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EXPLOSION AND EXPLOSIVES – A FORENSIC REVIEW

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ABSTRACT

Nowadays in developing country like India, Bomb blast and other means of explosions are increasing day by day. There are three major types of explosions with which investigators usually are involved: atomic (nuclear), mechanical and chemical. An explosion is classified either as a low-order or high-order explosion. Explosion leads to several types of injury due to its various effects like blast pressure effect, shrapnel (fragmentation) effect, thermal effect and seismic effect. An explosive is any chemical compound, mixture, or device whose primary purpose is to function by explosion. Explosives are mainly classified as Low or Deflagrating and High or Detonating. Post blast scene investigation is very important to determine the type of explosion, intensity of explosion, type of explosive materials used, number of victims injured or died and nature of explosion means either accidental or some terrorist attack. In this paper we discussed about types of explosions, orders of explosions, effects of explosions, factors controlling explosion effects, types of explosives and crime scene investigation.

Keywords: Explosion, Explosives and Crime Scene Investigation.

INTRODUCTION

Explosion is now become an emerging health hazard for the common man who is living in the country with population blast. Nowadays in developing country like India, Bomb blast and others means of explosions are increasing day by day. Bomb blasts in trains, buses, hospitals, theatres, markets and many more public places are now common in reading in the news papers. Involvement of different terrorist groups, newer technologies of making bombs, newer types of explosives and comparatively less efficient protection make people to live at the edge of sword of blast.

EXPLOSION

An explosion is a sudden and rapid release of energy from a confined space, accompanied by high temperatures, high pressure, violent shock, gas and loud noise. There are three major types of explosions with which investigators usually are involved: **atomic (nuclear)**, **mechanical and chemical.** There are several subtypes which are differentiated by the source or mechanism by which the explosive pressure is produced. [1]

Bomb (Greek word – Bombos) is a container filled with explosive mixtures or missiles, fired by detonator or fuse.

Nuclear or Atomic Explosion

A nuclear explosion is one in which a sustained nuclear reaction can be made to take place instantaneously and swiftly, releasing large amounts of energy. [1]

Mechanical Explosion

A mechanical explosion occurs when high pressure gas is produced by purely physical reactions and no basic chemical reaction is involved. When a container or vessel is heated, overpressure occurs; when the pressure no longer can be confined, the vessel fails and an explosion results. A steam boiler blowing or an air compressor exploding are common mechanical explosions.

The Boiling Liquid Expanding Vapour Explosion (BLEVE) is a type of mechanical explosion. A BLEVE occurs when the temperature of a liquid and vapour or compressed gas confined in a vessel or container is raised by heat, often external. When the internal pressure no longer can be contained, the vessel explodes. BLEVE's can occur in any liquid container, e.g., large, small or vessels. It does not require a flammable or combustible liquid. Any liquid with a boiling point has the potential to cause a BLEVE. [2]

Chemical Explosions

Chemical explosions generate high pressure, which changes the chemical nature of the fuel, resulting in an exothermic reaction. Combustion explosions are the most common of the chemical erosions. Combustion explosions are caused by the burning of a combustible hydrocarbon fuel when it is present with an oxidizer such as air. In combustion explosions, the burning of a fuel produces large quantities of heated gases and combustion by products which will raise pressures. According to the types of fuels involved, combustion explosions may be classified into several subtypes. Some of the most common are back draft explosions, dust, explosives, and flammable gases. [2]

ORDERS OF EXPLOSIONS

An explosion is classified either as a low-order or high-order explosion- this should not be confused with low or high explosives. The terms "yield" and "order" are considered interchangeable. Classifications are based on the type of damage incurred by the type of explosion.

Low Order Explosions

Low-order explosions occur when the pressure rises at a slow rate inside a confined space such as a structure. When the explosion occurs, large pieces of debris usually are blown short distances from the structure. Other common damage indicators include walls bulging outward and/or roofs or ceilings being lifted slightly and replaced, etc. Glass in windows or doors usually are intact, while the frame is dislodged. [2, 3, 4]

High Order Explosions

High-order explosions occur when the pressure rises at a rapid rate. Indications of a high-order explosion include structural members located long distances from the structure in small pieces, shattered, pulverized or destroyed. [2, 3, 4]

EFFECTS OF EXPLOSIONS

Groups of Effects

Damage to a structure or surrounding area is the result of expanding heat and pressure waves. In explosion investigation, the effects of an explosion are observed in four major groups: blast pressure wave, shrapnel effect, thermal effect, and seismic effect.

Blast Pressure Effect

The blast wave is the result of gases being released rapidly, resulting in a pressure wave which travels outward from the centre. As the wave increases in distance, the strength decreases. This pressure wave is the primary reason for injuries and damage.

The positive-pressure phase is the result of the blast wave moving away from the seat of the blast as gases are expanding. The positive phase is responsible for the majority of damage, because of its power.

