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Tire Failure on Takeoff Sets Stage for Fatal Inflight Fire and Crash

When the crew of a chartered DC-8 carrying hundreds of religious pilgrims elected to continue takeoff after the aircraft experienced blown tires, an error chain was established that led to tragedy.

Editorial Staff Report

During the takeoff roll, the left main gear tires and wheels failed on a Canadian-registered (C-GMXQ) McDonnell Douglas DC-8 aircraft as it took off from King Abdulaziz International Airport in Jeddah, Saudi Arabia.

The Nationair charter flight, with 247 passengers and 14 crew members on board, was bound for Sokoto, Nigeria, as Nigerian Airways Flight 2120. The passengers were religious pilgrims.

After liftoff, remnants of tires on the gear bogie [landing gear with a multi-wheel truck on each leg] were burning when the gear was retracted after liftoff.

According to an aircraft accident report prepared by the Saudi Arabian Ministry of Defense and Aviation, a fire that developed within the left main wheel wells that subsequently caused loss of pressurization, hydraulic failure, structural damage and loss of aircraft control. The burning aircraft crashed short of the runway while attempting an emergency landing in visual meteorological conditions. There were no survivors in the July 11, 1991, crash.

The Saudi report noted a series of maintenance and cockpit factors that contributed to the fatal crash. The U.S. National Transportation Safety Board (NTSB), which

reviewed the report, made additional recommendations. In a letter to the ministry, it took issue with several of the Saudi report's conclusions, especially the role of the flight crew in the accident.

According to the Saudi investigation report, the Nationair aircraft was "signed off as fit for flight, in an unairworthy condition, by the operating flight engineer who had no involvement in the aircraft servicing."

The investigation determined that the damage to wheels and brakes on the left bogie was the result of the failure of the No.1 and No.2 tires.

The report said that pressures for the No.2 and No.4 tires were below minimum for flight dispatch and that "other tires may also have been below minimum pressures."

The report noted: "Maintenance personnel were aware of the low tire pressures but failed to rectify the faults. There was no evidence that the tire pressures had been checked, using a tire pressure gauge, after July 7."

Moreover, the Saudi report said:

- The lead mechanic was aware of the low tire pressures;
- The persons who were aware of the low pressures had insufficient knowledge of the hazards of operating with low tire pressures; and,
- There was no evidence to indicate that the flight crew was ever informed of the low tire pressures.

After liftoff, the crew retracted the gear and "burning rubber was brought into close proximity with hydraulic and electrical system components.

"The evidence indicates that the wheel well fire involved tires, hydraulic fluid, magnesium alloy and fuel. The fuel was probably introduced as a result of 'burn through' of the center fuel tank."

The Saudi report added: "Fire within the wheel wells spread and intensified until the cabin floor was breached and control systems were disabled. The fuel increased the intensity of the fire until, shortly before impact, the airframe structural integrity was lost."

The aircraft had arrived in Jeddah at 1400 hours on July 10 and was scheduled to depart later the same day. Passenger processing difficulties delayed the flight until the next day.

On July 11, a Nationair coordinator at the airport called the crew at 0300 hours; they left their hotel about 0400. The crew arrived at the airport at 0500.

The captain, 47, had logged a total of 10,700 flight hours, of which 1,000 were in the DC-8. The first officer, 36, had a total of 8,000 flight hours, of which 550 were in the DC-8. The flight engineer, 46, had logged a total of 7,500 flight hours, of which 1,000 were in the DC-8.

The report said, "The coordinator stated that at about the time that all passengers had been loaded, shortly before 0800 hours, the mechanic told him that he needed nitrogen to inflate a tire. The coordinator further stated that he observed the rear inboard tire of the left main gear bogie to be underinflated. A ramp supervisor stated that he drove the mechanic to a support facility. They asked for nitrogen but were told that the bottles were empty. The only other source of nitrogen would have been Saudi Arabian Airlines' line maintenance facility and, according to witnesses, the inevitable delay in obtaining nitrogen from this source was unacceptable to the project manager. The coordinator stated that the project manager said: 'Forget it.'"

A short time later the aircraft was given takeoff clearance for runway 34L. Brakes were released for takeoff at 0827:58.

According to the cockpit voice recorder (CVR), about 15 seconds after brake release, at a speed of about 50 knots, an oscillating sound was heard in the cockpit. "Within two seconds, the flight engineer said: 'What's that?'"

