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In this issue

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Editorial

In-flight Smoke and Fire are two critical flight safety issues which demand immediate action by the flight deck and cabin crew and do not give much time to react. Even on ground, fire can be very quick and devastating as it happened in the latest China Airlines B737-800 fire accident at Naha, Okinawa, Japan.

In-flight Smoke and Fire is the topic of this issue. We start with the famous fire accident of Swissair flight SR111. This is followed by some facts and figures on in-flight smoke and fire accidents. Next we discuss important aspects of engine fire. Finally, we address the deck and cabin crew's response to smoke and fire onboard.

Your feedback is valuable. Suggestions and contributions can be sent to our office. Happy reading and many more safe landings.

Crash of Swissair flight SR111

based on Transportation Safety Board of Canada (TSB) report no. A98H003

On September 2,1998, at 0018 UTC(2018 Eastern daylight savings time), Swissair Flight 111, a McDonnell Douglas MD11(HB-IWF) departed JFK International Airport in Jamaica, New York, USA, on a scheduled flight to Geneva, Switzerland, with 215 passengers and 14 crew members on board. About 53 minutes after departure, cruising at FL 330, the flight deck crew smelled an abnormal odor 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 (see the route maps shown in page 2); however, when ATC mentioned Halifax, Nova Scotia, as an alternative airport, they changed the destination to the 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. Thirteen minutes after the abnormal odor 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. A minute later, radio communications and secondary radar contact with the aircraft were lost, and the flight recorders stopped functioning. About five and one-half minutes later, the aircraft crashed into the ocean about five nautical miles southwest of Peggy's Cove, Nova Scotia, Canada. The aircraft was destroyed and there were no survivors.

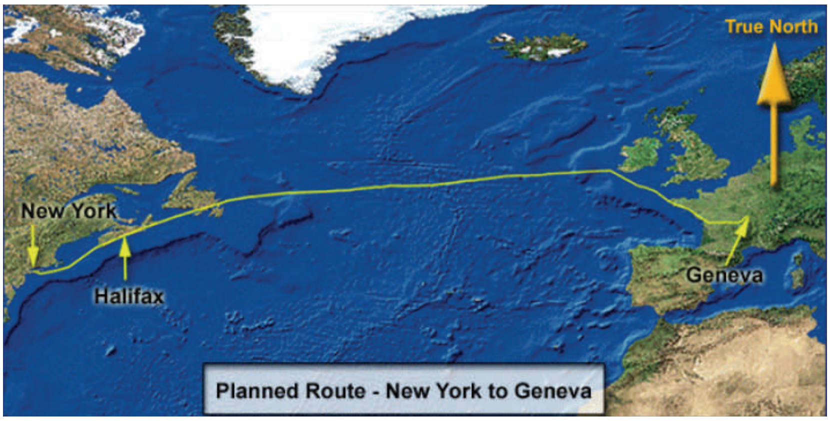
Now let us look at the sequence of events in detail. For this flight, the first officer was the pilot flying.

At 0058, SR111 contacted Moncton Air Traffic Services (ATS) Area Control Centre (ACC) and reported that they were at FL 330.

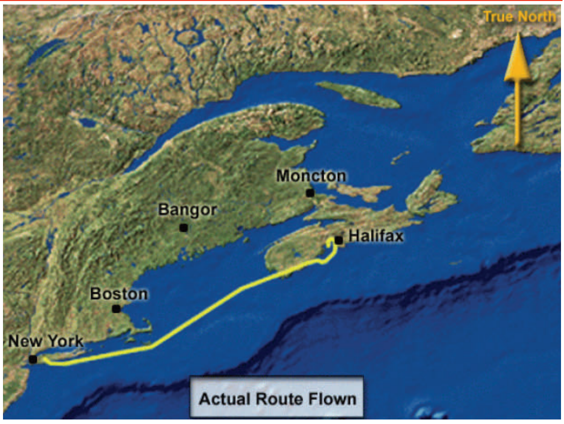
At 0110:38, the pilots detected an unusual odor in the cockpit and observed a small amount of smoke entering the cockpit from behind and above them. They began to investigate. CVR indicated that the smoke cleared after about 30 seconds and that the pilots believed the odor and the smoke had emanated from the air conditioning system.

A flight attendant who had been summoned to the cockpit told the captain that she smelled an odor in the cockpit but had not smelled the odor in the cabin.

At 0013, the pilots again observed smoke The captain said that it is not doing well at all up there and then the pilots discussed alter-



Planned Route - New York to Geneva



Actual Route Flown

nate airports and weather conditions at the airports.

