Investigating Small Craft Fires
A Primer

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One of the first things you learn when you make a living investigating fires is to work with what you have, even though it may not be much. The fire may have destroyed much of the boat, maybe even down to the waterline, but that doesn't mean that the cause of the fire can't be discovered. What you don't find is sometimes as important as what you do find.

One important word of caution: if you suspect arson, local authorities should be informed and other investigators may have to be called in. You should be very careful not to contaminate the scene. If for whatever reason the site is disturbed, make a note of who was responsible and how it occurred and take good photographs to document the condition the scene was in before being disturbed. When in doubt, you may want to call in another expert. This can make or break your investigation. Many cases have been lost because the investigator was not qualified to testify as an expert about a significant piece of evidence. The lesson here is not to investigate beyond your capabilities.

The above is also true if you suspect a piece of equipment may have caused the fire. Manufacturers representatives should be put on notice of their possible implication and destructive examination should not take place till they have responded.

For the Record

Upon receiving and assignment, the first order of business is to gather information as possible about the boat before, during, and immediately after the fire. Interview witnesses, even if they didn't see the fire begin. Where on the boat did the fire seem to be most intense? How long did the fire burn? Ascertaining wind direction can tell you why you're seeing certain burn patterns. Talk to the Coast Guard, fire department or whoever put the fire out and ask what they saw and how difficult it was to extinguish the fire.

Talk to the boat's owner about the condition of the boat and any recent maintenance that was done on the engine or electrical system. Get a description of the boat's interior, from either the owner or the manufacturer, which can be used later to locate various components. (It can also be used to take an "inventory" of equipment that is supposed to have been aboard.) Other questions you'll need to answer: Was the boat connected to shore power (and was the main battery switch left on)? Was there a portable heater or any other electrical appliances being used? Was the battery charger left operating? Documenting everything you see and do is critical; your investigation could be the beginning of a product liability claim or even a criminal investigation. These cases are often slow to develop, owever, and may not reach a courtroom for several years.

Keep notes on who you talked to and what they said. Don't trust your memory. Documentation should include close-up photographs (not with a Polaroid) with accompanying notes. Digital and video cameras are a great way to document the investigation. While doing a video tape make comments of what you see as you go along but do not record any conclusions on the tape. Remember that an attorney may interrogate you someday, so document your actions and reasons accordingly.

A Few Key Points about Boat Fires

Fire needs oxygen to burn the greater the supply of oxygen the more rapid and intense the fire will burn. Unlike a house or building where air is plentiful, a lack of a rapid supply of air/oxygen in the boat's cabins can slow down the initial spread of fire. Once the fire burns through an opening, a greater supply of air will be available, depending on the size and location of the hole, and the fire will then burn back down into the boat. This is why boat fires are compared to fires in a barrel: where the air/oxygen supply is at the top.

Most boats today are made of layers of fiberglass cloth held together by resins, which are petroleum products. Like any petroleum product, resins must be heated first to produce vapors that will burn. For fires that start small, this action takes time and generally does not allow the fire to spread rapidly until the heat builds up. A newer fiberglass boat will ignite and burn far more rapidly than one that is several years old. This is because volatile hydrocarbons trapped deep within the resin have not yet had a chance to evaporate. These fresh vapors fuel the fire.
Another product readily found on boats is polyurethane foam that burns close to the same intensity as gasoline, according to tests performed at the National Bureau of Standards. Polyurethane is used in seat cushions, headliners, dashboards, door panels, consoles, and armrests. It may also be spread over the interior as a protective coating. Like resins, polyurethane foam is a hydrocarbon that must be heated to a gaseous state in order to burn. Even if the hatches and doors are closed, there is ample air coming through the vents to feed a slow growing fire. The heat difference between the air inside of the cabin and the air outside will eventually fracture and break windows, allowing more air to enter.
The overall surface burning, or lack of burning, can tell the investigator what temperature level was reached in an area. This, in turn, can help him locate the origin of the fire. Wood paneling and wood trim are normally coated with a synthetic material such as polyurethane, which, when ignited, spread rapidly upwards.
If the fire appears suspect, burned debris from areas of low burn can be collected and analyzed for flammable liquids, chemicals or incendiary materials.

Engine Fires

Different types of engines are more likely to have different kinds of fires. For example, outboard fires tend to be fuel related. Poor or loose connections on fuel lines will allow gasoline to leak and an electrical spark ignites the vapors. The cause of such fires is usually obvious and typically results in damage to the boat's engine location. If the remainder of the boat burns quickly, look for other contributing factors, including the possibility that fuel was intentionally spread.
Although there is electric wiring on an outboard engine, the harness is usually well secured. Don't confuse a wire that was shorted because of the fire with a shorted wire that caused the fire. This can take some diligent investigating. If the shorted wire is the source of the fire, the fire will usually spread outward from this point.

