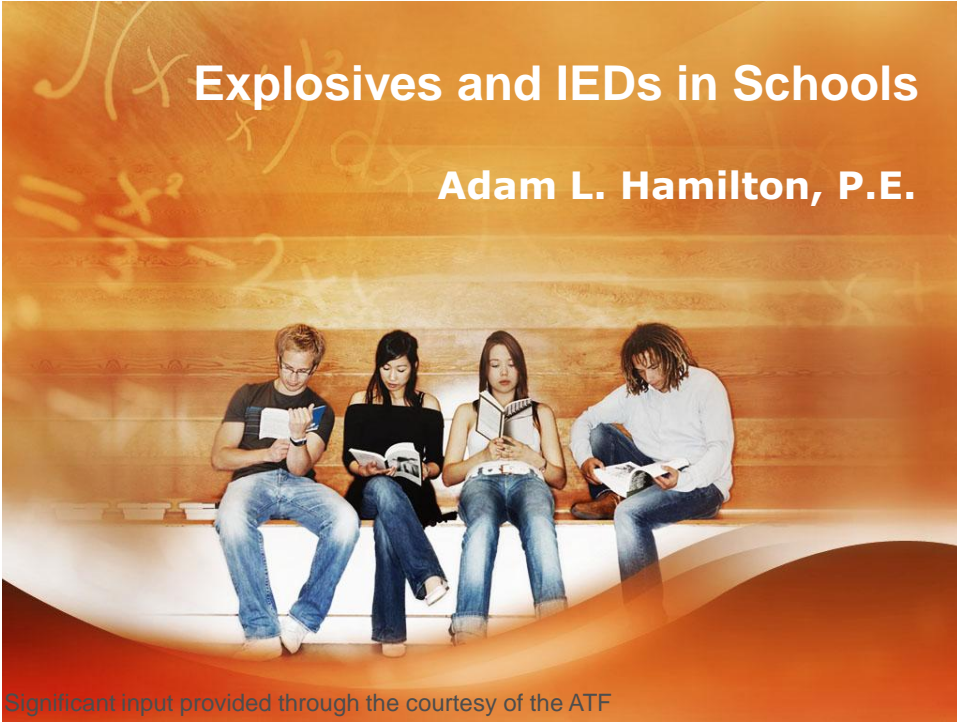


# Explosives and IEDs in Schools

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Significant input provided through the courtesy of the ATF

## Learning Goals

- I. Understand the concepts of an explosion
- II. Recognize different types of explosive devices
- III. Know the components of an explosive device
- IV. Become familiar with potential explosive concealment and delivery techniques
- V. Recognize potential indications and warnings
- VI. Be able to respond appropriately to observed potential threats
- VII. Enhance familiarity with blast injuries and first aid

## Outline

1

Explosions (20m)

2

Device Components (40m)

3

Recognition and Pre-Response (20m)

4

Injuries (10m)

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## 1) Explosions

15 minutes

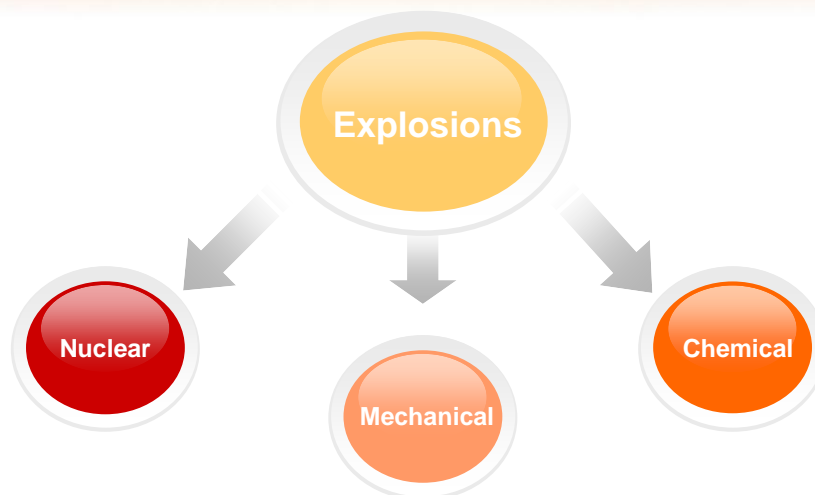


## Learning Objectives

1. Recall the three types of explosions
2. Explain the difference between deflagration and detonation
3. Name the two phases of an explosion

