Chapter 2

DETERMINATION OF POINT OF ORIGIN

INTRODUCTION

In fire investigation, the place where a fire starts is referred to as the "point of origin." This may be an exact point or a general area. In almost all cases, the point of origin must be correctly located in order to properly determine the fire cause. In the past, individuals often referred to cause and origin; the correct phrase and procedure is origin and cause.

In general, fire will burn longer at or near the point of origin, thus the damage generally will be greater. Normally the fire cause will be found at, or very near, the point of origin, and physical evidence of the fire cause, whether accidental or incendiary, is often recovered. Once the point of origin is determined, it may confirm or contradict the statements of owners / occupants / witnesses / suspects.

One of the most important aspects of any fire investigation is the proper recognition, identification, and analysis of fire patterns. The circumstances of every fire are different, but each fire is governed by the same scientific principles involved in the chemistry and physics of fire and by the physical construction of the ship.

The contents of this chapter are based substantially upon the material contained in Chapter 4 of NFPA Standard 921, *Guide for Fire and Explosion Investigations,* 1992 Ed.

DEFINITIONS

Fire patterns are the actual physical effects that can be seen or measured after a fire, including charring, oxidation, distortion, melting, color changes, and structural collapse.

Lines or areas of demarcation found on vertical and horizontal surfaces after a fire are the borders defining the different levels of heat and smoke as they affect various items at the fire scene. The production of these lines and areas is dependent upon a combination of variables: the material itself, the RHR, fire suppression activities, temperature of the heat source, ventilation, and the length of time of exposure.

Surface effect is the result of the nature and material of the surface which contains the fire pattern, affecting the actual shape of the lines of demarcation displayed, or increasing or decreasing the amount of pyrolysis and combustion in different areas. For example, if both smooth and rough surfaces of the same material are equally exposed to the same level of heat, the rougher surface will sustain more damage. Surfaces such as paint, tiles, brick, wallpaper, plaster, etc., can increase or decrease the amount of damage sustained to the surface.

The penetration of horizontal surfaces (burn throughs) from above or below, can be the result of radiant heat, direct flame impingement, or smoldering in a localized area. Downward penetrations often are considered unusual, since the more natural direction of heat and fire spread is upward. However, once flashover has occurred, the hot fire gases may be forced downward through small preexisting openings, such as for ductwork, resulting in a penetration. Downward penetrations also can result from the intense burning of polyurethane mattresses, couches, or chairs. Dropping of flaming or smoldering materials also can lead to floor penetrations. Any downward penetration should be examined carefully and its cause determined.

The burn direction of a penetration can be determined by an examination of the sides of the hole. Sides that are wider at the top of the hole, and slope inward, indicate that the fire came from above. On the other hand, sides that are wider at the bottom and slope upward toward the center of the hole indicate that the fire came from below.

Another method that can be used to determine whether a fire spread up or down through a hole is to compare the overall extent of damage to the two levels separated by the penetrated surface. If the fire moved upward, most often the damage to the underside of the surface will be more severe. If the fire moved downward, then the opposite most likely will be true.

Given the many circumstances that can affect fire behavior, it is possible for both upward and downward fire spread to occur through the same penetration. However, it is likely that only the last direction of movement will still be evident.

Loss of material and mass may occur when wood or other combustible materials burn. The remains of these materials themselves can display lines of demarcation, and ultimately fire patterns that can be analyzed. Examples of this are the top of wall studs burned away at progressively lower levels, which can be used to determine the direction of fire travel. Likewise, the extent of damage on opposite sides of a door opening can be used to determine the direction of fire travel.

PATTERNS AND SURFACE EFFECTS OF CHAR

Types of Patterns

Fire patterns fall into two general types, both of which are regulated by the chemistry and physics of fire, as well as by method of construction.

Movement patterns are those which are the result of growth and extension of fire and products of combustion away from the original heat source. Proper inspection of the fire scene will result in tracing these patterns back to the original heat source.

