FIRE – THE CLOCK IS TICKING FAST

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Always expect the unexpected

On 02 September 1998, flight SR 111 was established in the cruise at FL 330. The MD-11 had left New York for the flight to Geneva 53 minutes earlier and the crew was preparing for their Atlantic crossing when they smelt an abnormal odor. The crew concluded that the probable source was the air-conditioning system. Around two minutes later they re-assessed their observations and identified the problem as smoke.

They immediately started a descent and a diversion to Halifax, the nearest suitable airport. From their present position, they were 60 NM from the airfield. During the descent they donned oxygen masks and performed the relevant checklists for 'Air-conditioning Smoke' and then for 'Smoke/Fumes of Unknown Origin'. To avoid an overweight landing the crew descended and turned away from the airport and out to sea to dump fuel. Shortly thereafter communications were lost. Five minutes later the aircraft crashed into the Atlantic Ocean. The impact forces were non-survivable.

The accident investigation concluded that the fire had started in the electrical wiring of the in-flight entertainment system. The post-crash analysis of the last minutes of flight 111 was made difficult by the early failure of the FDR and CVR. Hence the events leading up to the impact with the ocean were reconstructed based on forensic examination of the wreckage fragments.

The aircraft was lost due to multiple system failures as a result of the uncontained propagation of a hidden electrical fire, the report continues. Smoke and intense heat on the flight deck caused the crew to lose control. Only 20 minutes and 40 seconds had elapsed from the first detection of an unusual odor until impact.

CRASH Flight SR 111 (top) was one of a series of aircraft lost due to inflight fire.

Time is Precious

Flight SR 111 is one in a series of aircraft lost due to an in-flight fire. Studies have shown that flight crews may have as few as 15 to 20 minutes to get the aircraft on the ground from the time of initial identification until the time the fire becomes catastrophically uncontrollable. Time is precious in the case of suspected or indeed actual in-flight fire. Small, hidden fires in areas which are not readily accessible pose a particular hazard. Timely identification and decisive action by the flight crew to land the aircraft as soon as possible, including an emergency landing outside of any airport or ditching is required to improve the chances of survival.

URGENCY
Time is precious during an in-flight fire – the crew on SR 111 decided to dump fuel before landing; a decision that proved fatal.

Confusion in the Cockpit

In 1994 a Learjet 35A crashed close to Fresno, California, after a short and intense fire in the aft electrical compartment which damaged airplane systems and resulted in the flight crew's loss of control.

From the flight crew's point of view, messages were confusing. The fire initially caused a spurious left engine fire warning leading the crew to shut down the left engine and activate the fire bottles. This warning was probably caused by damage to the engine fire warning system caused by the fire in the electrical compartment.

Accident investigators believe that one of the aircraft batteries in the electrical compartment exploded and damaged a fuel line runningthrough the electrical compartment. As the fire intensified the crew lost control of the aircraft shortly before landing due to control cable and aircraft structural fire damage. Both pilots died and 21 persons were injured on the ground as the aircraft came down in a residential area.

The cause for the in-flight fire was traced to the faulty installation of wiring when the aircraft was modified with a 'special missions' package in order to operate as a target aircraft during military exercises. The installation was not accomplished according to the drawings of the STC package and lacked an overload current protection. From the time the engine failure was declared until the loss of control only slightly more than 2 minutes had elapsed.

Troubleshooting vs. Landing

Checklists designed to identify the source of an unknown fire tend to rely on switching various equipment off and then evaluating whether this action has a positive effect. This process takes time and is ambiguous as the effect on the smoke density needs to be evaluated.

Powering equipment down usually removes the valuable assistance from systems such as autopilot, autothrottle, and stall protection and communication and navigation equipment. This increases the workload in a situation which is already demanding a lot from the crew.

In the case of Swissair flight 111 the crew initially applied the 'Air-conditioning Smoke' checklist. They later applied the 'Smoke/Fumes of Unknown Origin' checklist. It is unlikely that they completed this checklist. What is known is that the checklist actions did not have a material effect on the fire.

