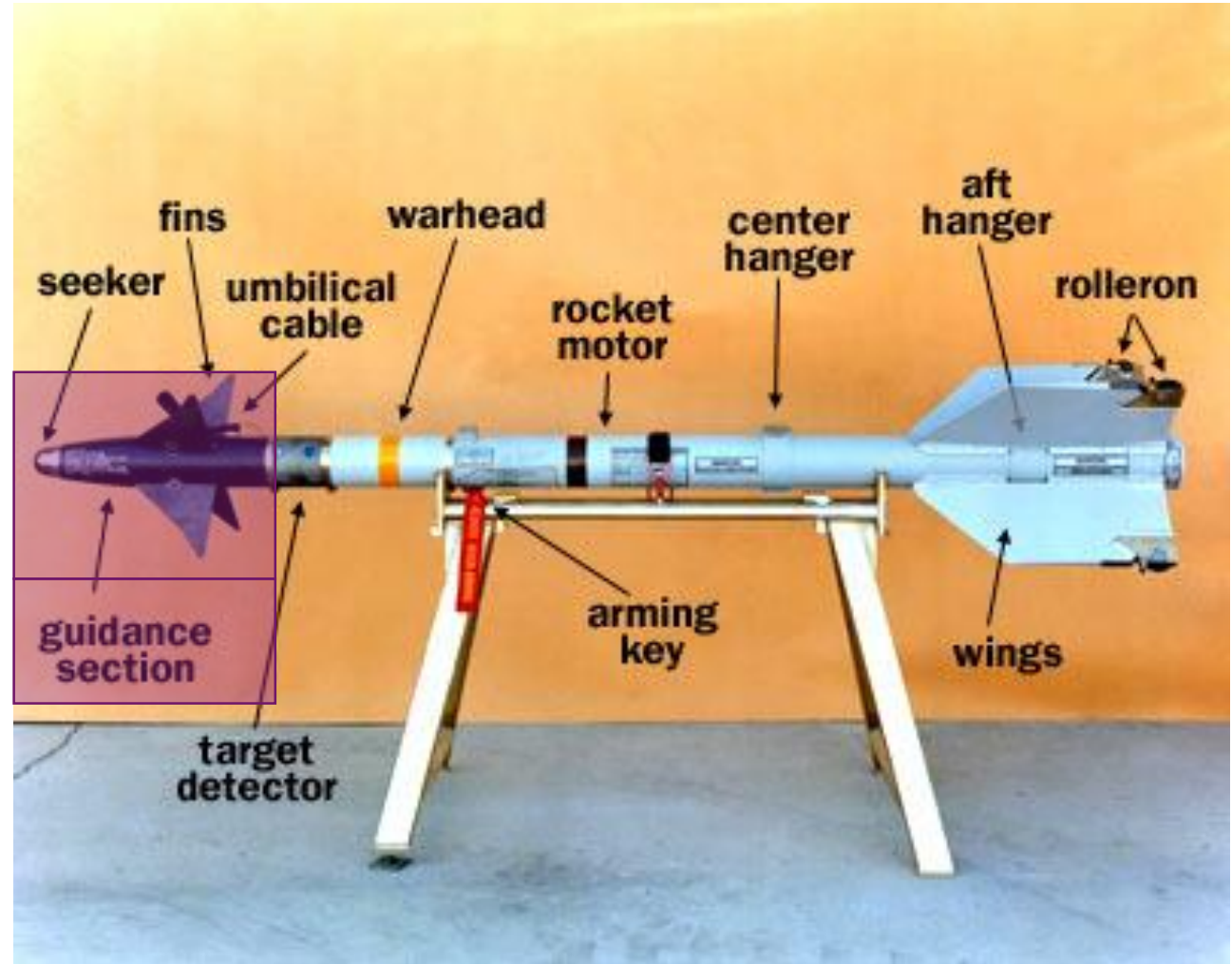
Basic Munition Design

- A modern cartridge consists of the following:
- 1. Bullet or projectile
- 2. Cartridge case
- 3. Propellant
- 4. Rim
- 5. Primer



