17minutes

Smoke from an onboard fire is likely to contain toxic substances that irritate the skin, eyes and respiratory system. Furthermore, the two main smoke gases, carbon monoxide and hydrogen cyanide, are very rapidly disabling if breathed in. Smoke can therefore quickly incapacitate the crew unless they wear goggles and breathe 100% oxygen. Smoke also reduces visibility, making it difficult, if not impossible, for the crew to see instruments or see out of the window. In such circumstances, a crew can become disorientated, lose situational awareness and then lose control of the aircraft.

Many airlines conduct smoke training sessions where, for example, crews are given experience in locating and fighting simulated fires, while wearing breathing apparatus, in a smoke filled cabin.

Many years ago now, I participated in such a smoke evacuation exercise. Sat on the flight deck in a very controlled environment, entirely pre-briefed, thick white smoke was pumped into the aircraft, quickly reducing visibility. We carried out immediate actions, donned smoke goggles and oxygen masks, set oxygen to 100% with overpressure, and then checked communications with the rest of the crew. There was no immediate evacuation; we were encouraged to consider how the reduced visibility and the wearing of masks and goggles might affect performance.

With mask and goggles on, it's like being in a separate world. You look out at the scene around you as if through a window. That separate world is dominated by the sound of your own breathing and you have an increased sense of self-awareness and alertness, possibly because of that enclosed feeling and possibly also because of the increased levels of oxygen and adrenalin in the blood stream.

Because of the oxygen masks, the voices of other crew members are slightly muffled and your own voice sounds as if it is coming from somewhere else, just like it does when you have a heavy head cold. Add to that the reduced visibility, and there is a sense of detachment and isolation. In a benign environment, such as an exercise, when there is no actual threat, it is actually quite relaxing and in similar training I have noticed how many people have their eyes closed.

In the reduced visibility, it becomes increasingly difficult to read instruments. The mask and goggles also restrict the field of vision. Warning lights and popped circuit breakers go un-noticed. Radio calls are missed. Calls from other crew members are misunderstood. Calls you make to other crew members get no response.

Situational awareness gradually deteriorates.

If the aircraft is on the ground, then evacuation is the best option. Evacuating a smoke filled aircraft requires concentration. You have to feel your way out based on a model of the aircraft in your mind – much as a blind person does every day of their lives. You have to take care not to accidentally breathe in any smoke – not so easy if you've disconnected from the aircraft oxygen system.

I have had the misfortune to experience 3 smoke events whilst on an aircraft, 2 of them while airborne.

In the worst case, while flying as a competition judge on a Canadian Forces CC130 at 250 ft AGL, thick white smoke began pouring out of the overhead panel. Being so close to the ground, the loss of visibility clearly represent-

UPS flight 006, en route from Dubai to Cologne, recently levelled off at FL320 when the crew advised ATC that the fire warning systems for the cargo compartments indicated an onboard main deck fire and advised ATC that they needed to land as soon as possible. *

ATC advised the crew that Doha International Airport was at the 10 o'clock position at 100 nm. Although Doha was closer, the Captain elected to return to Dubai and the crew declared an emergency.

3 minutes after the first alarm bell, the flight crew put on their oxygen masks and goggles. The crew experienced difficulties communicating via the intercom with the masks on.

5 minutes after the first alarm bell, the Captain told the Co-Pilot to pull the smoke evacuation handle and advised ATC that the flight deck was "full of smoke".

7 minutes after that first alarm bell, the Captain declared a lack of oxygen and left his seat, possibly to get a portable oxygen bottle, but he did not return.

9 minutes after the first alarm bell, the Co-Pilot advised ATC that he would remain on the Bahrain frequency, as it was not possible to see the radios.

14 minutes after the first alarm bell, the Co-Pilot asked for radar guidance due to difficulty viewing the instruments...

Smoke from an on board fire reduces visibility and can be very rapidly disabling

*GCAA Accident Report No. 13/2010. (Preliminary Report) - http://www.skybrary.aero/bookshelf/books/1485.pdf

17 minutes (cont'd)

ed an immediate threat to the safety of the aircraft. The Captain opened his side window and someone, possibly me but I can't remember, opened the roof escape hatch. The impact on visibility on the flight deck was instantaneous – the smoke disappeared completely – there was a lot of noise but the pilots could now see. Of course, opening the windows is not an option at FL320.

I recall the flight engineer being busy attempting to isolate the source of the smoke but to no avail – it later transpired that the source of the smoke was an autopilot unit under the flight deck and the smoke was working its way up behind the panelling before entering the flight deck from above. It is worth noting that many flight crews experiencing a smoke event may never succeed in identifying the source of smoke and any associated fire in the time available to them. While it is of course important to make every effort to isolate the source of the smoke and fight the fire, the top priority is to get the aircraft on the ground as soon as possible.

Luckily, we were just 10 nm to the south of the nearest airfield. I recall that the radio call I made did not adhere to standard phraseology but ATC certainly got the

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message. ATC reacted quickly to our emergency call. Although the active runway was 24, we were given immediate clearance to land straight in on Runway 36. We were on the ground within 6 minutes of the first signs of smoke and probably in the bar within another 6 minutes.

It's all about time. Crews need to develop a mindset that, following any indication of fire, an immediate landing is essential.

