FORENSIC SCIENCE STUDY MATERIAL

UNIT V

(EXPLOSIVES)

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5.1 INTRODUCTION

An explosive is a substance, an element, a compound or a mixture, which is capable of exerting pressure on its surroundings on explosion/transformation. Forensics plays an important role in the investigation of explosions where explosive substances/materials are the main ingredients. Explosives can be detected prior to explosions (during trafficking) and also after the explosion by forensic spot tests and also by hi-tech forensic analytical tools.

Role of Forensic Science in Explosives Examination

Forensic Science plays a role in relation to explosives. Explosives studied by forensic personnel mainly relate to mass destruction episodes wherein bombs are used for illicit activities. The explosive residues collected from the crime scene are examined for such causes especially as the constitution the explosive material, the source and intention of explosion.

5.2 APPLICATIONS OF EXPLOSIVES

An explosive have many applications, which are legal and do not cause harm to any human, animal or any other living being.

1. ***Legitimate Uses:*** An explosive might be used in blasting rocks for mining, oil explorations, in satellite and space craft propulsions, in constructing roads, railway line etc, in firework displays, and may also be used for military purposes which we will discuss latter.

   Ripple Rock was an underwater, twin-peaked mountain, hazardous to ships passing through the Seymour Narrows of the Discovery Passage in British Columbia, Canada. It was destroyed with the help of 1,270 metric tons of Nitramex 2H explosives.

2. ***Illegitimate Uses:*** The criminals are using the explosives for causing destruction to individuals or a nation by blasting bombs. The illegitimate use of explosives cause large scale destruction, as well as a threat to the integrity of any nation and is severely punishable under Indian Penal Code, Explosive Act and The Explosives Substance Act. Some common examples of explosives are RDX, TNT, TETN, ANFO, and Dynamite etc.

5.3 EXPLOSION

In simplest term we can define an explosion as a rapid increase in volume of gaseous substances and release of energy along with the generation of high temperature and release of gases.

Types of Explosion

An explosion may be exotic or chemical. The common examples of exotic explosion is nuclear explosion and the use of high intensity laser arc to heat a substance to its plasma state. Laser and electric energy are presently used only to start reactions rathar than producing energy.

Due to the existence of organic compounds containing -NO2, -ONO2 and -NHNO2 groups and others an explosion is a impulsive chemical reaction which is driven by enormous release of heat and energy. This type of eruption is known as chemical explosion.

The chemical explosion is of three types: Decomposition, deflagration and detonation. The chemical decomposition of an explosive is a gentler process which occurs during its storage. This can happen over years or days or hours or may be within a fraction of a second.

Deflagration and Detonation are two spontaneous types of Chemical decomposition. Deflagration of the explosive substance is proliferated by a blaze front which travels gradually through the explosive substance. Low explosive experiences the process of Deflagration.

In Detonation, the explosion is propagated by shock waves navigating through the explosive material. Detonation happens in high explosives.

5.4 EXPLOSIONS, DEFLAGRATIONS, AND DETONATIONS

When it comes to things that go boom, terms such as *explosion*, *deflagration*, and *detonation* are often incorrectly used interchangeably. To help clear things up, we will go into the technical definitions of explosions, deflagrations, and detonations, as well as the appropriate time to use each term.

- ***Explosion***

An explosion is a sudden, rapid release of energy that produces potentially damaging pressures.

When a gaseous fuel fills a space, it needs to mix to a certain air-fuel concentration to create an explosive atmosphere. When an ignition source is introduced into the explosive atmosphere, it creates a flame that travels away from the ignition site and expands the burned gases behind the flame front. When an explosion is confined, it creates a restraint of the expanding gases and results in an increased pressure within the enclosure. When the enclosure ruptures, this is what most people think of when they hear the term *explosion*. However, explosions don't always need to be confined. The flame speed in explosions can be quick enough to produce compression waves and cause damage with little or no confinement.

The damage potential of an explosion depends on the pressure that is created from the explosion as well as how quickly energy is released from the explosion. Explosions can be either detonations or deflagrations depending on their flame speed.

- ***Deflagration***

A deflagration is an explosion where the flame speed is lower than the speed of sound, which is approximately equal to 335 m/sec (750 mph).

Explosives that deflagrate are known as low explosives. The actual speed of the explosion can vary from 1–350 m/s (2–780 mph). Peak pressures produced by low explosives are orders of magnitude lower than those produced by high explosives, and the damage inflicted by low explosives can vary greatly depending on the fuel and confinement. For example, if black powder is ignited outside of containment, it just fizzles, but when it is confined, it creates an explosion that can propel bullets.