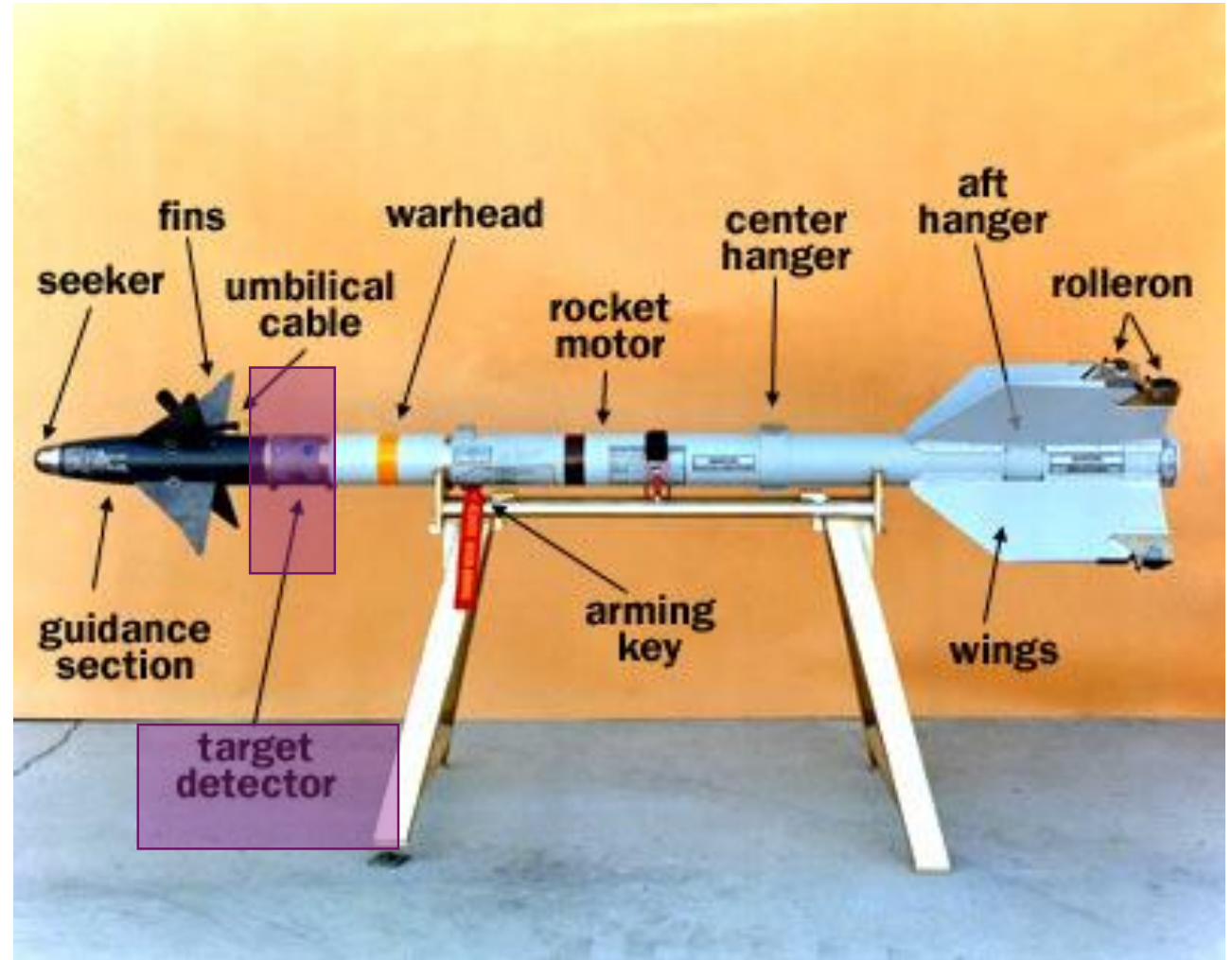
Basic Munition Design

- A Sidewinder Air to Air Missile System:
- Guidance Section
 - Seeker
 - Fins
 - Umbilical cable



