

Interim Report

Identification

Type of Occurrence:	Serious incident
Date:	8 October 2019
Location:	Münster/Osnabrück Airport
Aircraft:	Airplane
Manufacturer / Model:	BAe Systems / Jetstream 32
Injuries to Persons:	No injuries
Damage:	Minor damage to aircraft
Other Damage:	One runway edge light and an information sign damaged, crop damage
State File Number:	BFU19-1422-EX
Date of Publication	December 2019

Factual Information

The aircraft aborted take-off at a speed of approximately 130 kt and veered off runway 25 with a maximum distance of about 23 m to the runway edge. After about 530 m the airplane was steered back onto the runway and taxied back to the apron.

History of the Flight

At the day of the occurrence, a scheduled flight from Münster/Osnabrück Airport to Stuttgart Airport was planned with the airplane for 1730 hrs¹. On Board were two pilots, one flight attendant, and one passenger. For the co-pilot this was his first training flight (supervision flight) after acquiring his type rating. The Pilot in Command (PIC) was Line Training Instructor and responsible for training the co-pilot during this flight. The co-pilot was Pilot Flying (PF) and the PIC Pilot Monitoring (PM).

At about 1600 hrs, the crew had arrived at Münster/Osnabrück Airport, which means earlier than the 1 hour 15 min prior to departure required for a training flight.

After the co-pilot had viewed and filled in the flight documentation, at about 1630 hrs the crew went to the airplane. The PIC conducted the outside check. Then the crew completed the rest of the pre-flight checklist together. In the cockpit they learned that they had been given a slot for 1801 hrs. According to the PIC's statement he was angry about the delayed departure time. He told Münster Ground that he was displeased about the delay. At 1730:48 hrs, Münster Ground offered the crew to send a "ready message" in order to maybe receive an earlier slot.

According to the statements of roll control and tower controller, from the radio communication it became clear that the crew was not familiar with the meaning of "ready message". The slot did not improve and at 1752:42 Münster Ground issued the engine start-up clearance.

After both engines had been started, at 1758:35 hrs roll control issued taxi clearance via taxiways D and A to the taxi-holding position of runway 25. According to the co-pilot's statement during taxiing he already felt "[...] a bit lost [...] behind the aircraft [...]". He attributed this to the fact that he had not flown this aircraft type for 3 months.

As the aircraft was approaching holding position runway 25, the co-pilot switched frequency from roll control to Münster Tower following the instruction of roll control. At 1801:24 hrs, after the initial contact with Münster Tower, the tower controller issued take-off clearance for runway 25.

At 1801:44 hrs, the pilots began to complete the line-up checklist. The co-pilot read the individual items out loud, completed or checked them. According to the CVR recording, the co-pilot overlooked the item Flight Controls (Fig. 1). The two pilots

¹All times local, unless otherwise stated.

should have checked full and free movement of the flight controls and confirmed it with “checked”.

LINE UP		
Strobe lights	ON	RP
Cabin signal	GIVEN	RP
Cabin lights	OFF	RP
Flight controls	CHECKED	BOTH
Stall protection	TESTED & ON	RP
Transponder	TA/RA	RP
Windshield heat	ON & BLACK	RP
Pitot heats	ON	RP
Flows	OFF	RP
Oil cooler flaps	NORMAL	RP
Runway heading	CHECKED	BOTH
CAP	NORMAL	RP
WHEN TAKE OFF CLEARANCE RECEIVED		
Landing lights	ON	RP
RPM	FLIGHT	RP
APR <i>if used</i>	TESTED	RP
TTL	TEST	RP

First flight of the day

Fig. 1: Line-up checklist of the operator

Source: Operator

According to the co-pilot’s statement, at the checklist item Stall Protection he did not find the switch positions for the left and right stall protection right away, which the PIC noticed, but viewed as not so important (according to the CVR recording: “[...] leave it, not so important [...]”). Hence, the left and right stall protection was not switched on prior to take-off.

At 1802:56 hrs, 1 min 32 s after take-off clearance issued by Münster Tower, the crew began the take-off.

During take-off the PIC initially controlled the airplane with the nose wheel steering via a lever on the left cockpit side. According to his statement, he noticed that stall protection and landing lights were not switched on. At 1803:02 hrs at 70 kt IAS, he transferred aircraft control to the co-pilot. At 1803:08 hrs, at the decision speed V1 of 108 kt the PIC said “V1, rotate”. The co-pilot attempted to rotate the aircraft and noticed that the flight controls were blocked. He said: “[...] I cannot pull [...] the steering wheel [...]”. According to the PIC’s statement, the airplane had rolled straight ahead for a few seconds after control had been transferred and then began to veer right. The PIC tried unsuccessfully to counteract with rudder pedal inputs and at

1803:15 hrs aborted take-off at about 130 kt IAS and finally steered the airplane solely with the nose wheel steering.

