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Jammed Elevator Prompts Twin-turboprop Rejected Takeoff, Runway Over-run

The investigating authority said that deficiencies in the Hawker Siddeley 748 flight control gust-lock system might have caused the elevator gust lock to re-engage when the flight crew checked the flight controls at the beginning of the takeoff.

FSF Editorial Staff

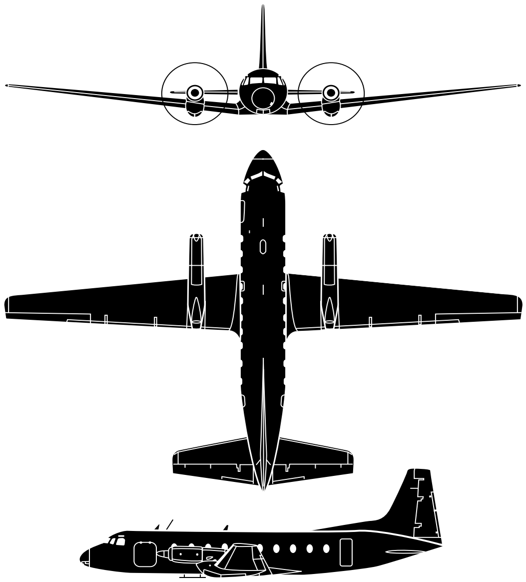
On Aug. 16, 1996, the flight crew of an Emerald Airways Hawker Siddeley (HS) 748 Series 2A rejected a takeoff at Liverpool (England) Airport when takeoff rotation was prevented by a jammed elevator. The airplane was substantially damaged when it struck an instrument landing system (ILS) power-supply building off the end of the runway. The flight crew, alone aboard the airplane, was not injured.

The U.K. Air Accidents Investigation Branch (AAIB) said, in its final report, that the causes of the accident were:

- "Flight control gust-lock system deficiencies, which probably caused the elevator lock to re-engage on completion of the crew's full-and-free check of the flight controls before the takeoff;
- "Lack of any indication of a jammed-elevator condition until the first officer attempted to pull the control column back at aircraft rotation speed, V_R;
- "Lack of sufficient remaining runway distance to stop the aircraft on the runway following the rejected takeoff at some eight knots above V_1 decision speed with the elevator jammed fully down;
- "Inadequacies in maintenance information and implementation that led to failure to correctly maintain a gust-lock system, the design of which is inherently sensitive to deficiencies; [and,]
- "Lack of fully effective modification action, following the fatal over-run accident to HS 748, G-BEKF, at Sumburgh [Shetland Islands, Scotland] Airport on 31 July 1979 (AIB [U.K. Accidents Investigation Branch[1]] Report 1/81), to address the inherent design sensitivity of the flight controls gust-lock system."

The Sumburgh accident occurred when the airplane, operated by Dan-Air Services, exited the end of the runway and entered the North Sea while taking off for a charter flight to Aberdeen, Scotland. Seventeen of the 47 occupants drowned, and two occupants were seriously injured.

In its final report, the AIB said, "The [Sumburgh] accident was caused by the locked condition of the elevators, which prevented the rotation of the aircraft into a flying attitude. It is likely that the elevator gust lock became re-engaged during the pilots' pretakeoff check, and that this condition was not apparent to either pilot until the takeoff was so far advanced that a successful abandonment within the over-run area could not reasonably have been made.



Hawker Siddeley 748

A.V. Roe and Co. (Avro) of Canada, a subsidiary of Hawker Siddeley of England, began designing in January 1959 the Avro 748, a pressurized, twin-turboprop, short-to-medium-range airliner. The prototype flew in June 1960, and production began in 1961. The airplane was renamed the Hawker Siddeley (HS) 748 following a company reorganization in 1963.

Hawker Siddeley, British Aircraft Corp. and Scottish Aviation merged to form British Aerospace in 1977. HS 748 production ceased in 1984.

The HS 748 has dimensions similar to those of the Douglas DC-3. The airplane has a two-pilot flight deck and cabin accommodations for a flight attendant and up to 62 passengers.