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## Types of Explosions



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## Nuclear Explosion

- Fission - splitting of the nucleus of atoms
- Fusion - under great force joining together the nuclei of atoms



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## Mechanical Explosion



Boiling Liquid Expanding Vapor Explosion (BLEVE)

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## Chemical Explosion

### A Detonation of Composition 4 (C-4)



Note shock wave

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## Decomposition, Deflagration, and Detonation

- Explosive materials can decompose, deflagrate, or detonate
- The difference is how long the process takes
- Decomposition may take years, days, or hours
- Of more interest to us are
  - Deflagration
  - Detonation

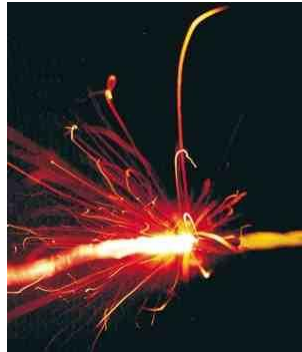


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## Deflagration

- Deflagration
  - Rapid but subsonic combustion
  - Particle to particle burning
  - Requires confinement to explode



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## Low Explosives

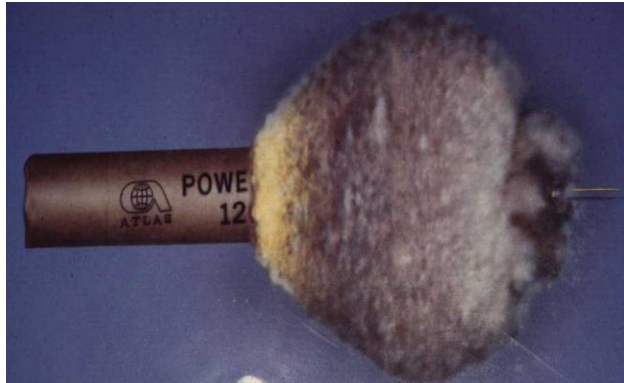
- Deflagration
- Requires confinement for explosion
- Initiated by flame, spark, heat, and/or friction
- Black powder and smokeless powder most common



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## Detonation

- Nearly instantaneous combustion
- Chemical reaction of an explosive substance which produces a shock wave, heat and noise



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## Detonation Velocity

- The single most important property used in “rating” an explosive material
- The rate at which the detonation/combustion wave travels through the explosive product
- Typical detonation velocities in gases range from 1,800 m/s to 3,000 m/s (~5,900 to 9,800 ft/s)
- Typical velocities in solid explosives often range beyond 4,000 m/s to 10,300 m/s (~13,100 to 33,800 ft/s)

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## Detonation Velocities of Common Explosives

	Acronym	Det Vel (m/s)	Det Vel (ft/s)
Trinitrotoluene	TNT	6,900	22,640
Picric Acid	TNP	7,350	24,140
Nitroglycerine	NG	7,700	25,260
Pentaerythritol Tetranitrate	PETN	8,400	27,560
Cyclotrimethylene-trinitramine	RDX	8,750	28,700
Cyclotetramethylene Tetranitramine	HMX	9,100	29,860
Ammonium Nitrate	AN	5,270	17,290

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## High and Low Order

- High order - complete consumption of the explosive at its optimum velocity
- Low order – incomplete consumption, or complete at a lower than optimum velocity

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## Example of Low Order Explosion



### The Blast

- All explosions will have two phases
  - Positive pressure
  - Negative pressure
- The shock wave will...