Intensity patterns are produced by the effects of the various intensities of heat exposure to the structure and its contents. The varying heat levels can produce lines of demarcation which can be used to determine the characteristics and quantities of fuel loading, as well as to indicate the direction of fire spread.

General Effects of Char

The heat produced during a fire will result in the decomposition of various surfaces. The extent and degree of the discoloration and charring that result from this decomposition are compared to other areas to find the areas of heaviest damage.

Although the use of wood in vessel construction is declining, there are still a large number of wooden vessels in service. Charred wood will be found after every structural fire on a wooden vessel and will provide the investigator with valuable information concerning the origin and spread of the fire. Wood undergoes a chemical decomposition when exposed to elevated temperatures. During this decomposition, gases, water vapor, and various pyrolysis products such as smoke are produced. After extended or intense heat exposure, the remaining solid residue is mainly carbon. As the charring is taking place the material shrinks, and develops cracks and blisters. Char is the carbonaceous material that has been burned and has a blackened appearance.

Rate of Wood Charring

An old rule of thumb was that wood would char at a rate of 1 inch per 45 minutes of burning. This rate of charring is based upon one set of laboratory conditions in a test furnace using pine lumber. Since fires burn with intensities that are different from those produced during this test, this rule of thumb should not be relied upon to determine the length of time that a fire has burned. In other words, no specific time of burning can be determined based solely upon the depth of char.

Another old rule of thumb is that old wood burns faster than new wood. However, wood tends to gain or lose moisture according to the ambient conditions to which it is exposed. Because of this, old, dry wood is no more combustible than new, kiln-dried wood under the same conditions.

Depth of Char

The depth of char can be used as a reliable means of establishing fire spread. By measuring the relative depth and extent of charring, it is possible to determine what portions of a material or construction have been exposed longest to a heat source. The relative depth of char from point to point is the key to appropriate use of chancing: that is, locating the places where damage was more severe due to exposure, ventilation, or fuel placement. In comparing the extent of charring, it also is important to take into consideration the type of materials involved. For example, a room in which wood paneling is the interior finish, may be more heavily charred than an adjoining room in which the interior is gypsum board, even though the fire may have originated in the gypsum board room. In comparing charring, remember not to "compare apples to oranges."

In comparing the depth of charring it also is critical to consider the effects of ventilation. Wood can exhibit a deeper charring when adjacent to a ventilation source or an opening *where* hot gases can escape. For example, the portion of a room adjacent to a an open door can be more heavily charred than a point of origin across the room, if the fire ventilated through the door opening.

The depth of char can be measured using blunt-ended probes such as certain types of calipers, tire tread depth gauges, or specifically modified metal rulers. The same measuring tool should be used for any set of compared measurements. Char depth measurements should be made in the center of char blisters.

When fuel gases or oxygen is the initial fuel source for a fire, the fire will generally produce relatively even char patterns over the often-wide area that they cover. Deeper charring may exist in proximity to the point of gas leakage. This type of charring may be highly localized because of the pressurized gas jets that can exist at the leakage point.

Certain segments of the fire investigation community have accorded greater significance to the appearance of charring, cracks, and blisters than is substantiated by scientific experiments. One of the old rules of thumb was that the presence of large, shiny blisters (sometimes called alligator char or alligatoring) is proof that a liquid accelerant was present. This is false. These types of char can be found in many different types of fires and there is no scientific justification they are an exclusive indication of an accelerated fire.

Another old rule of thumb was that the surface appearance of the char--dull, shiny, or colored--points to the use of a hydrocarbon accelerant. Again, there is no scientific justification for this correlation. Investigators should not claim that indicators such as large, shiny blisters or dull or colored char are indications of accelerant, based on the appearance of the char alone.

The depth of char can be *used* to estimate the duration of a fire. Remember that the charring of wood varies depending on such things as rate and duration of heating; ventilation effects; surface area to mass ratio; direction, orientation, and size of wood grain; species of wood; moisture content; and nature of surface coating.