The first officer replied: "We gotta flat tire, you figure?" Two seconds later, an oscillating sound was again recorded. The captain asked the first officer: "You're not leaning on the brakes, eh?" The first officer responded: "No, I'm not, I got my feet on the bottom of the rudder." By this time, the aircraft had accelerated to about 80 knots. The report said, "Marks on the runway showed that the No.1 wheel started to break up at about this time. In addition, the left and right flanges of No.2 wheel began to trace on the runway; rubber deposit from No.2 tire continued which appeared to be from a deflated tire between the flanges."

At 28 seconds after brake release, a speed of 90 knots was called by the captain and acknowledged by the first officer. The captain called V_1 about 45 seconds after brake release. Two seconds later, the first officer noted "sort of a shimmy like if you're riding on one of those ah thingamajigs." The report said, "Marks on the runway showed that No.2

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wheel was not rotating and that the full width of the wheel assembly was being ground away and had progressed beyond a wheel tie bolt. No.1 wheel continued to trace.”

The captain called “rotate” 51 seconds after brake release. Nine seconds later he called “positive rate” and the gear was retracted as the aircraft climbed.

The report said that witnesses on the ground reported that the “takeoff seemed normal except that sparks and flames were seen in the area of the left main landing gear. [Witnesses said] the flames remained visible until the landing gear was retracted shortly after takeoff.”

The control tower at Jeddah is 197 feet (60 meters) high and is located about 3,609 feet (1,100 meters) northeast of the threshold of runway 34L. The report said observation of aircraft ground movements from the control tower “showed that at the holding point and during the take-off roll, the left landing gear was obscured by the fuselage until after liftoff. Even if the controller had an unobstructed line of sight to the landing gear, the viewing distance would prevent identification of a flat tire.”

Shortly after the aircraft was airborne, the flight engineer reported “four low-pressure lights,” followed 12 seconds later by “losing pressurization.” The report said that during the next three minutes “several indications of system anomalies occurred, which included a spoiler light, a gear unsafe light, a loss of hydraulics and a flap-slot light.”

Two minutes and 37 seconds after brake release, the captain called air traffic control (ATC) to request a level-off at 2,000 feet (610 meters) because of the pressurization problem. In his radio call, the captain used the callsign “Nationair 2120” instead of “Nigerian 2120” and the controller mistook the transmission to be from a Saudi flight returning to Jeddah, and cleared the Jeddah-bound aircraft to 3,000 feet (915 meters). The captain of the accident aircraft, however, acknowledged the ATC transmission, without a call sign, saying “understand you want us up to 3,000 feet.”

This misunderstanding continued for the next three minutes, with ATC assuming that all calls were from the Saudi flight, not from the accident aircraft.

The Saudi report said that about four minutes after brake release the captain called ATC and reported that the aircraft was leveling at 3,000 feet, adding “and ah, if you

could give us a heading back towards ah.” At this point the first officer interrupted with “... declaring an emergency. We’re declaring an emergency at this time. We believe we have ah, blown tires.”

The CVR indicates that as the aircraft continued on the downwind heading, a flight attendant came into the cockpit and reported “smoke in the back ... real bad.” A few moments later, the first officer said “I’ve got no ailerons.” The captain responded: “OK, hang on, I’ve got it.” It was the last record on the CVR, which failed (along with the flight data recorder [FDR]) at 0833:33.

Before the CVR and FDR failed, they showed that the captain was flying and operating the radio. He reported control difficulties several times.

According to the Saudi report, it was only at this point that ATC realized which aircraft had the emergency. The controller “gave a heading to intercept the final approach and thereafter continue[d] to give heading information.”

The report said: “At about 11 miles [18 kilometers] from the airport in final approach, which would be a reasonable position for extending the landing gear, the first of a number of casualties fell from the aircraft, which was at about 2,200 feet [671 meters].”

“The scenario that best explains these circumstances is that during the downwind and base legs, the fire had consumed the cabin floor above the wheel wells, permitting cabin furnishing to sag into the wheel wells. When the gear was probably extended at 11 miles on the final approach, the first body fell out because fire had burned through the seat harness. Subsequently, with the gear down and a forceful

air supply through the open gear doors, rapid destruction of more floor structure permitted the loss of more bodies and seat assemblies. Despite the considerable destruction to the airframe, the aircraft appeared to have been controllable until just before the crash.”

