

Chapter 4

FIRE SCENE INVESTIGATION

INTRODUCTION

Due to the destructive powers of fire, investigators must be aware of their surroundings. Fire scenes, as can be expected, are dangerous places. Fire investigators have a duty and a responsibility to themselves and to others to conduct a safe fire scene investigation. This includes working in pairs, wearing proper safety clothing, using proper respiratory protection, and remaining alert to fire scene hazards.

Only with such safety precautions instituted can the investigator commence the scene investigation. The investigator must know what information is to be collected during the examination of the incident scene. He also must understand the necessity for proper security to protect the incident scene during fire suppression and continuing through the scene investigation. How exterior structural conditions of the burned structure may affect the examination of the incident must be understood. Finally, the investigator must understand the relationship between the physical condition of the structure and the identification of motives.

FIRE INVESTIGATOR SAFETY

Fire investigation can be more complex than fire suppression. Investigators find themselves examining more areas than those actually involved in the fire, spending more time processing the fire scene, conducting detailed scene examination, and sifting through the debris. Thus, they are exposed to a variety of hazards and usually are subject to continuous *physical* exertion.

Fire investigators have a tendency to ignore personal safety in their effort to determine the origin and cause of the fire. However, personal safety should be a top priority.

Prior to the interior examination of the fire scene, the fire scene area must be determined safe to work in. Prior to going inside, ensure that the atmosphere has been analyzed and is safe. Confirm that the electricity has been shut off prior to examining any electrical circuit, appliance, or wiring.

Avoid working alone. If an accident occurs, no one may be present to help. Use proper personal protective equipment at all times, including approved boots with steel toe and midsole, gloves, helmet or hardhat, respiratory protection (self-contained Breathing

Apparatus (SCBA) or particle respirators), eye protection, and a work uniform. Finally, do not eat or drink at the fire scene.

FIRE SCENE HAZARDS

Respiratory Hazards

Heated air and gases generally rise during the fire. As the area cools, gases drop to lower levels. The atmosphere must cool before investigators spend extended periods processing the fire scene. If it is not possible to allow for cooling and to provide adequate ventilation, then respiratory protection should be used. Common combustible materials will give off toxic gases when exposed or involved in fire.

Structural Hazards

Investigators also must be concerned with structural hazards. Did the fire weaken support structures, stairways, ladders, rails, or walkways? Are there glass and jagged metal hazards present? Is there a possibility of structural collapse? Fire suppression activities can result in structural damage such as hanging steel beams; holes or missing floor plates in walkways. Water and fire fighting foam residues may make surfaces extremely slippery and dangerous to walk upon. Extreme care must be exercised, especially in engine rooms after a fire where dim lighting and slippery surfaces make walking conditions hazardous.

In sifting through fire debris, remember that ashes on top may be cold while the ashes in lower layers may be still hot.

Hazardous Substances

Materials containing asbestos may be found in some ships. Materials which contain asbestos deteriorate during fire, releasing asbestos fibers into the air. The primary hazard to the investigator is inhalation. Asbestos fibers can be reduced by wetting down the area. Investigators also should observe safety precautions such as wearing a respirator mask with a particle filter, and bagging uniforms and washing them separately. If breathing apparatus (SCBA) is available, use it.

PCBs (Polychlorinated biphenyl(s)) are found in electrical equipment. The main hazards are skin exposure and ingestion. PCBs can be spread by fire. If involved in fire, dioxin is created in the smoke. PCBs are nonvolatile. Safety precautions include chemical-resistant gloves and shoe covers, and the use of a respirator mask.

Chemical fires present a variety of hazards, such as instability, combustibility, explosive tendencies, oxidation, corrosiveness, and water or air reactivity. Stable chemicals involved in fire may become unstable. Identification of fire-damaged chemicals

often proves difficult; in addition, chemicals or explosives may have been used to start the fire. Unburned chemicals often remain after the fire, and explosives may not have detonated completely and can be unstable. Safety precautions include identifying the chemicals involved, securing the area, getting technical assistance, and using special protective gear and breathing apparatus.

Always seek assistance from the proper authorities when dealing with chemicals, asbestos, and PCBs. This includes hazardous materials units, or the bomb squad if you need to X-ray articles.

