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The Investigation of Explosion Scenes

By James T. Thurman

Improvised Explosive Devices

Improvised explosive devices (IEDs), or "homemade" bombs, have been thrust upon the world stage of international terrorism and brought into our homes through daily newscasts.

An IED is essentially a combination of components not originally designed to be combined with each other; some explosive, and some not, which when combined, form an *improvised device* that is capable of exploding violently. In its simplest form, an IED consists of a main-charge explosive and a fusing, or initiation, system that provides the detonation stimulus.

Some IEDs have few components, while others have many. The number and type of components fabricated into an IED are dependant on many factors. The first is how and where the device is to be

used. It may have a timing mechanism to afford a time-delayed initiation of the explosive. Examples of timing-mechanism components found after a bombing are shown in Figures 1 and 2. Usually the builder "hides" this type of device to prevent its discovery prior to explosion. There are several additional factors that affect the construction of an IED, including the following:

- the ingenuity of the builder;
- the skill of the builder;
- access to nonexplosive components; and
- access to explosives.

Although extensively fragmented, most of the components, other than the explosives, at least partially survive the explosion of the IED. This basic point of component survivability is not apparent when the bomb explodes, and most people incorrectly believe that nothing can survive the blast. However, bomb components do survive explosions, and the recovery of those fragmented components constitutes the processes referred to as Bombing Crime Scene or Postblast Investigation. Figures 3 and 4 show the postblast remains of two pipe bombs: one that was held together with threaded caps and the other held together by welded metal plates. Figure 5 depicts the fragmented remains of electrical detonators recovered following their use to initiate high explosives.



Figure 1. Fragments of a mechanical timing device compared with undamaged components.



Figure 2. Remains of a mechanical clock used as a timing device, found after a bomb blast.

Bomb scene investigation involves a series of challenges to the investigator, which require not only basic crime scene investigation skills, but also knowledge in a number of specialized disciplines. These disciplines include the following:

- explosion dynamics;
- identification features of main charge explosives and the accessories used to initiate them (detonators, detonation cord, safety fuse, shock tube, etc.);
- pre- and postblast identification features of nonexplosive components used to fabricate the IED;
- understanding the laboratory's capabilities with regard to examinations conducted on debris collected from blast scenes;
- understanding and identifying features associated with military explosive ordnance.

Additionally, the postblast investigator should be aware of the types and indicators of weapons of mass destruction (WMD), specifically, chemical, biological, and nuclear materials. This is especially important in understanding that the explosion of an IED may be a precursor to the delivery of WMD material.

The investigation into a reported explosion involves two stages: the scene investigation and the field investigation. The scene investigation involves site documentation and collection of postblast debris and components. The field investigation is the work done away from the actual scene.

Scene Investigation

The following investigative steps are used to determine whether an explosion scene actually exists and then, the identification, collection, and documentation of bomb components:

- initial response;
- evaluation of the explosion scene;
- entering the scene;
- documentation of the scene;



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Figure 3. Pipe bomb fragments. This bomb was constructed with a pipe nipple and two threaded end caps to form an enclosure for the explosive.



Figure 4. Pipe bomb fragments. This pipe bomb was constructed with a pipe nipple and two welded end plates that formed an enclosure for the explosive.

- where to find evidence;
- how to find evidence;
- final survey; and
- release of scene.¹

The initial incident response may or may not include a postblast investigator or a bomb technician, but it certainly includes a uniformed police officer. The first responding officer evaluates whether an explosion occurred, and the additional resources (police, firefighters, and/or medical support) required. If there are indications of an explosion, it is not the first responding officer's duty to determine the cause of the explosion, but only to determine that the scene "appears" to be the result of an explosion. The cause determination is made later by the postblast investigator, who may be working with a bomb technician.

It is the responsibility of the first responders, regardless of the cause of the explosion, to immediately assess the safety of the scene, establish exclusion perimeters, remove personnel from the scene, and assist medical support personnel in the removal and care of the injured.