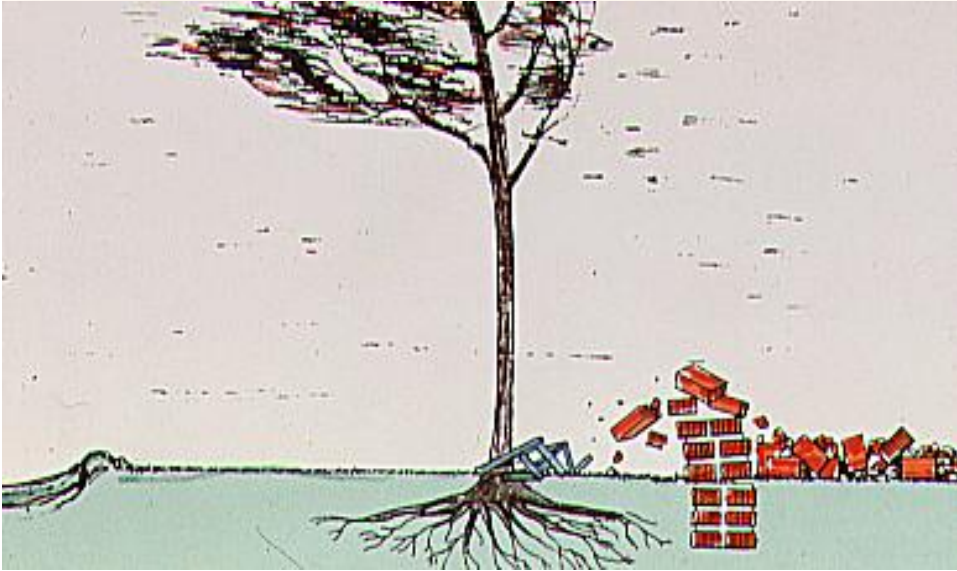
## Conditions Prior to an Explosion



## Positive Pressure Phase



## Negative Pressure Phase



## Conditions after an Explosion





## 2) Devices and Components

30 minutes



### Learning Objectives

1. Name at least four components of an explosive device
2. List at least three types of switches/triggering devices
3. Identify potential explosive materials from a list of various materials
4. List at least three types of IED enhancements that can be used to increase the number of injuries

## Device Components

- Power source
  - Usually a battery (or batteries)
- Switch
  - Arming or fusing
- Initiator
  - Used to start the detonation in the main explosive
- Explosive
  - Main charge
- Shrapnel/fragmentation
  - Materials added or intended to inflict maximum casualties

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## Power Sources

- Electric circuits with battery power are commonly used
  - Typically not watch or calculator batteries



- Some devices may not have a “power source”
  - What kinds?

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## Switches

- Manual
  - Wired
  - Integral
- Remote
  - Wired
  - Wireless
- Timer
  - Electronic
  - Mechanical
- Trigger
  - Contact
  - Trip-wire
  - Tamper
- Combination



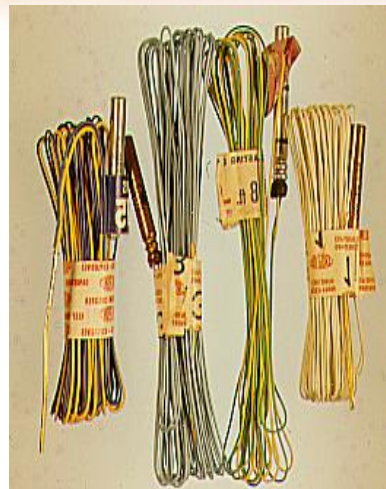
- Pager
- Mobile phone
- Garage door opener



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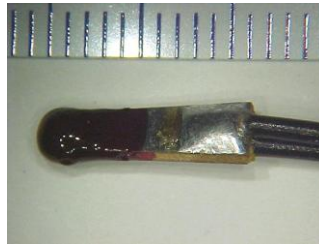
## Electric Blasting Caps (Initiators)

- These devices have no legitimate uses on school property



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## Electric Match Igniters



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## Electric Match Igniters



- These devices have no legitimate use on school property

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## Quick Match



A non-electrical initiator



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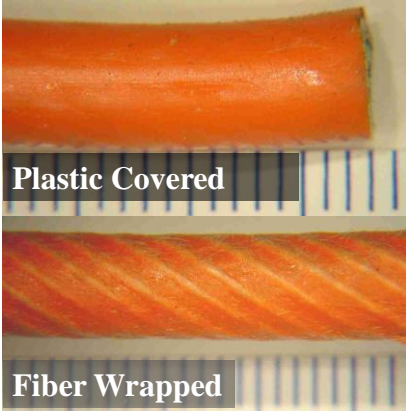
## Pyrotechnic Fuse



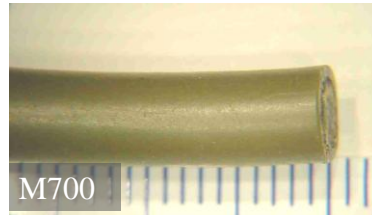
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## Safety Fuse