In addition to the black powder example, examples of deflagrations involving low explosives include the ignition of propane gas for a cooking grill and fuel powering of a combustion engine in a car.

- ***Detonation***

A detonation is an explosion where the flame speed is greater than the speed of sound.

Detonations are louder and often more destructive than deflagrations. While deflagration occurs when a fuel and oxidizer (typically air) mix, a detonation doesn't always need an external

oxidizer. Explosives that detonate are referred to as high explosives and have a detonation speed in the range of 2,000–8,200 m/sec (4,500–18,000 mph). High explosives are typically designed to cause destruction—often for demolition, mining, or warfare.

Examples of high explosives that detonate include dynamite, TNT, and C4, a plastic-based explosive.

5.5 CHEMICAL COMPOSITION OF EXPLOSIVES

An explosive can be characterized based on their Chemical composition which is either a chemically pure compound, such as nitroglycerin, or a mixture of a fuel and an oxidizer, such as black powder or grain dust and air.

A. Chemically pure compounds:- Some chemical compounds are unstable. Every molecule of the compound separates into two or more new molecules (mostly gases) with the liberation of energy e.g. Nitroglycerin, Acetone peroxide, organic peroxide TNT, Nitrocellulose, RDX, PETN, HMX.
B. Mixture of oxidizer and fuel:- An oxidizer is a pure substance (molecule) that in a chemical reaction can contribute some atoms of one or more oxidizing elements, in which the fuel component of the explosive burns. On the simplest level, the oxidizer may itself be an oxidizing element, such as gaseous or liquid oxygen. e.g. Black powder (Potassium nitrate, charcoal and sulfur), Flash powder, Ammonal, Armstrong's mixture, Sprengel explosives, ANFO, Cheddites. Oxyliquits, Panclastites.

5.6 CLASSIFICATION OF EXPLOSIVES

The Explosives can be classified on the basis of composition, velocity, sensitivity and physical forms. But broadly explosives are of three types: Low explosives, high explosives and miscellaneous. The latter sub-divided into homemade explosives, nuclear explosives.

1. ***Low Explosives:*** - Low explosives are solid flammable materials that deflagrate. Low explosives liberate enormous quantity of gases that generate sufficient pressure to force a projectile in a specific direction upon ignition and decomposition. The proportion of

burning of explosive depends on combustion gas pressure, grain size and form, and composition.

Low explosives experience deflagration at amounts that fluctuate from a few centimeters per second to about 400 metres per second. Gunpowder or black powder, smokeless powder, flash powder, Pyrotechnics are few common examples of low explosives.

2. ***High Explosives: -*** The explosives that detonate, meaning that the explosive shock front passes through the material at a supersonic speed. These are commonly used in carrying out the activities involving mining, destruction, and military applications. The high explosives may be further grouped into primary and secondary high explosives. High explosives experience detonation with explosive velocity ranging from 3 to 9 km/s. RDX, PETN, TNT, ANFO are the examples of high explosives.

3. ***Miscellaneous:-*** It may be further divided into homemade explosives, .Improvised Explosive Devices-Briefcase Bomb, nuclear explosives.

- ***Homemade Explosives-Molotov Cocktail***

Improvised Explosive Devices-Briefcase Bomb A Molotov cocktail consists of a glass bottle semi-filled with flammable liquid, usually gasoline (petrol) or alcohol (generally methanol or ethanol); the mouth of the bottle is fitted with a cork or other type of airtight stoppes (rubber, glass, or plastic), and a cloth rag fixed securely around the mouth. The weapon is used by first soaking the rag in a flammable liquid immediately prior to using it, lighting the rag and throwing the bottle at the target. The bottle shatters on impact, spilling the flammable liquid over the target, which is then ignited by the burning rag.

- ***Improvised Explosive Devices-Briefcase Bomb***

An improvised explosive device (IED) is a product, assembled in contravention to the existing rules of law of nation adopting unconventional or semi-conventional methods of formulating ammunition/explosives, with a criminal/anti-national intention. IED is also known as homemade bomb. IED's are formed by incorporating destructive, lethal, and noxious, pyrotechnics or incendiary chemicals. An IED is basically composed of

explosives, a detonator, a power source (battery) and an Initiation mechanism (switch). For example- roadside bombs, letter bomb, bombs incorporated in briefcase/vehicle etc

- ***Nuclear Explosives***

A nuclear explosive is an unstable device that stems its energy from nuclear reactions. Virtually all-nuclear explosive devices that have been devised and produced are nuclear weapons anticipated for warfare. Atom bomb is an example of nuclear explosive.