The initial production version had Rolls-Royce Dart 6 Mk. 514 engines, each rated at 1,880 equivalent shaft horsepower (eshp; 1,403 kilowatts [kW]), and four-blade Dowty Rotol propellers. The HS 748 Series 2 entered production in 1962 with Rolls-Royce Dart 7 Mk. 531 engines, each rated at 2,105 eshp (1,570 kW).

The HS 748 Series 2 has a maximum takeoff weight of 44,500 pounds (lb; 20,185 kilograms [kg]). Maximum landing weight is 41,500 lb (18,824 kg). At an airplane operating weight of 38,000 lb (17,237 kg), rate of climb at sea level is 1,380 feet per minute (421 meters per minute), maximum cruising speed is 238 knots (441 kilometers per hour [kph]), service ceiling is 25,000 feet, single-engine service ceiling is 13,000 feet and power-off stall speed in landing configuration is 69 knots (128 kph).

Sources: *Jane's All the World's Aircraft* and U.K. Air Accidents Investigation Branch

"The re-engagement of the gust lock was made possible by the condition of the gust-lock-lever gate plate and gate-stop strip." The report said that nonstandard repairs had been conducted on the components, and component dimensions were not within the manufacturer's tolerances. The result was that the gust-lock lever appeared to be in the "off" position but was not in the "off" position.[2]

Among AAIB recommendations resulting from the Sumburgh accident investigation was Safety Recommendation 4.1:

"Serious consideration [should] be given to the re-design of the gust-lock system so as to ensure that positive operation of the gust locks is achieved at all times and that the possibility of the crew being misled as to the position of any lock is eliminated."

Figure 1 (page 3) shows the gust-lock system in the locked configuration. The cockpit gust-lock lever is in the "on" position; the lock rollers are in the locking slots in the lock plates attached to the primary flight controls (rudder, ailerons and elevator).

The system is designed so that when the gust-lock lever is moved to the "off" position, the lock rollers move from the locking slots and into the wider portion of the open areas within the lock plates, allowing unrestricted movement of the flight controls.

The AAIB report on the Liverpool accident said that, as a result of the Sumburgh accident, British Aerospace (BAe) and the U.K. Civil Aviation Authority (CAA) took the following actions regarding the HS 748 flight control gust-lock system:

- In March 1980, BAe issued a service bulletin (SB 27/76) recommending checks of gust-lock-lever gate-plate dimensions, console interlocks and gust-lock-system operation. CAA required operators to comply with the SB;

- In August 1982, BAe issued SB 27/82, recommending installation of a gust-lock warning indicator (a red light that flashes when the gust-lock lever is between the "on" and "off" positions). CAA did not require operators to comply with the SB; and,

- In October 1982, BAe issued SB 27/88, recommending installation of modified gust-lock lock plates. CAA required operators to comply with the SB.