### Commercial



### Military



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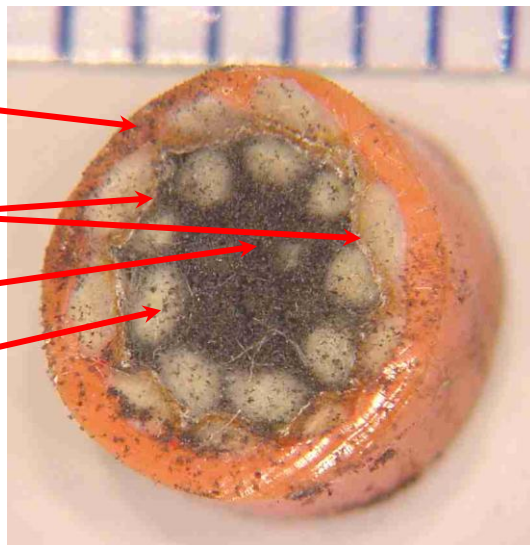
## Commercial Safety Fuse (Plastic Covered)

Outer Plastic Cover  
(Waterproofing)

Fiber Wrap (White)

Black Powder Core

Core Fiber (White)



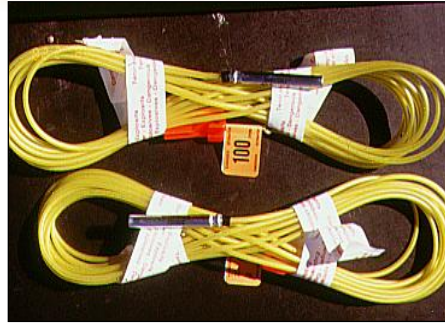
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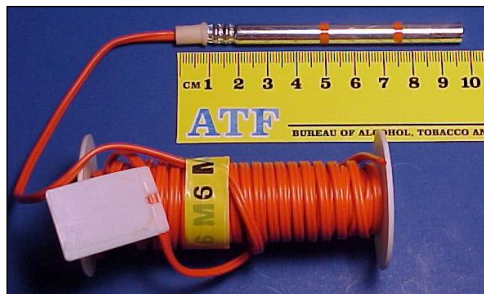
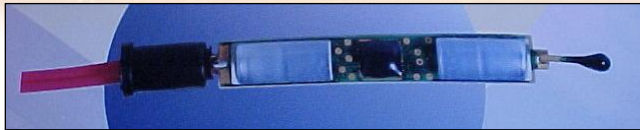


## Shock Tube Initiation Systems

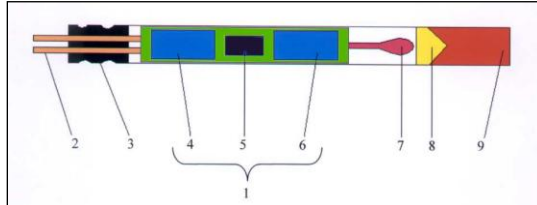


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## Electronic Detonators



## Electronic Detonators



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## Explosives

All explosives contain:

- Fuel – Substances that readily accept oxygen molecules, either from the air or from an oxidizer
  - Powdered aluminum
  - Magnesium
  - Oil/diesel fuel
  - Sulfur
  - Charcoal
  - Sugar
  - Etc.
- Oxidizer - substances that readily give up oxygen molecules
  - Ammonium nitrate
  - Chlorates



Powdered Aluminum

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## Black Powder

- Does not deteriorate with age if stored properly
- It may absorb moisture which reduces its effectiveness
- Once black powder dries out, its effectiveness is restored



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## Smokeless Powder

- Frequently used in pipe bombs and as a propelling powder in small arms, cannons and rockets
- Manufactured as single base, double base and, rarely for the commercial market, as a triple base



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## Smokeless Powder

- Sensitive to heat, spark, friction or impact
- Usually gray or black, or green in color



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It can be found in

## Secondary High Explosives

- Less sensitive to heat, shock, impact or friction than primary explosives
- **Usually** requires a detonator or detonator and booster to initiate
- Often used as boosters



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## Blasting Agents

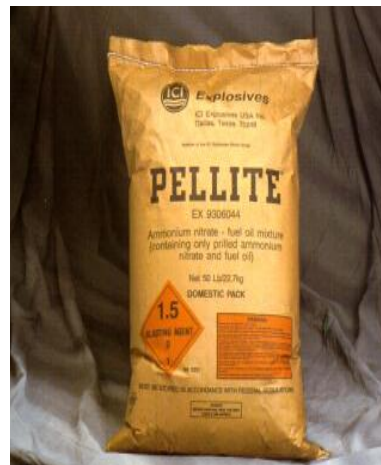
- One of the least sensitive of all explosives
- Consist mainly of ammonium nitrate