The safety assessment should include an evaluation of the following list of possible explosion scene hazards:

- blood-borne pathogens;
- metal-glass debris;
- fire;
- structural integrity;
- utilities, especially electrical;

- hazardous materials; and
- secondary explosive devices, if the incident was caused by a bomb.

The explosion scene is evaluated by a trained investigator who determines whether the blast was caused by the detonation of an explosive (a chemical compound or mixture of chemicals), the detonation of a diffuse fuel explosion (e.g., natural gas or propane), or vapors from pooled flammable liquids or dusts, or some other source.

Detonations are explosions in which the combustion zone propagates at a rate in excess of the speed of sound, while a deflagration's combustion zone propagates at a rate less than the speed of sound.² Mechanical explosions, such as those caused by ruptures of boilers or other pressure vessels are usually not difficult to recognize.

Table 1 is a list of characteristics that an investigator may use to help distinguish between an event caused by an explosive material and an event involving the deflagration or detonation of a diffuse fuel.

The evaluation of the scene that is formed by an IED explosion requires additional steps to ensure that the scene is safely secured and that potential evidence is protected until it can be collected. These steps include locating the seat of the explosion or crater, and from that conclusion the demarcation of more specific inner and outer perimeters. Once this is accomplished, an evidence collection command post should be established. The person in charge of the evidence command post should document all personnel entering and leaving the scene, establish evidence documentation

Table 1. Investigative Characteristics of Explosion Scenes

Explosive material	Gas, vapor, or dust ³
Crater	No crater
Localized damage	Entire walls blown out
Defined epicenter	No epicenter
Presence of bomb components	No bomb components
Explosives or residues present	No explosives present
No gas, vapor, or dust fuels on site	Gas, vapor, or dust fuel on site
Location of incident	Location of incident
Witness statements	Witness statements

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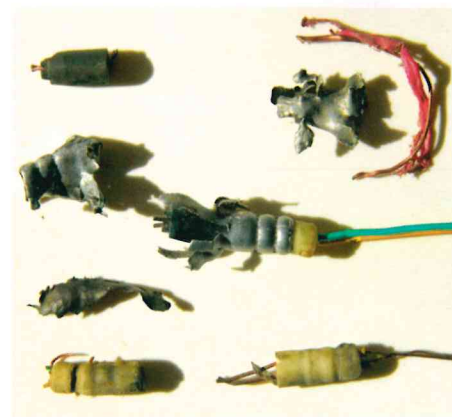


Figure 5. Fragmented remains of electrical detonators recovered following their use to initiate high explosives.

procedures, determine the level of investigative assistance required to locate the evidence, and obtain the legal authority required to search and collect evidence. This involves determining whether a consent to search is sufficient, or a search warrant is required. Additionally, at this time, the principal scene investigator assembles the postblast investigative team that has the responsibility of locating and securing the bomb remains.

The number of team members depends on the size and complexity of the scene, but can be from as few as one to dozens of investigators. Their team members play the following roles:⁴

- team leader;
- bomb disposal technician;
- photographer and assistant;
- evidence recovery personnel (searchers);
- evidence custodian;
- sketch artist; and
- specialists (e.g., chemist and structural engineer).

Additionally, the types of evidence collection equipment and supplies vary depending on the complexity of the scene. At a minimum, the team requires various types of containers (plastic and nylon bags of many sizes, metal cans), paper, writing instruments for evidence documentation, evidence labels, rulers and measuring tapes, hand tools, sifting screens, and residue collections kits.

Prior to the actual investigation of the bombing scene, it should be clearly

understood by all involved that the investigative process has at least three main goals. First, to establish a legal basis that an explosion of malicious intent occurred. Second, to investigate the scene to recover IED components. And third, to link a subject with the bomb scene and/or the fabrication of the bomb. All three tasks must be accomplished in a manner that is of sufficient integrity and credibility that the evidence developed is acceptable in a court of law.