OXIDATION

Oxidation is a very basic chemical process associated with fire. Even though some materials do not burn readily, oxidation of these materials can produce lines of demarcation and fire patterns. The effects of such oxidation can include changes of color or texture. Generally, the higher the temperature and the longer the exposure time, the more pronounced the oxidation will be.

Bare galvanized steel exposed to a mild level of heating will result in the surface becoming a dull white. When uncoated iron or steel is exposed to a fire, the surface first becomes a dull blue-gray. Further oxidation can result in thick layers of oxide that flake off. After the fire, if the metal has been wet, the usual rust-colored oxide may appear.

Since the steel surface is being oxidized by the fire, and most probably is being wetted down during suppression activities, it is not unusual to find holes in thin metal surfaces.

On stainless steel, mild oxidation has color fringes, while severe oxidation will result in a dull gray color.

When exposed to heat, copper forms a dark red or black oxide. The color of the oxide is not important. What is significant is that oxidation can form a line of demarcation.

Soot and char also are subject to the effects of oxidation. The char of the paper surfaces of gypsum wallboard, soot deposits, and paint can be oxidized by continued exposure to heat. The result of this oxidation is that the carbon will turn to gases and disappear from the surfaces on which it was present. This oxidation results in what is known as a "clean burn".

MELTING OF MATERIALS

The melting of any material is a change in its physical state brought about by its exposure to heat. The border between melted and solid portions of materials can produce lines of heat and temperature demarcation, which can be used to define fire patterns.

Knowing the melting points of various materials can help establish temperatures reached during the fire. Melting temperatures of materials may range from slightly over normal ambient room temperatures to thousands of degrees. The following chart, taken from NFPA 921, *Guide for Fire and Explosion Investigations* provides the melting temperatures of numerous common materials.

Material	Melting Temperatures (Approx.)	
	^{o} F	^{o} C
Aluminum (alloys)	1,050-1,200	566-649
Aluminum	1,220	660
Brass (yellow)	1,710	932
Brass (red)	1,825	996
Bronze (aluminum)	1,800	982
Cast iron (gray)	2,460-2,550	1,349-1,399
Cast iron (white)	1,920-2,010	1,049-1,099
Chromium	3,550	1,954
Copper	1,981	1,082
Fire Brick	2,980-3,000	1,638-1,649
Glass	1,100-2,600	593-1,427
Gold	1,945	1,063
Iron	2,802	1,539
Lead	621	327
Magnesium (AZ31B alloy)	1,160	627
Nickel	2,651	1,455
Paraffin	129	54
Platinum	3,224	1,773
Porcelain	2,820	1,549
Pot metal	562-752	294-400
Quartz	3,060-3,090	1,682-1699
Silver	1,760	960
Solder (tin)	275-350	135-177
Steel (stainless)	2,600	1,427
Steel (carbon)	2,760	1,516
Tin	449	232
Wax (paraffin)	120-167	49-75
White pot *metal*	562-752	294-400
Zinc	707	375

Alloying of Metals

Another reaction that occurs during a fire is the formation of eutectic alloys. A eutectic is defined as the lowest melting point of an alloy or solution of two or more substances that is obtainable by varying the percentage of the components. This takes place when the melting temperature of one material is reached during the fire, and this melting material comes in contact with another metal. The resulting mixture (alloy) will melt at a temperature lower than the melting temperature of the higher melting temperature metal, and in many cases lower than either metal. In fire situations eutectic alloying occurs when molten aluminum or zinc comes in contact with steel or copper.

Copper wiring, tubing, and piping are quite often affected by alloying. Aluminum can mix with the copper to form an alloy, which ranges in color from yellow to silvery. The surface of the spot of aluminum might appear gray in color, while the surface near the aluminum-copper interface may be fairly dark. The copper wire will be very brittle. Zinc also will alloy with copper, forming a yellowing brass.