When dealing with any of the aforementioned materials, be sure to notify appropriate agencies such as the U.S. Coast Guard, OSHA, the Health Department, and EPA.

INVESTIGATOR PRIORITIES UPON ARRIVAL AT THE SCENE

Fires in Port – Shoreside fire departments will undoubtedly respond to a shipboard fire in port and the Incident Commander (IC) from the local fire jurisdiction will probably be the official in charge of the fire scene. Always inform the IC of your arrival. This is not only a courtesy. The IC usually will have pertinent information to pass along, such as the safety of the involved structure and the progress of suppression efforts.

Authority over the incident must be established as soon as possible. Any need to delay or eliminate normal operations by other agencies should be explained and arranged by the investigator. Examples of activities or procedures which may be delayed during the scene investigation include salvage operations, occupants' return, property survey, repair crew inspections, and news media survey.

The investigator should solicit specific information from the incident commander regarding fire suppression activities such as placement of companies, assignments given to companies, identification of companies on scene, strategy/tactics employed, unusual odors noted, reaction observed at application of water, location of the fire upon arrival, ventilation methods, hoseline placement, etc. Obtaining information about firefighting operations during the incident may be invaluable.

Find out if any overhaul operations were conducted prior to your arrival. Did fire suppression companies use wet water (chemical additive) or foam to suppress the fire? If objects were removed, what was removed, from where, and by whom? Firefighters should be made aware of their responsibility to provide the investigator with accurate, complete, and timely information about the incident.

Time and method of alarms are also critical information. Times play an important part in the investigation, because the investigator may be able to show an abnormality between the time the fire was reported and the amount of fire at the time of the first arrival of fire suppression companies. The investigator should interview the person(s) reporting the fire. Also, it is important to note the time the first fire suppression company arrived.

The investigator must observe condition of the scene at his/her time of arrival. Note the amount of damage as viewed from the exterior, as well as extension of the fire to the interior portions of the vessel. Note the progress of fire suppression efforts at this time as well. Observe how the fire vented itself: natural ventilation versus fire suppression ventilation techniques. Note any removal of debris, furnishings, stock, supplies, etc. Ensure security procedures are established.

The vessel may suffer extensive damage after the arrival of the investigator. Such information helps eliminate wasted time and effort in determining the origin of the fire. Remember that areas of extensive damage may not indicate the area of origin; this may have been caused by fire suppression efforts. In addition, a fire still can result in a total loss even after the fire is thought to be under control.

Other areas of burning may have required more immediate attention by fire suppression personnel because of protection of life, dangerous materials, high value areas, or preventing extension of the fire. Note areas of open burning (visible flames) which may indicate the types of fuel being consumed.

Ascertain whether there was complete or partial collapse of any of the vessel's structure. Was there ignition or exposure of flammable or hazardous materials? Were there reports of an explosion? Were firefighters forced to back out due to fast fire spread?

Weather conditions should be noted and recorded. Note wind direction and speed, and compare it with the direction of fire travel. Wind may account for the intensity and/or spread of the fire. Make note of clear weather conditions versus rain, snow, ice, etc.

Note fire protection systems such as alarms, sprinklers, standpipes, or smoke detectors. Ensure that a qualified investigator will determine their status and effectiveness at the time of the fire. If the occupancy has a security/fire alarm, check to see the time the alarm went off; if the system is monitored, are there any printouts, tapes, or videos available? Note the fire load of the fire area as it relates to furnishings and appliances.

Color of Flames and Smoke

Color of smoke may indicate the type of material being burned. Complete combustion often produces little or no smoke, while dense smoke often indicates incomplete combustion. Flame color may indicate the type of materials being burned. As the amount of hydrocarbons increase the flames will become darker or more orange in color. A lack of sufficient oxygen usually causes flames to be darker than when the same fuel is burned in a well-ventilated area.

Extreme caution is required when using color of smoke and flames as an indicator. Remember, the investigator often arrives on the fire scene during the latter stages of the fire, and may observe smoke colors that relate to materials burning in the latter stages, which will give false indications. Also, most vessel contain fuels with hydrocarbon

bases which, when burning, may produce smoke and/or flames which can mislead the investigator. Smoke and flame colors which indicate the type of material being burned are listed in the chart below.

