

# SKIDDING OFF A CLIFF

BY MARK LACAGNINA

Unnecessary engagement of the emergency brakes locked the BAe 146's wheels, reducing deceleration on a damp runway.



An “unacceptable combination” of airport, aircraft and operational factors led to the overrun of a British Aerospace BAe 146-200 at Stord Airport, said the Accident Investigation Board Norway (AIBN). The small, four-engine jet hydroplaned off a damp runway and plunged down a steep cliff, killing three passengers and a cabin crewmember, and seriously injuring three passengers, another cabin crewmember and both pilots. Six other passengers

escaped the Oct. 10, 2006, accident with minor or no injuries.

In a final report issued in April, the AIBN said that the aircraft's spoilers failed to deploy after touchdown, and the flight crew misinterpreted the consequent absence of expected deceleration as a fault in the wheel brake system. They responded, according to procedure, by applying the emergency brakes, which, without anti-skid capability, locked the four main wheels. There were no grooves in the runway



to decrease its surface slickness, and friction between the motionless tires and the pavement heated the thin layer of moisture into steam, melting the rubber in a process called *reverted rubber hydroplaning*. The aircraft skidded sideways off the end of the runway at 15 to 20 kt. The exit speed might have been slow enough to bring the aircraft to a halt *if* the paved safety area between the runway and the precipice had been just 50 m (164 ft) longer — in conformance with new Norwegian standards. The aircraft caught fire when it came to an abrupt stop at the bottom of the cliff. “The fire spread so fast that there was not enough time for everybody to evacuate the aircraft,” the report said.

The flight crew had followed their training in responding to the abnormal deceleration as an apparent malfunction of the normal wheel-braking system. “Neither the manufacturer nor the airline had prepared specific procedures stating how the crew should act in a situation where the lift spoilers did not deploy,” the report said. “The pilots had not trained for such a situation in a simulator.

“The AIBN considers that the excursion could have been prevented by relevant simulator training, procedures and a better system-understanding related to failures of the lift spoilers and the effect that it has on the aircraft’s stopping distance.”

Had the runway end safety area been 50 m longer, the overrun might not have occurred, investigators said.

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## Coastal Run

The BAe 146 was operated by Atlantic Airways, which conducted scheduled and on-demand service with five airplanes and two helicopters to Denmark, Iceland, Norway and the United Kingdom from its main base on the Faroe Islands.<sup>1</sup> The accident occurred during a scheduled round-trip flight from Stavanger with stops in Stord and Molde, all on the west coast of Norway.

The commander, 34, had 5,000 flight hours, including 1,500 hours in type. He had served as a Jetstream 31 pilot in Denmark for three years before being hired by Atlantic Airways in 2004 as a BAe 146 and Avro RJ first officer. He was promoted to commander in May 2006 and “had carried out 21 landings at Stord Airport as a commander, most recently on 17 September 2006,” the report said. “Prior to the accident, he had been off duty for two days.”

The first officer, 38, had 1,000 flight hours, including 250 hours in type and 231 hours in the preceding 90 days. He was hired by Atlantic Airways in April 2006 and held a Danish airline transport pilot license and a type rating for the Avro RJ/BAe 146.

Both pilots had deadheaded to Stavanger the night before; the captain arrived at 2330 local time, the first officer at 2145. They told investigators that they felt “sufficiently fit and rested” when they reported for duty at 0555. Operating as Flight 1670, the aircraft departed from Stavanger at 0715, with the commander as the pilot flying. “After departure, the aircraft rose to Flight Level 100 [approximately 10,000 ft] and set a direct course for the Stord VOR [VHF omnidirectional radio],” the report said.

At 0723, a Flesland Approach controller cleared the crew to begin a descent and advised that weather conditions at Stord included winds from 110 degrees at 6 kt, visibility greater than 10 km (6 mi), a few clouds at 2,500 ft and a temperature and dew point of 10 degrees C (50 degrees F).

## Dry Runway Assumed

The controller did not provide information on runway condition.<sup>2</sup> The airport had received 10 mm (0.4 in) of precipitation in the 24-hour

Left main landing gear tires show damage consistent with reverted rubber hydroplaning.



period ending at 0700, and AIBN investigators who arrived at the airport about 6 1/2 hours after the accident found dark patches of moisture remaining on the runway. Nevertheless, “since the crew were not otherwise informed, the runway was assumed to be dry, and this was the basis for their landing calculations,” the report said.