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## Blasting Agent - Ammonium Nitrate (ANFO)

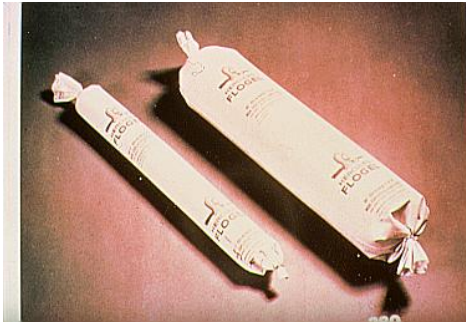
- AN is the basic ingredient in all commercial blasting agents
  - Common fertilizer
  - Extremely hygroscopic
  - Requires a booster



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## Water Gels/Slurries



- Less sensitive
- May be classified as a blasting agent
- Water may make up 5% to 40% of the compound
- Usually have ammonium or sodium nitrate

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## Emulsions

- Blended mixture of ammonium nitrate and density control materials such as micro-balloons and oil



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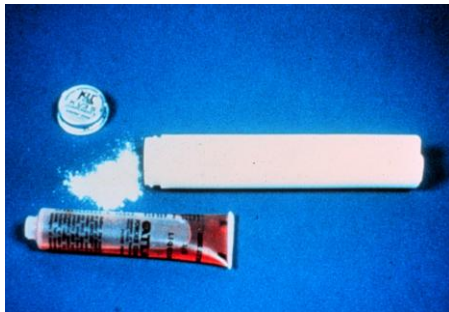
## Binary Explosives (Two-Part Explosives)

- One container holds fuel, usually nitromethane
- One container holds oxidizer, usually ammonium nitrate
- Not an explosive until mixed together



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## Binary Mixtures



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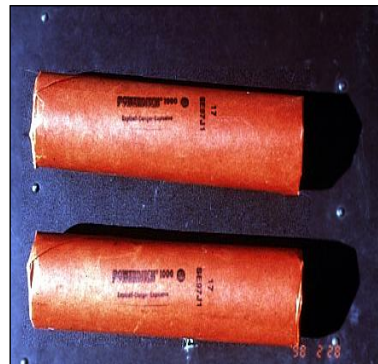
## Dynamite



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## Straight Dynamite

- Sodium Nitrate added to supply oxygen and increase strength
- Heavy, pungent, sweet odor
- NG vapors quickly absorbed and cause severe headaches
- Velocity of approximately 5,000 MPS



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## Ammonia Dynamite

- Portion of NG replaced with Ammonia and Sodium Nitrate



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## Ammonium Dynamite



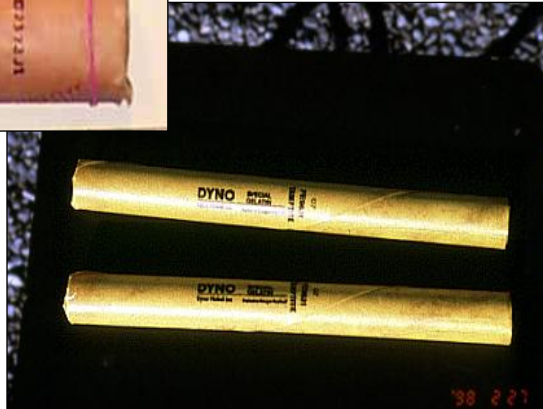
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## Gelatin Dynamite



Dynamite with added Nitrocellulose



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## Trinitrotoluene (TNT)