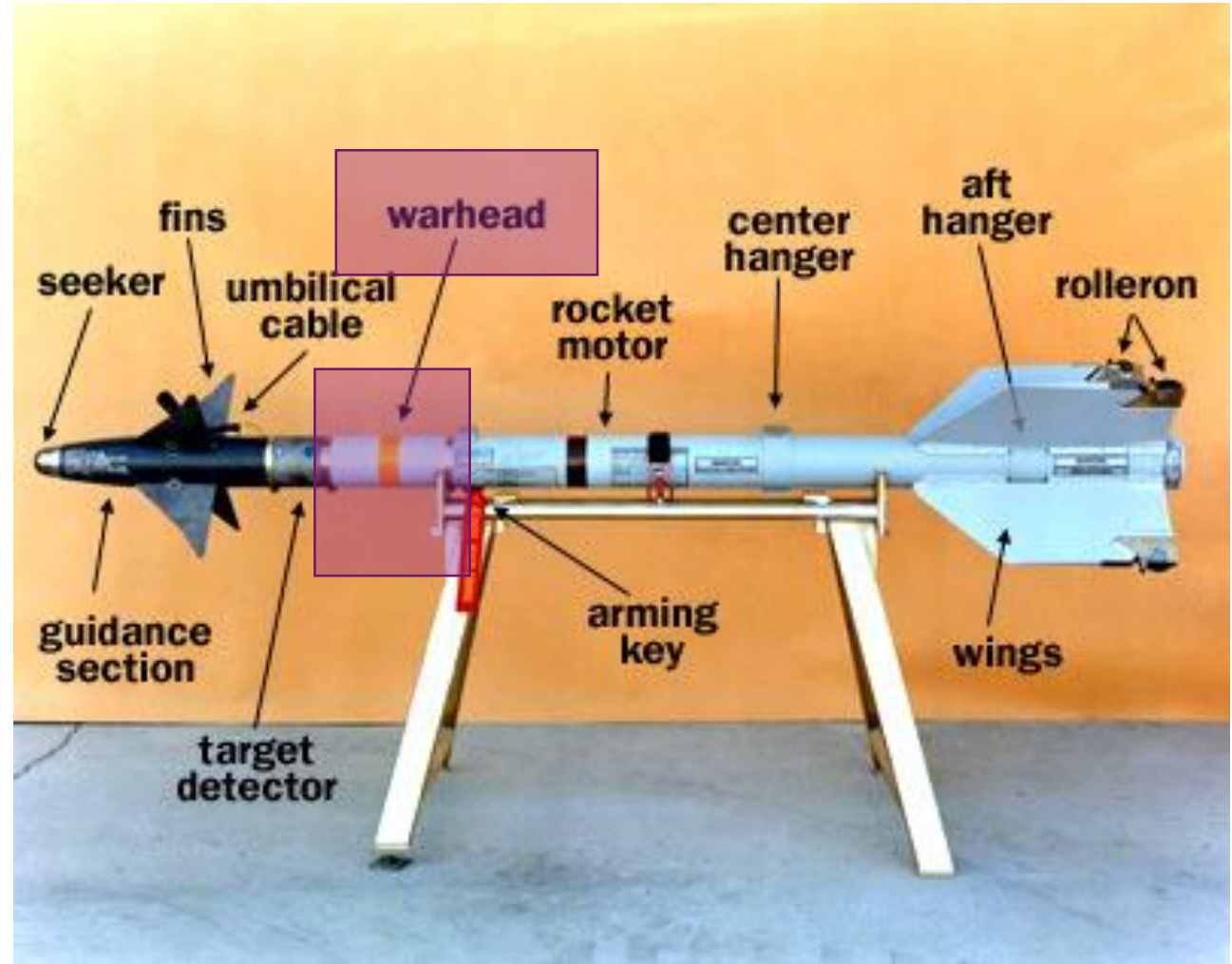
Basic Munition Design

- A Sidewinder Air to Air Missile System:
- Target Detector



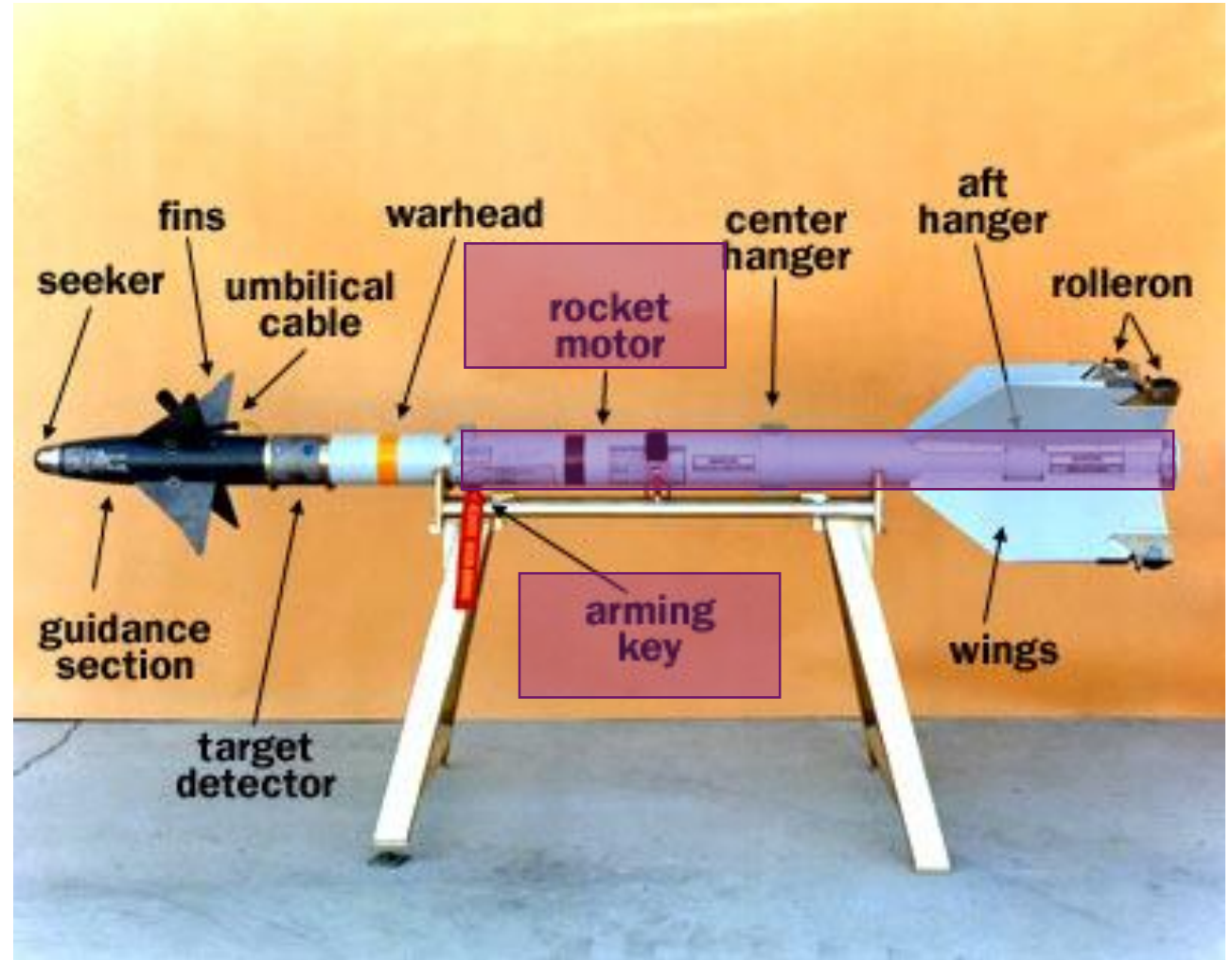
Basic Munition Design

- A Sidewinder Air to Air Missile System:
- Warhead



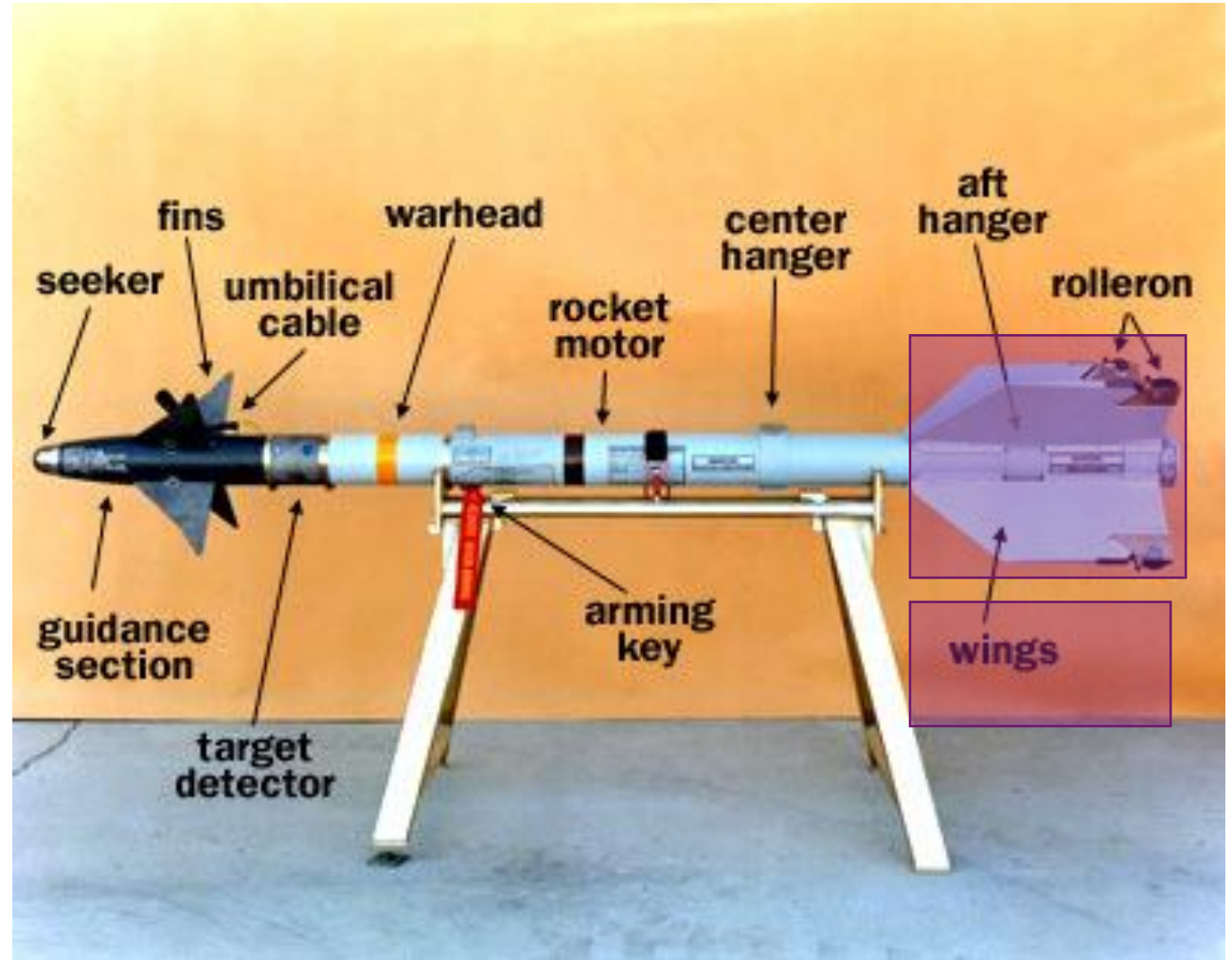
Basic Munition Design

- A Sidewinder Air to Air Missile System:
- Rocket Motor Assembly
 - With arming key



Basic Munition Design

- A Sidewinder Air to Air Missile System:
- Wings
 - With rolleron assemblies



Basic Munition Design

- A Sidewinder Air to Air Missile System:
- Hangers
 - Aft
 - Centre
 - Forward – with rocket motor fire connector



15 minute break

Explosive Principles

What can make explosives unsafe



Explosive Principles

- What circumstances do you think could lead to explosives becoming unsafe?
- Poor storage conditions –resulting in exposure to
- Moisture/Humidity
- Temperature



Explosive Principles

- What circumstances do you think could lead to explosives becoming unsafe?
- Age leading to decomposition

Picture showing old dynamite:

