AIRCRAFT FIRES

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Everyone knows that fires kill. In airplanes situations the statistics show that fires kill by asphyxiation, superheated air, poison gas and contact with flames. From a crashworthy aspect many victims have died of fire and smoke from an otherwise survivable and not too serious accident. Aircraft materials cause the production of toxic gasses when burned. Therefore a complete autopsy should be conducted to include toxicology to determine cause of death. Charred and burned bodies often mask the true cause of death.

By Federal Air Regulation aircraft materials are not supposed to sustain burning after the heat source is removed. The testing to determine whether a material is fire resistant, fire retardant or fire proof is set by how much burning continues after ignition source is removed. Some older General Aviation interiors burn like world War two period photo negatives. Scary! On autopsy when a fire is suspect the pathologist toxicologist should test for cyanide, carbon monoxide, sulphur dioxide, Hydrogen Chloride and Hydrogen Fluoride.

FIRE PATTERNS

An in flight fire on the airframe will leave distinctive patterns recognizable to a trained investigator. The growth and heat of the flame is effected and to an extent controlled by the airflow over the airframe while airborne. The resultant wind flow creates horizontal fire and heat damage patterns along but opposite the direction of flight wind flow.

Once the airplane crashes and comes to a stop all heat and fire patterns turn vertical in pattern alignment. If a horizontal pattern is present the fire started while airborne. Every material known will burn if it gets hot enough, so by looking at aircraft materials, knowing their properties, an investigator can tell the heat of the fire.

Fuel fed airborne fires attain temperatures around 3,000 degrees F. Fires on the ground attain temperatures around 1,550 degrees F.

As examples:

Tungsten melts	6,200 F
TITANIUM melts	3,100 F
STEEL melts	2,700 F
GLASS deforms	1,500 F
ALUMINUM melts	1,100 F
Plastic melts	250 F

From the melting points of various materials such as titanium, stainless steel and other modern heat resistant alloys the investigator is now presented with another method of determining whether the fire was airborne rather than ground initiated. The first was the obvious: if an aircraft piece was pristine that was next a burned part, then the fire occurred after the pristine part was separated.

Add to this the newer melting point methodology and there are three methods to help determine whether it was a ground fire or an airborne one. If the heat got to the extent of melting the exotics then it probably occurred airborne since airborne fires are in the range of 3,000 degrees due to the draft of the aircraft slipstream. Ground fires, even with gasoline, are cooler. The methodologies compare.

Airborne fire:

1) Higher heats melting points
2) Horizontal air stream patterns

Ground fire:

1) Lower heats
2) Vertical patterns (relative to wreckage)
3) Non continuous patterns due to wreckage scatter.

Electrical fires: leave peculiar evidence that is likely to be discovered if it exists during the "electrical inventory" as described in a separate chapter. In short circuit overloads the investigator will be looking for:

a) Boiling of insulation
b) Insulation burned back
c) Arcing gouges (melted areas)
d) Melted wires - smooth melted tips
e) Metal spattering

If normally brittle metal parts have ruptured on impact and there is ductile evidence - it must have been heated pre impact.

Aluminum plate or skin heating indications

1) 500 degrees - paint discoloration
2) under 600 degrees - sooting
3) 900 degrees – broom strawing
4) 1200 degrees - melting
5) Aluminum melts before it ignites

When an investigator looks at a fire from the legal standpoint he is investigating to see if he can identify whether the cause of the fire is a result of a definable breach of duty or from a defect. He is interested as well as whether the spread of the fire affected the survivability or damage to the occupants.

This was the crashworthiness aspects designed into Army helicopters. That theory was that the helicopter should not burn upon impact unless the impact forces were great enough to create an un survivable crash. The crashworthy criterion for design of human transportation devices with respect to fires is optimum if it:

1) Provides for egress - ejection seats
2) Provides a cocoon of safety from fire and impact resistant structurally up to human tolerance
3) Provides an egress path and time to make the egress before fire consumption.

So as in most investigations, the investigator must find the source of the ignition. In fires, this may be difficult to do if the conflagration burns very intensely and falls stationery in on itself. A match in a fire place may start a fire that the homeowner stokes and tends for ten hours. At the end of that time the chances of finding remnants of the match is minimal.

Aircraft may carry over 100,000 lbs. of fuel as well as ordinance. The chance of obliteration of ignition source is high. Let's review the clues of fire and explosion that an investigator may find helpful.

1) All airplanes exhibit a normal soot and dirt distribution patterns. Get a set of photos of a dirty old exemplar.
2) Soot along skin cracks and over breaks means the fire was last.
3) Molten metal and droplets usually do not attach to cold metal. Thus if it happens the metal was suitably hot.
4) Melted metals after identification are proof of temperatures attained.
5) Heat is transferred by conduction, radiation and convection.
6) Electrical damage that may have been the ignition source will remain localized since the heat source is always a power transmission line.
7) Parts burned in a ground fire may cover a greater percentage of the aircraft. Parts burned airborne may show more intense heat damage.
8) Ignition source may be obliterated by residual fire damage.
9) Laboratory examinations are helpful to confirm field observations.
10) Soot will only accumulate on relatively cool pieces. Soot will follow airflow patterns.
11) Clean fracture areas in metal on a part otherwise soot covered shows the break came after the sooting.
12) Vapor phase explosions in closed containers like fuel tanks result in about eight to ten atmosphere overpressures.
13) Airborne fire and soot patterns are distinct. Ground soot patterns are vertical and effected by drafts of differing direction and intensity.
14) Jet engines that have ingested wood and created sawdust then charcoal were hot at impact and rotating.
15) Forced air fires bear temperatures upwards of 3,000 F. Ground fuel burns at about 1800 F.
16) Burned parts along path show in flight fire.
17) Overpressure panels along path may show in flight fuel vapor explosion.

18) All discoloration, sooting and disfiguration is heat and time dependent.
19) Aircraft have oxygen systems. If these leak fire may be severe in area of leak.
20) Explosions of ordinance or bombs will curl edges of aluminum skin away from epicenter - look for a blowout.