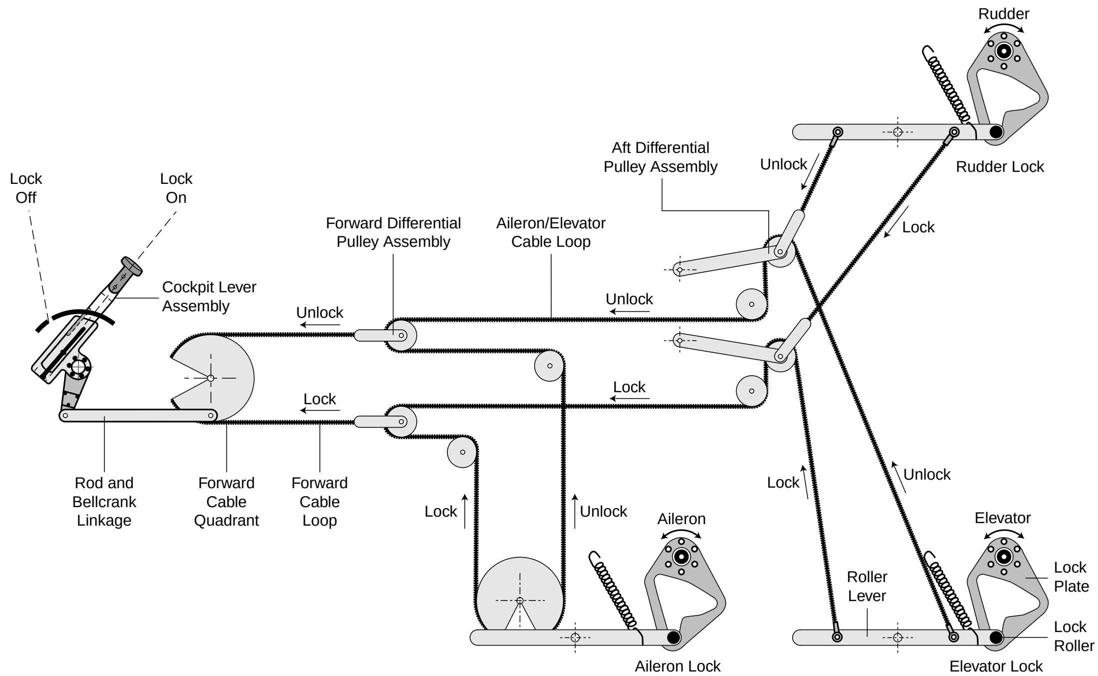
The accident airplane, G-AMTI, was built in 1966 and was operated in Antigua before being placed in service in the United Kingdom in the early 1970s. The airplane was acquired by Dan-Air Services in 1975; the airplane was acquired by Emerald Airways in 1992.

Maintenance complying with SB 27/76 and SB 27/88 was conducted on the airplane; the warning indicator recommended by SB 27/82 was not installed.

The report said that the airplane was involved in an incident on Aug. 6, 1981, that might have been caused by a gust-lock-system anomaly. The airplane was on initial climb from Berne, Scotland, when the ailerons locked in the neutral (nondeployed) position. The ailerons unlocked when a flight crewmember pushed hard on the gust-lock lever.

At the time of the Liverpool accident, the airplane had 52,033 airframe hours.

Hawker Siddeley 748 Flight Control Gust-lock System



Source: U.K. Air Accidents Investigation Branch

Figure 1

The airplane was equipped with a cockpit voice recorder (CVR) and a flight data recorder (FDR). The CVR functioned properly during the flight crew's preflight checks and the rejected takeoff; a transcript of the recording, however, was not included in the report. The FDR did not function properly.

"The five-parameter FDR had failed prior to these events and so was of no use to the investigation," the report said. A tape-transport fault had jammed the FDR.

The airplane was scheduled to depart from Liverpool at midnight to deliver 6,132 kilograms (kg; 13,519 pounds [lb]) of newspapers to Belfast, Ireland. The actual takeoff weight was 19,933 kg (43,944 lb); the maximum certified takeoff weight for the current meteorological conditions was 19,995 kg (44,081 lb). The center of gravity (CG) was within limits. "The [CG] position was mid-to-forward," said the report.

The flight crew had operated frequently from Liverpool. The captain, 31, had an airline transport pilot (ATP) certificate and 2,504 flight hours, including 1,461 flight hours in type. The first officer, 35, had an ATP certificate and 3,040 flight hours, including 125 flight hours in type.

A large high-pressure area over the Irish Sea was producing warm, dry, stable conditions throughout the United Kingdom. The surface wind at Liverpool was from 360 degrees at three knots. Visibility was greater than 10 kilometers (six statute miles), and there were no clouds below 5,000 feet (ft). The surface temperature was 16 degrees Celsius (61 degrees Fahrenheit).

The crew requested taxi clearance at 2353 local time. Liverpool Tower told the crew to taxi to the holding point for Runway 27. The lighted, asphalt runway was 2,288 meters (m; 7,500 ft) long and 46 m (150 ft) wide.