- ***Dirty Bomb***

It is generally known as radiological dispersion device (RDD). A dirty bomb is a radiological weapon, which is a combination of radioactive material with conventional explosives such as dynamite. A dirty bomb is basically used to contaminate the affected area with radioactive material. The main purpose of a dirty bomb is to frighten people. It may also cause people to be exposed to radioactive material.

5.7 FORENSIC ANALYSIS OF EXPLOSIVES

A. Evidence That May be Collected:- A detailed investigation of a blast site will reveal crucial clues to lead the investigation. By thoroughly documenting the condition of the scene, including any structural damage and injuries or fatalities, investigators can slowly piece together what occurred.

Fragments of an exploded device will often be left intact, including switches, wiring, timers and circuit boards. If the timer was made from a unique type of watch, for instance, that information could help narrow the search for who created the device or where it may have come from.

After an explosion, residue from the explosive that was used will be left behind. To identify the type of explosive used, investigators may use an ion mobility spectrometer (IMS), a handheld chemical detection device, to identify residues that may be present around the blast site.

For large-scale incidents, the area of investigation may be expansive. The bombing of the Pan Am Flight 103 over Lockerbie, Scotland in 1988 created the largest crime scene in

the world. It stretched for more than 1,200 square miles. By painstakingly piecing together the wreckage that was found in this area, investigators identified trace amounts of explosives that helped confirm the incident was indeed caused by a terrorist attack. Two hundred seventy people died that day—259 on the plane and 11 residents of Lockerbie.

In addition to collecting physical evidence, video footage may be available from security cameras or from witnesses' cell phones. Investigators will also interview witnesses and victims to gather crucial details.

B. How the Evidence Is Collected

If an undetonated device is located, it must first be rendered safe. A bomb should never be moved from where it was found because it could detonate. This should only be conducted by a qualified bomb technician. Safety is the primary consideration; damage to a structure can be repaired, but injury to a person could be life-altering or fatal.

To examine the type of explosive, bomb technicians use remote robotic equipment to take pictures of the device, or even to detonate the bomb. Robots are commonly fitted with a device that can shoot a high velocity jet of water into the device, disrupting it. The bomb squad technician can then move in to confirm the area is safe and law enforcement can begin an investigation.

A bomb squad technician may also use a portable X-ray tool to examine a suspicious package to determine if it contains an explosive. X-rays are commonly used in airports to examine luggage to ensure baggage does not contain explosive devices.

Before being transported from the scene, all physical evidence is photographed, packaged, placed into containers, labeled and secured. Evidence could even be lodged in the bodies of victims or a suicide bomber. The body can be examined via X-ray images and the evidence retrieved if necessary.

If a community doesn't have its own specialized unit to handle explosives, it will have an agreement with a nearby bomb squad to handle these types of situations.

5.8 DISPOSAL OF EXPLOSIVES

'Disposal of explosives' means their destruction, or rendering them permanently explosively inert, or their safe and legal transfer to a competent person.

One of the main causes of accidents in the explosives industry is the disposal of explosives waste.

The risks associated with disposal of explosives waste means that incidents often lead to injuries or fatalities.

Accidents can be avoided by:

- a better appreciation of the properties and behaviour of explosives under certain conditions – explosives earmarked for destruction may be unusually unstable due to deterioration
- drawing up properly considered systems of work, with appropriate safety precautions

There is generally more than one way of destroying an explosive. The method used will depend on the nature of the explosive and its hazards, and the type and position of the disposal site.

There are five main methods for the safe disposal or destruction of explosives:

- functioning in the design mode
- burning
- detonation
- dissolving or diluting by a solvent or
- chemical destruction (including bioremediation)

Sometimes a combination of methods can be used.

Sea dumping and burial are not suitable methods for disposal and are not generally considered as being safe ways to discard explosives, as they will not generally destroy the explosives or render them harmless.

Explosives should be disposed of by the most suitable method. Identification of the most suitable disposal method needs to consider the nature of the explosive and its hazards, and any hazards associated with the disposal method or created during the disposal process. The nature and position of any disposal site should also be considered as part of the identification of the most suitable method.

Anyone disposing of explosives should be aware that they have duties to do so in a way that is not harmful to the environment