A crash investigation assignment engineering essay

Engineering

Airtours Boeing 737-236 series 1, Manchester International Airport, 22cnd August 1985On the morning of 22cnd August 1985, a British Airtours Boeing 737 suffered an uncontained engine failure that resulted in the deaths of 54 of the 131 passengers. The aircraft was en route to Corfu International Airport in Greece, originating from Manchester International Airport. The aircraft began its take-off at approximately 0613hrs reaching a speed of 125 knots before the left engine suffered an uncontained failure, puncturing the fuel tank access panel. This caused a large plume of smoke to trail directly behind the engine. The crew, being oblivious to the cause of the sound, assumed a tire had burst and immediately aborted the take-off, clearing the runway to the right. A wind of 7 knots from 250 degrees resulted in the flames and smoke being directed towards the rear of the fuselage. Shortly before the aircraft came to a stop, the aft right door had been opened, which caused the fuselage to be penetrated and subsequently filled with smoke and fire. This resulted in a fire developing in the cabin. The causeThe left engines number 9 combustor can had been the subject of repair, a section of which had been forcibly removed from the engine upon take-off, breaching the underwing fuel access panel. Due to the aircrafts position relative to the wind after stopping, the fire was intensified greatly, and redirected onto the rear of the fuselage. Contributory factors: Fuel access panels vulnerability to impact and penetrationLack of means to prevent and stop fire in the cabinVulnerability of aircrafts hull to fireExtremely toxic properties of interior materials upon burningCause of incapacitationDue to the aforementioned interior material properties and hull vulnerability to fire, passengers were quickly exposed to noxious gasses which caused incapacitation, being the major cause of loss of life. Together with evacuation delays as a result of restricted exit access and door malfunctioning, 54 passengers suffered fatal burns and incapacitation. The lungs and airways of all fatalities showed high levels of carbon deposits, whilst blood samples contained cyanide, benzene and toluene the latter two being the most prevalent. All 54 of the fatalities had high levels of cyanide which would have been the cause of incapacitation, 21 of which showed levels high enough to be fatal. 48 of the 54 fatalities were the result of toxic gas and smoke inhalation. http://watchdocumentary. org/watch/air-crash-investigation-s09e01-panic-on-the-runway-british-airtours-flight-28m-video_46cdd0906. htmlFlight ReconstructionBoth pilots and all four cabin crew (one purser and three stewardesses) reported for the British Airtours flight KT28M, flying from Manchester to Corfu at 0500hrs on the 22cnd August 1985, scheduled for departure at 0600hrs. Pre-flight preparations were carried out by the training captain and a senior first officer, whilst the purser briefed the other three members of the cabin crew. The training captain carried out an external check on the aircraft as the co pilot conducted pre-flight checks in the cockpit. Before the passengers began to board the aircraft, the purser checked the safety equipment in the cabin. A number of the crew discussed and examined an entry in the aircrafts technical log from the previous day pertinent to slow acceleration from the left engine, one member of which was the co-pilot. After the repairs made to the left engines No 9 combustor can had been made, no problems had been reported and the captain signed his acceptance of the aircraft in the technical log. Both pilots undertook a thorough conversation of their duties and procedures to be undertaken In the event of an emergency during take-off, up to and above 146 knots. The co-pilot started both engines and no problems were reported. Clearance was requested by the captain at 0608hrs and the aircraft was taxied to a holding point of runway 24 (two-four denoting the runways heading). As is normal procedure, the cabin crew demonstrated safety equipment usage to the passengers, of which there were 131 including two infants. After the aircraft was cleared to line up on runway 24, the co-pilot assumed control as full nose wheel steering is available to the captain only. At 0612 hrs the aircraft was cleared for takeoff and the co-pilot requested take-off power, reaching 80 knots as the captain called the speed and the co-pilot confirmed. 12 seconds after the call out for 80 knots, a thump was heard and the captain immediately ordered " stop" and closed the throttles and selected reverse thrust for both engines. Both spoilers were extended and the maximum Indicated Air Speed (IAS) achieved on the take-off run was 126 knots. The Engine Pressure Ratio (EPR) for the right engine indicated normal operational values in the given situation, but the left engine EPR fell to zero within two seconds of the thump. The reverser buckets for the right engine had been retracted, while falling oil pressure in the left engine operating systems inhibited this. Because the captain assumed the aircrafts landing gear had suffered a tire failure, he ordered the co-pilot not to apply full pressure to the breaks, to which he responded by modulating them. Nine seconds after the sound was heard, the captain informed Air Traffic Control that they were abandoning the take-off. Fourteen seconds after the aircraft had stopped, the captain issued a broadcast over the cabin address system; " Evacuate on the starboard side please". A fire drill was ordered by the captain to be carried out by the co-pilot on the aircrafts left engine, as the right engine was shut down. Passengers then began to evacuate the aircraft on the starboard (right) side. Before the pilots were able to carry out a non-memory drill in the Quick Reference Handbook, the captain deemed it necessary for both to evacuate the cockpit through the sliding window as fire and fuel were seen to be spreading forward on the left side of the aircraft. After the Purser had confirmed evacuation of the aircraft with the captain, he made the issue repeatedly over the PA system. He then attempted to open the aircrafts right front door (R1) and release the inflatable escape slide. The door unlocked normally but would not open through its full range of motion as the slide container lid jammed on the doorframe. He then moved on to the L1 door which he cracked open, and inflated the slide. 