Alloying with steel does not readily occur in most fires; however, if aluminum or zinc is heated for an extended time with a steel object then alloying may result in pits or holes. Alloying may be confirmed by metallurgical analysis, and the alloy may be identified. One theory is that if metals with high melting temperatures are found melted, this is an indication of incendiarism. Scientific fact shows that if these metals are melted due to alloying, such melting is not an indication that accelerants or unusually high temperatures were present during the fire.

Plastics

Thermoplastics have melting temperatures ranging from around 200 ^{o} F (93 ^{o} C) to near 750 ^{o} F (399 ^{o} C). Knowing the approximate melting temperatures of various materials enables the investigator to estimate the temperatures achieved during the fire. This assists in determining the intensity and duration of the heating, the extent of heat movement, and the relative rate of heat release from fuels.

THERMAL EXPANSION AND DEFORMATION OF MATERIALS

All common materials will expand when heated. Such expansion can adversely affect structural stability. The bending of steel beams and columns will occur when the temperature reaches 1,100 ^{o} F (593 ^{o} C) and steel will not support its own weight at 1,500^{o} F (816 ^{o} C). The greater the load the steel structure is carrying, the more severe the deformation will be.

Bending is not a result of melting and the thermal expansion of a beam can be a factor if the ends of the beam are restrained. Contrary to belief, the application of a hose stream will not cause heated steel to collapse. Such water application will "freeze" the steel in its current position if it has already been deformed, and if applied early in the fire may prevent the steel from being heated sufficiently to cause collapse.

SMOKE AND SOOT

Smoke is an airborne particulate product of incomplete combustion suspended in gases, vapors, or solid and liquid aerosols. Soot consists of the black particles of carbon produced in a flame.

Any fuel that contains carbon is going to produce soot under normal fire conditions. This is especially true with petroleum products and almost all plastics. Soot can be deposited on walls and ceilings by direct flame contact or it can be deposited on surfaces by settling.

Smoke and soot can collect on cooler surfaces of the structure and/or its contents, and quite often on upper portions of walls in rooms away from the fire. Smoke, especially smoke generated by a slow, smoldering fire, has a tendency to condense on walls, windows, and other cooler surfaces.

Brown deposits are from smoke; soot deposits are black. Smoke condensates can be wet and sticky, thin or thick, or dried and resinous. After drying, such smoke deposits are not easily wiped off. Where there has been open flame, both soot and smoke are likely to be deposited. During some fires, only dry soot deposits will be produced. Such deposits are wiped easily from windows and other surfaces. When smoke deposits on a window are heated later in the fire, the brown deposits will turn black due to carbonization.

CLEAN BURN

Clean burn occurs on noncombustible surfaces when the soot and/or smoke deposits are burned off. Such clean burning is most commonly a result of direct flame contact or intense radiant heat. Although such clean burns can indicate intense heating, they do not, by themselves, necessarily indicate point of origin. Demarcation lines between the clean burn and the sooted/smoked areas may be used to determine the direction of fire spread or differences in intensity or time of burning.

WINDOW GLASS

Current research indicates that temperature differences of 140 ^{o} F or more between the exposed and insulated portions of the glass will result in long, smoothly undulating cracks radiating from the edges of the frame to the center of the pane.

Sudden flame contact with one side of the windowpane, such as occurs during flashover, will cause the glass to fracture. It once was thought that such rapid heating would result in a complicated pattern of small cracks (often called crazing), but this has not been confirmed by scientific research.

It is possible that interior pressures developed during a fire, especially if a backdraft explosion occurs, may be sufficient to either break windows. Broken glass on the deck outside of a burned out pilothouse is evidence that such over-pressurization occurred during the fire.

Crazing, small craters, or pits are caused by the application of water to the glass surface when the surface of the glass is heated to at least 600 ^{o} F (316 ^{o} C).

Finding glass fragments which are free of soot or smoke deposits is evidence that the glass has been subjected to rapid heating, failure early in the fire, or flame contact. The proximity of the glass to the area of origin or heat source can affect the amount of deposits.

