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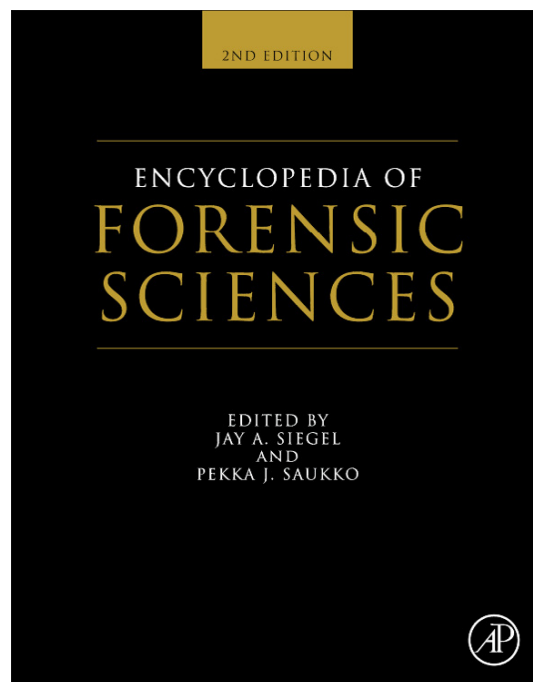
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Lentini J.J. (2013) Fire Patterns and Their Interpretation. In: Siegel JA and Saukko PJ (eds.) *Encyclopedia of Forensic Sciences, Second Edition*, vol. 3, pp. 396-405. Waltham: Academic Press.

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Fire Patterns and Their Interpretation

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Glossary

Flashover A transition phase in the development of a fire in a structure, in which all combustible surfaces exposed to thermal radiation ignite more or less simultaneously and fire spreads rapidly throughout the space, resulting in full room involvement. The transition is from 'a fire in a room' to 'a room on fire.'

Fuel-controlled fire A fire in which the heat release rate and growth rate are controlled by the characteristics of the fuel,

such as quantity and geometry, and in which adequate air for combustion is available.

Full room involvement A compartment fire in which the entire volume is involved in the fire, but flaming will only occur when there is sufficient oxygen available.

Ventilation-controlled fire A fire in a postflashover compartment, where all fuels are involved, and the heat release rate of the fire is controlled by the availability of oxygen.

Introduction and Overview

A fire pattern, also called a burn pattern, is the visible or measurable physical changes or identifiable shapes formed by a fire effect or group of fire effects. Fire effects are the changes in or on a material as a result of exposure to the fire.

The term 'fire effects' describes the artifacts left behind by many different processes, including dehydration, melting, color changes, oxidation, charring, loss of material, alloying, spalling, expansion and deformation, annealing, soot and smoke deposition, and clean burn. Even damage to an electrical system can constitute a fire pattern. Fire investigators are thus presented with a vast array of different patterns, all of which require some level of understanding of how they are created and what they mean.

Accurate interpretation of fire patterns can lead the fire investigator to the correct origin of the fire, and hopefully, to the correct identification of the fire's cause. However, accurate interpretation is often an elusive goal.

For many years, fire investigators followed the simplistic maxim that heat rises, and fire burns up and out. While it is true that heat rises, it does so only until it reaches the ceiling. At this point, the behavior of the fire changes.

When the rising smoke and heat reach the ceiling, the upward movement is stopped and a ceiling jet is created, sending the products of combustion in a horizontal direction, which then become confined by the walls of the compartment.

A hot gas layer develops at the ceiling, and gradually, this layer becomes thicker and more energetic. It radiates heat in all directions, including downward. When the temperature of the hot gas layer reaches 500–600 °C, all exposed combustible surfaces in the room ignite more or less simultaneously. This transition from 'a fire in a room' to 'a room on fire' is known as flashover. It is the fire investigator's goal to determine the first fuel package to ignite. That ignition necessarily occurred some minutes before flashover. Postflashover burning, however, is usually far more energetic than preflashover burning, and it has the capability to obscure or even obliterate patterns that existed prior to flashover.

By visualizing the interaction of a conical plume with a vertical surface, one can understand the generation of some fire patterns. Such patterns are common fire artifacts, and often

help fire investigators determine the origin of small fires. As a fire progresses to full room involvement, however, the 'rules' of fire pattern interpretation change.

Unfortunately, many fire investigators fail to understand underventilated fires and may misinterpret the most heavily damaged area of the room as necessarily being the origin of the fire. This is explained further when ventilation-generated patterns are discussed.