17 surviving passengers escaped through the L1 door, while 34 escaped through R1 and a further 27 through the overwing exit. ATC and ground control had sighted the flames emanating from the Boeing 737 and initiated " full emergency" action. Manchester International Airport Fire Service (MIAFS) was alerted by the air controller and issued a briefing pertaining to the incident. As and just after the L1 door opened, two Rapid Intervention Vehicles (RIVs) arrived at the crash site and approximately 35 seconds later, two major foam tenders took up position as the R1 door was opened and its slide deployed. Damage reportThe combustion casing in the L1 engine was split open causing damage to engine and nacelle. The forward section of the No 9 combustor can had been forcibly ejected through the split in the engine casing, penetrating a fuel access panel on the lower wing surface immediately outboard of the engine which resulted in a large hole in the base of the main fuel tank. The nacelle of the engine had been damage from fire and surrounding areas of the wing suffered damage from an explosion from over pressure in the fuel tank. The plume of smoke and fire caused extensive damage to the left side of the fuselage and much of the rear cabin roof had been burnt away, resulting in the rear fuselage and tail section collapsing to the ground. Damage to the interior of the fuselage was also extensive, much of the rear cabin floor had collapsed into the lower cargo hold, and intact sections were covered in a layer of soot from burnt materials. Engine maintenance and repairThe L1 engine was delivered to British Airtours in 1980, and removed in 1983/1984 for a sample layout. A Light Maintenance Inspection (LMI) was performed and the engine was reassembled and fitted with previously repaired combustor cans from a different engine of the same kind. This particular engine was removed prematurely due to a pilot report of high exhaust gas temperature and visible damage to the compressor. The LMI was conducted to repair the damage to one of the compressor stages and repairs were made to the combustor cans. The lengths of the cracks in the combustor cans were not reported, but details were estimated after the incident on the 22cnd August 1985, indicating a circumferential crack in the No 9 combustor can of approximately 160mm. Another crack of 25mm, only visible from a radiograph was also found on the can. Combustor cans number 6 and 7 were also found to have cracks, but all were considerably smaller than those found on can No 9. The aforementioned cracks found in the three cans were repaired using a direct fusion weld method, carried out during the LMI. Cause of IncidentFrom the previous maintenance carried out on the L1 engine and air crash investigation findings, the cause of the incident was conclusive. The No 9 combustor can failed as a result of a number of cracks that had propagated around its circumference during its previous 7482 hours of service in another engine that had been the subject of compressor damage. The following table shows engine reports and actions taken to correct irregularities: DateDefectMaintenance performed05/08/85L1 engine very slow to accelerate both forward and reverseLubrication applied to Fan Coil Unit (FCU)20/08/85L1 engine slow to spool up during take-off. 1 and half – 2 inches throttle staggerPipes checked for leaks. Fuel system bled. 21/08/85No acceleration in L1 engine for 5-6 seconds with thrust lever halfway up quadrant. Low ground idle. 28% N1 and 50% N2. L1 engine slower than L2 when airborne. ADD (Acceptable Deffered Defect) raised for full trim with test for L1. PS4 Filter water drain trap removed – water found. Ground idle adjusted. L1 matches No 2 engine but still slow. Preventative recommendationsEngineIn order to prevent the engine failure so as to avoid fatalities, the replaced parts of the engine (combustor cans) should be inspected by a radiograph, which would have shown a number of the cracks that went unfound. If this procedure had been made, the accident would not have occurred, lives would have been saved and Airtours could have avoided the loss of aircraft and future customers. In conjunction with the radiograph, a number of engine tests and run time allow for engine health reports to be made, and a thorough analysis of the slow acceleration/loss of power would indicate that something in the engine may cause problems in the future. Exact flight engine operating parameters may have reproduced the same incident without fatalities, prompting the fitting of a new engine for the aircraft. Pilot actionsDue to the position of the aircraft upon stopping relative to the wind, the smoke and fire from the failed engine were directed over the rear left side of the fuselage, causing the cabin to rapidly fill with smoke, fire and toxic fumes. Although such incidents are rare (only this case) pilots should take into account the direction of the wind and