At 0114:15, SR111 made a Pan Pan radio transmission to Moncton ACC. The aircraft was about 66 nautical miles (nm) southwest of Halifax International Airport, Nova Scotia. The pilots reported that there was smoke in the cockpit and requested an immediate return to a convenient place and named Boston, Massachusetts, which was about 300nm behind them. The Moncton ACC immediately cleared SR111 to turn right toward Boston and to descend to FL310. At 0115:06, the controller asked SR111 whether they preferred to go to Halifax, Nova Scotia as it was considerably closer. The pilots expressed a preference for Halifax and immediately received an ATS clearance to fly directly to Halifax, which was by then about 56 nm to the northeast. At this time, the pilots donned their oxygen masks.

At 0116:34, the controller cleared SR111 to descend to 10000 ft ASL, and asked for the number of passengers and amount of fuel on board. The pilots asked the controller to stand by for that information. At 0118:17, the controller instructed SR111 to contact Moncton ACC on 119.2MHz. SR111 immediately contacted Moncton ACC and stated that the aircraft was descending out of FL254 on a heading of 050 degrees on course to Halifax. The controller cleared SR111 to 3000ft. The pilots requested an intermediate altitude of 8000ft until the cabin was ready for landing.

At 0119:28, the controller instructed SR111 to turn left to a heading of 030 for a landing on Runway 06 at the Halifax International Airport, and advised that the aircraft was 30nm from the runway threshold. The aircraft was descending through approximately FL210 and the pilots indicated that they needed more than 30nm. The controller instructed SR111 to turn to a heading of 360 to provide more track distance for the aircraft to lose altitude.

At 0120:48, the flight crew discussed internally the dumping of fuel based on the aircraft's gross weight, and on their perception of the cues regarding the aircraft condition, and agreed to dump fuel.

At 0121:20, the controller made a second request for the number of persons and amount of fuel on board. SR111 did not relay the number of persons on board, but indicated that the aircraft had 230tonnes of fuel on board *(this was actually the current weight of the aircraft, not the amount of fuel)* and specified the need to dump some fuel prior to landing.

At 0121:38, the controller asked the pilots whether they would be able to turn to the south to dump fuel, or whether they wished to stay closer to the airport. Upon receiving confirmation from the pilots that a turn to the south was acceptable, the controller instructed SR111 to turn left to a heading of 200, and asked the pilots to advise when they were ready to dump fuel. The controller indicated that SR111 had 10 nm to go before it would be off the coast, and that the aircraft was still within 25 nm of the Halifax airport. The pilots indicated that they were turning and that they were descending to 10000ft for the fuel dumping.

At 0122:33, the controller heard, but did not understand, a radio transmission from SR111 that was spoken in Swiss–German, and asked SR111 to repeat the transmission. The pilots indicated that the radio transmission was meant to be an internal communication only; the transmission had referred to the Air Conditioning Smoke checklist.

At 0123:30, the controller instructed SR111 to turn the aircraft farther left to a heading of 180, and informed the pilots that they would be off the coast in about 15 nm. The pilots acknowledged the new heading and advised that the aircraft was level at 10000 ft.

At 0123:53, the controller notified SR111 that the aircraft would be remaining within about 35 to 40 nm of the airport in case they needed to get to the airport in a hurry.

At 0124:09, FDR began to record several aircraft system-related failures including the disengagement of autopilot 2 and loss of data to some of the pilot's electronic displays. The pilots notified the controller that they had to fly the aircraft manually and asked for a clearance to fly between 11000 and 9000ft. The controller notified SR111 that they were cleared to fly at any altitude between 5000 and 12000ft. The pilots indicated that this was fine and asked to be notified when they could start dumping fuel.

Soon after, the systems failures began to occur, the fire likely breached the cockpit-ceiling liner and caused dense smoke to enter the cockpit.

At 0124:42, both pilots almost simultaneously declared an emergency on frequency 119.2 MHz; the controller acknowledged this transmission.

At 0124:53, SR111 indicated that they were starting to dump fuel and that they had to land immediately. The controller indicated that he would get back to them in just a couple of miles. SR111 acknowledged this transmission.

At 0125:02, SR111 again declared an emergency, which the controller

ELAPSED TIME FOR KEY EVENTS		
UTC Time	**Elapsed Time (minutes)**	**EVENT**
0110:38	00:00	Unusual smell detected in the cockpit
0113:14	02:36	Smoke assessed as visible at some location in the cockpit; no smell reported in cabin
0114:15	03:37	SR111 radio call: "Pan Pan Pan"; diversion requested naming Boston (It is unknown whether visible smoke was still present in the cockpit)
0115:36	04:58	Decision made to divert to Halifax, Nova Scotia
0120:54	10:16	Decision made to dump fuel
0123:45	13:07	CABIN BUS switch selected to OFF
0124:09	13:31	Autopilot 2 disengages, and the FDR begins to record aircraft system failures
0124:42	14:04	Emergency declared
0125:02	14:24	ATS receives last communication from SR111
0125:41	15:03	Recorders stop recording
0131:18	20:40	Impact with water

acknowledged. At 0125:16, the controller cleared SR111 to dump fuel; there was no response from the pilots.