Plume-Generated Patterns

Fire patterns can result from several different kinds of interactions between the fire and its surroundings. The best-understood interactions are those that occur between the fire plume and a nearby vertical surface. Such patterns are often called 'truncated cone patterns.' (Fire investigators refer to 'cones' and 'inverted cones,' but their definition is the exact opposite of the classic geometric definition of a cone. In fire investigation, the apex of the cone is at the bottom.) These patterns are typically recorded on vertical surfaces, and fire investigators look for what they call 'V' patterns.

Fire patterns evolve over the life of a fire. When the fire is new, the pattern on an adjacent vertical surface will assume the shape of the flame, and will exhibit what fire investigators call an inverted cone pattern. This triangular pattern is characteristic of young fires. [Figure 1](#) is a schematic representation of how such a pattern is created, and [Figure 2](#) shows a triangle-shaped pattern produced by a test fire. As the fire continues to grow, the pattern becomes columnar, and the sides of the pattern are roughly perpendicular to the floor. Columnar pattern production is shown schematically in [Figure 3](#) and an actual columnar pattern is shown in [Figure 4](#). Columnar patterns have a very short life span, and change as soon as the fire begins to interact with the ceiling.

Once the fire plume encounters the ceiling, or an intervening horizontal surface, a 'V' pattern is the result. A semicircular pattern is created on the ceiling. [Figure 5](#) shows how the pattern is produced when the burning fuel package is close to the wall, and [Figure 6](#) shows an actual V pattern from a fire scene. As can be seen, the schematics are quite a bit

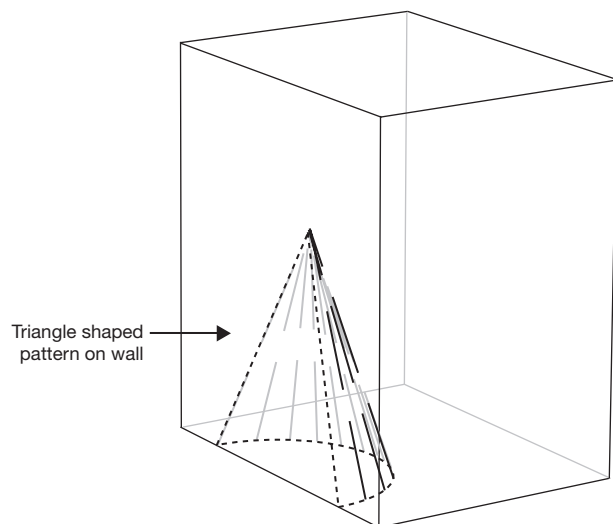


Figure 1 Intersection of an incipient fire with an adjacent wall. Copyright 2012 from *Scientific Protocols for Fire Investigation*, 2nd Edition by John J. Lentini. Reproduced by permission of Taylor and Francis Group, LLC, a division of Informa plc.



Figure 2 Triangle-shaped pattern, also called an inverted cone pattern, produced in a test fire. Copyright 2012 from *Scientific Protocols for Fire Investigation*, 2nd Edition by John J. Lentini. Reproduced by permission of Taylor and Francis Group, LLC, a division of Informa plc.

cleaner than the actual patterns, and sometimes fire investigators will disagree about whether a pattern is actually a V (or half of a V).

When the fuel package burns farther away from the wall, the interaction of the fire plume with the wall occurs at a higher level, and the bottom of the intersection of the cone and the wall is not as sharp. This results in a U-shaped pattern on the wall, and a circular pattern on the ceiling. **Figure 7** shows schematically how a U-shaped and circular patterns are created, and **Figure 8** shows a classic U-shaped pattern from a fire scene. Patterns on ceilings are often more difficult to recognize, because ceilings are likely to collapse sooner than walls.

Figure 9 shows a semicircular pattern above the origin of a fire that originated inside a wall.

As a fire progresses, more fuel packages become involved, and may result in new 'V' patterns or 'U' patterns being