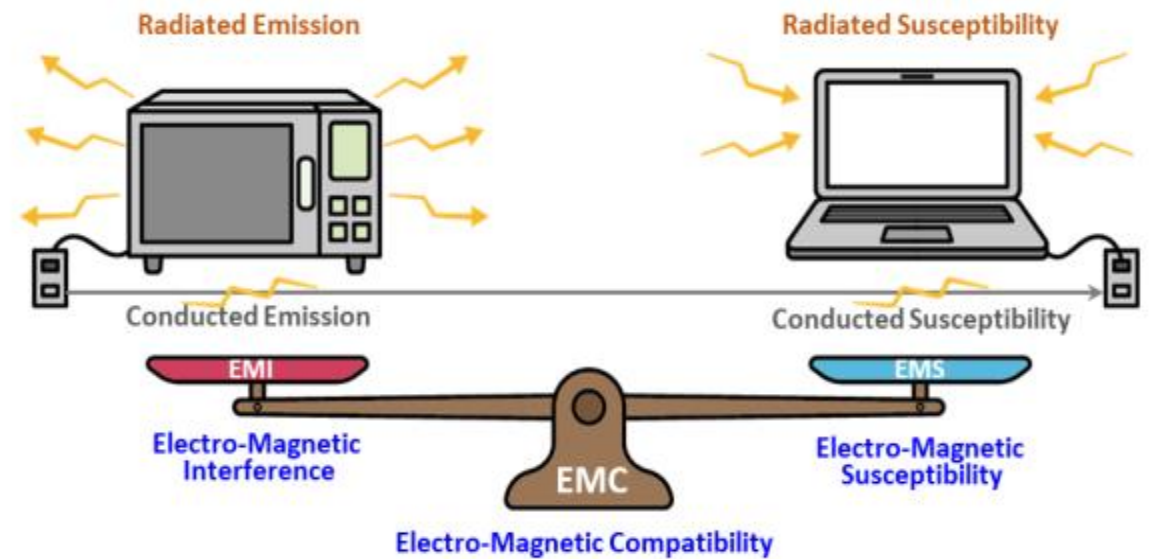
Over time, the dynamite will "weep" or "sweat" its Nitroglycerine, which can then pool in the bottom of the box.

Crystals will form on the outside of the sticks.



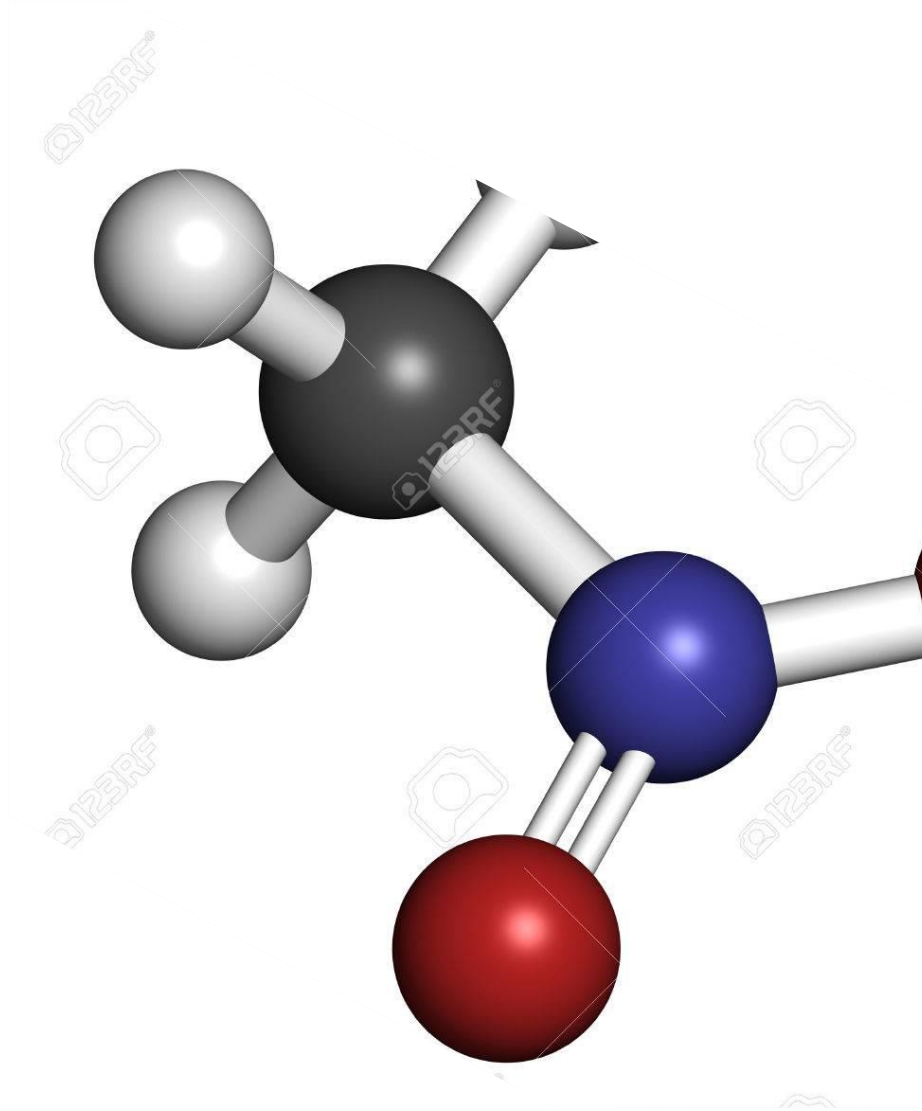
Explosive Principles

- What circumstances do you think could lead to explosives becoming unsafe?
- Poor or incorrect handling resulting to exposure to:
- Friction
- Impact
- Ignition by flame
- Ignition by spark
- Ignition by heat
- Electrostatic discharge
- Electromagnetic Compatibility (EMC)



Explosive Principles

Explosive stability



Explosive Principles

Factors which can affect explosive stability



Temperature

The rate of decomposition of explosives increases at higher temperatures.



Sunlight

When exposed to the ultraviolet rays of sunlight, many explosive compounds containing nitrogen groups rapidly decompose.



Electrical discharge

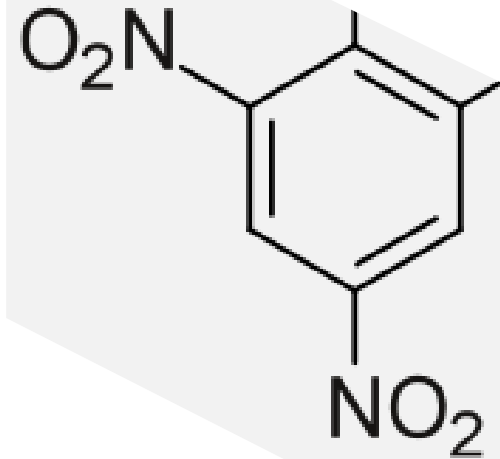
Electrostatic or spark sensitivity to initiation is common in a number of explosives



Correct packaging.
Correct temperature and humidity of storage environment.