At 0125:20, the captain told the first officer that something was burning. The first officer said that his side of the instrument panel was "all dark", indicating his electronic flight displays had failed.

At 0125:40, the controller repeated the clearance. There was no further communication between SR111 and the controller.

At 0125:41, the CVR, the FDR and the VHF radios ceased functioning.

At approximately 0130, observers in the area of St. Margaret's Bay, Nova Scotia, saw a large aircraft fly overhead at low altitude and heard the sound of its engines. At about 0131, several observers heard a sound described as a loud clap. Seismographic recorders in Halifax, Nova Scotia, and in Moncton, recorded a seismic event at 0131:18, which coincides with the time the aircraft struck the water. The accident occurred during the hours of darkness. The centre of the debris field, located on the ocean floor at a depth of about 55metres was at the approximate coordinates of latitude 44°24'33" North and longitude 063° 58'25" West.

The table above summarizes the sequence of key events along with the time of occurrence. In about twenty minutes from the time the smoke was first sensed the fire created an havoc and the aircraft was lost.

Transportation Safety Board (TSB) of Canada investigated the accident and found the following major causes and contributing factors of the accident.

1. Flammable material propagated a fire that started above the ceiling on the right side of the cockpit near the cockpit rear wall. The fire spread and intensified rapidly to the extent that it degraded aircraft systems and the cockpit environment, and ultimately led to the loss of control of the aircraft. *(Aircraft certification standards for material flammability were inadequate in that they allowed the use of materials that could be ignited and sustain or propagate fire.)*

2. Metallized polyethylene terephthalate (MPET)–type cover material on the thermal acoustic insulation blankets used in the aircraft was flammable. The cover material was most likely the first material to ignite, and constituted the largest portion of the combustible materials that contributed to the propagation and intensity of the fire.

3. Once ignited, other types of thermal acoustic insulation cover materials exhibit flame propagation characteristics similar to MPET-covered insulation blankets

4. Silicone elastomeric end caps, hook-and-loop fasteners, foams, adhesives, and thermal acoustic insulation splicing tapes contributed to the propagation and intensity of the fire.

5. The circuit breakers (CB) used in the aircraft were similar to those in general aircraft use, and were not capable of protecting against all types of wire arcing events. The fire most likely started from a wire arcing event.

6. A segment of in-flight entertainment network (IFEN) power supply unit cable(1-3791) exhibited a region of resolidified copper on one wire that was caused by an arcing event. This resolidified copper was determined to be located in the area where the fire most likely originated. This arc was likely associated with the fire initiation event; however, it could not be determined whether this arced wire was the lead event.

7. There were no built-in smoke and fire detection and suppression devices in the area where the fire started and propagated (they were not required by regulation). The lack of such devices delayed the identification of the existence of the fire, and allowed the fire to propagate unchecked until it became uncontrollable.

8. There was a reliance on sight and smell to detect and differentiate between odor or smoke from different potential sources. This reliance resulted in the misidentification of the initial odor and smoke as originating from an air conditioning source.

9. There was no integrated in-flight firefighting plan in place for the accident aircraft, nor was such a plan required by regulation. Therefore, the aircraft crew did not have procedures or training directing them to aggressively attempt to locate and eliminate the source of the smoke, and to expedite their preparations for a possible emergency landing. In the absence of such a firefighting plan, they concentrated on preparing the aircraft for the diversion and landing.

10. There is no requirement that a fire-induced failure be considered when completing the system safety analysis required for certification. The fire-related failure of silicone elastomeric end caps installed on air conditioning ducts resulted in the addition of a continuous supply of conditioned air that contributed to the propagation and intensity of the fire.

11.The loss of primary flight displays and lack of outside visual references forced the pilots to be reliant on the standby instruments for at least some portion of the last minutes of the flight. In the deteriorating cockpit environment, the positioning and small size of these instruments would have made it difficult for the pilots to transition to their use, and to continue to maintain the proper spatial orientation of the aircraft.

TSB Canada also identified risks that could potentially degrade aviation safety. Following are the risks that affected the deck crew performance.

• In the last minutes of the flight, the electronic navigation equipment and communications radios stopped operating, leaving the pilots with no accurate means of establishing their geographic position, navigating to the airport, and communicating with air traffic control.