According to tower tapes, eight minutes after brake release and 10 miles (16 kilometers) from the runway, the captain declared an emergency for the third time, saying, “Nigeria 2120 declaring an emergency, we are on fire, we are on fire, we are returning to base immediately.”

The aircraft crashed 9,433 feet (2,875 meters) short of the runway at 0838. According to one witness, the aircraft “all of a sudden came down nose first in about a 70-degree [angle] and crashed and exploded.”

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According to the report, impact marks and wreckage distribution indicated that the major portion of the aircraft struck the ground in a nose-low, right-bank attitude, just after an in-flight break-up.

The report said that “very little of the fuselage was recognizable” at the crash site. Because of high ambient temperature (88 degrees Fahrenheit [31 degrees Celsius]), recovery of human remains began immediately, and their distribution was not plotted, the report said. Nine of the crew members were later identified. “No attempt was made to identify the passengers,” the report said.

“The bodies found outside the crash site [showed] charring and severe impact injuries,” the report said. “Also found near the first body was a yellow life vest that was charred all along one edge, consistent with being folded underneath the seat and being charred in situ. This indicates that

there was a severe fire in the cabin of the aircraft at least 11 miles from the runway.

“Bodies recovered from the wreckage showed burns consistent with the flash fire that took place post-impact; one-third of the bodies recovered showed signs of severe burns sustained prior to impact. The occupants of the cockpit suffered little or no burns either pre- or post-impact.”

The Saudi accident report devoted considerable time to an examination of flight deck decision-making, procedures and rejected takeoff and crew resource management issues.

During takeoff, the report said that the “cues available were insufficiently demanding to make the captain believe that a [rejected takeoff] was essential. Conditioning factors may have included the captain’s training regarding takeoff decision speed and lack of adequate knowledge of the tire conditions or the consequences of operating an underinflated tire.”

The report said that the captain’s training and other flight crew members’ training on the DC-8 “did not include rejecting for tire or wheel failures, nor was there any such requirement.” The report said Nationair flight crews were trained to reject takeoffs for scenarios that included engine fire, engine failure and complete electrical failure prior to V_1 . “Given this training, the captain’s continuance of the takeoff was entirely consistent with his training.

“It is probable that had clearer indications been available to the captain, the takeoff would have been rejected and the accident would not have occurred. Indicators and protection systems available on other aircraft include wheel well heat indicators, wheel well fire warning, wheel well fire extinguishers, brake temperature indications and tire pressure indications.”

The Saudi report recommended that all transport aircraft “be equipped with wheel well overheat and fire detectors, wheel well fire protection, brake temperature sensors, tire pressure sensors and corresponding indicators in the cockpit.”

The decision to retract the landing gear after takeoff was also fully in accordance with company procedures and followed the checklist, the report said.

Cockpit coordination also appeared to be lacking, the report said. “The captain and the first officer had vastly different backgrounds and experience to call upon. The captain’s military background, with its inherent command structure, was different to