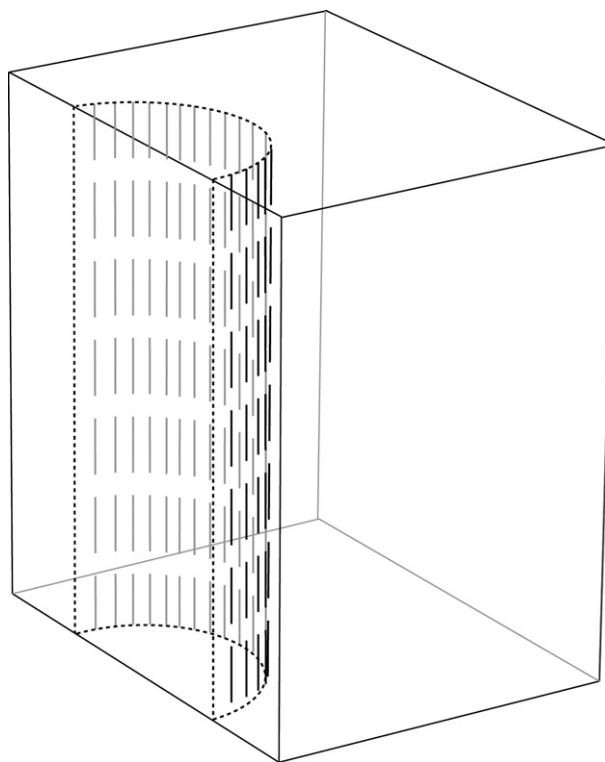


Figure 3 Intersection of a columnar fire with an adjacent wall. Copyright 2012 from *Scientific Protocols for Fire Investigation*, 2nd Edition by John J. Lentini. Reproduced by permission of Taylor and Francis Group, LLC, a division of Informa plc.



Figure 4 A columnar fire pattern produced by a fire that was extinguished prior to the formation of a V-shaped pattern. Copyright 2012 from *Scientific Protocols for Fire Investigation*, 2nd Edition by John J. Lentini. Reproduced by permission of Taylor and Francis Group, LLC, a division of Informa plc.

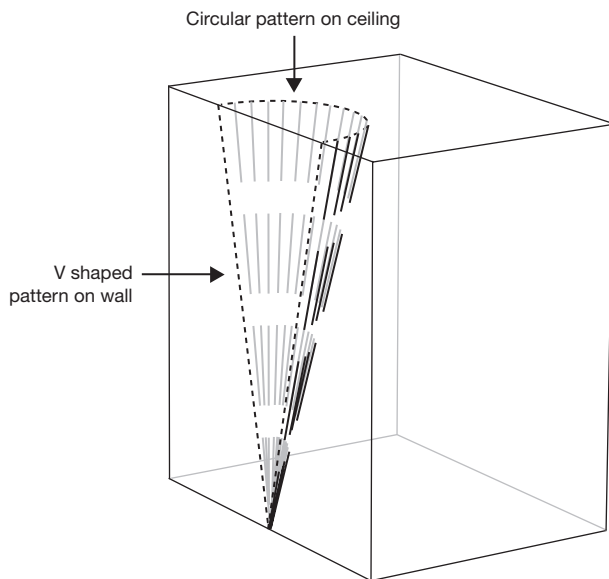


Figure 5 Intersection of an established fire plume with an adjacent wall. Copyright 2012 from Scientific Protocols for Fire Investigation, 2nd Edition by John J. Lentini. Reproduced by permission of Taylor and Francis Group, LLC, a division of Informa plc.

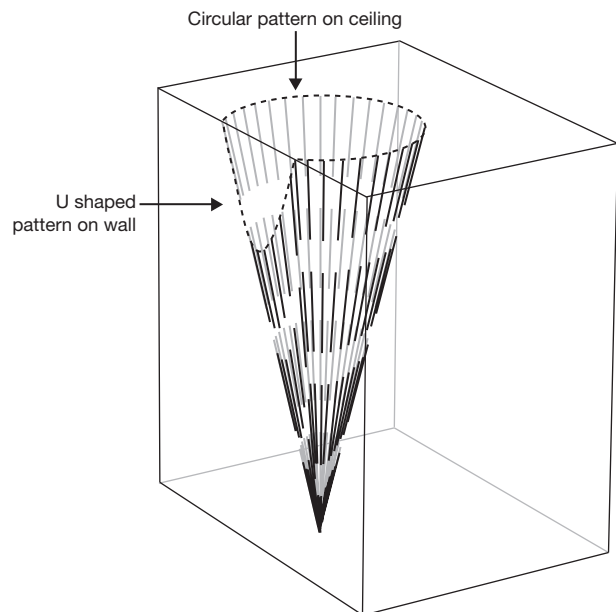


Figure 7 Intersection of a fire plume located some distance from the wall with the wall and ceiling. Copyright 2012 from Scientific Protocols for Fire Investigation, 2nd Edition by John J. Lentini. Reproduced by permission of Taylor and Francis Group, LLC, a division of Informa plc.



Figure 6 Typical V pattern in a residential fire. The fire originated in a plastic trash can located against the wall in the background. Copyright 2012 from Scientific Protocols for Fire Investigation, 2nd Edition by John J. Lentini. Reproduced by permission of Taylor and Francis Group, LLC, a division of Informa plc.