Explosive Principles

Effects of ageing, humidity and temperature



Explosive Principles

- Ageing
- Cause explosive to become Instable
- Which can lead to Thermal explosion



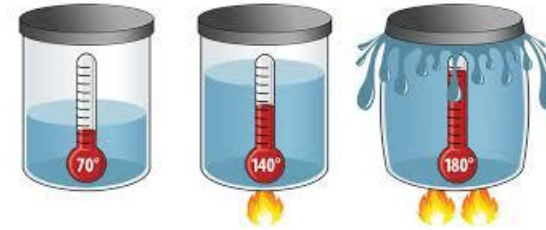
Explosive Principles

- Humidity
- Cause Instability
- Make explosive more Sensitive
- Reduce its Strength
- Reduce its Velocity of detonation



Explosive Principles

- Temperature
- Physical – expansion rates
- Chemical – reduced performance

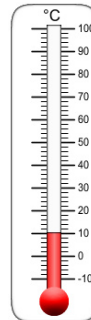


Explosive Principles

- Shelf life
- Chemical deterioration has a profound effect on the shelf-life of many explosives, especially propellants.
- The rate of chemical deterioration is approximately doubled for every 10°C rise in temperature above 30°C.



2x



30° C

Lotting and batching



Lotting and batching

Used to describe discrete quantities of ammunition

Contains

RG = Radway Green

Manufacturer's Monogram

Date of Filling

FNB = Fabrique National Beligue

Lot or Batch Number – Always underlined

All Known as Batch Identity (BI)



Explosive Principles

Shelf life



Explosive Principles

- Shelf life
- Best before – use by date
- Life expiry date
- Finite life of explosives
- All dates are calculated from date of manufacture and LOT number.

SHELF LIFE	
BY _____	DATE _____
EXPIRES _____	



Bans and constraints



Bans and constraints

Ordnance, Munitions and Explosive (OME) are designed and constructed so as to be safe.

Legal requirement for dissemination of information regarding munitions controls and limitations

Joint Service Munitions Control Register (JSMCR).



ADAC	Ban Ref No	NSN	Designation	Ban Bki Mfr	Ban Bki Mth From	Ban Bki Yr From	Ban Bki Pfx	Ban Bki No From	Ban Bki Sfx	Ban Bki Mth To	Ban Bki Yr To	Ban Bki Pfx	Ban Bki No To	Ban Bki Sfx	Ban Appn Date	Ban Text
11203-08	30955	1305-19-000-6236	ROUND 12.7MM 4B/1T LINKED L8A1/L9A1	CBC	07	2008		000010		07	2008		000010		30/03/12	AMMUNITION INVOLVED IN BREACH EXPLOSION. AMMUNITION BANNED FROM ISSUE AND USE PENDING TECHNICAL INVESTIGATION. AMMUNITION IS SAFE TO STORE AND TRANSPORT.
11210-01	30951	1305-21-921-4051	ROUND 12.7MM LRTA 4B/1T LINKED L10A1/L11A1			0				0					10/02/12	BANNED FROM ISSUE AND USE PENDING REVIEW OF SAFETY ADVICE. AMMUNITION IS SAFE TO STORE, PROCESS AND TRANSPORT.
11211-01	30951	1305-20-006-1210	ROUND 12.7MM LRTA 1B/1T LINKED L10A1/L11A1			0				0					10/02/12	BANNED FROM ISSUE AND USE PENDING REVIEW OF SAFETY ADVICE. AMMUNITION IS SAFE TO STORE, PROCESS AND TRANSPORT.
12111-02	30949	1305-99-724-0944	ROUND 0.338 INCH BALL L4A1	T	04	2011		000072		04	2011		000072		15/02/13	BANNED FROM ISSUE AND USE DUE TO PERFORMANCE ISSUES. NO SAFETY CONCERNS. INVESTIGATION PENDING. UNITS REQUIRING REPLACEMENTS STOCK SHOULD REDEMAND USING THIS BAN AS THE AUTHORITY.
12508-03	30848	1305-99-720-6482	ROUND 30MM ADEN PRACTICE MK4Z LHF MK2 LINKED			0				0					11/03/08	AMMUNITION BANNED FROM ISSUE OR USE PENDING TECHNICAL INVESTIGATION. STOCK SAFE TO HANDLE AND TRANSPORT.
12509-03	30848	1305-99-720-6483	ROUND 30MM ADEN PRACTICE MK4Z RHF MK2 LINKED			0				0					11/03/08	AMMUNITION BANNED FROM ISSUE OR USE PENDING TECHNICAL INVESTIGATION. STOCK SAFE TO HANDLE AND TRANSPORT.
12707-01	30874	1370-12-367-1146	ROCKET HAND FIRED PARACHUTE	PSH	10	2008		000001		10	2008		000001		14/05/10	BANNED FROM USE SUBJECT TO FULL TECHNICAL INVESTIGATION
12831-01	30867	1340-99-776-6555	DECOY RETARDER MODULE 1308 10500 DLH	IGQ	02	2004		799181		02	2004		799181		10/08/09	NO MOVEMENT WITHOUT NEW-PT AUTH.POC:AW 9679 37452
12831-01	30867	1340-99-776-6555	DECOY RETARDER MODULE 1308 10500 DLH	IGQ	07	2003		798980		07	2003		798980		10/08/09	NO MOVEMENT WITHOUT NEW-PT AUTH.POC:AW 9679 37452
12831-01	30867	1340-99-776-6555	DECOY RETARDER MODULE 1308 10500 DLH	IGQ	11	2003		799077		11	2003		799077		10/08/09	NO MOVEMENT WITHOUT NEW-PT AUTH.POC:AW 9679 37452
18405-54	30949	1315-99-549-3393	MORTAR BOMB 81MM ILLUMINATING L54A1 FZD DM93 MK4 CHGE SYS	SIL	03	2009		000081	B	03	2009		000081	B	18/01/12	BANNED FROM ISSUE AND USE DUE TO PERFORMANCE ISSUES. NO SAFETY CONCERNS. INVESTIGATION PENDING. UNITS REQUIRING REPLACEMENTS STOCK SHOULD REDEMAND USING THIS BAN AS THE AUTHORITY.
19990-01	30909	1305-12-383-1736	ROUND 7.62MM 4AP/1T LINKED L57A1/L47A1	MEN	11	2010		000822		11	2010		000822		17/03/11	BANNED FROM ISSUE AND USE PENDING REPACK, AMMUNITION IS REQUIRED FOR TRIALS. AMMUNITION IS SAFE TO STORE AND TRANSPORT.
35470-24	30930	1315-99-818-7041	CARTRIDGE PROPELLING 105MM FD NORMAL L35A3	GD	07	2008		000029	BX	07	2008		000029	BX	16/08/11	FOR KINETON DEPOT ONLY. THE L35A3 CHARGES AFFECTED BY THIS BAN ARE PART OF A PROPELLANT STABILISER TRAIL AND ARE NOT TO BE ISSUED UNTIL COMPLETION OF THE TRIAL.