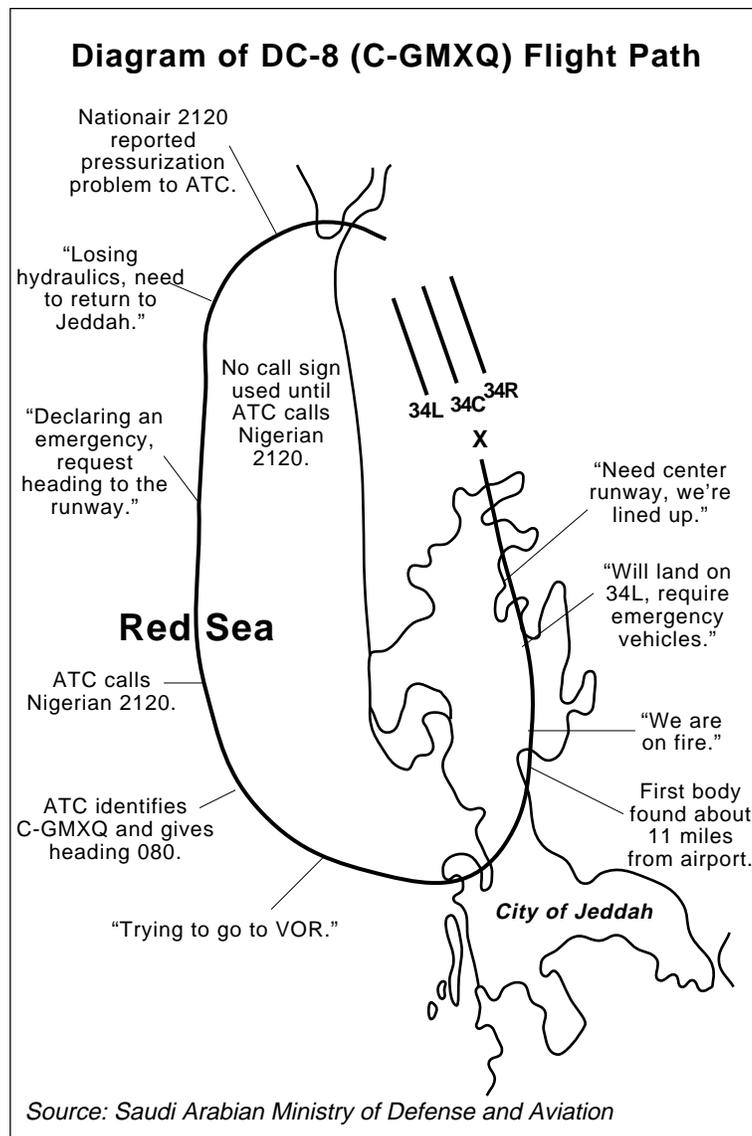


Figure 1

that of the first officer, who had progressed through smaller aircraft where command and control had been his responsibility and he was reportedly uncomfortable with the captain's 'commanding' cockpit management style."

In addition, the report said that the CVR recording revealed that, "there was little evidence of crew resource management or the use of emergency checklists."

Other Saudi recommendations included "training of flight crews on tire performance and vulnerability to ensure safe operation and the formal inclusion of crew resource management in initial and recurrent training."

The Saudi report also recommended better monitoring of maintenance operations and training maintenance personnel in adequate tire servicing and tire vulnerability.

NTSB officials, in a May 27, 1993, letter to Saudi Aviation Standards and Safety authorities, said the NTSB believed that the "issues of flight crew decision-making and airmanship should [have been] given greater attention" in the accident analysis.

The NTSB said the Saudi report should have clearly indicated that the flight crew was aware of a problem on the takeoff roll while at a speed and with sufficient runway remaining to reject the takeoff successfully.

"The [Saudi] report does not make this point because it rationalizes that the captain would not have been expected to reject the takeoff based on his knowledge of an abnormality unless the cues were sufficient to permit him to define the nature of the problem. Our staff believes that this analysis sends the wrong message to crews. Rather, the report should examine flight crew training and the knowledge imparted to crews about the consequences of damaged or underinflated tires on continued safe flight."

The NTSB letter added: "Having expressed concern about a tire failure at low speed, the flight crew should have been concerned about the condition of the tires upon becoming airborne, before the tires were retracted into the wheel well. Even though the exact cause of the vibration was not known to the flight crew, it would have been prudent and advisable under such circumstances to leave

the landing gear extended for a relanding at Jeddah, or at least to allow for a tower flyby to determine whether damage to the landing gear was externally visible. Our staff believes the report should make a strong case for more prudent action by flight crews when faced with the circumstances of this takeoff."

Based on its review, the NTSB recommended the following changes to the Saudi findings:

- The flight crew was aware of unusual symptoms within seconds of the start of the takeoff roll at an airspeed of about 60 knots, a speed at which a takeoff could have been safely rejected;
- The captain did not react to the available cues and continued the takeoff;
- The aircraft was not equipped with tire-under-pressure or overheat warning devices, which might have provided additional cues to aid the crew in the go/no-go decision;
- The crew retracted the landing gear, and burning rubber was brought into close proximity with hydraulic and electrical system components; and,
- While the action to retract the landing gear after takeoff was consistent with company procedures, it was not an optimum action considering the possibility of tire failure during takeoff.

The NTSB concluded that "had the crew left the landing gear extended, the accident might have been averted." ♦

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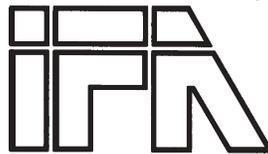
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