Figure 8 Typical U pattern in a residential fire. The fire originated behind the door at the left side of the photo. Copyright 2012 from Scientific Protocols for Fire Investigation, 2nd Edition by John J. Lentini. Reproduced by permission of Taylor and Francis Group, LLC, a division of Informa plc.

produced. In the past, some fire investigators have interpreted multiple 'V' patterns as evidence of multiple origins, but this is an interpretation that can rarely be justified once a fire becomes fully involved. Such interpretations are not justified in



Figure 9 Semicircular pattern on the underside of the floor above the origin. The fire originated at an overheated switch inside the wall cavity. Copyright 2012 from *Scientific Protocols for Fire Investigation*, 2nd Edition by John J. Lentini. Reproduced by permission of Taylor and Francis Group, LLC, a division of Informa plc.

cases of full room involvement or in any fire scene where all of the fire damage is contiguous. It is only when there is no communication between the fire patterns generated by separate fire plumes that one can state with any validity that there were two (or more) origins.

Plume pattern generation is simple to understand and explain; the difficulty lies in locating the first plume pattern generated. Further, once a compartment progresses beyond flashover, interaction with the fire plume may not be the dominant means of pattern generation on building surfaces.

Confinement Patterns

Like plume-generated patterns, confinement patterns are easily explained. Confinement patterns are caused by the hot gas layer being trapped beneath a ceiling, and interacting with the walls. The result can be either a smoke horizon or a heat horizon, depending on how well developed the fire becomes in the compartment where the pattern exists. **Figure 10** shows a smoke horizon and **Figure 11** shows a heat horizon.

Confinement patterns can provide a fire investigator with sequential data because if there is a smoke horizon or a heat horizon on a wall, then in all likelihood, that pattern was generated before the failure of the ceiling above it. This can be very useful for determining the origin in a multilevel structure, and in some cases, the confinement pattern may be the only pattern remaining. Even the absence of a confinement pattern can help to eliminate a particular level of the structure as the location of the origin.

Consider a structure where everything has collapsed into the basement. If there is a smoke or heat horizon on the basement wall, it is unlikely that the fire entered the basement late in its development. Conversely, the absence of a smoke or heat horizon in the basement tends to eliminate the basement as the origin.

A different kind of confinement pattern is sometimes produced when the heat of the fire was confined in a wall space between two vertical studs. While the pattern on the side of the wall where the fire originated may be unclear, the pattern on the opposite side of the wall may show a clear delineation of



Figure 10 An example of a typical smoke horizon. Photo courtesy of Mick Gardiner, Gardiner Associates, with permission.



Figure 11 An example of a typical heat horizon. Photo courtesy of Mick Gardiner, Gardiner Associates, with permission. Copyright 2012 from *Scientific Protocols for Fire Investigation*, 2nd Edition by John J. Lentini. Reproduced by permission of Taylor and Francis Group, LLC, a division of Informa plc.

the location of the studs. **Figures 12** and **13** show both sides of such a confinement pattern. Similarly, fires burning upward through a floor will be influenced by the structural members under the floor and patterns with parallel edges may be the result. A fire penetrating downward through the floor, on the



Figure 12 An example of a horizontal confinement pattern. Hot embers from above fell onto the horizontal member, where they caused damage to the drywall. Copyright 2012 from *Scientific Protocols for Fire Investigation*, 2nd Edition by John J. Lentini. Reproduced by permission of Taylor and Francis Group, LLC, a division of Informa plc.



Figure 13 Opposite side of the wall shown in [Figure 12](#). The outline of the stud space can be clearly seen. Copyright 2012 from *Scientific Protocols for Fire Investigation*, 2nd Edition by John J. Lentini. Reproduced by permission of Taylor and Francis Group, LLC, a division of Informa plc.

other hand, is unlikely to be significantly influenced by structural members below the floor.

Movement Patterns

When the fire moves from one room to another, it frequently records movement patterns at or near the doorways. An example of such a pattern is shown in [Figure 14](#). Movement patterns are useful for tracing a fire back to its origin and for helping to eliminate the room into which the fire moved as the compartment of origin. Movement patterns typically appear as diagonal patterns moving upward from a doorway.

Irregular Patterns

Irregular patterns are typically found on floors in compartments where fires have gone to flashover and burned for some time thereafter. For decades, fire investigators thought that they could identify irregular patterns on floors as having been caused by the presence of ignitable liquids burning there. This misconception resulted from training exercises designed to teach participants to 'recognize arson.' These training exercises almost invariably involved the extinguishment of the fire before it became fully involved. In such a case, it is indeed possible to recognize a pattern caused by a flammable liquid.



Figure 14 Typical movement pattern through a doorway. Photo courtesy of Mick Gardiner, Gardiner Associates, with permission. Copyright 2012 from *Scientific Protocols for Fire Investigation*, 2nd Edition by John J. Lentini. Reproduced by permission of Taylor and Francis Group, LLC, a division of Informa plc.