In fact, the criticality of a situation can be classified as normal, abnormal, emergency, and beyond. As long as the situation's criticality does not exceed the emergency level, some procedures are still available to the crew. When the situation develops beyond an emergency, no pre-determined procedures or checklists are available any longer. The crew is then on their own and the commander is authorized by fact and regulation to take any action he/she considers necessary under the circumstances. "In such cases he/she may deviate from rules, operational procedures and methods in the interest of safety." (EU-OPS 1.085 (g) and the new CAT.GEN.MPA.105 (b) in Regulation (EU) 965/2012).

Regulatory Developments

The focus for regulatory activity after the crash of Swissair flight 111 was to replace the insulation blankets used above the flight deck with blankets made with more fire retardant materials.

The training of flight crews and the design of checklists for smoke and fire received new attention. The need to don oxygen masks and to initiate descent and diversion immediately should be reflected as one of the first items in the abnormal and emergency checklists and this should be emphasized in any simulator training dealing with in-flight fires.

The recent loss of two large cargo aircraft (a UPS Boeing 747 in 2010 in Dubai and an Asiana Boeing 747 in 2011 in the East China Sea) to catastrophic in-flight fires in the cargo hold have focused the attention of regulators on the loading and packaging of dangerous goods (in particular lithium-ion batteries) and on the smoke/fire detection and suppression systems used on large freight aircraft. In both cases the crews lost control of the aircraft due to catastrophic fires in the cargo hold. The time from initial detection of the fire to the loss of control was approximately 29 minutes and 15 minutes respectively. In both of these instances the crew ran out of time to make an emergency landing or ditching.

Risk Mitigation by Design

Any fire requires 3 elements: fuel, oxygen and heat. If any one of these three ingredients is removed, the fire is extinguished. Based on this principle current aircraft certification standards (CS 25 for large and CS 23 for normal, utility, aerobatic and commuter aircraft) distinguish betweendesignated, potential and non-specified fire zones. Designated fire zones (engine, APU) and potential fire zones (cargo compartment, lavatory) contain both flammable material and potential ignition sources. Therefore they are fitted with smoke/fire detection and suppression devices.

Non-specified fire zones contain flammable material, but the potential for ignition is considered minimal. Hence smoke/fire detection or suppression devices are not required. Non-specified fire zones include areas such as the cockpit, cabin, galleys, electrical and electronic equipment compartment, attic spaces, areas behind side walls, and areas behind electrical panels. Fire in non-designated fire zones are considered extremely rare and are designed to be dealt with by the crew members using hand-held fire extinguishers.

On-board fire-fighting equipment has continuously improved over the years and today contains as a minimum a Halon fire extinguisher, a smoke hood and a crash axe (to gain access to hidden fires). Still it can be a challenge for the crew to locate a hidden fire. Smoke can enter the cabin in a location removed from the fire.

Mental Model

The appreciation of risk changes over time and often as a consequence of cataclysmic events. The accident of SR 111 was such an event.

The crew was confronted with a very difficult task. Smoke and heat was developing in the flight deck. Decisions had to be taken under time pressure. The pilots were probably not aware of significant amounts of flammable material in the attic area or in other hidden areas of the aircraft. Isolation measures would have identified the source of the smell/smoke. The crew had no reason to believe that the additional risk of attempting an immediate emergency landing should be taken.

Canada's Transport Safety Board (TSB) remarks in its SR 111 accident report that at the time of the SR 111 occurrence, there was a diminished concern within the aviation industry about "minor" odors. There was an experience-based expectation that the source of such odors would be discovered quickly, and that actions could be taken to rapidly eliminate the problem, the TSB continues. The TSB observes that operators did not have policies in place to ensure that flight crews would be expected to treat all odor and smoke events as potential serious fire threats until proven otherwise.

Previous experience had shaped a mental model of fire hazards and associated risks; SR 111 proved them wrong.

After SR 111 operators worldwide changed their policy regarding odors and smells in the cabin. Today, in the event of smoke/smells in the cabin, an immediate landing is considered and often executed. Risking an initially minor odor event to develop into a full fire is not worth the risk.

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