The negative-pressure phase occurs in the same way as the positive- pressure phase, except that it displaces and heats the surrounding air creating low air pressure at the seat or origin. As the positive phase moves outward, a negative phase or low-pressure region is formed behind the pressure wave. The result is air rushing back towards the explosion centre. This negative wave results in additional structural damage and may conceal the origin due to debris being carried backwards. [1, 3, 5, 6]

Shrapnel (Fragmentation) Effect

Shrapnel (or fragmentation) consists of small pieces of debris from a container or structure which ruptures from containment or restricted blast pressure. Shrapnel may be thrown over a wide area and a great distance causing personal injury and other types of damage to surrounding structures or objects. [1, 3, 5, 6]

Thermal Effect

Thermal heat is energy in the form of a fireball, the result of burning combustible gases or flammable vapours and ambient air at very high temperatures. Thermal heat is present as a ball of fire during an explosion and for a limited duration after the explosive event. [1, 3, 6]

Seismic Effect

When a blast occurs at or near ground level, the air blast creates a ground shock or crater. As shock waves move across or underground, a seismic disturbance is formed similar to an earthquake. The distance the shock wave travels depends on the type and size of the explosion and the type of soil. [1, 3, 6]

FACTORS CONTROLLING EXPLOSION EFFECTS

A number of important factors may influence the effects of an explosion, which produces a wide range of physical damage.

The design and construction of a **containment vessel,** along with the type of fuel and volume stored, affect an explosion. A small vessel (volume) has a higher rate of pressure in relation to air/fuel mixture. This usually results in a stronger or more violent type of explosion.

The strength of an **ignition source** usually has little effect on the type of explosion which may occur. However, a larger ignition source usually increases the pressure development.

Venting of a vessel or structure usually will cause damage outside of the vessel or structure, with the most damage occurring at the vent opening. When a structure is able to allow the venting process through windows or doorways, the damage incurred is usually in direct line of the openings. However, if there is a rapid pressure build up inside a structure and the venting effects are insufficient, depending on construction materials, usually more of a shatter effect occurs, and residue or debris is located some distance from the structure. [4, 5]

The shape and size of a containment vessel, along with the pressure and location of the source that introduces a fuel into a vessel, have an important effect on the severity of the explosion. Any **turbulence** with a dust/air or vapour/air mixture increases the combustion rate and pressure.

Seated Explosions

The word "seat" is defined as a crater or area of greatest damage as related to an explosion. The greatest damage is located at the point of detonation. "Seats" may range from a few inches to several feet in diameter. Evidence of a "seated" explosion is usually a crater which will show pulverizing of soil or structural members. Explosive velocities exceeding the speed of sound produce a "seat," except when damage is produced by shrapnel. BLEVE's which occur in small, tightly confined containers (steam boilers, explosives, and fuel gases or liquid vapours) are other types which may produce "seated" explosions. [4, 6]

Non seated Explosions

Fuels which are diffused at the time of an explosion because the explosive velocities are subsonic often produce a non seated explosion. Certain fuel gases, such as natural gas and liquefied petroleum (LP) gases usually produce non seated explosions because the explosive speeds are subsonic. Back draft or smoke explosions and the explosion of vapours from pooled flammable or combustible liquids also produce non seated explosions due to their subsonic explosive speed. Usually the most violent and damaging of the non seated explosions are dust explosions in confined areas. Some of these areas are coal mines, processing plants, and grain elevators. These large areas preclude the production of a crater or "Seat." [4, 6]

Vapour Density and Structural Damage

Vapour density is defined as the ratio of weight of a volume of a given gas or vapour fuel to an equal volume of dry air (air = 1). Under laboratory conditions, this is used to determine if a given gas or vapour fuel will rise or sink in relation to air in a given area.

Lighter-than-air gases (vapour density less than 1.0), such as natural gas, tend to rise and collect in upper areas. Burning between ceiling joints or pocketed areas may be indicative of a lighter-than-air fuel rather than a heavier-than-air gas or vapours. Heavier-than-air gases and vapours (vapour density greater than 1.0), such as flammable liquids and liquefied petroleum (LP) gases, tend to settle to lower areas. Ventilation, both natural and mechanical, can change the movement of the gas and vapour and move or spread to adjacent areas or rooms.

It has been widely thought that if the walls were blown out at ceiling level, the fuel was lighter than air; if blown out at floor level, the fuel was heavier than air. However, it has been demonstrated that the level of the explosion damage within a conventional room is a function of the construction strength of the wall, headers, and bottom plates, with the least resistive giving way first. [3, 4]

EXPLOSIVES

An explosive is any chemical compound, mixture, or device whose primary purpose is to function by explosion.

Explosives are used commercially to do various types of work. They also are used in a clandestine manner to destroy and to kill. In the commercial field, an explosive in the form of a cup shaped charge will, when detonated, actually drill a hole in metal or rock. Another type of charge is a linear shape charge, which is laid on metal, rock, or wood. When detonated, it cuts the metal, wood, or rock along the length of the explosion, much as one would cut something with an axe. Explosives are used most commonly in mining or quarry operations, to break up rock, or to move dirt in large amounts at one time. [1, 3]

TYPES OF EXPLOSIVES

Explosives (not to be confused with explosions) are classified into two main types: low explosives, and high explosives. Classifications are based on the explosive velocities of the materials when activated.