[Figure 15](#) shows such a pattern, which can be characterized as 'an obvious pour pattern.'

[Figure 16](#) also shows an irregular fire pattern, but there was no accelerant involved in the test fire that generated this



Figure 15 Irregular pattern caused by the burning of a medium petroleum distillate on a carpet. This is a rare instance where the cause of the pattern can be interpreted as having been caused by ignitable liquids on the basis of appearance alone. Copyright 2012 from Scientific Protocols for Fire Investigation, 2nd Edition by John J. Lentini. Reproduced by permission of Taylor and Francis Group, LLC, a division of Informa plc.



Figure 17 This fire pattern was erroneously attributed to the burning of ignitable liquids. The unburned areas were protected by objects on the floor. Photograph courtesy of David M. Smith, Associated Fire Consultants, with permission.



Figure 16 A more typical irregular pattern caused by the random failure of the carpet, resulting in alternate areas of exposed and protected subflooring. Copyright 2012 from Scientific Protocols for Fire Investigation, 2nd Edition by John J. Lentini. Reproduced by permission of Taylor and Francis Group, LLC, a division of Informa plc.

pattern. This pattern was produced when the carpeted floor was exposed to radiant heat from above. The carpet failed by randomly tearing open and shrinking back in response to the heat. Some parts of the floor were protected by the carpet and other parts were exposed. The lines of demarcation between burned and unburned areas were sharp, continuous, and irregular.

It is these alternating exposure and protection patterns that occur in fully involved compartments that are capable of confusing fire investigators, particularly those who have not watched test fires burn beyond flashover. The patterns shown in [Figures 17](#) and [18](#) were both interpreted by fire investigators as indicating that flammable liquids burned on the surface of the floor. Even though the laboratory samples tested negative for the presence of ignitable liquid residues, arson and homicide charges were brought against survivors of both fires. Convictions resulted in both cases.

A peer-reviewed study of test fires set with gasoline and kerosene revealed that patterns produced by ignitable liquids on floors often appear different than what fire investigators might expect. The pattern shown in [Figure 19](#) is similar to one that an investigator characterized as ‘puddle-shaped,’ and therefore caused by flammable liquid burning on the floor. An actual gasoline fire on a similar parquet floor that resulted in a pattern with an entirely different appearance is shown in [Figure 20](#).

The attribution of holes in the floor to the burning of an ignitable liquid on top of the floor is almost always in error.



Figure 18 This fire pattern was erroneously attributed to the burning of ignitable liquids. The unburned areas were protected by objects on the floor.



Figure 19 A 'puddle-shaped' pattern, similar to one that was attributed to the burning of a puddle of ignitable liquid. Actually, this pattern was caused by the burning of a cardboard box. Copyright 2012 from Scientific Protocols for Fire Investigation, 2nd Edition by John J. Lentini. Reproduced by permission of Taylor and Francis Group, LLC, a division of Informa plc.



Figure 20 A fire pattern on a parquet floor that was caused by the burning of 1 l of gasoline.

Ignitable liquids are incapable of existing at temperatures above their boiling point, so as long as liquid remains, the temperature on the floor will be less than the boiling point of the flammable liquid. Once the liquid has completely vaporized, there will be no more heat from that source. Arsonists use ignitable liquids to cause a fire to spread more rapidly than it would otherwise. The ignitable liquids themselves tend to burn

out very quickly, and in the greater scheme of the overall fire, provide relatively little fuel or energy.

It has been the misidentification of patterns similar to those shown in [Figure 16](#) that have caused numerous false convictions for arson.

Laboratory analysis is required to accurately identify all but the most obvious 'pour patterns,' and even in the case of obvious patterns, a laboratory analysis certainly does no harm.

Spalling

Spalling is the chipping or pitting of concrete or masonry surfaces in response to heat. The spalled area can range in size from a few square centimeters to a few square meters. Because the result of spalling is a depression in a concrete surface, spalling is often 'puddle-shaped.' For years, fire investigators attributed spalling of concrete to the intense heat generated by the burning of an ignitable liquid. This is incorrect on a number of levels. First, spalling can be caused by the differential expansion of the aggregate and the cement matrix, by the presence of steel reinforcement bars, or by the vaporization of the waters of hydration that are a part of the concrete.

More importantly, a flammable or combustible liquid burns no more intensely than other carbonaceous fuels such as wood. Burning ignitable liquids are no more likely to cause spalling than they are to burn holes in wooden floors, installing is frequently seen on surfaces where no flammable liquid could exist, such as a concrete ceiling.