• The Swissair Smoke/Fumes of Unknown Origin Checklist did not call for the cabin emergency lights to be turned on before the CABIN BUS switch was selected to the OFF position. Although a switch for these lights was available at the maître de cabine station, it is known that for a period of time the cabin crew were using flashlights while preparing for the landing, which potentially could have slowed their preparations.

• Neither the Swissair nor Boeing Smoke/Fumes of Unknown Origin Checklist emphasized the need to immediately start preparations for a landing by including this consideration at the beginning of the checklist. Including this item at the end of the checklist de-emphasized the importance of anticipating that any unknown smoke condition in an aircraft can worsen rapidly.

In-flight fire accidents - some facts & figures

based NTSB accident summaries, articles in air safety forum and Boeing article on in-flight smoke in Aero no.14

We had discussed in-flight fire and smoke in the April 2006 issue of Flight Safety. In that issue we had covered in-flight fire and cabin smoke incidents of Boeing777.

An IATA study on in-flight smoke and fire reveals that about 1000 in-flight smoke events occur annually – mostly in cruise. In US itself, there is an average of one diversion a day due to cockpit or cabin smoke.

A study by the International Water Spray Research Management group, during the 1980's and 1990's found that there were 95 fire related civil passenger aircraft accidents resulting in 2400 fatalities. An US Government study reveal that nearly 16% of all US transport aircraft accidents during 1985-1991 involved fire and 22% of the fatalities in these accidents resulted from fire and smoke.

In the following, a brief account of some of the major in-flight smoke and fire accidents is given to bring out the criticality and rapidness with which in-flight fire accidents occur.

• On August 19, 1980, a **Saudi Arabian Airlines, L-1011,** returned to Riyadh, Saudi Arabia and made a successful landing, after reporting **a fire in its C-3 cargo compartment**. However, after landing, no doors opened and no one evacuated. All 301 on board perished, from the inhalation of toxic fumes and exposure to heat. There were no traumatic injuries.

Just prior to landing, the captain ordered his crew *not to evacuate* and he failed to shut off the engines after the aircraft was stopped.

Captain John Irving an ex-Saudia captain that took the rapid response team to the accident has following explanation:- " The flight was from Riyadh to Jeddah and the pressurization system's automatic controller was set for a landing at Jeddah (sea level) and was not reset for the return to Riyadh (2,100ft). As was normal, the Cabin Rate Controller was set to minimum so when the plane landed with about 2 PSIG differential pressure the cabin altitude started climbing but only at the selected rate of 150ft per minute.

As a result the aircraft landed pressurized and even when the cabin crew tried to open the doors the cabin differential pressure prevented the plug type doors from opening. With a Cabin Rate at 150 feet per minute and the Landing Altitude incorrectly set for sea level(-200ft), instead of Riyadh's 2,100 ft, it would take 9-11 minutes for the cabin to depressurize enough to allow the doors to be opened. So all onboard died before this time elapsed."

On June2, 1983, **Air Canada flight 797, a DC-9** was on a scheduled flight from Dallas to Montreal via Toronto had a rear toilet fire while cruising at FL33, just south of greater Cincinnati airport. The flight left Dallas with 5 crewmembers and 41 passengers on board.

About 1903, eastern daylight time, while en route at FL330, the cabin crew discovered **smoke in the left aft lavatory.** After attempting to extinguish the hidden fire and then contacting ATC and declaring an emergency, the crew made an emergency descent and ATC vectored flight 797 to the Greater Cincinnati International Airport, Covington, Kentucky.

At 1920:09, Flight 797 landed on runway 27L at the Greater Cincinnati International Airport. As the pilot stopped the airplane, the airport fire department, which had been alerted by the tower to the fire on board the incoming plane, was in place and began firefighting operations. Also, as soon as

SAUDI ARABIAN AIRLINES L-1011

AIR CANADA DC-9

the airplane stopped, the flight attendants and passengers opened the left and right forward doors; the left forward overwing exit, and the right forward and aft overwing exits. About 60 to 90 seconds after the exits were opened, a flash fire engulfed the airplane interior. While 18 passengers and three flight attendants exited through the forward doors and slides and the three open overwing exits to evacuate the airplane, the captain and first officer exited through their respective cockpit sliding windows. However, 23 passengers were not able to get out of the plane and died in the fire. The airplane was destroyed.