ADAC	Ban Ref No	NSN	Designation	Ban Bki Mfr	Ban Bki Mth From	Ban Bki Yr From	Ban Bki Pfx	Ban Bki No From	Ban Bki Sfx	Ban Bki Mth To	Ban Bki Yr To	Ban Bki Pfx	Ban Bki No To	Ban Bki Sfx	Ban Appn Date	Ban Text
11203-08	30955	1305-19-000-6236	ROUND 12.7MM 4B/1T LINKED L8A1/L9A1	CBC	07	2008		000010		07	2008		000010		30/03/12	AMMUNITION INVOLVED IN BREACH EXPLOSION. AMMUNITION BANNED FROM ISSUE AND USE PENDING TECHNICAL INVESTIGATION. AMMUNITION IS SAFE TO STORE AND TRANSPORT.
11210-01	30951	1305-21-921-4051	ROUND 12.7MM LRTA 4B/1T LINKED L10A1/L11A1			0					0				10/02/12	BANNED FROM ISSUE AND USE PENDING REVIEW OF SAFETY ADVICE. AMMUNITION IS SAFE TO STORE, PROCESS AND TRANSPORT.
11211-01	30951	1305-20-006-1210	ROUND 12.7MM LRTA 1B/1T			0					0				10/02/12	BANNED FROM ISSUE AND USE PENDING REVIEW OF
NATO Stock Numl 1305-19-000-6236 Designation: 4B/1T linked Ban Bki Numbe CBC Ban Bki Companhia Brasileira de Cartuchos Ban Approv Ban Text: Ammunition involved in breech explosion. Ammunition Banned from issue and use pending technical investigation. Ammunition is safe to store and transport.																
12506-03	30848	1305-99-720-6482	ROUND 30MM ADEN PRACTICE MK4Z LHF M LINKED												11	
12509-03	30848	1305-99-720-6483	ROUND 30MM ADEN PRACTICE MK4Z RHF MK2 LINKED			0					0				11	
12707-01	30874	1370-12-367-1146	ROCKET HAND FIRED PARACHUTE	PSH	10	2008		000001		10	2008		000001		14	
12831-01	30867	1340-99-776-6555	DECOY RETARDER MODULE 1308 10500 DLH	IGQ	02	2004		799181		02	2004		799181		10	
12831-01	30867	1340-99-776-6555	DECOY RETARDER MODULE 1308 10500 DLH	IGQ	07	2003		798980		07	2003		798980		10/08/09	NO MOVEMENT WITHOUT NEW-PT AUTH.POC:AW 9679 37452
12831-01	30867	1340-99-776-6555	DECOY RETARDER MODULE 1308 10500 DLH	IGQ	11	2003		799077		11	2003		799077		10/08/09	NO MOVEMENT WITHOUT NEW-PT AUTH.POC:AW 9679 37452
18405-54	30949	1315-99-549-3393	MORTAR BOMB 81MM ILLUMINATING L54A1 FZD DM93 MK4 CHGE SYS	SIL	03	2009		000081	B	03	2009		000081	B	18/01/12	BANNED FROM ISSUE AND USE DUE TO PERFORMANCE ISSUES, NO SAFETY CONCERNS. INVESTIGATION PENDING. UNITS REQUIRING REPLACEMENTS STOCK SHOULD REDEMAND USING THIS BAN AS THE AUTHORITY .
19990-01	30909	1305-12-383-1736	ROUND 7.62MM 4AP/1T LINKED L57A1/L47A1	MEN	11	2010		000822		11	2010		000822		17/03/11	BANNED FROM ISSUE AND USE PENDING REPACK, AMMUNITION IS REQUIRED FOR TRIALS. AMMUNITION IS SAFE TO STORE AND TRANSPORT.
35470-24	30930	1315-99-818-7041	CARTRIDGE PROPELLING 105MM FD NORMAL L35A3	GD	07	2008		000029	BX	07	2008		000029	BX	16/08/11	FOR KINETON DEPOT ONLY. THE L35A3 CHARGES AFFECTED BY THIS BAN ARE PART OF A PROPELLANT STABILISER TRAIL AND ARE NOT TO BE ISSUED UNTIL COMPLETION OF THE TRIAL.

Bans and constraints

A Ban

Temporary or permanent instruction ordering the immediate prohibition of use of a munition.

- Segregated
- NOT FOR ISSUE OR USE".
- The ban serial number.
- Any special instructions



Bans and constraints

A Constraint

Imposition of a specific limitation or restriction within the whole life of the munition

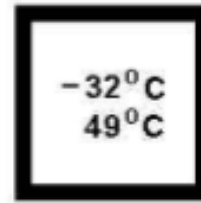
Examples of constraints include:

Changes to storage temperatures.

Special handling instruction.

Item for training use only.

Change of Life parameters



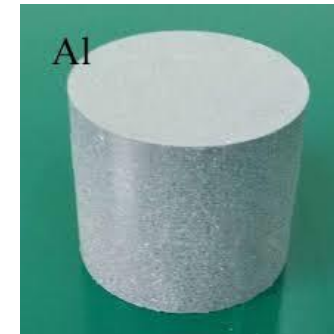
Storing sensitive substances.



Storing sensitive substances.

Special arrangements need to be made for the storage of explosives which cannot be classified, for example:

- New explosives for which no explosive hazard data sheet has been completed.
- Deteriorated explosives
- Experimental explosives
- Explosives with doubts about their safety or stability.
- Explosives in damaged packages.



Storing sensitive substances.

Arrangements to be decided on by Head of Site, but may include:

- Reduced explosive limits
- Reduced man limits
- Segregation
- Isolation

~~500 KG~~



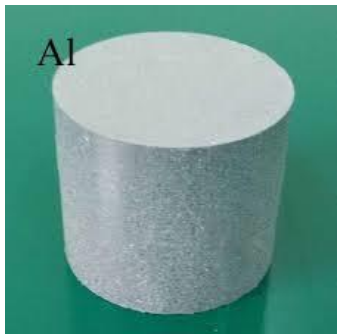
200 KG



Storing sensitive substances.

Typical stores which may require segregation or isolation are:

- Unserviceable stores that are suspected of being unsafe.
- Salvaged stores recovered after a trial, explosion, fire or accident.
- Stores that have failed to function and are unsafe for use, but not unsafe for storage.
- Explosives recovered during EOD operations
- Upon instruction from MoD PT or supplier
- Experimental explosives.