Numerous experiments have been conducted to try to cause spalling using ignitable liquids, and most of those experiments have failed. On the other hand, setting a well-ventilated wood fire above a concrete floor will almost invariably result in spalling.

Electrical Damage

When a fire damages the insulation of an energized electrical conductor, the first thing that happens is the formation of carbonized insulation, which can conduct electricity from one conductor to another. The resulting current flow may or may not be sufficient to activate the overcurrent protection, that is, trip a circuit breaker or melt a fuse.

A fire investigator may observe multiple areas where this 'arcing through char' has occurred during the course of a fire. Arcing through char will leave behind artifacts in the form of globules melted copper. The first conductors that are likely to be compromised by a fire are power cords to electrical appliances. Branch circuit conductors behind walls and ceilings can also be damaged.

By noting the location of arcing artifacts on various circuits, the investigator may be able to infer the sequence of the arcing events. Certainly, all the arcing events will have taken place before the disconnection of power to the structure, and the events on a particular circuit will have occurred before the activation of any overcurrent device protecting that circuit. If a particular conductor is severed, then any arcing event that is electrically downstream of the point of severance can be logically inferred to have occurred before the event that caused the conductor to be severed.

This mapping of arcs can result in a pattern that allows an investigator to determine which parts of the electrical system were compromised first, and provide clues to the origin of the fire.

Clean Burn

Clean burn is a fire pattern on surfaces where the soot has either burned away, or was never deposited because the surface was too hot. It stands to reason that if the surface had soot deposited on it and then the soot was burned away, chances are the fire originated elsewhere. The problem of fire patterns is that they do not come with time stamps on them. If the fire begins close to a wall, it may heat the wall to the point where soot is never deposited on it, yet there is a white area that is indistinguishable from a clean burn that occurred later in the fire.

Figure 21 shows a clean burn located directly above the origin of a test fire, on the left wall between the bed and the chair. It is unlikely that there was ever any significant amount of soot deposited in the white area. Video of the test showed that the area indicated by the arrow was an area of early flame contact with the wall. The white areas to the right of the nightstand and to the right of the bed on the rear wall were actually not burned. The wall above the nightstand caught fire before the nightstand. This test fire was extinguished after only 10 s of postflashover burning. Figure 22 shows another ventilation-generated pattern from a similar test fire. It is interesting to note that the pattern assumes a V-shape, but the pattern was caused by a cloud of fuel-rich gases burning from the top downward.

Intensity Patterns

Fires produce patterns as a result of the response of materials to heat exposure. The various heat effects on materials can produce lines of demarcation. These lines of demarcation may be helpful in determining the characteristics and quantities of fuel materials, as well as the direction of fire spread.



Figure 21 Clean burns resulting from a short-lived test fire. The wall between the bed and the chair never accumulated any soot. The wall and ceiling above the nightstand were damaged by the burning of a fuel-rich cloud of smoke produced by the chair. Photo courtesy of ATF Fire Research Laboratory and Steven W. Carman, Carman Fire Investigations, with permission.

Intensity patterns may be very confusing, because of the difficulty in determining whether the pattern was caused by a fire of longer duration or of higher intensity. Attributing more intense damage to longer duration frequently will result in determining an incorrect area of origin. The test fire shown in Figure 23 was set in the kitchen, which is at the left side of the photo. Because of more fuel and better ventilation, however, there was much more severe damage in the living room, shown at the right side of the photo.

Often, fire patterns are a combination of movement, intensity, ventilation, and plume-generated patterns.

Ventilation-Generated Fire Patterns

In the early stages of a fire, the rate of heat release increases as more fuels become involved. The plumes from these burning fuel packages pump smoke and energy into a hot gas layer trapped beneath the ceiling. As the fire grows, the hot gas layer becomes thicker and hotter. It radiates heat in all directions, including downward. When the temperature of the hot



Figure 22 Clean burn resulting from a fire that burned for approximately 2 min beyond flashover. The V-shape developed from the top downward. The fire originated between the bed in the chair. Photo courtesy of ATF Fire Research Laboratory and Steven W. Carman, Carman Fire Investigations, with permission.



Figure 23 Although this fire started in the kitchen at the left, the living room at the right exhibited far more damage. Copyright 2012 from *Scientific Protocols for Fire Investigation*, 2nd Edition by John J. Lentini. Reproduced by permission of Taylor and Francis Group, LLC, a division of Informa plc.

gas layer reaches 500–600 °C, it radiates sufficient heat downward (on the order of 20 kW m⁻²) to ignite every exposed combustible surface in the compartment. This begins the transition phase known as flashover.