Stord Airport is uncontrolled and has a single runway that is 1,460 m (4,790 ft) long and 30 m (98 ft) wide, with an available landing distance of 1,200 m (3,937 ft). There were paved, 130-m (427-ft) safety areas at both ends of the runway, with steep cliffs beyond. Although the safety areas had met previous Norwegian requirements, the standard had been changed in July 2006 to require that safety areas for such a runway be at least 180 m (591 ft) long. “The short runway, in combination with an inadequate safety area and the steepness of the

Fire consumed most of the aircraft after it plunged down the rock- and tree-covered slope.



adjacent terrain, were decisive for the severity of the accident,” the report said.

The pilots initially had planned to conduct the VOR approach to Runway 15 but later decided to save time with a visual approach to Runway 33. The report said that this decision was “understandable” because the crew assumed that the runway was dry and considered that the 5-kt tailwind component was well within the aircraft’s 10-kt limit.

As the aircraft neared the airport, the Flesland Approach controller cleared the crew to change radio frequencies. They subsequently advised the Stord aerodrome flight information service (AFIS) duty officer of their intentions to conduct a visual approach to Runway 33. The aircraft was 2 nm (4 km) from the threshold when the AFIS duty officer advised “runway free” and reported the winds as from 120 degrees at 6 kt.

“Information on the aircraft cockpit voice recorder (CVR) shows that the pilots communicated strictly regarding official matters and with good cockpit resource management” while conducting a stabilized approach, the report said.

The target landing speed was 112 kt, and groundspeed was between 115 and 125 kt when the aircraft crossed the runway threshold. The commander moved the thrust levers to the flight idle position over the runway threshold and then to ground idle as the aircraft touched down at 0732. “Both pilots stated that the landing took place a few meters beyond the standard landing point and that it was a ‘soft’ landing,” the report said.

### ‘No Spoilers’

The spoilers — six panels on the upper surface of the wing that reduce lift by about 80 percent when extended — did not deploy when the commander moved the air brake/lift spoiler handle from the air brake position to the lift spoiler position immediately after touchdown.<sup>3</sup> Noticing that the annunciator lights indicating spoiler deployment had not illuminated, the first officer called “no spoilers,” per standard operating procedure, four seconds after touchdown. However, as mentioned earlier, the crew had not



been trained to recognize or to handle non-deployment of the lift spoilers.

“The wings continued to produce lift, so that the weight of the aircraft was not sufficiently transferred to the landing wheels,” the report said. “Hence, the main wheels did not get sufficient contact with the runway, and the braking effect was reduced.” (The BAe 146 does not have thrust-reverse capability.)

By itself, the failure of the spoilers to deploy likely would not have resulted in an overrun, the report said; the crew probably could have brought the aircraft to a stop on the runway if they had used maximum wheel braking. However, the report noted that the commander received “three disturbing warnings” within the space of five seconds: “first the lack of spoilers, then the apparent failure of the brakes, followed by the end of the runway coming toward [him] at high speed. ... The commander did not have time to consider his actions, but acted almost instinctively.”

He later told investigators that the less-than-expected braking action became apparent when the aircraft was halfway down the runway, and he felt that it was too late to conduct a go-around at that point. “The commander applied full force on both brake pedals, without achieving normal braking action,” the report said. “In an attempt to improve retardation, he moved the brake selector lever from the ‘Green’ [hydraulic system] position to the ‘Yellow’ position, but this did not help. He then moved the lever to the ‘Emergency Brake’ position, whereby the aircraft’s anti-skid system was disconnected.”

The CVR recorded “the first screeching noises from the tires” about 13 seconds after touchdown, the report said. “The aircraft skidded with locked wheels along the last 520 m [1,706 ft] of the runway length.”

### Off the End

Because of a steep drop-off to an inlet of the North Sea on the left side of the runway and rocky terrain off the right side, the commander continued steering the aircraft toward the end of the runway. “In a last attempt to stop the aircraft, he steered it toward the right half of the

## British Aerospace BAe 146-200



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Hawker Siddeley Aviation began work in 1973 on a short-range, four-engine transport called the HS 146. The company was acquired four years later by British Aerospace, which brought two versions of the airplane into production in 1983: the BAe 146-100, which was designed for operation on short and unimproved airstrips; and the BAe 146-200, which was designed for operation only on paved runways and has a longer fuselage and a higher maximum takeoff weight.

Powered by Avco Lycoming ALF 502R-5 engines of 31 kN (6,970 lb) thrust, the BAe 146-200 accommodates up to 111 passengers in six-abreast seating. Maximum weights are 42,185 kg (93,000 lb) for takeoff and 36,741 kg (81,000 lb) for landing. Maximum operating speed is 295 kt. Maximum range is 2,734 km (1,476 nm). Stall speed in landing configuration is 92 kt.