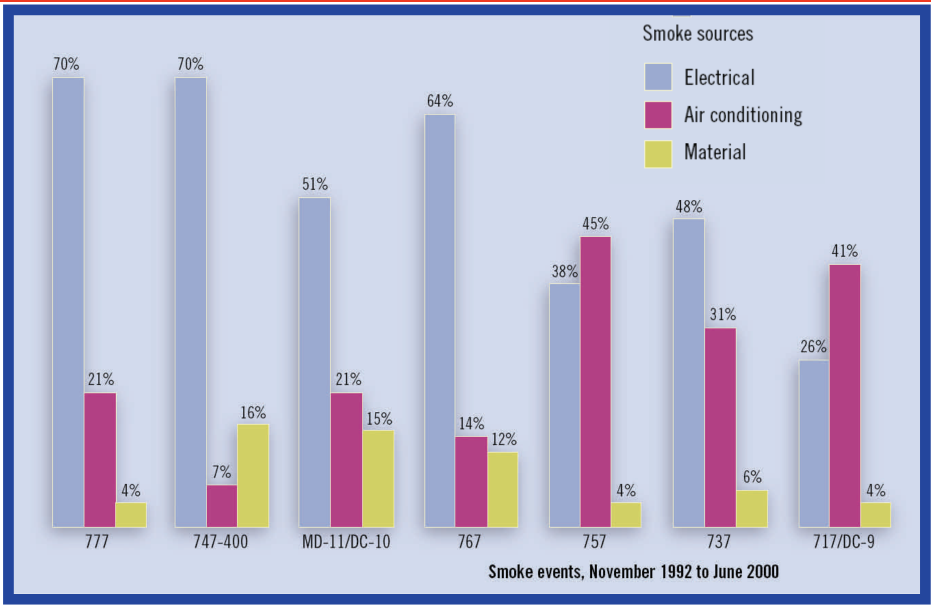
The National Transportation Safety Board determines that the probable causes of the accident were a fire of undetermined origin and the underestimation of the seriousness of the fire as relayed to the captain which caused a five minute delay in the activation of rapid descent. This delay was a critical factor between life and death - for those unable to exit the aircraft in time.

• On May 11,1996, ***a Valujet DC-9***, crashed shortly after takeoff from Miami International Airport. Improperly packed oxygen generators in the cargo bay ignited, leading to a fire which burned through control cables and filled the cabin with smoke. There was no warning, until the flight attendants yelled to the cockpit that the cabin was on fire. There were no fire/smoke detectors or a fire suppression system for its cargo compartments. All 110 onboard perished in the accident. ValuJet maintenance contractor SabreTech was criminally charged and found liable for placing the canisters aboard the aircraft.

• There have been many other accidents where inappropriate and hazardous cargo resulted in fire and smoke in the cargo bay, which in turn resulted in smoke in the cockpit.

Boeing performed an analysis of all reported events involving smoke, fumes, fire, and overheating in the pressurized areas of its airplanes between Nov.1992 and June 2000.

For this study, the events were categorized into three classes: air conditioning, electrical, and material. The term **smoke** here refers to odors, smells, fumes, or overheating as well as visible



smoke.

• Air-conditioning smoke events were cases in which incoming bleed air was contaminated, perhaps from engine oil or contaminated outside air.

• Electrical events were cases in which electrically powered equipment overheated or emitted smoke or fumes.

• Material events involved material that gave off smoke or fumes such as food burning in an oven, lavatory waste ignited by a discarded cigarette, or spilled chemicals in the cargo compartment.

The above Boeing chart depicts a summary profile of smoke events for each airplane model included in the study. For each model, the number of events in each source category was divided by the total number of smoke events for that model, yielding the percentage contributions depicted in the profile. Larger airplanes with more complex systems show a predominance of smoke events of electrical origin, compared with air-conditioning and material smoke events. B777 has a history of many smoke and fire accidents originating from electrical system. Few of these involve the burning of the electrical switchgear contacts and wires.

To have the further break-up, for each airplane model, the air conditioning, electrical, and material events were subdivided by airplane system. The subcategories within the electrical category included systems or functions such as environmental control, electrical power, galleys, and flight deck equipment.

The study also collected data on how the crews perceived the in-flight smoke events. The data were grouped in a structure similar to the flight crew *Quick Reference Handbook (QRH)* produced by airplane manufacturers and operators.

Most smoke events occurred with the flight crew on board (above 70%) For many in-flight events, flight crews took action consistent with having identified the smoke source, such as removing electrical power to that equipment. There was a significant number of events in which crew actions suggest that the smoke source could not be identified while in flight. Smoke events in which the flight crew could not determine the smoke source were most were subsequently determined by maintenance crews to be of electrical origin.

The study of all in-flight fire emergencies resulting in total hull loss with fatalities show that

• The cabin or cargo fire that cannot be extinguished in two minutes from its start cannot BE EXTINGUISHED.

• With an in-extinguished in-flight fire, there will be only 4 to 14 minutes to land/ditch and evacuate.

• If this time frame is not adhered to the fire will destroy the aircraft.