FUEL	COLOR OF SMOKE	COLOR OF FLAME
Plastics	black	yellow, smoky
Rubber	black	yellow, smoky-
Wood	gray to brown	yellow to red
Paper	gray to brown	yellow to red
Cloth	gray to brown	yellow to red
Gasoline	black	yellow to white
Naptha	black to brown	yellow to white
Benzene	white to gray	yellow to white
Lubrication	black	yellow to white
oil	brownish to black	yellow to red
Lacquer	brown to black	yellow to white
Turpentine	black	blue
Acetone	brown	yellow
Cooking oil	black	yellow
Kerosene	green	yellow
Chlorine	black	yellow, smoky
Tar	gray	yellow to orange
Grass	brown	yellow to orange
Brush		

Source: Kirk's *Fire investigation*, 1991 and Factory Mutual Engineering Corporation. *A Pocket Guide to Arson Investigation*, 1979.

SCENE SECURITY

Fire, police, or other security personnel should be posted at all the points of entry, and they should be instructed to deny entry to all unauthorized personnel, including spectators, crewmen, owners, and news media. Individuals claiming to have authority should be referred to the lead investigator. Scene security personnel should be in work or dress uniform with proper identification.

Scene security is of the utmost importance both during and after firefighting operations have been completed.

Deny entry to all unauthorized persons. Owners and/or crew usually will attempt to re-enter the area, claiming the need to survey damages or salvage property. The arsonist may attempt to re-enter the fire scene for the purpose of destroying or recovering evidence of incendiary devices, covering up incendiarism, or attempting to mislead investigators.

The investigator should anticipate problems of scene security. Locate and inform the owners/crew that their re-entry into the fire area will be delayed during the scene examination.

If the investigator cannot be present on the scene during the suppression efforts, the fire department or police department should be asked to provide scene security until his/her arrival.

FIRE SCENE EXAMINATION

The "Backwards Theory"

In determining the origin and cause of a fire, the "Backwards Theory" provides a systematic investigative process that ensures that the total occupancy is investigated.

A backwards investigation is conducted from the exterior to the interior, and from the least damaged areas to the most heavily damaged areas. Be sure to examine the entire area surrounding the fire scene, even areas where no fire damage occurred. Note the direction of heat flow, the lowest point of burning, overhead damage, and fire patterns, including "V" patterns, glass, char, and lines of demarcation.

Determining the Point of Origin

An exterior examination of the vessel should be conducted. Observe exterior fire or heat patterns and smoke/soot damage. Such patterns on the hull plating will help to identify the hottest part of the fire and may be of some help in determining the low point of the fire, which is often the area of point of origin. On exterior decks look for flammable liquid containers or containers which could have been used to transport liquid accelerants to the scene.

Record and photograph the condition of doors, windows and locks in the fire area. Look for fire doors left open, blocked open, or tied open. Check overall condition and degree of housekeeping in undamaged areas close to the fire. Pay special attention to the presence of unauthorized electrical appliances.

Search for, identify, record, and photograph all evidence and note its location in a rough fire scene sketch. The investigator can never take too many photographs of a fire scene.

Reconstruction of the Fire Scene

Reconstruction is the act of finding the point of origin and reconstructing the fire scene. Replace doors and furnishings; match up furniture posts with marks on the floor. If necessary, seek the assistance of firefighters, ship's officers, and crew. When possible, examine other rooms or vessels with similar layouts and/or features.

Fire scene reconstruction can fit in anywhere during the examination process. The scene examination and reconstruction processes are interwoven. Reconstruction not only involves replacing furnishings, but entails validating the fire indicators through interviews with firefighters, owners, crewmen, ships officers, and other witnesses.

Fire suppression personnel can provide information about the condition of doors and about conditions in the fire area at the time of their initial entry. They can provide information on suppression tactics, such as whether there were any unusual odors, how the fire reacted to the application of water, whether they saw, heard, or found any devices, the location of the fire at their time of arrival, etc. The person(s) who discovered the fire must be interviewed, as must owner's representatives, occupants, witnesses, police officers, contractors, and emergency medical personnel. Each story should be compared; variations will result with respect to time of discovery. Witnesses will observe the fire in different stages and from different locations, which will cause discrepancies in the accounts of their observations.