The presence of thick, oily soot on glass was once thought to indicate positive proof of the presence or use of an accelerant. This has not been supported by scientific research. The presence of such deposits also can result from incomplete combustion of various materials.

COLLAPSED SPRINGS

The collapse of furniture springs was thought to indicate exposure to a flaming accelerant or smoldering combustion. Scientific laboratory testing has shown that annealing of springs (loss of spring tension) is a function of the total heat treatment.

Testing has shown that short-term heating at high temperatures and long-term heating at moderate temperatures of about 750 ^{o} F (399 ^{o} C), both can cause annealing and collapse. The presence of any weight load upon the springs during the heating increases the loss of spring tension.

Any analysis of the condition of springs after a fire must take into consideration all materials that were placing a load on them, and a comparison of the lines of demarcation.

LOCATION OF OBJECTS

The location of objects at the fire scene can be determined by the identification and use of certain patterns.

Heat shadowing occurs when the object blocks the path of radiated heat, convected heat, or direct flame contact. Conducted heat does not produce heat shadowing. Any object that absorbs or reflects heat energy can produce a heat shadow on the material that it protects.

Protected areas are caused by an object preventing the deposit of products of combustion on the material that the object protects. Any object that prevents the settling of the products of combustion may cause the production of a pattern on the material it protects.

Both heat shadowing and protected areas assist the fire investigator in reconstructing the scene. Quite often these patterns will be obscured by debris, and in order to properly use these patterns, debris removal will be necessary.

LOCATION OF PATTERNS

Patterns developed during the course of a fire may be found on any exposed surface. These include the structure itself, its contents, and exterior surfaces exposed to heat, smoke and soot.

Patterns present on bulkheads are the most observable. These patterns may appear as lines of demarcation resulting from heating to deeper burning. The patterns may extend to the underlying support members.

Patterns also can occur on overheads and the bottom surfaces of such items as tables and shelves. Since heated fire gases rise, they will concentrate the heat energy on the horizontal surfaces above the heat source. Most horizontal patterns are roughly circular with portions of circular patterns often being found at the junction of bulkheads and overheads and at the edges of tabletops and shelves.

Patterns present on the deck are extremely important. To inspect the deck properly for patterns, the debris must be removed. Deck patterns can be the result of intense radiant heat, melted plastics, burning liquids, or the hot gas layer produced during and after flashover.

Seams or cracks in the decking materials and around door thresholds can show evidence of burning from radiation or collection of liquid accelerants. Post-flashover burning also can produce holes in [wooden] decks or deck coverings and around door thresholds as a result of the hot combustible fire gases and the air gaps provided in construction. Even very small gaps can provide sufficient air for combustion.

Fire-damaged vinyl floor tiles may exhibit curled edges, which expose the deck underneath. While this action has been attributed to the presence of an accelerant, it also can occur solely because of radiant heating of the floor surface. Analysis for the presence of accelerants may prove difficult due to the presence of hydrocarbons in tile adhesives.

Surfaces of external structures also can display fire patterns. In addition to the regular patterns that may be found, burnthroughs on wooden vessels can be present on both vertical and horizontal surfaces. As a general rule, these burnthroughs can point to areas of intense or sustained burning. If the fire occurred close to the ship's side, external scorch marks may indicate the hottest points of the fire and may provide an indication of the probable location of fire origin.

Patterns also can be present on the sides, tops, and bottoms of vessel or room contents. Any pattern that can be produced on walls, ceilings, and floors also can be produced on contents. The patterns will be similar in shape but *may* display only a portion of the pattern due to the limited size of the items.

Low burn patterns may be produced by an accelerant, but they are not in themselves proof of an accelerant fire. Post-flashover conditions also can produce low burn patterns. During the progress of any fire, burning debris quite often will fall to lower levels. This fall down (drop down) may result in secondary fires. It also can ignite other combustible materials resulting in low burn patterns and burnthroughs.