the effect it will have on possible engine fires, thus allowing them to position the aircraft in such a way as to direct the fire and smoke away from the fuselage if possible. If the pilots had managed to position the aircraft with a heading of 250 degrees (the direction of the wind) or less, the fire and smoke would have been directed parallel and away from the fuselage resulting in damage only to the engine and possibly the tail sections. This way, the number fatalities would be minimized. Manchester currently consists of two runways, 05L/23R and 05R/23L. In 1985, the incident occurred on runway 24, which has since been changed to 05R23L. The following image demonstrates the approximate situation of the aircraft when stopped. It also shows the direction of wind and the resultant direction of the smoke and fire from the engine. (Red arrow)Airtours 737 crash. jpg

Direction of wind (7knots at 250°)

Fire fightingAlthough the crash was seen by ATC and a response occurred before the alarm was sounded, fire crew did not manage to arrive early enough to extinguish the fire before the cabin filled with smoke and fumes. The situation and position of the aircraft meant that the fire spread very rapidly, penetrating the cabin causing incapacitation of a number of passengers. One such reason could be the location of the fire station with respect to the final position of the aircraft. If the fire station was separated into two or more locations in opposite areas of the airport, a RIV (Rapid intervention Vehicle) could arrive at any site more quickly, which would at least supply some means of fighting fire before foam tenders and a reliable supply of water arrived. Human errorOne of the most prevalent human errors associated with the incident is the repair and replacement of the combustor cans that ultimately led to an engine failure. Although the cans were inspected for signs of localized hotspots and cracking, no effort to use a radiograph was made. This would have prevented the crash and saved lives. Such cracks can only be seen in this way, but it is an expensive procedure that some airlines prefer to avoid and thus assume certain engine parts are safe for use. This is a dangerous assumption and perhaps worth avoiding so as to ensure no engine failure will result from unseen internal damage. As mentioned in the preventative measures section, the final position of the aircraft greatly contributed to the flames and smoke penetrating the fuselage. The pilots had a very short window of opportunity to correct their position relative to the wind, and may not have considered its effect due to other seemingly more pressing matters. It is difficult to carry out all necessary procedures in an emergency, as well as considering environmental factors. Upon stopping, both engines were shut down; a procedure that must be made in such a situation, but one that caused the smoke and fire to spread around the rear of the cabin. If the pilots had only shut down the left engine and used the right engine to steer them into a safer position, the fire would have been redirected away from the fuselage, buying all aboard the aircraft more time to evacuate. Official aaib reportThe official report on the accident at Manchester International Airport on the 22cnd August 1985 involves all aspects of the incident. Causes, flight reproduction, weather, ground response, crew and passenger details are all discussed in great detail. Reports on the engines life cycle, maintenance and repair clearly show a well structured and fair analysis of the sequence of events leading up to the incident. It is chronologically sound whilst highlighting important events first, later elaborating on them to establish a high level of clarity. Such aspects of the incident such as passenger reactions to the fire and the role it played in fatalities indicate that the blocking of the aisles was one of the key factors. If the passengers had kept to a quick but efficient means of leaving the aircraft, perhaps fewer fatalities would have been caused. Besides ground response and passenger reactions to the fire, it was also noted that the R1 door did not open fully due to it catching on the lid of the container for the deployed slide. This shows a clear design flaw in exits functionality. The purser then had to spend time opening the L1 door to allow for evacuation. This process wasted only a few seconds, but it was sufficient to cause the smoke, flames and toxic gases to begin filling the cabin. Although the report does discuss the effects of the inhalation of toxic gases in great detail, there is little criticism on the interior material properties. Clearly, such materials can be very dangerous when exposed to high temperatures, and should not be used in aircraft. Fire retardant materials are better suited for such applications as they would not emit harmful chemicals. Seemingly less important aspects such as the aircrafts build, fire fighting tactics and evacuation procedures are heavily analyzed and the effects are stated. The width of the aisles in the cabin (22. 5 inches) only allowed single file exit of the plane, with some passengers attempting to flee the aircraft by climbing over seats. The purser may not have opened the L1 door had the R1 door opened on the first attempt, allowing for a swifter evacuation period and thus fewer fatalities. Passenger's evacuation was also slowed by the presence of the armrests of the chairs. In conjunction with aisle width and the malfunctioning R1 door, the report also mentions the chairs armrests which were in fact capable of being folded up, but no indication of this was evident to some passengers. http://www. aaib. gov. uk/cms_resources. cfm? file=/8-1988%20G-BGJL. pdf