"From the threshold, at 77 ft above mean sea level, Runway 27 rose imperceptibly to 81 ft in the first 500 m (1,640 ft)," said the report. "It then sloped down at [a] 0.39 percent [gradient] for the remaining 1,786 m (5,860 ft) to the end of the runway, which was at 58 ft, giving an overall downslope of 0.25 percent. The over-run area relevant to the accident continued the slight downslope."

The airplane was approaching the holding position for Runway 27 at 2357 when Liverpool Tower cleared the crew for takeoff. The crew completed the before-takeoff checklist while taxiing the airplane onto the runway.

"This included selection of 7.5 degrees of flap and water methanol 'on,' a system incorporated on this type of aircraft to augment the engine performance during the takeoff," said the report.

"The flight controls gust-lock lever was selected 'off' as they entered the runway, and the first officer (FO), who was to be the handling pilot for the takeoff, checked for full-and-free movement of both the aileron and elevator controls while the commander [captain] checked for full-and-free movement of the rudder pedals; this was in accordance with the company standard operating procedures (SOPs)."

The FO told investigators that he checked movement of the ailerons while holding the control column full forward, and then moved the control column aft and forward again with the yoke centered.

The crew began the takeoff from near the threshold of Runway 27. “The FO, who had charge of the control column, applied full power, with the commander following through on the throttles and in control of the steering tiller,” said the report. “During the ground roll, the control column was held in the full-forward position.

“The SOP required that at the [commander’s] call of ‘80 knots,’ the FO removes his left hand from the throttle[s] and places it on the control column; the commander now has charge of the throttles in order to be ready for a rejected takeoff up to the decision speed, V_1. This call was made at 80 knots, and all available evidence suggested that the SOP was complied with.”

The crew had calculated both V_1 and V_R to be 112 knots. The commander called “V_1, rotate” when the airspeed reached 112 knots.

The FO, 3.6 seconds later, said, “Jeez, this is heavy.” The FO told investigators that he pulled the control column back approximately one inch (in.) to two in. (2.5 centimeters [cm] to five cm) but then was unable to pull the control column any farther.

“The commander, who was monitoring the position of the control column, glanced across and saw that the FO was pulling hard with no resultant movement of the control column,” said the report. “He realized that there was a problem and immediately aborted takeoff procedure by closing the throttles, commencing braking and calling for the flight-fine pitch stops (FFPS) to be removed.”

The FFPS prevent propeller-blade angle from reducing below 18.5 degrees (flight-fine pitch). When the FFPS are removed (by repositioning a small lever between the throttles), propeller-blade angle can be reduced to zero (ground-fine pitch). The resulting drag created by the propeller blades in ground-fine pitch assists airplane deceleration during a rejected takeoff.[1]

The CVR recorded the sound of decreasing engine power 4.7 seconds after the commander called “rotate.” The commander said that he initiated the rejected takeoff at an indicated airspeed of approximately 120 knots.

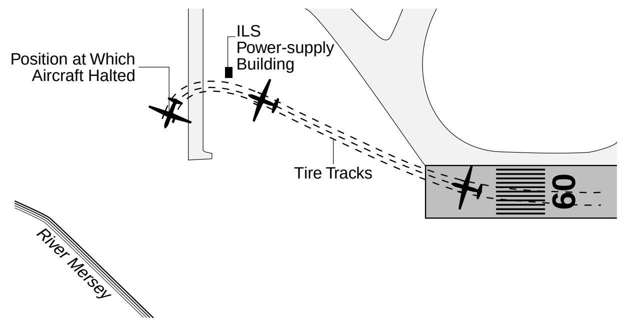
“The high speed at which the takeoff was aborted made a significant over-run of the paved runway inevitable, particularly as the full-down position of the elevators reduced the weight on the main wheels and reduced the braking efficiency,” said the report.

The commander applied maximum force on the brake pedals and selected propeller ground-fine pitch, but he realized that he would not be able to stop the aircraft on the runway.

“As the aircraft approached the threshold for Runway 9, he decided to maneuver to the right in order to avoid the steep drop into the River Mersey,” said the report.