PATTERN GEOMETRY

The chemistry and physics of fire result in various types of patterns having distinctive geometry or shapes. Since the interpretation of all possible fire patterns cannot be traced directly by scientific research, the fire investigator is cautioned that alternative interpretations of a given pattern are possible.

A common fire pattern shape displayed on vertical surfaces is the "V" pattern. The lateral spread of the sides of this pattern are caused by radiated heat from above and by the upward and outward movement of flames and hot fire gases when they encounter a horizontal surface such as a ceiling, an eave, a tabletop, or a shelf.

The angled lines that produce the "V" can often be traced back toward a point of origin. As a general rule, the wider the angle of the "V" the longer the burned material has been subjected to heating. The angle produced on a vertical combustible surface will be wider than on a noncombustible surface for a comparable heat source and burn time.

It was long believed that a fast-burning fire produces a narrow-angle "V" pattern, while a a slow-burning fire produces a wide angle "V" pattern. This is incorrect, since the angles of the lines of the "V" pattern actually are a result *o*f the size of the fire, burning rate, ventilation, and combustibility of the walls. These patterns are valuable because they indicate the direction of fire spread, not what caused them.

Inverted cone patterns, also called inverted "V" patterns are triangular patterns wider at the base than at the top. Inverted cone patterns are the result of relatively short-lived fires which do not fully evolve into floor-to-ceiling name plumes or flame plumes that are not restricted by ceilings. Since they often appear on noncombustible surfaces, it was thought that they were caused by fast-burning fires. The correct analysis of such patterns is that the burning was of short duration. Inverted cone patterns also have been interpreted as proof of a liquid accelerant fire, but any fuel that produces flame zones that do not become vertically restricted can produce such patterns.

Hourglass patterns result from the combination of the plume of hot gases and the flame zone. The plume of hot fire gases is shaped like a "V", while the flame zone is shaped like an inverted "V". If the fire itself is very close to or in contact with the vertical surface, this may result in a pattern displaying the effects of both the hot gas plume and the flame zone. This results in a pattern with the general shape of an hourglass.

"U" patterns are similar to "V" patterns. "U" patterns display more gently curved lines of demarcation, as opposed to the angled lines of the "V" pattern and are the result of the effects of radiant heat on vertical surfaces more distant from the heat source than surfaces displaying sharp "V" patterns. "U" patterns are analyzed in the same manner as "V" patterns.

Truncated cone patterns (also called truncated plumes) are three- dimensional fire patterns, created on both horizontal and vertical surfaces. This pattern occurs at the intersection of two vertical surfaces. The cone-shaped pattern is the result of the natural expansion of the fire plume as it rises and the horizontal spread of the heat energy when the plume encounters a horizontal surface such as a ceiling.

Circular patterns are common at fire scenes and generally represent areas which were protected from burning by circular items such as wastebaskets or the bottoms of pieces of furniture.

Irregular, curved, or pool-shaped patterns on floors and floor coverings once were considered positive proof of the presence or use of a liquid accelerant. While such patterns can be the result of an accelerant, this cannot always be determined reliably from visual observation alone.

These types of patterns are very common in post-flashover fire conditions, in fires with long extinguishing times, or in structure collapse. They can be the result of radiant heat, flaming and smoldering debris, melted plastics, or ignitable liquids. If the presence of ignitable liquids is suspected, supporting evidence such as the use of a combustible gas indicator and/or chemical analysis of debris for residues, or the presence of liquid containers should be sought. Be cautious when using combustible gas indicators, since many plastic materials release hydrocarbon fumes when they pyrolize or burn. These fumes may very well have an odor similar to petroleum products, and can be detected by a combustible gas indicator when no ignitable liquids have been used. In addition, chromatographic analysis of burned carpet made of petroleum-based materials can indicate the presence of hydrocarbons even when no accelerants were used.