Our Ref: FOI2014/04793

Your Ref:

Ministry of Defence
Main Building (01/D/06)
Whitehall
London SW1A 2HB
United Kingdom





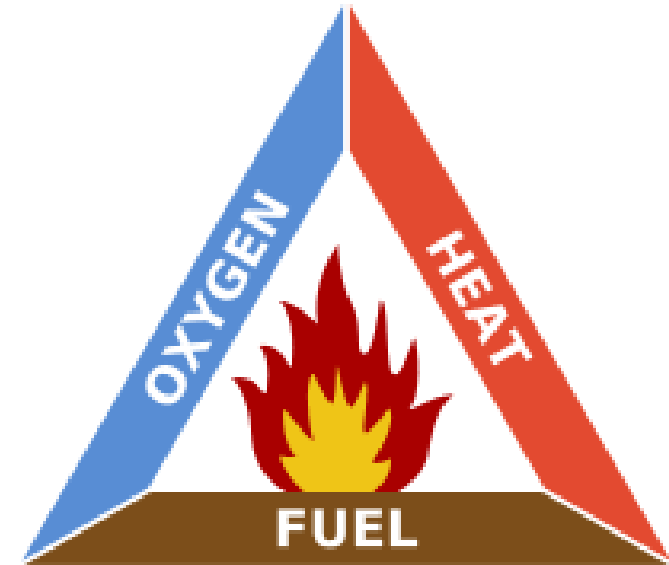
Difference between a conventional fire and a fire involving explosives

Difference between a conventional fire and a fire involving explosives

The Fire Triangle or Combustion Triangle is a simple model for understanding the necessary ingredients for most fires.

The triangle illustrates the three elements a fire needs to ignite:

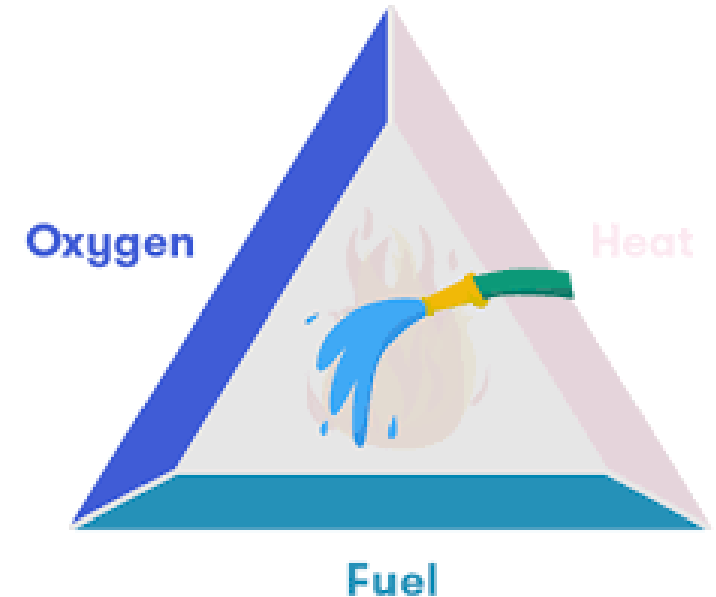
heat,
fuel,
and an oxidizing agent (usually oxygen).



Difference between a conventional fire and a fire involving explosives

We all know that if we remove one of the elements the fire will be extinguished.

Normally to do this we use a fire extinguisher, for example, remove the HEAT with water.



Difference between a conventional fire and a fire involving explosives

Fires involving explosives are far more complicated.

DSEAR stands for the Dangerous Substances and Explosive Atmospheres Regulations 2002.

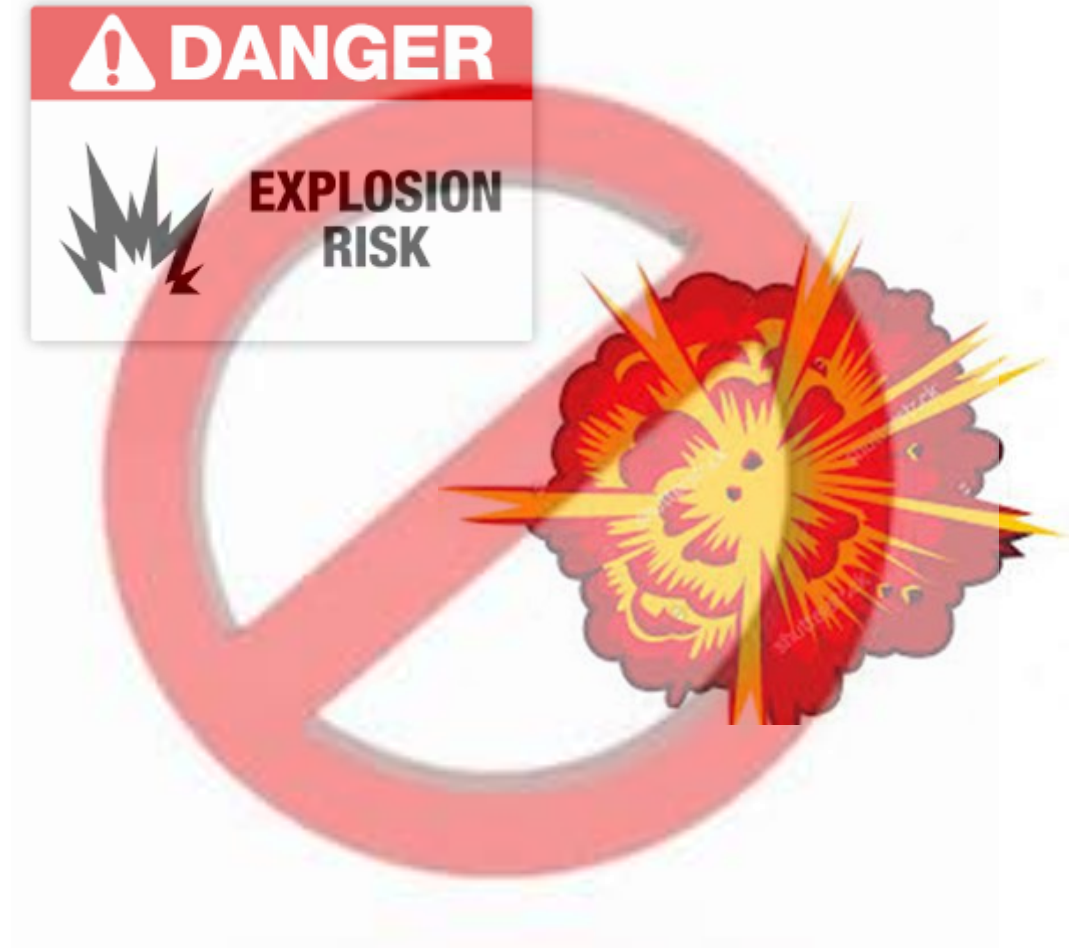
DSEAR puts duties on employers and the self-employed to protect people from these risks to their safety in the workplace, and to members of the public who may be put at risk by work activity



Difference between a conventional fire and a fire involving explosives

How do we fight fires involving explosives?

WE DO NOT FIGHT FIRES INVOLVING EXPLOSIVES



Explosive Disposal – Safety



Explosive Disposal – Sources of ignition

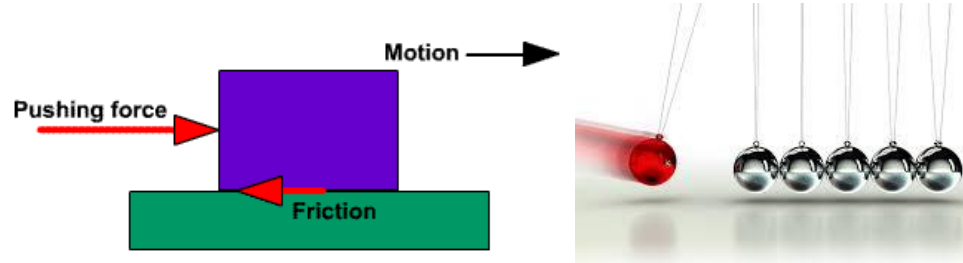
- When carrying out explosive disposal, what sources of ignition should you consider?