Interviews should focus on ascertaining the circumstances surrounding the fire, as well as information on records, inventory, valuables, keys, electrical service, personnel history, and repairs.

Determine the Fire Cause

In brief, you must be able to eliminate natural and accidental fire causes (mechanical, electrical, spontaneous heat, etc.) prior to determining the fire to be incendiary. Once you have determined the fire to be incendiary, note all evidence of incendiarism, including trailers, plants, devices, accelerants, multiple fires, or crime coverup. If the cause of the fire cannot be definitely determined, then stating that the fire cause is undetermined pending the receipt of further information is appropriate.

DOCUMENTATION

Field Notes

Document all pertinent information related to the investigation in the form of field notes (facts, observations, questions and answers, incident information, scene information, and suppression information).

Sketching

Another step in the documentation of evidence is preparing diagrams or sketches of measurements for the location of evidence. Sketching is a basic, but essential investigative technique that is well within the capability of the most novice investigator, and is employed conscientiously by more experienced investigators on every fire scene.

A sketch is a graphic representation of an incident scene and of the items within that scene that are of interest to the investigation. It is the investigator's responsibility to decide what must be sketched. Sketches are important for, unlike photographs, they depict only the conspicuous aspects of the scene without showing nonessential detail; they also have the advantage of showing relative proportions, distances, and dimensions.

The primary purpose of an evidence sketch is orientation, which shows the positions of objects that were collected as evidence. This overall view of the scene usually is not available in photographs, and shows only relevant and important items that were collected and their location in a room or area.

An accurate sketch provides a clear overall illustration of the scene and shows the exact location of various items of evidence and their position in relation to each other and their surroundings. Thus, the scene will be preserved for future use in questioning witnesses and assisting the investigator to better understand the conditions at the fire scene.

Rough Sketch

The rough sketch is made at the scene of the investigation after the preliminary search of the scene, but before movement or removal of any evidence. When objects, such as bodies, must be removed from the scene before the sketch is complete, the object should be photographed and exact locations recorded and marked with chalk or other marking device.

The sketch must contain all appropriate information, i.e., name of person making the sketch, date, accident number, furniture placement, smoke damage, and dimensions. Usually it is not drawn to scale.

When doing a sketch, objects are not drawn as they actually appear; rather, symbols are used when possible. Architectural supply shops have available at very modest cost plastic templates of architectural symbols. The templates may not have a great practical application when preparing the rough sketch in the field, but they will be invaluable in the preparation of the finished drawing. Considerable time will be saved when rough sketching if some of the most commonly used symbols, such as windows, doors, and stairways are used.

The legend is an explanation of the signs, symbols, or characters used in a sketch or drawing. Whenever possible, conventional signs and symbols should be used. When unconventional signs and symbols are used, an explanation or description is required in the legend.

When numbers are used to differentiate objects in a sketch, they should be circled or squared to prevent confusion with the numbers used as measurements. Symbols used in a sketch must be consistent with the ones appearing in the legend. Examples:

-- N= North

- G = Gas
- W = Water
- E = Electrical
- A = Access
- = Light *char*
- =Heavy char
- = Smoke stain

The diagram/sketch is done by the investigator to show different objects of importance and their locations. Diagrams/Sketches will not always show the same objects, because objects of importance change with each investigation. Multiple diagrams/sketches can be done to show multiple floors, points of origin and/or body locations if there are fatalities.

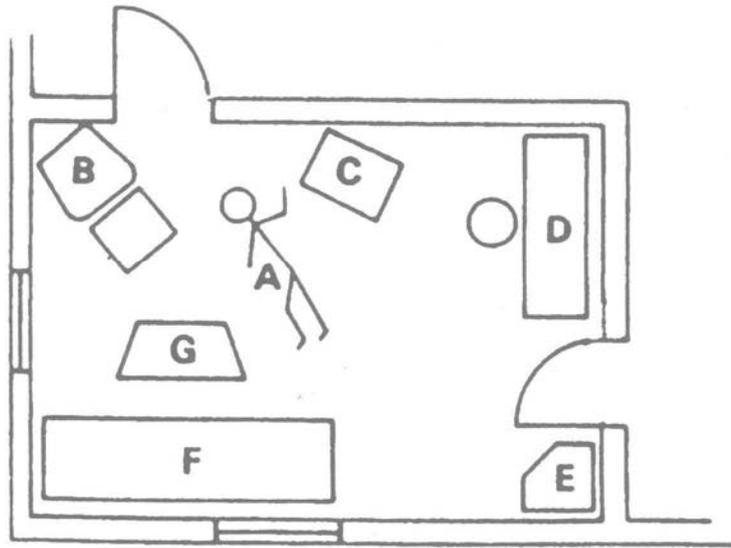
The information, a diagram/sketch must be accurate and consistent with information in the investigator's notes and photographs. A diagram/sketch should not be drawn to scale: the entire diagram/sketch could be discredited by a single inaccuracy and a diagram/sketch must be completely accurate.