Low or Deflagrating explosives are characterized by a deflagration which has a subsonic blast wave. Low explosives are designed to be used where a slow pushing action is required, such as weapon cartridges and rockets, or in pyrotechnics where the effects desired arc heat and light, but where blast effects are to be avoided. Some common low explosives are black powder, flash powder, smokeless gun powder, and solid rocket fuel. [1, 2]

High or Detonating explosives are characterized by a detonation designed to produce a shattering effect by their high rate of pressure and extremely high detonation pressure. These high pressures are responsible for localized damage near the "seat" of the explosion and cratering at the epicentre. Some common high explosives are dynamites, plastics, ammonium nitrate fuel oil (ANFO), penta erythritol tetra nitrate (PETN), cyclo trimethylene tri nitramine (RDX), and cast types such as Tri nitro Toluene (TNT). [1, 2]

Blasting Caps

Blasting caps are used as an initiator for other explosives. Blasting caps contain the most sensitive type of primary explosives and are considered to be the most dangerous item in the field of explosives.

There are two types of blasting caps: electric and nonelectric fuse. Each type contains the same type of explosives, is of the same diameter (approximately ¼ inch), and is the same relative size. The size or lengths range in even graduations such as #2, *#4*, #6, #8, #10. The shell or casing is made from copper or aluminium.

The basic difference between the electric and nonelectric (fuse type) blasting cap is that the electric blasting cap will have two plastic covered wires of various colours and lengths, depending on the brand and use. The two wires are joined inside the blasting cap with a thinner bridge wire. When electricity flows through the wires, it meets the smaller bridge wires which become overloaded and heat, which, in turn, causes instant detonation of the explosives inside the blasting cap.

The nonelectric blasting cap usually has an opening on one end, into which the time fuse is inserted and crimped, using a pair of crimpers. This creates an indentation in the metal near the top of the blasting cap and holds the fuse inside the cap. The time fuse is lit manually by using a fuse lighter or a match and is detonated by the use of nonelectric detonators Using detonating cord, shock tubes, safety fuse, or any other replacement for electric leg wires. The black powder core of the time fuse burns inside the fuse at a rate of 35 to 45 seconds per foot. When the fire has reached the end of the fuse inside the blasting cap, a small spit of fire exits the fuse and causes the explosive inside the blasting cap to detonate. [3, 4]

The most important advantage of the electric blasting cap over the nonelectric blasting cap is actual control of the detonation. The electric blasting cap is detonated instantly when electricity is applied by the blaster. On the other hand, once the time fuse on the nonelectric blasting cap is lit and burning inside a bore hole or even while covered with dirt, and even under water, the fuse cannot be stopped from burning and there is no further control of the detonation.

SCENE INVESTIGATION

Post blast scene investigation requires specialized explosives training. Investigators with this specialized training should lead an explosives investigation and those without this training should contact law enforcement or other agencies for assistance. A systematic approach to post blast investigation is the most effective.

The first responder should establish and maintain control of the structure and surrounding area and all unauthorized persons should be prevented from entering the scene before the arrival of the investigators. No blast debris or evidence should be touched or removed by anyone prior to documentation. Securing the scene also prevents injuries to personnel and unauthorized persons. The scene should be searched from the outer perimeter inward toward the area of greatest damage.

Each scene will dictate the type of search pattern to be used. The pattern may be a grid, circular, or spiral. The search pattern should overlap; all areas should be searched more than once so no evidence is undetected or lost. [4, 5]

The investigator in charge should brief all searchers on proper procedures of identifying, marking and mapping of evidence, logging, and photographing of evidence.

Special scene safety considerations always are recommended when dealing with post blast explosive investigations. Structures which have been subject to an explosion and/or fire have a greater tendency to collapse.

Investigators should be on the lookout for additional devices and undetonated explosives. A thorough search of the scene should be conducted for secondary devices, explosives, and any undetonated explosive devices prior to the post blast investigation. If any explosives are located, do not touch or move them under any condition. The structure and surrounding area should be evacuated immediately and the explosives isolated. Only qualified and trained explosive disposal personnel should be allowed to handle these explosives.

Debris is thrown from the centre of the explosion by force. The greater the explosive energy, the farther the debris will be thrown. All significant evidence should be documented properly and completely on the scene, along with the direction and distance. Different drag/lift characteristics of fragment shape will indicate the need for further investigation. [4, 5, 6, 7]

SUMMARY

A forensic investigator may encounter crime scenes in which explosions or explosives may have been located or used. Each incendiary device, explosion, or explosive usually leaves certain kinds of evidence and residue.

Scene safety is a major priority for investigators and forensic personnel. The scene should be rendered safe before post blast investigation and any secondary devices or explosives should be handled only by trained explosive disposal personnel.

All evidence should be documented properly prior to removal. Sketches and photographs always should be completed prior to evidence removal.

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