The airplane exited the runway at approximately 60 knots (Figure 2). When the ILS power-supply building became visible in the airplane’s lights, the commander maneuvered the airplane to the left to avoid striking the building.

Rejected-takeoff Ground Track Of Hawker Siddeley 748; Liverpool, England; Aug. 16, 1996



ILS = Instrument landing system

Source: U.K. Air Accidents Investigation Branch

Figure 2

“The right wing passed over the building but struck the support structure of a surveillance camera and relay unit mounted on its roof,” said the report. “The commander tightened the turn and deliberately entered a ‘ground loop’ to the left in order to stop the aircraft.”

The airplane was stopped approximately 250 m (820 ft) from the end of Runway 27 and 61 m (200 ft) right of the extended runway centerline.

“Aircraft damage consisted of substantial local deformation of the right wing structure, the outboard end of the right flap and the inboard end of the right aileron,” said the report. “The tire on the no. 3 wheel had rolled off the wheel rim and deflated.”

The crew shut down the engines, advised Liverpool Tower of their situation, selected the battery switches off and exited the airplane. Liverpool Tower activated the crash alarm at 2359, and aircraft rescue and fire fighting (ARFF) personnel responded immediately. There was no fire; nevertheless, ARFF personnel dispensed foam around the airplane and remained on site until AAIB investigators arrived.

Initial examination of the airplane showed that the flight control gust-lock lever was in the “off” position and that the control column moved without restriction to the normal limits of travel. The elevator did not jam during subsequent tests.

"Although no restriction of the elevator-control circuit was found on initial examination, and the reported jam could not subsequently be reproduced, there was little doubt that the accident had resulted from such a jam, and extensive investigation of the elevator-control system was undertaken," said the report.

Investigators found no indication of disconnection, severe binding or interference in the elevator-control system. Nevertheless, the examination revealed several discrepancies.

Some moving parts rubbed against fixed airplane components. The report said, "A number of areas were found in the region beneath the flight deck floor where the clearance between moveable parts of the elevator-control run and static components was extremely small, or zero, including areas where rubbing had occurred.

"The characteristics of the associated markings and the type of contacts that had produced them indicated that it was not possible that contact in these areas could have strongly restricted [control-]column rotation.

"Elevator-surface clearance from surrounding fixed structure was also tight, but signs of contact consistent with the accident events [were] not apparent."

Numerous foreign objects were found beneath the flight deck floor, beneath the cabin floor and in the tail section. The objects included drill bits, a steel file, a riveting clamp, hundreds of drilled-out rivets, and several nuts, bolts and washers.

The report said, "The most significant items found were a 1.7[-in.] by 0.9-in. [4.3-cm by 2.3-cm] rectangle of 0.13-in.-thick [0.3-cm-thick] steel lying on the floor beam … close beneath the elevator control cables, and a 0.9-in.-long, 0.175-in.-diameter [0.4-cm-diameter] bolt and a large rivet fragment, both lying on the lower boom of the floor beam … close beneath the elevator-control-cable twin pulley mounted from this beam.

"However, close inspection revealed no evidence that any foreign object had interfered with the elevator-control run."

Investigators found that the rigging of some portions of the flight control gust-lock system differed substantially from airplane-maintenance-manual (AMM) rigging requirements.

"The misrigging had resulted either because the AMM procedure had not been followed correctly at the time of the last recorded rigging in October 1994, or due to unrecorded adjustment since that date," said the report. The airplane was flown 1,485 hours after the rigging adjustment and check in October 1994.

The misrigging resulted in contact between the aft differential-pulley levers and in entanglement of the right-aft differential pulley with a fixed bracket when the gust-lock lever was moved.

"The misrigging and the two fouls of the aft differential-pulley assemblies were unlikely to have caused an elevator-lock re-engagement, but the possibility that they had contributed could not be dismissed," said the report.

The AMM provided a misworded statement regarding adjustment of the gust-lock system to preclude fouling of the aft differential pulleys. The AMM said that accurate adjustment is required "to preclude any possibility that the pulley assembly cannot foul the structure."