When sketching a fatal fire scene, the location(s) of the body or bodies is very important and is always included on the diagram/sketch. The diagram/sketch can be done in connection with photographs to better illustrate the fire scene. The diagram/sketch should be retained with the case file.

Sketching Systems

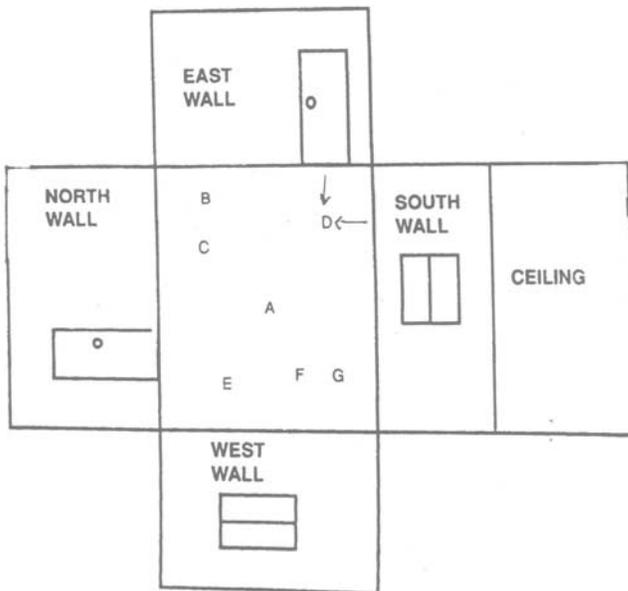
There are two common types of sketches. A two-dimensional sketch shows the length and width of an area from above. It is sometimes called a "bird's eye" view and is the most common type of sketch.

Two-Dimensional Sketch



- Legend:**
- A. Body
 - B. Chair and ottoman
 - C. Television
 - D. Piano and stool
 - E. Corner cabinet
 - F. Sofa
 - G. Cocktail table

The three-dimensional sketch shows the entire area sketched. It looks as if the walls have been folded flat.



- Legend**
- A. Body
 - B. Piano and stool
 - C. Television
 - D. Cabinet
 - E. Chair and ottoman
 - F. Cocktail table
 - G. Sofa

For accurate case documentation, record basic information on each sketch: incident/case number; incident date; case name; location; "not to scale" identifier; person making sketch; date sketch was drawn and plotting method.

Plotting Methods

Accurate measurements are a must to establish the reliability of the drawing. They eliminate any guesswork in locating objects and they permit the investigator to testify with confidence and precision. It is, therefore, essential that all measurements be taken from fixed objects that normally cannot be moved or misplaced. It is not necessary to be overly precise in taking measurements. There are certain acceptable latitudes in measuring. To say, for example, that the bottle of alcohol was found 10' 7-3/16" from a bulkhead is somewhat overdoing it.

When measuring the inside of a room the measurements are taken from finished wall to finished wall, and inside trim such as baseboards are disregarded. Windows, doors, and other openings are measured along the bulkhead in which they are located, but window and deck trim also are disregarded, and only the actual openings are measured.

When critical measurements are taken, the investigator preparing the sketch should verify the readings. This will permit two investigators to verify the data in the event the accuracy of the measurements is challenged.

There are three basic methods of locating objects on a sketch: rectangular, triangulation, and straight line. Rectangular measurement is a simple and commonly used method in which a point is located by making a measurement at right angles from two bulkheads, thus establishing an imaginary rectangle.