The burning of all of this exposed fuel dramatically increases the heat release rate within the compartment, but even more importantly, it consumes most of the oxygen. At this point, the fire can burn only in those places that have sufficient oxygen. This fire is known as a 'ventilation-controlled' or 'ventilation-limited' fire.

The compartment in this case is full of fuel in the form of combustible vapors, aerosols, and gases, as well as particles of unburned fuel. The entire atmosphere is flammable. In an atmosphere of air, one can create a flame by introducing and igniting a flammable gas such as methane or acetylene. If the atmosphere is methane, however, as occurs on some extraterrestrial bodies, one could create a flame by introducing a stream of oxygen. This is exactly what happens in ventilation-limited fires.

There is likely to be more intense burning around ventilation openings such as doors and windows. What has been learned lately, however, goes far beyond that and has important ramifications for the validity of fire origin determination. Patterns are likely to be created not only around the ventilation openings, but, because of the way a ventilation-limited fire behaves, they may also be created on walls and other surfaces opposite to the ventilation openings as a result of a jet of air being drawn in by the fire.

Ventilation-generated patterns can create significant confusion. Fire investigators very often will use the level and intensity of the fire patterns to determine the area of origin. The 'lowest and deepest char' is often singled out as the point where the fire must have burned the longest, but this is not true.

In 2005, agents of the Bureau of Alcohol, Tobacco and Firearms (ATF) conducted an experiment at a fire investigation seminar in Las Vegas, Nevada, to replicate similar experiments they had conducted at their training facility in Glynnco, Georgia. They built two identical rooms furnished as bedrooms, and then set them on fire and allowed them to burn for 7 min.

They then asked 53 participants in the seminar to observe the fire patterns and determine which quadrant of the room contained the origin. Three of the participants identified the correct quadrant in room number one and three different participants identified the correct quadrant in room number two. Although it was argued that some of the participants were not qualified fire investigators, and that time and resources were limited and investigators were not allowed to touch the evidence, the low success rate of the participants was a cause for concern.

The ATF agents conducting the experiment formed a hypothesis that the amount of postflashover burning would influence the investigator's ability to correctly identify the quadrant of origin. The experiment was repeated with some modifications.

In 2007, three burn cells were constructed in Oklahoma City, and 70 fire investigators were asked to identify the quadrant of origin. In the first burn cell, the fire was allowed to burn 30 s beyond flashover, and 64 of 70 investigators correctly identified the quadrant of origin.

In the second burn cell, the fire was allowed to burn for 70 s beyond flashover. In this case, six investigators declined to

identify the quadrant of origin but of the 64 who did attempt to identify where the fire started, only 44 correctly identified the quadrant of origin.

In the third burn cell, the fire burned for 3 min beyond flashover. Seventeen investigators declined to make a determination. Of the 53 investigators who responded, only 13 correctly identified the quadrant of origin. This amounts to a 75% error rate, which is no better than if 53 untrained individuals had picked the quadrant of origin at random. Clearly, these snapshots of origin determination accuracy indicate that there are serious problems with the training of fire investigators.

In an effort to understand what was causing the confusion, the experimenters reconstructed three burn cells at the ATF laboratory Fire Research Laboratory in Amundale, Maryland. The burn cells were equipped with thermocouples and radiometers and the burning was carefully monitored. The results indicated that what was happening was that the fire was burning most intensely at a point directly across from the single opening, a doorway, as a result of the vitiation (lack of oxygen) of most of the compartment and a jet of clean air coming in at the bottom of the door.

The test fire was modeled using FDS (fire dynamics simulator) and the output was translated using smokeview, a program that allows visualization of the numerical output of the model. **Figure 24** shows that the radiant heat flux opposite the doorway was 150 kW m⁻² on the wall. **Figure 25** shows a 'slice' of the smokeview output, where red indicates oxygen at a concentration of 21% (air) and blue indicates a concentration close to zero.

These results help us to understand what is happening in the production of fire patterns after flashover, but far more research is needed. This was a simple test with a single opening and a single compartment. Simple tests similar to this are necessary to understand what is happening, but the conditions of this test seldom obtain in a typical structure fire. Many times, the initial ventilation source (before the windows break) is from inside the structure. Many times, there are multiple ventilation sources, especially after the windows break.

The consumption of all the oxygen in the room can cause the fire at the origin to burn much more slowly there than elsewhere. If the origin is located in a place where a ventilation-generated pattern is overlaid, then information about the origin may be lost.

Fire investigators' confusion about how to correctly locate the origin of the fire is not a trivial matter. It is generally accepted that if one does not correctly identify the origin, one is likely to incorrectly identify the cause. Even more concerning is the fact that when a fire investigator identifies an area of origin and then finds no competent ignition source or even a competent fuel source in that area, he is likely to conclude that the fire was set using an open flame that was removed from the scene, and that the initial fuel was an ignitable liquid or some other highly flammable fuel that was introduced and completely consumed. A false determination of arson is likely.