The report said, "Information from the manufacturer indicated that [this] was an inadvertent miswording and that the intention was to ensure that the assembly did not foul the structure."

Investigators found that a turnbuckle in the aileron/elevator gust-lock cable loop passed through a cutout in a floor beam when the gust-lock lever was moved to the "off" position. The report said, "This appeared abnormal, with the travel of all other turnbuckles in this and the other cable systems apparently arranged to take place between floor beams and not through them.

"Signs of contact between the turnbuckle and the edge of the cutout were present, but did not appear to be consistent with a jam having occurred.

"A prohibition on the turnbuckle passing through the floor beam was not identified in the AMM. The manufacturer reported that the feature was the result of system malrigging."

The report said that AMM procedures for maintaining the gust-lock system and checking gust-lock-system operation were inadequate. When investigators, assisted by manufacturer's representatives, attempted to rig the gust-lock system according to AMM procedures, they found the work difficult and time-consuming.

The report said, "The procedure was difficult to follow, in a number of areas was nonspecific and in parts was impossible to accomplish realistically, for example:

- "Bellcranks that were required to be set to a particular orientation, apparently by eye, were largely hidden from view;
- "Access to enable required measurements to be made was not available;
- "The required action if certain specified check measurements were not met was not given;
- "In most cases, no allowable tolerances on specified dimensions were given;" [and,]
- "No definition was given of the turnbuckle lengths that were specified."

Nevertheless, tests conducted after the system was re-rigged showed no substantial change in system operation. "Overall, there was little evidence to indicate that the misrigging had, on its own, directly caused the gust-lock system to malfunction sufficiently to cause re-engagement of the elevator lock," said the report.

Investigators found that substantial backlash (recoil) occurred when the gust-lock lever was moved, because of worn (elongated) bolt holes and loose bolts connecting two sections of the lever. The backlash reduced travel of the gust-lock rollers out of their locked positions in the lock plates when the lever was moved to the "off" position.

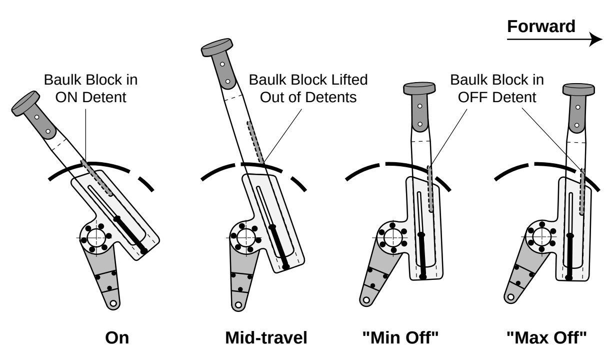
"The available evidence suggested that looseness of the lever joint had probably contributed to a re-engagement of the elevator gust lock," said the report.

Investigators also found that movement of the gust-lock lever within the "off" detent caused proportionally much greater movement of the gust-lock system. Figure 3 shows that to unlock the gust locks, the lever is lifted approximately 3.5 in. (8.9 cm) to bring the baulk block out of the "on" detent and then is moved forward until the baulk block drops into the "off" detent. The lever is spring-loaded to facilitate engagement of the detents.

The lever could be moved 0.12 in. (0.3 cm) within the "off" detent — between positions (labeled only for purposes of this accident report) "min off" (minimum off) and "max off" (maximum off). Lever travel from "min off" to "max off" represented 5 percent of total lever travel from "on" to "max off," but caused the aft differential pulleys to move a distance proportional to 24 percent of their total travel, the forward differential pulleys to move 12 percent (of their total travel) and the rudder gust-lock roller to move 21 percent (of its total travel).

"The substantial effect on the system of pushing the lever fully forwards was reportedly not known to the manufacturer, operator or maintainer at the time of the accident," said the report.

Hawker Siddeley 748
Flight Control Gust-lock Lever



Source: U.K. Air Accidents Investigation Branch

Figure 3

"It was considered that minimal combined travel of the gust-lock roller levers associated with an apparently adequate selection of the flight deck lever assembly to 'min off' may well have been a significant factor in allowing the elevator gust lock to re-engage."