Standard by which most other explosives are measured



Detonates at approximately 6,700 meters per second

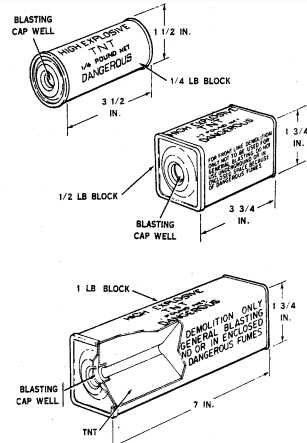


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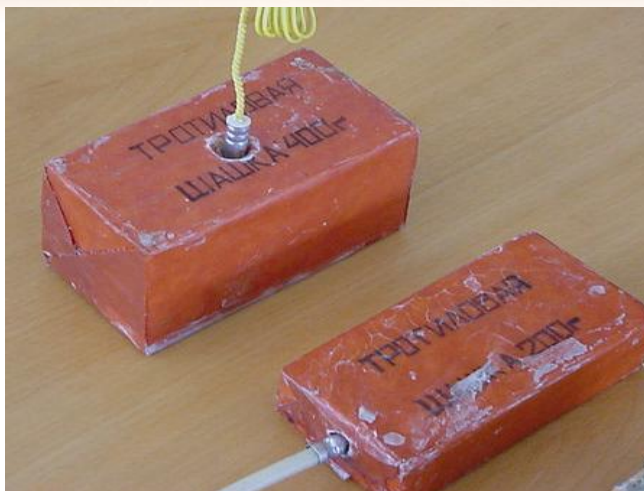
## TNT

- US TNT blocks are sold in .11, .5, and .45 kg
- Metal ends with a threaded detonator well in one end
- Light yellow to brown in color or sometimes gray



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## TNT



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## Military Dynamite



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## RDX and HMX

- RDX - Research Development Formula X, also known as cyclonite. Used in detonating cord, detonators, C-4 and Semtex
- HMX - Her Majesty's Explosive, also known as homocyclonite, a by product of RDX

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## High-Explosive Compound



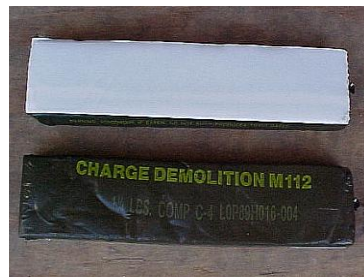
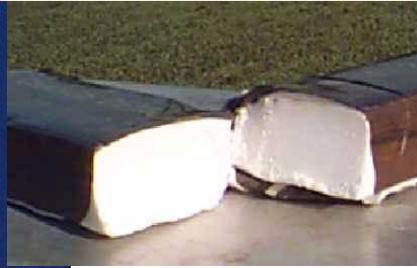
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## Composition 4 (C-4)



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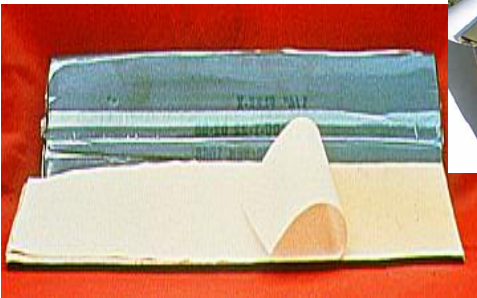
## C-4



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## Sheet Explosives

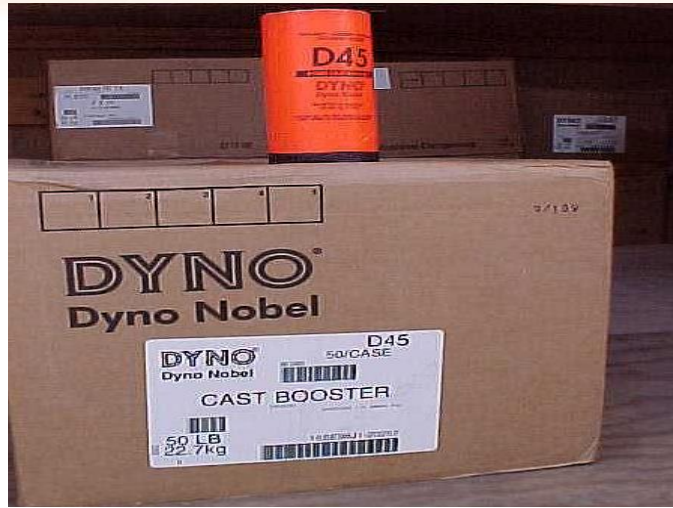
- FLEX-X or Detasheet



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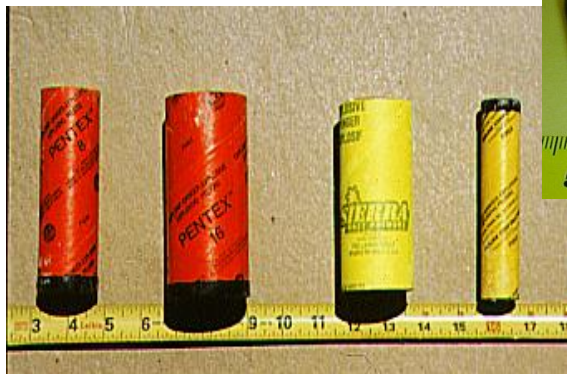