Establishing malicious intent is not a trivial exercise in many cases. While it is always necessary to eliminate the possibility of an accidental explosion, scenes like the one shown in Figure 6, where a government building was destroyed by an exterior blast, leave little doubt about the malice of the bomber. Establishing the cause of aircraft explosions (particularly those that explode over water) is far more difficult. TWA flight 800 is an example of an explosion determined to have been caused by the ignition of jet fuel in the center fuel tank by what is believed to have been an electrical spark from deteriorated wiring. (There are still some skeptics.) The evidence that proved Pan American Flight 103 was the victim of a malicious act was postblast components, including a tiny fragment of a circuit board from the electronic timer, shown in Figure 7. It was possible to trace



Figure 6. The Alfred P. Murrah Federal Building destroyed by American terrorists Timothy McVeigh and Terry Nichols on April 19, 1995.



Figure 7. Small section of a circuit board that was part of the MST 13 electronic timer for the bomb that destroyed Pan American Flight 103 over Lockerbie, Scotland in 1988.

the source of the timer and determine that the timer was custom manufactured for Libya.

Upon entering the scene to conduct the investigation and collection of evidence, one of the first responsibilities is to begin the process of documenting the explosion scene. The documentation involves three separate forms that are used to supplement, and not replace, one over the other. These are as follows:

- written notes and logs;
- sketches and diagrams; and
- photographs.⁵

These types of documentation provide a written and visual record of all the actions and conclusions of the investigative team, a systematic depiction of the scene, and the inventory and collection of evidence. Additionally, the investigators continually monitor the scene for any previously unidentified hazards, re-evaluate the scene perimeters to determine whether they are appropriate, and begin their efforts to locate evidence.

Once inside the scene, the investigative team needs to determine where to search for evidence. There are three general areas that contain evidence from the explosion. These are⁶ as follows:

- the target of the bomb;
- victims of the bombing; and



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- areas outside of the immediate target.

Obviously, the target of the bombing is the area that was impacted by the blast of the explosion. Depending on the quantity and type of explosive used, the target can be small (such as a postal box) or quite large such as an office building. Within the target, evidence can usually be found in the crater or epicenter of the explosion, and in the area and materials immediately surrounding the crater. Depending on where the explosion took place, the materials around the crater may be household furniture, vehicle components, building materials, and earthen materials. These materials are referred to as witness materials. The bodies of bombing victims, particularly those that were close to the blast, are excellent receptors of bomb debris. As such, all victims should be examined for the presence of bomb components, both construction components and explosive residues. The third area of search should be outside of the epicenter of the explosion. These areas usually are the places where bomb components have been projected away from the immediate scene along flight paths that can be identified by careful examination of the scene with an understanding of explosion dynamics.

Once a determination has been made regarding where to look for evidence of the bombing, the investigators need to determine how they search for evidence. The physical search for evidence can involve four types of organized methods. These are as follows:⁷

- explosive residue swabbing;
- organized search;
- sifting; and
- vacuuming.

Swabbing is a systematic collection procedure used to collect organic and inorganic residues of explosives resulting from main charge explosive. It is best used on nonporous items, too large to be taken to the laboratory. The swabs are taken at the scene, entered into evidence, and then shipped to the laboratory with the other items of evidence recovered from the scene.

The organized search typically employs one of three types of search pat-

Following the collection of the evidence and scene documentation, a final survey should be conducted prior to leaving the scene. The final survey is a review of all aspects of the scene investigation to ensure that the objectives of the investigative team have been met, and that all identifiable evidence has been collected, packaged, marked, inventoried, and entered into the evidence log.

terns: grid, line (or strip), and the spiral search. These patterns can be used independently, or in conjunction with each other, and involve the visual search of a given area for bomb debris. Of these patterns, the grid offers the most reliable method for locating evidence.