Investigators found that the elevator gust-lock roller lever rubbed against the elevator lock plate. This was caused by distortion (bending) of the lever by an overtightened nut on a bolt passing through the roller-lever side plates, and by omission of one bushing from the roller-lever pivot bolt.

"While the reasons for [the bushing] omission could not be positively established, it was considered that an error in the [HS 748 Illustrated Parts Catalogue], where the illustration and listing incorrectly showed only one bush per assembly, may have been a major factor," said the report.

The report said, "The contact between the elevator gust-lock plate and the roller lever … imposed friction forces which tended to move the roller lever towards the lock position when the control column traveled forwards.

"It was concluded from the available evidence that this effect, with the gust-lock system significantly degraded by other deficiencies, probably caused the elevator lock to re-engage as the control column traveled fully forward on completion of the pitch channel full-and-free check."

The report said that the flight crew had no reliable indication of whether the gust locks were engaged or disengaged.

The report said, "The only available indication of the state of the gust locks for a given selection of the pilot's lever, without removing external bolted access panels, is that obtained from a full-and-free check of the primary flight controls.

"While this verifies that the lock rollers are not engaged in their respective lock slots, it provides no indication that all rollers are fully, or even substantially 'off.' The position of the pilot's lever provides an indication only of the selection, but no information on the state of the locks … unless the system is functioning exactly as intended. …

"The optional modification available to provide a gust-lock warning light [BAe SB 27/82] merely monitors the pilot's lever position."

The report said that the gust locks can be engaged only when the control column is fully forward. Nevertheless, the Emerald Airways operations manual requires that the handling pilot hold forward pressure on the control column to keep weight on the nosewheel during the takeoff roll.

"During the course of the investigation, evidence obtained suggested that pilot technique in handling the HS 748 control column during the takeoff ground run might vary," said the report.

"Those pilots who were particularly aware of the Sumburgh accident … tended to make it their practice to ease back on the column from the full-forward position periodically during the takeoff run to feel that it had remained free."

The first officer of the Liverpool accident airplane, after checking for full-and-free movement of the flight controls, held the control column fully forward until the commander called for rotation. He then was unable to pull the column back for rotation.

"A jammed condition may have been apparent to the crew earlier had the control column been allowed to 'float back' from its fully forward position during the takeoff ground run," said the report. "However, while such a procedure was apparently followed by some crews, it was not a requirement."

One month after the Liverpool accident, the manufacturer issued a notice to operators (NTO 22) with the following operating instructions:

"At the start of the takeoff run, ensure that the control column is held slightly forward of neutral with the ailerons in the appropriate position for the prevailing wind conditions. The control column should then be allowed to move back toward the neutral position at 50–60 knots IAS [indicated airspeed]. If the elevator movement is not normal, abandon the takeoff."

The CAA Accident and Incident Database for the 10 years preceding the Liverpool accident contained eight HS 748 accidents or incidents that might have been caused by gust-lock anomalies. They included the Sumburgh accident, the aileron-locking incident in the accident airplane and the following:

- On May 18, 1977, the control column jammed fully forward when the crew attempted to rotate at V_R during takeoff from Leeds, England. The crew rejected the takeoff and stopped the airplane 30 m (98 ft) from the end of the runway;

- On June 21, 1980, an HS 748 exited the runway during a rejected takeoff at Chiang Rai, Thailand. [The Sumburgh accident report said that three occupants were seriously injured, and that the airplane was substantially damaged[2]];

- On Sept. 24, 1980, the crew heard an intermittent clunk while checking for full-and-free rudder movement while taxiing at an undisclosed location. No cause was found, but a "similar event [was] found to be due to [a] foul by [the] gust-lock rudder lever";

- On Sept. 10, 1982, the crew was unable to move the gust-lock lever to the "off" position during a pretakeoff check at Glasgow, Scotland. The problem was believed to have been caused by gust-lock-system misrigging and by a crosswind;

- On Sept. 24, 1987, an HS 748 ran off the runway during a rejected takeoff at Jakarta, Indonesia. The elevator might have been mistrimmed, but there was no conclusive evidence of this; and,

- On Oct. 30, 1989, an HS 748 experienced a "violent pitch maneuver [and the] elevator jammed in the full-down position" during approach to an undisclosed location in Canada. The incident was attributed to possible misrigging of the gust-lock system.