## Boosters



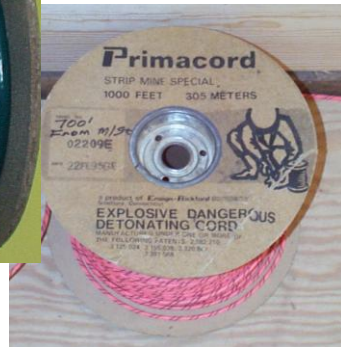
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## Boosters



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## Detonating Cord (Det Cord)



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## Det Cord

- Used to interconnect multiple charges
- Used to initiate a main charge
- Unlike safety fuse, which has a black core, detonating cord usually has a white (PETN) core



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## Detonation (Det) Cord



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## TATP (Triacetone Triperoxide)



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## HMTD (Hexamethelenediamine Peroxide)



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## Fragmentation

- Fragmentation occurs when material which had been a part of the bomb casing or objects nearby are ruptured in the blast



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## Shrapnel

- Additional objects, such as nails, ball bearings, fence staples, that are attached to the device
- Anti-personnel
- May be placed inside or outside the device



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## 3) Recognition and Pre-Response

20 minutes



## Recognizing Bombers

- Know your students, staff, and faculty
  - Thoughtfully challenge (you may not want to aggressively challenge a homicide bomber!)
- Look for
  - Behaviors
  - Concerns
  - Scenarios



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## Behaviors

- Nervousness
  - Hands
    - In pockets
    - Cupped
  - Favoring
  - Adjusting
  - Patting
  - Coming and going
  - Rehearsals
  - Time fixation
  - Rigidity/lack of range of motion
- Intense focus
  - Awkward attempts to blend in
  - Avoidance of authorities
  - Attraction to authorities



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## Concerns

- Inappropriate, oversize, loose-fitting clothing
- Unusual bulk
- Packages
- Projected angles (“printing”)
- Wires
- Triggering devices



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## Scenarios

- Significant dates
- School calendar
- Large groups
- Religious groups
- Locations with limited visibility
- Triggering events
- Unauthorized visitors, service providers, or deliveries
- Locations of most potential damage

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## Vehicle-Borne Explosives



Does a VBIED always stand out?



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## VBIED Evacuation Distances

Vehicle Type	Explosives Capacity	Lethal Air Blast	Minimum Evacuation
Compact	500 lbs	100 ft	1,500 ft
	227 kg	30 m	457 m
Full-Size	1,000 lbs	125 ft	1,750 ft
	455 kg	38 m	534 m
Van	4,000 lbs	200 ft	2,750 ft
	1,818 kg	61 m	838 m
14 ft Truck	10,000 lbs	300 ft	3,750 ft
	4,545 kg	91 m	1,143 m
Water/Fuel Truck	30,000 lbs	450 ft	6,500 ft
	13,636 kg	137 m	1,982 m
Semi	60,000	600 ft	7,000 ft
	27,273 kg	183 m	2,134 m

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## Terrorist Bomb Threat Stand-Off Distances

THREAT	THREAT DESCRIPTION	EXPLOSIVES CAPACITY <sup>1</sup> (TNT EQUIVALENT)	BUILDING EVACUATION DISTANCE <sup>2</sup>	OUTDOOR EVACUATION DISTANCE <sup>3</sup>
	PIPE BOMB	5 LBS/ 2.3 KG	70 FT/ 21 M	850 FT/ 259 M
	BRIEFCASE/ SUITCASE BOMB	50 LBS/ 23 KG	150 FT/ 46 M	1,850 FT/ 564 M
	COMPACT SEDAN	500 LBS/ 227 KG	320 FT/ 98 M	1,500 FT/ 457 M
	SEDAN	1,000 LBS/ 454 KG	400 FT/ 122 M	1,750 FT/ 534 M
	PASSENGER/ CARGO VAN	4,000 LBS/ 1,814 KG	640 FT/ 195 M	2,750 FT/ 838 M
	SMALL MOVING VAN/DELIVERY TRUCK	10,000 LBS/ 4,536 KG	860 FT/ 263 M	3,750 FT/ 1,143 M
	MOVING VAN/ WATER TRUCK	30,000 LBS/ 13,608 KG	1,240 FT/ 375 M	6,500 FT/ 1,982 M
	SEMI-TRAILER	60,000 LBS/ 27,216 KG	1,570 FT/ 475 M	7,000 FT/ 2,134 M

All personnel must either seek shelter inside a building (with some risk) away from windows and exterior walls, or move beyond the Outdoor Evacuation Distance.