British Aerospace also produced the BAe 146-300, which has a longer fuselage that can accommodate a galley and 103 passengers in five-abreast seating, or 128 passengers in six-abreast seating. The Avro RJ (regional jet) versions were launched in 1992 with slightly more powerful Honeywell LF 507 engines and digital avionics equipment. An upgraded RJX model was introduced in 2001 by BAE Systems, formed from the 1999 merger of British Aerospace with Marconi Electronic Systems.

A total of 221 BAe 146s, 170 RJs and three RJXs were built before production was terminated in 2002.

Source: *Jane's All the World's Aircraft*

runway and then maneuvered it with the intent to skid sideways to the left,” the report said. “The commander hoped that skidding [sideways] would increase friction and help to reduce the speed of the aircraft.”

**The engine continued running at high speed, and its exhaust flow fanned a post-impact, fuel-fed fire that rapidly intensified.**

The AFIS duty officer and airport fire and rescue service personnel saw the aircraft pointed 45 degrees left of centerline and banked steeply right when it traveled off the end of the runway about 23 seconds after touchdown. “In accordance with procedure, the fire and rescue service at Stord Airport are on standby beside the fire engines when aircraft take off or land at the airport,” the report said, noting that they began spraying water and foam on the wreckage from the end of the runway in less than a minute.

The aircraft had struck approach lights and partially dragged them by their wiring as it plunged nose-first about 100 m (328 ft) down a 30-degree slope inside a bowl-like depression in the cliff leading to the sea. “The slope consisted of uneven rock, partially covered in low vegetation, bushes and small trees,” the report said.

“On the way down the slope, the wheel doors and later the outer starboard engine (engine no. 4) were ripped off,” the report said. “The starboard wing sustained several cuts as it pulled down trees and the approach lighting. It is probable that the aircraft maintained its speed down the slope and that it was still traveling at a relatively high speed when its nose encountered rising ground.”

When the aircraft came to a stop, the commander shut off the fuel supply to the engines and activated the engine fire extinguishers. Because of a broken mechanical connection from the fuel shut-off lever to the no. 2 (left inboard) engine, however, the engine continued running at high speed, and its exhaust flow fanned a post-impact, fuel-fed fire that rapidly intensified.

The pilots were unable to open the cockpit door and exited through the left window. The right forward cabin door was blocked, and the commander was unable to open the left forward door from outside the aircraft. “There are grounds for supposing that problems with opening the [forward] cabin doors, in combination with the early outbreak of fire at the forward end of the cabin, explains why all those who died were sitting in the forward half of the cabin,” the report said. The surviving passengers and cabin

crewmembers exited through the left rear door, which required substantial force to open.

### Call for Training

Because of the extensive impact and fire damage to the aircraft, investigators were not able to determine conclusively why the spoilers failed to deploy, but the report discussed two possibilities — a mechanical fault in the air brake/lift spoiler lever mechanism and faults in the microswitches in the thrust lever mechanism, which signal that the levers are in the ground idle position, a prerequisite for spoiler deployment. “It cannot be ruled out that there are also other explanations,” the report said.

The investigation prompted the AIBN to recommend that the European Aviation Safety Agency in conjunction with BAE Systems “make operators of the BAe 146 aware of the problem associated with inoperative lift spoilers [through] both theoretical and practical training.”

The board also recommended that the Norwegian Civil Aviation Authority, upon identifying regulatory “nonconformities,” require airports to effect “compensatory measures” — for example, installation of an engineered material arresting system where there is insufficient space to install a standard runway end safety area.

The report noted that Stord Airport made a number of safety-related changes following the accident, including extending the runway end safety areas to 190 m (623 ft) and incorporating grooves while repaving the runway. ➤

*This article is based on the English translation of AIBN Report SL 2012/04, “Report on Aircraft Accident on 10 October 2006 at Stord Airport, Sørstokken (ENSO) Norway, Involving a BAE 146-200, OY-CRG, Operated by Atlantic Airways.” The report is available at <[www.aibn.no/aviation/reports](http://www.aibn.no/aviation/reports)>.*

### Notes

1. The Faroe Islands are a self-governing dependency of Denmark.
2. Norwegian civil aviation regulations require controllers to advise pilots when runways are wet or contaminated by ice, slush or standing water.
3. The airbrakes consist of two hinged panels at the rear of the fuselage that create substantial drag when deployed.