"Other incidents in addition to the above could have occurred, particularly to overseas operators, but [might not have] come to the CAA's attention," said the report. At the time of the accident, 14 HS 748s were in service in the United Kingdom, and approximately 246 HS 748s were in service in other countries.

Based on these findings, the AAIB made the following recommendations:

- "The CAA should require an early check of U.K.-registered HS 748 aircraft for adequate flight control system clearances;

- "The CAA should require an early check of aircraft with an operating and maintenance background similar to G-AMTI's for foreign objects that could possibly interfere with flight control systems;

- "The CAA should require an early check of the complete gust-lock system on U.K.-registered HS 748 aircraft … ;

- "The CAA should require measures to prevent contact between the aft differential levers of the HS 748 flight control gust-lock system;

- "British Aerospace [BAe] Regional Aircraft should expedite the generation of flight control gust-lock system adjustment, test and check procedures, and revision of the HS 748 [AMM] to ensure that:

  – "The warning against the aft differential pulley fouling the structure is clear;

  – "The adjustment procedure is clear, specific and practical;

  – "The adjustment procedure achieves optimal unlocking performance; [and,]

  – "Test procedures verify that optimal unlocking performance is achieved;

- "The CAA should require [BAe] Regional Aircraft to introduce measures to preclude the possibility of any HS 748 gust-lock-system cable turnbuckles jamming against floor-beam aperture edges;

- “[BAe] Regional Aircraft should revise the HS 748 Illustrated Parts Catalogue to correctly show all detail parts of the elevator gust-lock assembly;
- “The CAA should require modification of the HS 748 gust-lock system to provide substantial overtravel of the mechanism with respect to the flight deck selector-lever assembly;
- “The CAA should require for U.K.-registered HS 748 aircraft the development and fitment of a system to continuously monitor the position of each of the three gust-lock rollers and to provide an associated flight deck indication of a potentially unsafe condition;
- “[BAe] Regional Aircraft should expedite the development and introduction of a repetitive check procedure for the HS 748 gust-lock system that adequately verifies system integrity;
- “The CAA should prohibit the use of flight-data-recording systems that use a nondigital method of recording data;
- “The CAA should take additional measures aimed at ensuring that adequate standards of maintenance are achieved on U.K.-registered aircraft, and undertake more extensive monitoring of actual aircraft-maintenance standards achieved, with effective enforcement action where these are found to be inadequate;
- “The CAA should inform foreign airworthiness authorities with responsibility for HS 748 aircraft operations of the findings arising from this investigation and the associated safety recommendations; [and,]
- “The CAA should reassess its response to Safety Recommendation 4.1 in AIB Aircraft Accident Report 1/81, *Report on the Accident to BAe HS 748 G-BEKF at Sumburgh Airport, Shetland Islands, on 31 July 1979*, in light of the subsequent occurrence of the accident to G-ATMI at Liverpool Airport on 16 August 1996, and other possible instances of inadvertent gust-lock engagement on HS 748 aircraft.”♦

Editorial note: This article, except where specifically noted, was based entirely on U.K. Air Accidents Investigation Branch Aircraft Accident Report 1/99: *Report on the Accident to HS 748 Series 2A, G-ATMI, at Liverpool Airport on 16 August 1996*. The 80-page report contains diagrams, photographs and appendixes.

Note and Reference

1. The U.K. Accidents Investigation Branch in 1987 was renamed the Air Accidents Investigation Branch.
2. U.K. Accidents Investigation Branch. *Report on the Accident to BAe HS 748 G-BEKF at Sumburgh Airport, Shetland Islands, on 31 July 1979*. Aircraft Accident Report 1/81. May 1981.

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