The cardinal rule in case of in-flight smoke or fire is to <u>Land As Soon as Possible</u>.

FOR SAFETY, LAND FIRST & THEN TROUBLE SHOOT .

Engine On Fire

Adopted from article - "Tail pipe or Engine fire" by Michel Palomeque in Airbus SAFETY FIRST # 2, Sept.2005

The details here are applicable to all Airbus aircraft, whatever the engines and with or without the ECAM system.

Engine fire is fortunately rare but when it occurs needs correct identification and appropriate action.

An aircraft engine fire may be a result of different malfunctions and may have different origins. Thus the fire affecting the engine has to be dealt appropriately depending on its origin.

The fire affecting the engine is of two types: engine (or nacelle) fire and tail pipe fire. With the engine belching smoke and fire, this cannot be differentiated from the cockpit and flight deck crew have the tendency to discharge the fire extinguisher bottles.

Engine (nacelle) fire:

HP compressor or combustion chamber zone of the nacelle compartment may reach a very high temperature. The nacelle has many ducts and subsystems that contain fuel, oil or hydraulic fluids which are all flammable. Thus the source of fire could be the malfunctioning external component or a flammable fluid line fitted on the engine core in the nacelle compartment. The auto-ignition temperatures of fuel, oil and hydraulic fluids are 230°C, 260°C and 450-500°C respectively. When these fluids come in contact with very hot engine surfaces they auto-ignite and engine fire occurs.

Engine fire can occur due to

- Rupture of a pipe containing fuel, oil or hydraulic fluid;
- Damage to the accessory gearbox which has fuel, hydraulic and oil pumps, IDG and starter;
- Rupture of a rotating engine part such as fan blade or an uncontained compressor blade rupture, which while ejecting could damage a pipe; and
- Rupture of the combustion chamber leading to fuel leaks
- In less frequent cases, an internal gas path abnormality could lead to an engine case penetration resulting in an engine fire.

An engine fire mainly affects the nacelle compartment and could occur during any on-ground or in-flight phase irrespective of the power setting. This is why an engine fire is also called nacelle or external fire.

To protect the engine and the aircraft against an engine fire, fire detectors are fitted in the nacelle compartment. These are located at the most sensitive areas of the nacelle considering the temperature of each area, presence of flammable fluid and the ventilation. The location and the number of detectors vary with the engine type, engine arrangement and the equipment fitted on the engine. Whatever the engine type or model, the core element is always protected because of the compressor and the combustion chamber. These parts of the engine can reach very high temperatures. Additionally, many fluid pipes are fitted all along the engine core and particularly fuel pipes at the level of the combustion chamber.

The pylon area is always fitted with fire detectors to detect any torch flame which could result from a rupture of the combustion chamber and affect the pylon structure integrity. The detectors are always installed on the engine core in the nacelle compartment.

Each fire area is well marked out and protected by fireproof partitions which not only contain the fire in a given area but also maintain the agent concentration when the fire extinguishing agent is discharged. The turbines are usually made of highly resistant steel capable of sustaining extreme temperatures (for instance, combustion chamber exit temperature at HP turbine is between 1000 and 1200°C at max cruise). Due to this and the fact that there are no flammable fluid pipes or equipment in the turbine area, there is no fire detection system.

When an engine fire is detected, the flight crew will have following indications:

- The fire warning is triggered. This includes the fire handle illumination, the ECAM activation, the Master Warning and fuel lever illumination accompanied by the continuous chime,
- A rise of nacelle temperature
- An engine surge and/or engine performance abnormalities may be noticed if a critical component of the engine is affected.

Then, a fire warning indicates that a fire has been detected in a sensitive area of the engine with possible continuous feeding of fire due to hydraulic fluid, fuel or oil leak. Consequently, this warning requires immediate action from the crew.

Tail Pipe Fire: A tail pipe fire occurs during ground engine start or shutdown and results from an excess of fuel in the combustion chamber or in the turbine area. Consequently, this is an event that may occur on ground only during engine start or shutdown sequence.

The excess fuel in the combustion chamber or in the turbine area may be the result of:

- Engine control unit over-fuelling, or
- Rotating stall with fuel continuing to be supplied to the engine, or
- Malfunction of the ignition system,
- Second engine start attempt with some residual fuel pooled in the turbine area due to the first unsuccessful engine start, or
- Oil leak in the tail pipe, or
- To a lesser extent, severe case of fuel in the oil or fuel nozzle cracking at a lower pressure than the design on a shutdown engine, allowing the fuel to enter a combustion chamber which is still hot.