In general, patterns resulting from accelerants have deeper char at the edges than in the center (doughnut patterns). However, pooled ignitable liquids that soak into decking or deck covering materials, as well as melted plastics, can produce irregular patterns that are more deeply burned in the center than at the edges. These patterns also can be the result of localized heating after flashover or drop down. Irregular patterns on wood decking caused by ignitable liquids will have "fingers" that follow the cracks in the flooring.

A distinct "doughnut" pattern, where a roughly ring-shaped burn surface surrounds a less burned area, may result from an ignitable liquid. This pattern is the result of the cooling effects of the liquid in the center of the pool; the edges burn, producing charring around the perimeter. When this condition is found, further examination is needed to seek supporting evidence of the presence of ignitable liquids.

In any situation where the presence of ignitable liquids is suggested, the effects of flashover, airflow, hot gases, melted plastics, drop down, and building collapse must be eliminated. The investigator must be careful to identify the initial fuel source correctly for any irregularly shaped or circular burn patterns.

Many modern plastic materials will burn. They first react to heating by liquefying (melting); when they burn as liquids they produce irregularly shaped or circular patterns. When discovered in unexpected locations, they can be identified mistakenly as flammable or combustible liquid patterns and thus associated with an incendiary fire cause.

Often the presence of an ignitable liquid is ruled out, based upon the fact that an explosion did not occur. This is not always accurate, since the expansion of the products of combustion from flammable liquids will cause explosions only if they are sufficiently confined and have the proper fuel-to-air mixture.

LINEAR PATTERNS

Patterns that have overall linear or elongated shapes are referred to as linear patterns. They most commonly appear on horizontal surfaces.

When fuels are intentionally "trailed" from one area to another, the elongated patterns may be visible. Such trailers can be found along decks, connecting separate fire sets, or up stairways to move fires from one level to another. Trailers may be ignitable liquids, solids, or a combination.

Long, wide, fairly straight patterns may be a result of protected areas caused by furniture, counters, storage, or other items. These patterns also may be the result of normal wear to the floor and floor coverings from high traffic. Irregularly shaped objects, such as clothing or bedding, also may provide protection and produce patterns that may be inaccurately interpreted. Linear patterns also can be produced by ignited fuel gas jets.

AREA PATTERNS

Some patterns may be found which appear to cover entire rooms or large areas without any readily detectable source. These patterns are most often caused by fuels that are widely dispersed prior to ignition or when the movement of the fire through an area is very rapid, as in a flash fire.

Whenever flashover occurs in a compartment, the spread of fire from one point to another in the compartment is very rapid. Flashover can produce entire areas of relatively even burning, without good physical evidence of the direction of fire travel in the affected area. Flashover may not necessarily destroy previously generated fire patterns, but the time and extent of burning, both pre-flashover and post-flashover, is important in considering the relationship between the movement patterns and flashover area patterns.

The ignition of gases or vapors from liquids does not always result in an explosion. If the fuel/gas mixture is at or very near the LEL, and there is no explosion associated with ignition, the gases may burn as a flash fire and there will be little or no subsequent burning.

MATERIAL DISTORTION

Other fire patterns can be observed in the changes in the physical shape and distortion of objects in the fire scene.

Incandescent light bulbs can sometimes indicate the direction of fire travel. As the side of the bulb facing the heat source is heated and softened, the gases inside a bulb of greater than 25 watts begin to expand and can push out the softened glass in a "bubble" effect. The bulged portion of the bulb will point in the direction of the heat source. With bulbs under 25 watts, the exposed surface will pull inward, due to the interior of the bulb creating a vacuum. When heated, metal construction elements will soften and collapse or expand.

SUMMARY

An understanding of what types of patterns are produced during a fire and the factors that influence their production, gives the fire investigator scientific factors upon which to base his/her opinions. Without this understanding and its proper application, a fire investigator's opinions will be based upon old fire investigators' tales and such opinions will not meet the challenge of reasonable examination.

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