Preferred area (beyond this line) for evacuation of people in buildings and mandatory for people outdoors.

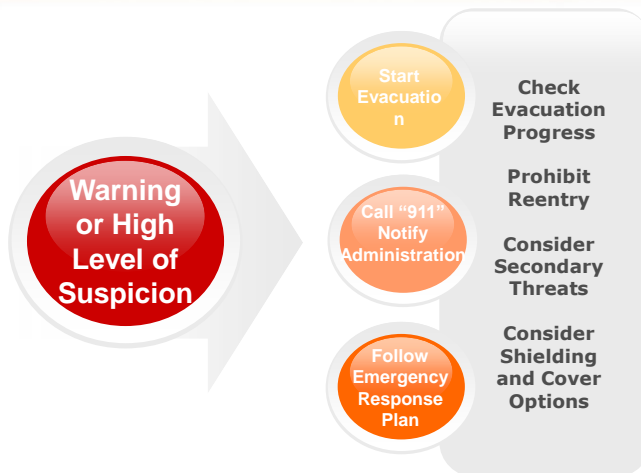


<sup>1</sup> Based on maximum volume or weight of explosive (TNT equivalent) that could reasonably fit in a suitcase or vehicle.

<sup>2</sup> Governed by the ability of an unstrengthened building to withstand severe damage or collapse.

<sup>3</sup> Governed by the greater of fragment throw distance or glass breakage/falling glass hazard distance. Note that pipe and briefcase bombs assume cased charges which throw fragments farther than vehicle bombs.

## Imminent Explosion



## At the Last Minute...

- Seek distance
  - Generally speaking, the more distance from the incident, the less potential damage from the shock
- Seek blast shielding
  - Well-fortified structural features may provide some blast protection
- Seek cover
  - Injury from flying debris, shrapnel, and glass can be minimized with good cover

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## 4) Injuries

10 minutes



## Blast Injuries

	Characteristics	Types
Primary	Results from pressure wave. Affects gas/air-filled anatomy	Blast Lung Concussion Eye Rupture Eardrum
Secondary	Debris and fragments	Penetrations Blunt Injury Lacerations
Tertiary	Displacement by blast	Fractures Amputations Brain Injury
Quaternary	All other injuries	Burns Crush Breathing Problems

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## Blast Lung

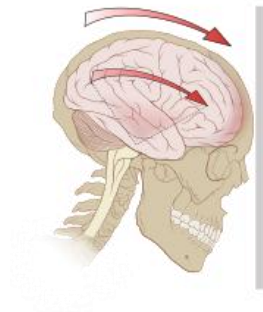
- The most common fatal blast injury among explosion survivors
- Can be reported (by victim) up to 48 hours after explosive event
- Victims may appear to not be seriously injured



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## Concussion

- Most common and least serious type of traumatic brain injury (MTBI = mild TBI)
- Caused by a blow to the head or sudden acceleration/deceleration
- Common symptoms
  - Headache
  - Dizziness
  - Nausea
  - Vomiting
  - Lack of coordination



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## Ear Injury

- Ruptured ear drum (tympanic membrane perforation)
- Caused by excessive pressure on the TM
- Common symptoms
  - Hearing loss
  - Tinnitus (ringing, whining, buzzing, etc.)
  - Otalgia (ear pain)
  - Vertigo (dizziness)
  - Bleeding from the ear
- May be indication of more serious injuries

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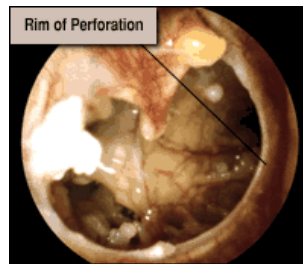


# Ruptured Tympanic Membrane

A ruptured TM is an indication that the victim may have more substantial pressure-wave induced injuries



Normal



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Questions???



Thank You!