This excess fuel ignites in the combustion chamber with the engine not rotating or rotating below idle thrust and incapable of utilizing the energy released in production of thrust. Unlike engine fire, a tail pipe fire is an internal fire and will develop in the aft turbine race and is normally contained within the engine core and should not damage sensitive parts.

As there are no fire detectors in this zone a tail pipe fire will not trigger the ENGINE FIRE warning. Tail pipe fire is mainly indicated by a visual report. As this type of fire typically occurs at engine start or shutdown, the crew is mainly made aware of a tail pipe fire by either ground crew, cabin crew or tower.

As EGT probe is located in the turbine area, a rapid EGT rise can also be an indication that a tail pipe fire is developing. This is one of the reasons why the EGT has to be monitored in accordance with the SOPs during engine start or shutdown.

This particularly true in case of a second engine start attempt following an unsuccessful attempt where the risk of some residual fuel pooled in the combustion chamber or the turbine area exists.

In case of a reported tail pipe fire, the appropriate procedure is to ventilate the engine to blow out the fire and any residual fuel or vapor. Internal engine damage will normally not occur provided the engine is ventilated with minimum delay.

If ignored and the fuel source is large enough or continual, a tail pipe fire can become very intense and an external fire. In such a case, an external observer will warn that the fire is going on and appropriate actions will be taken.

In the event of a tail pipe fire,

- Shutoff fuel supply (fuel HP valve off),
- Open the cross-bleed valve (it has to be opened manually to prevent its closure when the fire handle is pulled),
- Pull the fire handle to shutoff fuel LP valve (A300/A310 only)
- Establish air bleed to supply the affected engine starter using either the opposite engine (if still running), or APU bleed or GPU (if connected)
- MAN START (if manual start performed)…OFF
- ENG MASTER (affected)…OFF (Note: Do not press the ENG FIRE pushbutton, since this will cut off the FADEC power supply which will prevent the motoring sequence.)
- Crank the engine in order to: inhibit the ignition circuit and dry motor the engine reduce the internal temperature, blow out the fire and residual fuel or vapor.

In the very worst case where no bleed is available, a ground fire extinguisher can be used as a last resort to extinguish a tail pipe fire if there is no means to ventilate the engine.

The ground fire extinguishers should be used as a last resort as they usually contain dry chemical powder or chemical foam extinguishing agents. These agents are very corrosive agents and may cause serious corrosive damage to the engine. Further, the engine must be removed from aircraft for disassembly inspection and cleaning after the use of such an extinguishing agent.

However, if there is no other way to arrest a tail pipe fire or even worse if the fire is developing, there is no doubt that ground fire extinguishers should be used to protect the aircraft.

CREW RESPONSE TO IN-FLIGHT SMOKE AND FIRE

based on Airbus flight safety operations briefing notes and Boeing in-flight smoke article in Aero 14

An in-flight fire or smoke event is a time-critical situation that demands immediate action by the flight and cabin crews. Cigarettes aside, any smoke in an airplane is not normal. Crew response must be timely and use available airplane controls and non-normal procedures.

In the event of an in-flight smoke or fire, communication between the cabin crew and flight crew is vital. If a smoke or fire is discovered in the cabin, the cabin crew must inform the flight crew immediately.

Although most smoke events in the pressurized area of an airplane are resolved and rarely affect continued safe flight, landing, or egress, smoke is always a significant issue with operational consequences.

Direct crew response to smoke and fumes originating from readily accessible equipment, referred to as known smoke, is key to minimizing operational consequences. Timely and prudent crew response to smoke events of undetermined origin, or unknown smoke, minimizes risks during the remaining flight, landing, and egress. The aircraft QRH has procedures to handle smoke, fumes and fire.

In aircraft, there are known and unknown/difficult sources of smoke.

The known sources are the galley equipment (oven and coffee maker), seat screens or seat screen control malfunction, and lavatories. The smoke from air conditioning, sidewall and ceiling panels are difficult to detect. Unknown smoke sources include ECS, APU, cabin recirculation fans, equipment cooling fans, door heaters, avionics bay,

When a flight crew determines smoke is of electrical origin, the affected equipment should be depowered immediately.

For a known smoke event, confirming that the situation has been resolved is as important as identifying the source. The smoke or fumes must dissipate and any overheating condition must improve for the crew to be confident the situation is under control.

An unknown electrical smoke source calls for the removal of electrical power for specific systems not necessary for safe flight, landing, and egress. The crew should plan to land at the nearest suitable airport. During the remainder of the flight, the crew should be alert to any new signs that suggest the smoke source and remain mindful of operational functions needed to accomplish the diversion.

Any in-flight fire, no matter how small, may rapidly go out of control, if not dealt with quickly. The first priority is to put it out. The key to fire prevention is keeping fuel and ignition sources separate. A fire will stop when the fuel supply is cut off, or there is no more oxygen available or the temperature is below the flammability temperature.