Evidence screening or sifting involves the separation of evidence from background materials by the use of a set of screens. These screens, much like those used on archaeological sites, have been found to be very useful when searching for evidence among soil, sand, or finally divided materials.

Table 2. Recommended Evidence Collection Containers.

Type of evidence	Type of container
Components not requiring residue testing	Polyethylene zip-top bag
Materials requiring residue testing	Nylon zip-top or heat sealed bag
Materials requiring residue testing	Metal can or glass container
Unconsumed low explosives	Antistatic polyethylene bag
Dried clothing or cloth containing blood	Paper or Tyvek® bag

The last method is vacuuming that is used on porous surfaces too large to send to the laboratory for examination. This method can not only recover explosive residues but also minute bomb components that may be embedded in carpets, floors, and bomb fabrication workbenches. Vacuuming should be conducted after the bomb scene has been cleared of the larger debris and items of evidence; therefore, it should be the final search conducted.

Once evidence has been located, it needs to be collected and packaged in order to afford protection for it to be shipped to the laboratory, or used in any subsequent legal proceedings. The usual means is by "bagging and tagging." This operation provides a seamless chain of custody for each item recovered at the scene. The "bagging" refers to the placement of evidence into an appropriate type of container that protects it from being contaminated, altered, or lost. "Tagging" is the process of marking each evidence container with the required information that identifies where the evidence was found, by whom, the date it was found, and an inventory of the container by a numerical description that, in turn, corresponds to the evidence log. Guidance on the appropriate means of labeling evidence may be found in ASTM E1459, **Guide for Physical Evidence Labeling and Related Documentation**⁸ and the **Federal Bureau of Investigation, Handbook of Forensic Services**.⁹

Table 2 is a listing of the types of evidence that may be found at the bomb scene and the type of container that is recommended for its collection.

Following the collection of the evidence and scene documentation, a final

survey should be conducted prior to leaving the scene. The final survey is a review of all aspects of the scene investigation to ensure that the objectives of the investigative team have been met, and that all identifiable evidence has been collected, packaged, marked, inventoried, and entered into the evidence log. One of the last acts of scene documentation should be to depict the post-inspection appearance through photography. This provides a visual record regarding the appearance of the scene after the scene investigation should any questions arise as to the appropriateness of the collection process and what the investigators did or did not do at the scene.¹⁰

Finally, the team leader releases the scene to an authorized entity, if available, such as the property owner or public health official. In many instances, this may not be possible because of the victim's injuries or death. In the case where no actual person is available to take "custody," all reasonable efforts should be made to secure the scene prior to departure.

Following the completion of the scene investigation, the next phase of the post-blast investigation process begins, the field investigation. The field investigation endeavors to establish a link between the person(s) responsible for the bombing and the evidence recovered from the bomb scene, by establishing who had the motive, opportunity, and the means to commit the bombing.

To provide answers to these questions, various lines of investigation need to be considered. Depending on the circumstances of the bombing incident, these include detailed interviews of personnel associated with the following:

1. the neighborhood for a witness who may have observed suspicious activity prior to the bombing;
2. medical treatment facilities for the recovery of evidence from victims;

3. the first responders for what they saw upon arrival at the scene and what the victims may have told them;
4. victim associates and relatives for information that would lead to establishing an actual subject; and
5. review of logical sources of the components of the bomb in attempts to associate the bomb builder with the purchase of components. Retail outlets where bomb components are often purchased include hardware or home improvement stores, electrical supply houses, hobby shops, sporting goods stores, distributors of low and high explosives, farm supply stores, drug stores, mail order, and internet suppliers of componentry.¹¹

In conclusion, it is the responsibility of the postblast investigator and the investigative team to conduct as thorough and imaginative scene investigation as possible, to determine and document the actual cause of the explosion and, if it is determined to have been the result of a criminal act, to assist in the search for the person(s) responsible by locating, collecting, and securing the physical evidence.

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