Masks, goggles, hoods and oxygen provide protection from the effects of smoke. Depressurisation, and opening flight deck windows, vents and hatches, help to clear the smoke, and there are devices available to improve visibility on a smoke filled flight deck. However, an aircraft oxygen system has finite capacity. It was not uncommon in my experience for the portable oxygen bottles to become exhausted well before the time advertised – masks leak, people breathe more heavily when engaged in physical activity, and oxygen bottles may leak between periodic servicing, etc.

An on board fire can affect aircraft systems and the structural integrity of the aircraft leading eventually, and inevitably, to loss of control

A fire in the air can affect aircraft systems and the structural integrity of the aircraft – out of control, a fire will eventually result in loss of control.

On 11 May 1996, a fire broke out on board a Valujet DC9. The fire damaged the aircraft flying controls before the crew were able to land the aircraft and it crashed in the Florida Everglades. All of the occupants were killed. The first indications that the crew had were an unusual sound followed swiftly by major electrical problems and physical signs of fire. Little more than 3 minutes after those first indications of a fire, the aircraft crashed.

On 2 September 1998, while cruising at flight level 330, the crew of Swissair Flight 111 smelled an abnormal odour in the cockpit. Their attention was then drawn to an unspecified area behind and above them and they began to investigate the source. Whatever they saw initially was shortly thereafter no longer perceived to be visible. They agreed that the origin of the anomaly was the air conditioning system. When they assessed that what they had seen or were now seeing was definitely smoke, they decided to divert. They initially began a turn toward Boston; however, when air traffic services mentioned Halifax, Nova Scotia, as an alternative airport, they changed the destination to Halifax International Airport. While the flight crew was preparing for the landing in Halifax, they were unaware that a fire was spreading above the ceiling in the front area of the aircraft. About 13 minutes after the abnormal odour was detected, the aircraft's flight data recorder began to record a rapid succession of aircraft systems-related failures. The flight crew declared an emergency and indicated a need to land immediately. About one minute later, radio communications and secondary radar contact with the aircraft were lost, and the flight recorders stopped functioning. About five and a half minutes later, the aircraft crashed into the ocean about five nautical miles southwest of Peg-

gy's Cove, Nova Scotia, Canada. The aircraft was destroyed and there were no survivors.

A smoke or fire event on an aircraft presents a challenging situation for a controller. Initially, the controller might be advised of a technical problem and a possible need for a precautionary diversion. This is understandable – the crew may be unsure of the nature of the problems they are experiencing. Several minutes may therefore have elapsed before an emergency is formally declared. Nevertheless, the controller should use this time to consider options and warn those he may need to call upon if the situation develops into an emergency.

An immediate landing is essential following any indication of an in-flight fire

As with all emergency situations, the controller will need to pass timely and appropriate information and guidance to the crew. In the case of an in-flight fire, the support provided to the crew may include:

- Information on the nearest airfield with sufficient runway length, ceiling and visibility,
- Airfield information including ILS frequency, threshold elevation, and runway/ILS centreline, and
- Vectors for a minimum track mile approach, regularly advising the crew of the track distance to touchdown.

All of this information will support the situational awareness and decision-making of the crew.

The crew will wish to minimise frequency changes in order to reduce workload and avoid the chance of an incorrect frequency selection and loss of communications.

Communications with the aircraft may be particularly difficult. The situation on the aircraft may mean that the aircraft does not respond to calls, information passed to or by the aircraft may be misunderstood, information may need to be relayed through other aircraft or ground stations, frequency changes may not be possible, and communications may be lost altogether. If communications are lost completely, then the controller will need to anticipate the actions of the crew based on previously declared intentions.

A team effort will be required to carry out all the necessary coordination between sectors, airports, and other airspace users to ensure system safety and facilitate getting the Mayday aircraft on the ground as soon as possible – direct routings, expedited descent, straight in approach. Numerous other airspace users will need to be re-routed, passed to alternative frequencies, told to enter holding patterns or divert. As the situation develops, the plan will likely need to change and change again.

Ordinarily, the definition of a "suitable alternate" might rightly include considerations such as aircraft and passenger handling facilities, customs and immigration availability, or a contracted service provider. With a fire on board, "suitable" very quickly simplifies to a long enough runway. Sometimes, getting an aircraft "on the ground" might necessitate an off-airfield landing or a ditching.

On 16 May 1995, an RAF Nimrod suffered an uncontrollable fire in one of its four engines, which subsequently spread to the adjacent engine and threatened the structural integrity and therefore likely controllability of the aircraft. Hearing a report from the rear crew that the wing was "melting", and fearing that he may have only seconds before the wing failed, the captain decided to ditch the aircraft into the sea. All of the occupants survived. It is most likely that, had he tried to reach the nearest runway, he would not have made it.

To handle an emergency such as this, where time is critical, controller overload is likely if support and supervisory back-up is not immediately forthcoming. To do this successfully requires well thought through and regularly practiced contingency plans – there isn't time for an ad-hoc response.

Similar examples of in-flight fire show that the average time between first indications of fire and loss of control, either through structural/system failure or crew incapacitation, is just 17 minutes.

26 minutes after the first alarm, UPS 006 was approximately 10nm from Dubai. ATC advised, through a relay aircraft, a 360 degree turn as the aircraft was too high and fast. The Co-Pilot responded "negative". Shortly afterward, the Co-Pilot indicated that the landing gear was not functioning.

28 minutes after the first alarm, UPS 006 was overhead Dubai. The aircraft was advised to turn left for Sharjah. The pilot acknowledged. The autopilot subsequently disconnected and the aircraft entered a descending turn to the right.

29 minutes after the first alarm, radar contact with UPS 006 was lost.