Firefighting requires coordination amongst the cabin crew. The duties are divided into three main roles, the Firefighter, the Communicator, the Assistant Firefighter, all other cabin crewmembers play a supporting role.

The cabin crew who finds the fire will assume the role of the Firefighter. The Firefighter alerts other cabin crewmembers; takes the nearest appropriate fire extinguisher; immediately locates the source of the fire and extinguishes the fire.

The second cabin crew on the scene will be the Communicator and will

- inform the flight crew on the location of fire, its source, severity, smoke odor and color, and the time the firefighting action started. He times the firefighting progress and the number of fire extinguishers used;
- Maintain the communication link between the cabin and the flight crew, via

an interphone near the firefighting scene;

- Provide the flight crew with an accurate description of the firefighting effort, and of the situation in the cabin.

The third cabin crew on the scene will be the Assistant Firefighter who

- provides additional firefighting equipment and supports firefighting
- removes flammable material from the area and is prepared to replace the firefighter, and change role with firefighter if required.

Remaining cabin crew shall relocate the passengers, provide necessary first aid, calm and reassure passengers. After the fire or smoke occurrence, one cabin crew should monitor the affected area for the remainder of the flight and should regularly report the cabin-in-charge who in turn will report to the deck crew.

Fire in hidden areas are indicated by an unusually hot surface; Fumes and unusual odors; smoke emitted from a wall seams or ceiling panels; Snapping, or popping noises indicative of a possible electrical arcing.

If a fire is suspected in a hidden area, for example, behind a panel, try to locate a "hot spot", this is an unusually warm area and is generally a good indicator as to where the source of the fire is.

To find the "hot spot", move the back of the hand along the panel to find the hottest area.(the skin on the back of the hand is thinner and, is more sensitive to temperature changes than the palm). It may be necessary to remove panels to access the hidden area, or to make an incision in a panel large enough to insert the nozzle of the extinguisher, to discharge the extinguishing agent.

Cabin crew should consider the use of other equipment to remove panels, these include: Ice tongs, Spoons, Knives, Scissors from the first aid kit and manual release tool (which is provided for opening the oxygen mask containers). Caution must be taken when removing, or making incisions in panel, some of these areas may contain essential wiring or aircraft systems. Carefully lift, lever, or cut a panel.

Oven fires are common onboard but are preventable.

Some of the contributing factors to oven fires have been items left in the oven such as paper towels, saran wrap.

In case of an oven fire, the oven door should be kept closed. It is hazardous to open an oven door when a fire is present, as this will introduce oxygen and may cause a flash fire. The Firefighter should take the following action:

- Keep the oven door closed, to deprive the fire of oxygen. In most cases, the fire will extinguish by itself
- Isolate the electrical power from the oven by pulling the corresponding circuit breaker and turning off the oven power
- Monitor the situation
- Have a fire extinguisher, protective breathing equipment (PBE) and fire gloves ready to use if the situation deteriorates.

If the situation worsens, or fire is still present:

- Don the PBE & fire gloves for protection; open the oven slightly, just enough to insert the nozzle of the fire extinguisher; insert the nozzle of the fire extinguisher; discharge the extinguishing agent and close the oven door.
- Repeat the procedure, if necessary.

All lavatories have smoke detectors and automatic fire extinguishers under each sink. All crew rest areas have smoke detectors and extinguishers. Cabin crew must react immediately to smoke detector alerts.

When fire occurs in an enclosed area, such as, a lavatory, an overhead bin, closet or crew rest area, before opening the door, always check the door panel for heat using the back of your hand.

- Open the door or the overhead bin slightly (just enough to pass the nozzle of the fire extinguisher).
- If the fire is visible: Discharge the fire extinguisher at the base of the fire in a sweeping motion. If the source of the fire has not been located **do not** randomly discharge the fire extinguisher into an enclosed area.

If the source fire is not visible, the cabin crew must aggressively search the entire area to locate the source of the fire.

Flight deck and cabin crew's alertness to any sight, odor or sound that indicates the presence of smoke or fire is very important and vital for the safety against smoke/fire hazards in flight.

WEB WATCH

http://www.airborne.org/flying/forum3.htm *details and discussions on on-board fire and smoke accidents, and discussions by the pilots on in-flight smoke and fire issues*

PHOTO OF THE MONTH

At the airport in Madrid - Barajas (MAD/LEMD), Spain, a Thai 747 was taxiing on a taxiway open to aircraft not bigger than an A321, with a spectacular result!

See the fate of the Air France Embraer Regional jet vertical tail. Jumbo Wing did a good slicing job?!