Always keep in mind that fire burns up unless it has a fuel to bring it back down. Depending on the extremes of the fire, you will be able to follow the burn pattern back to the source of the fire. Wires that short out will normally overheat back to the source of electricity.
On inboard engines, there are more possible sources for ignition. Begin by determining if the engine was running when the fire started. Cold engines burn differently than hot engines. For example, engine oil starts burning much easier hot than cold and the same relates to all petroleum products in and about the engine. Determine if the blower was on and the other sources of ventilation for the engine compartment. Also, if possible, determine the condition of the engine before the fire. Was oil leaking from the valve covers? Were there fuel leaks? Oil will easily reach its autoignition temperature of 850° F on a hot surface. A spark can ignite gasoline vapors, which has a flash point of -45° F. This rarely happens to diesel fuel, however, which has a flash point greater than 100° F. In closed cooling systems where a leak occurs it is possible for a fire to start. The reason for this is: Ethylene Glycol is a petroleum distillate and has a flash point of 240.8° F and an auto ignition temperature of 775° F. The water mixed with the anti-freeze boils away at 212° leaving pure ethylene glycol that does not boil until 387°. A spark can easily ignite the vapors from ethylene glycol. Depending on the engine and cooling system, the investigator should be able to determine if these temperatures are obtainable on the surface of various components in the engine. These type fires are very common in automobiles.

Examine the structure of the engine compartment and determine if there is a bulge or component

bent out of position, which indicates an explosion occurred. Look for chafed or shorted wires as well as components in the charging system that may indicate the origin of the fire was electrical. Examine drive shaft and transmission bearings that may have partially seized and overheated. This heat can ignite lubricating oils and nearby synthetic materials.
In questionable fires, pull the oil filter and examine the filtrate for metal striations or excessive carbon to determine the condition of the engine. The oil filter examination is preferred over oil analysis because the oil passes through the filter thousands of times, concentrating the debris or byproducts. This makes the analysis a very accurate representation of the engine's mechanical condition.

This is done to show that the engine may have seized or was having mechanical problems.
The reasoning is, that in most cases, an insurance company will not pay for a blown engine (wear and tear), but if will pay for an engine that burned accidentally in a fire. Was the engine fire an accident?

In most cases, the fuel tanks are separated from the engine compartment. Fuel tanks rarely explode (except in movies). The concentration of fuel vapors in the tank far exceeds their upper explosive limit. You will see fire at the filler ports where the external air can mix with the vapors and bring them into an ignitable range.

Electrical Fires

Patience is mandatory when you examine a burned out electrical system; the wires are often buried in burned wiring harnesses. Separating the wires within the harness is time consuming. If the fuse panel is still intact, it can be a good source of direction for interior fires. A lot of the wiring around engines, for example, does not have fuses and will usually melt or fuse together when they come in contact.

Such wires are often very brittle because they became white hot as a result of excessive current. When a wire shorts to ground within a harness, you will often find that the entire wire has the vinyl insulation melted from the point of the short back to the electrical source, which could be the electrical panel or battery.
Fires can also start in or near switches, relays, or small motors. A good example is a wall switch controlling an appliance and the contacts in the switch are making a poor connection. This can cause the switch contacts to overheat to the point where it will ignite the switch housing or insulation on the wires. The casing can then burn to a hard ash. Many electric motors on boats (especially older boats) were not required to have overload protection or fusing, which is a considerable fire risk if the motor seizes or is overloaded. Care should be taken with any of these components, however, as they can fall apart easily, sometimes disintegrating in your hand. It's best to put a container underneath to catch any little parts that fall out as you examine them.

In dock side fires, shore power connections are responsible for many fires. Poor maintenance, worn plugs and poor connections are typically the cause. Dirt and salt buildup on the surface of the plug causes heat to build up and is known as a high resistance short. The small current flow forms carbon deposits, which forms more of a conducing surface and consequently more current then flows. This process continues until the connector surface gets hot enough to ignite nearby flammables, such as plastics in the plug or wire insulation. If the connector is the origin of the fire, there should be no shorting of the AC wires beyond that point in the boat. Check to make sure by searching the debris in the area of the connector to find the metal connectors from within the plugs and look for indications of arching or overheating.

Collecting Evidence and Report

Collecting evidence is a vital part of any fire investigation and your determination of the cause will

predicate what samples need to be collected. If you determine that the fire may be of a suspicious origin, talk it over with the insurance company. (Don't mention your suspicions to the boat owner!) You may want to invite law enforcement to join you if they're not already there. Collect evidence carefully so that it represents exactly what you've seen. Photographs should also be taken and kept along with the evidence. When collecting samples of possible accelerates, be sure you put them in a clean airtight container and mark them accordingly. In product liability cases, the product representative may not want you to disturb the evidence until they see it as it was found. If possible, stop at this point. If it is unrealistic to have a factory representative visit the scene, have it removed and stored. Photograph and document the evidence before and after removal and do as little as possible to disturb its condition.

Reporting your findings is one of the most important parts of the investigation. Your report may be very sensitive and confidentiality is essential. Be detailed in your report, but not wordy. Make sure to describe and document what you observed and the tasks you performed. Do not theorize; it could haunt you later. If you do know what caused the fire, state that! Then add to it based on your investigation

the things that could not have caused the fire. If there are indicators that would lead you to believe what started the fire, state them as well.

If your conclusion is going to be based on the results of a forensic examination, then leave your conclusion open based on the result of the lab. Always remember the nature of fire is to destroy. It is not possible to make a determination as to the cause of every fire.

Dot your I's and cross your T's as best you can and report what you did see.

Please note that this article is by no means a complete guide to investigating boat fires. It is meant as a basic guide to help the inexperienced investigator or jar loose some old thoughts of experienced investigators.

Mike Higgins has over twenty-five years experience in the investigation of fires and has lectured throughout the United States and in Europe. He has burned hundreds of cars, trucks and boats and performed thousands of laboratory experiments in determining the causes of fires and the flammability of materials. His reports have been used in

cases nationwide. Do not hesitate contacting him with questions or comments.

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