The triangulation method is simple and accurate and is particularly good for areas lacking straight lines. A measurement is made from each of two fixed objects to the point you desire to locate so as to form an imaginary triangle. The point of intersection of the two lines is the exact location.

Straight line measurements are usually made of furniture or evidence which may be located on a wall. Two measurements are taken from fixed points to either side of the object.

Photographs

Take as many photographs as necessary to document and record the scene adequately. It is recognized that time and expense considerations may affect the number of photographs taken.

Photographs need to be taken as soon as practical to ensure the scene is undisturbed.

If you are present during fire suppression efforts, beginning photo documentation then will prove invaluable.

When collecting evidence samples be sure to take a minimum of three photographs for each sample:

- Photograph the sample prior to collecting.
- Photograph the sample in the evidence container adjacent to collection site.
- Photograph the sample site with sample and evidence container removed.

Photographs should be organized into photograph logs that specify photograph number, roll number, subject of the photograph, direction taken, case number, incident date, and photographer's name. When taking photographs, do not include equipment or fire department personnel in the picture. Don't add anything to the photograph that is not part of the fire scene. This can contaminate the picture and cause confusion later on when you are trying to analyze the scene. When photographing the fire scene take pictures in the same order in which you are processing the fire scene.

The photographer is responsible for the complete accountability of all photographs. Photographs must be recorded, processed, and stored in a way which ensures the integrity of photographs. Do not throw away bad pictures.

Negatives should be maintained, as would any other evidence.

Do not mix fire scenes on the same roll of film. Negatives should be cataloged and stored separately. This eliminates the possibility of loss and damage.

Evidence

Use notes, photos, and sketches to document the evidence collection process. Remember to make notes and sketches pertaining to the collection, and photograph the collection of each piece of evidence. Just as in photographing the fire scene, you need to document evidence in a similar fashion. This documentation is done on an evidence log.

INCIDENT COMMAND SYSTEM (ICS) FOR FIRE INVESTIGATION

Larger investigations, e.g., complex fires, multiagency fires, or serial arson fires merit an organizational structure which assures that all participants can fit into the command structure. Procedures need to be established for designating who will be in charge of the incident (incident commander); who will be responsible for the overall operations of the investigation, including origin and cause determination; photography; evidence; diagrams; fatalities; injuries; interviews; who will handle the planning stage, which includes the research and technical phases of the investigation; and who will be

responsible for the logistics, including supplies, security, sanitation, food, communication, and finance.

Consider whether additional resources will be required, such as assistance from other jurisdictions; mutual-aid agreements; local task forces; or the Bureau of Alcohol, Tobacco, and Firearms (BATF) National Response Teams. Accelerant detection dogs are available. Computerized arson information systems can assist in investigative analysis.

SUMMARY

Due to the destructive powers of fire, the investigator must continually be aware of his/her surroundings and must ensure that proper scene safety measures are instituted. This includes always working in pairs, wearing proper safety clothing, using proper respiratory protection, and being alert to fire scene hazards.

This unit has explained how fire suppression companies can assist in the investigation process by not destroying or damaging the structure and contents any more than needed during extinguishment. During overhaul, the fire suppression fire fighters should be asked to proceed as carefully as possible to safeguard possible evidence. In order to ensure scene safety, properly determine the origin and cause, prevent contamination, and properly conduct your investigation, scene security must be legally maintained. The importance of securing the fire scene cannot be overemphasized.

Determining the point of origin is a critical first step in fire investigation. There are many factors to consider in this process of conducting a systematic investigation, while attempting to reconstruct the fire scene from the area of least damage to the area or point of most damage. Only after the exact point of origin has been established can a fire cause be determined.

Complete and accurate documentation of the fire scene consists of good field notes, diagramming/sketching the fire scene, photographing the fire scene, and collecting fire scene evidence. In large fire investigations where multi-agencies are working together, serial arson fires, or complex fire scenes, the use of a fire investigation Incident Command System has proved to be a very useful tool in maintaining control and providing for an effective investigation.

Fire scene investigation can be more complex than fire suppression. The process of correctly determining the origin and cause of the fire may take hours, days, or even weeks to complete. Investigators must be mentally alert at all times since they will be exposed to a variety of hazards and will be subject to continuous physical exertion.

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