This is new knowledge for many fire investigators, and upon being confronted with it, they are likely to reject the scientific basis of the experiments and insist on their ability to determine an origin even in a fully involved compartment.

What should happen is that once a compartment is identified as having been fully involved, every potential ignition

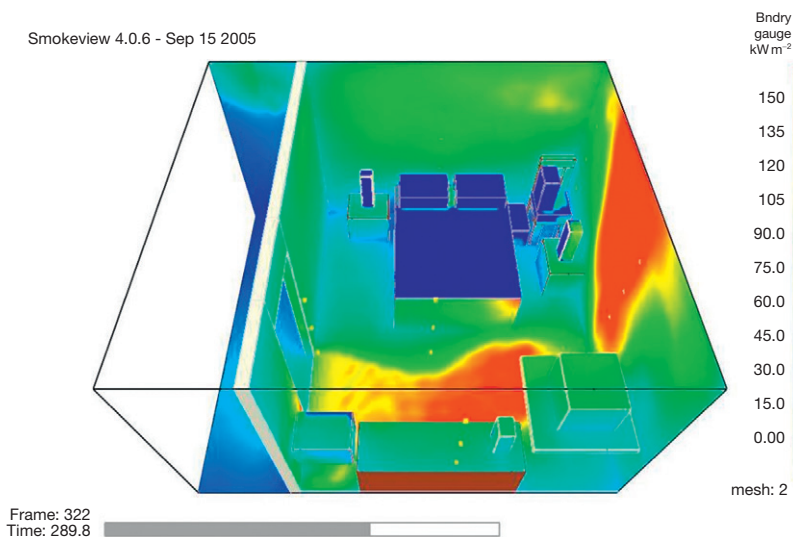


Figure 24 Smokeview output of an FDS model, showing the effects of ventilation. The fire originated to the right of the headboard, but air flowing in through the bottom of the door resulted in a radiant heat flux of more than 150 kW m^{-2} on the wall opposite the door. Photo courtesy of ATF Fire Research Laboratory and Steven W. Carman, Carman Fire Investigations, with permission.

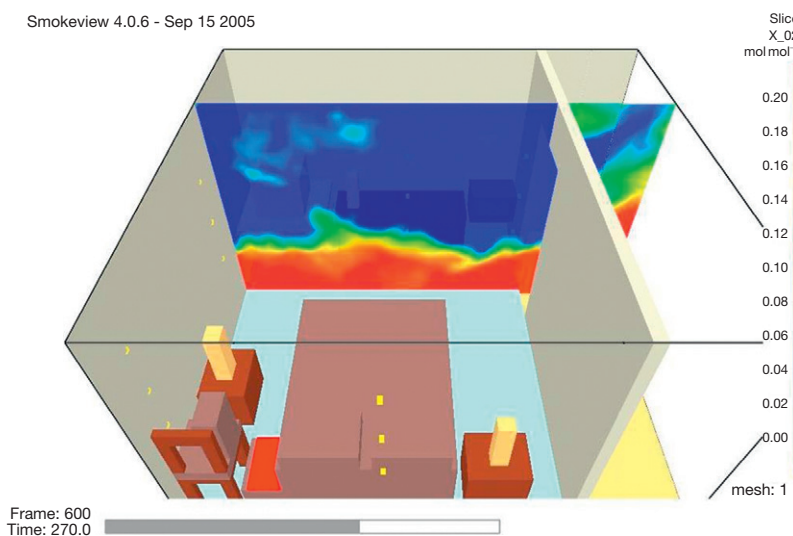


Figure 25 Smokeview slice showing the oxygen concentration in the plane of the door. Photo courtesy of ATF Fire Research Laboratory and Steven W. Carman, Carman Fire Investigations, with permission.

source in that room should be examined, unless there is some compelling evidence that allows the origin to be narrowed further than the entire confines of the compartment. An eyewitness to the beginning of the fire or perhaps a videotape of the fire might meet these criteria. Certainly, the simple traditional interpretation of fire patterns in such a situation is likely to lead to error.

See also: [Chemistry/Trace/Fire Investigation](#): Analysis of Fire Debris; [Chemistry of Fire](#); [Interpretation of Fire Debris Analysis](#); [Physics/Thermodynamics](#); [Thermal Degradation](#); [Investigations](#): [Evidence Collection at Fire Scenes](#); [Fire Scene Inspection Methodology](#); [Types of Fires](#).

Further Reading

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