Explosive Disposal – Sources of ignition

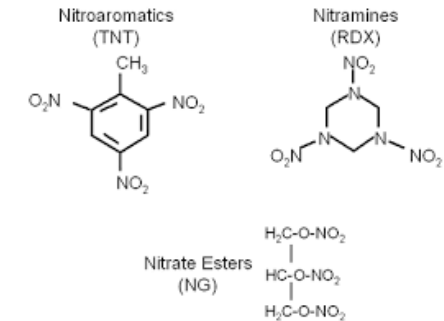
• The common issues are:

- Friction
- Impact
- Ignition by flame
- Ignition by heat
- Electrostatic discharge
- Inadequate procedures
- Inadequate supervision
- Poor maintenance



The Academy

- The common issues are:
- Ignition of solvent vapour, dust or reaction by-product
- Inadequate removal of explosive material
- Lack of knowledge of presence of explosive material requiring disposal or destruction
- Lack of knowledge of the properties of explosive materials
- Inappropriate confinement
- Poor control of equipment requiring treatment, modification or disposal at facilities outside process area



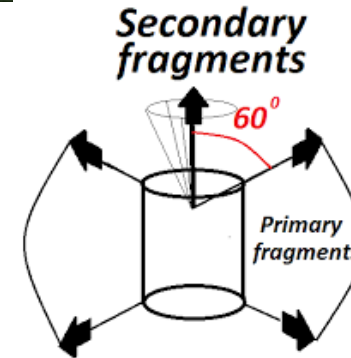
Explosive Disposal – Sources of ignition

- Previous incidents have shown there is a range of circumstances leading to
- Premature
- Unwanted, or
- Unplanned events and explosions

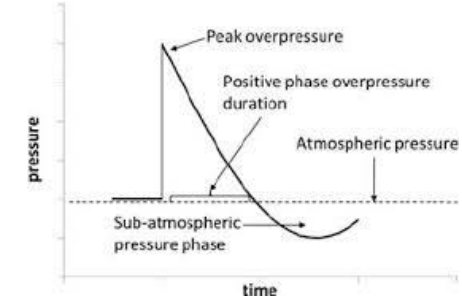


Explosive Disposal – Sources of ignition

- Hazard identification should consider:
- Shock or other effects derived from the brisance of explosives
- Blast overpressure
- The formation and propulsion from an event of primary and secondary fragments
- Projected burning brands
- Projected pyrotechnic effects
- Projected explosive sub-assemblies or complete pyrotechnic and/or explosive articles.



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Explosive Disposal – Incidents

- The following are actual events published by the HSE.
- Contrary to instructions, two workers tipped a box of waste firework composition on to the ground, which had been used for burning other materials earlier in the day and stirred or spread the material with a steel pole.
- The waste composition ignited causing burns to both workers.



Explosive Disposal – Incidents

- The following are actual events published by the HSE.
- Three soldiers died when inspecting a disposal site.
- Munitions had been detonated in an unventilated area and the soldiers succumbed to carbon monoxide poisoning during the subsequent inspection



Explosive Disposal – Incidents

- The following are actual events published by the HSE.
- A man received fatal injuries whilst destroying obsolete signal distress rockets.
- The rockets were being destroyed by lighting the fuze and pointing the rocket into an incinerator.
- The man was killed when a rocket discharged backwards.

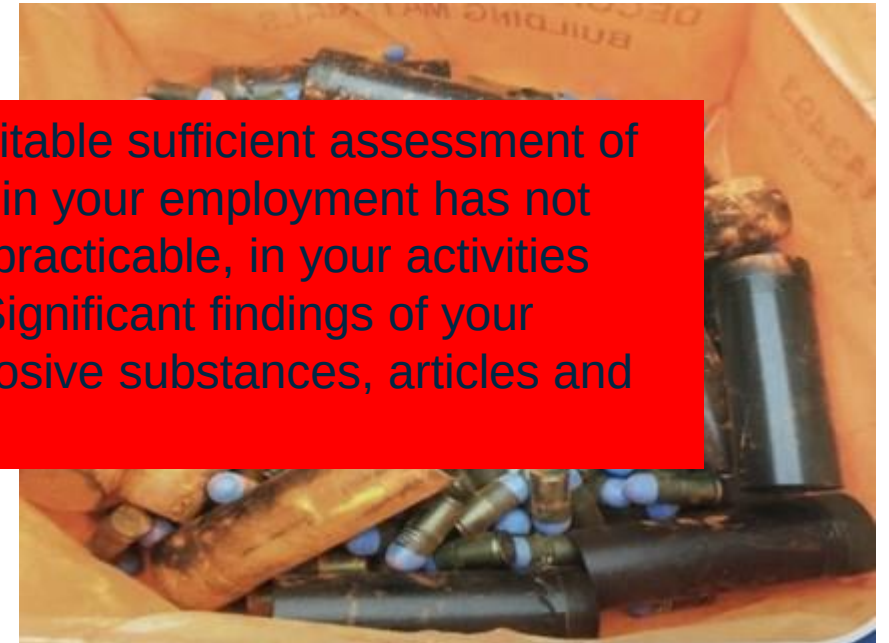


Explosive Disposal – Incidents

- Has QinetiQ ever had any incidents involving explosives?
- HSE Improvement notice 309259408, 12/09/2018

1 x Improvement Notice (KL/QQ/120918/1, 309259408) issued:- a suitable sufficient assessment of the risks to the health and safety of your employees and persons not in your employment has not been made to ensure their health and safety, so far as is reasonably practicable, in your activities relating to the disposal of explosive substances, articles and waste. Significant findings of your existing risk assessments for activities relating to the disposal of explosive substances, articles and waste have not been suitably recorded.

- Round functioned



Course Objectives – Day 1

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- | | |
|---|--|
| 1 | Explain the nature and characteristics of explosives |
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| 2 | Explain Hazard Divisions, Compatibility Groups and Hazard Types |
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| 3 | Describe Explosion types and Basic Explosive Chemistry |
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|---|-----------------------------|
| 4 | Explain the Explosive Train |
|---|-----------------------------|
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|---|---|
| 5 | Be able to identify Explosives, Ammunition Markings and Basic Munition Design |
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| 6 | Describe circumstances which can make Explosive Unsafe |
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| 7 | Understand Lotting Batching, Bans Constraints and Safe Storage |
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|---|---------------------------------------|
| 8 | Understand fires involving Explosives |
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|---|--------------------------------------|
| 9 | Understand Explosive Disposal Safety |
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