During the aborted take-off the aircraft veered north off the runway after about 1,080 m (Fig. 2). One runway edge light and an information sign (for the glider area) were damaged in the process. The aircraft crossed the northern taxiway (connection with the flying club) of runway 25. The maximum distance to the runway edge was 23 m. After about 530 m on unpaved ground the aircraft returned to the runway.

At the time of the aborted take-off another airplane (DR400) ready for take-off waited at the holding position of the northern taxiway. The Jetstream 32 passed the DR400 with about 119 kt IAS.

At 1803:33 hrs, the Tower controller asked about the reason for the rejected take-off. At 1804:15 hrs, the PIC said the gust lock was still locked. He gave the same reason when the roll controller asked (at 1807:48 hrs). In addition, he informed about the runway excursion ("We had still the gust lock on, so [...] we [...] drift to the grass, and [...] I aborted the take-off"). An employee of the Aviation Supervision Office later drove to the parking position and determined the damage of the aircraft. Subsequently, further investigations of the runway were initiated.

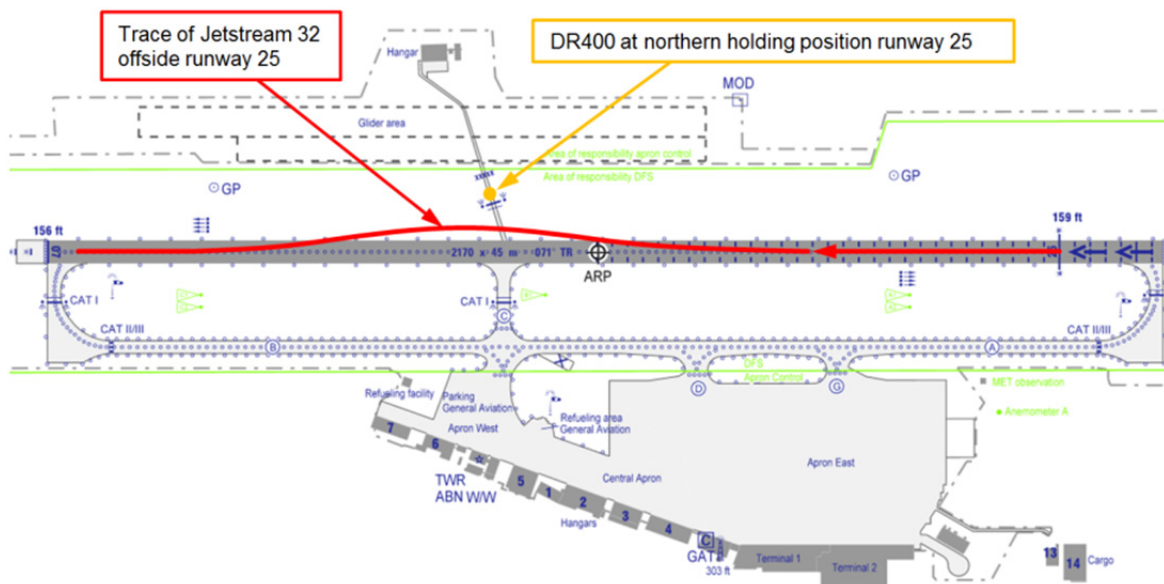


Fig. 2: Trace of the aborted take-off on runway 25

Source: AIP/BFU



Fig. 3: The end of the traces next to runway 25 (view direction 070°) Source: BFU

After the rejected take-off, the PIC taxied the aircraft back to the apron. During taxi he requested the taxi checklist which the co-pilot completed. At 1806:44 hrs after arriving at the parking position, the co-pilot began the shutdown and parking checklist, which he completed together with the PIC up until the item Transponder (Fig. 4). Then he began the after landing checklist which he did not start at the beginning, but with the item Flaps. After completing the after landing checklist he continued with the shutdown and parking checklist from the item Taxi Light until the end.

At 1808:36 hrs the engines were shut down.

AFTER LANDING		
RPM levers	TAXI	RP
Ice protection	OFF	RP
Transponder	AS REQ.	RP
Weather radar	STANDBY	RP
Flaps	UP	RP
Trims	NEUTRAL	RP
Gust lock	ENGAGED	RP
Fuel boost pumps	OFF	RP
Strobe lights	OFF	RP
Landing lights	OFF	RP
Taxi light	ON	RP
Air / Ground switches	GROUND	RP
Stall protection	OFF	RP
Oil cooler flaps	AS REQ.	RP
Temp. control switches	OFF	RP
SHUTDOWN & PARKING		
Parking brake	SET	LP
Oil contamination	CHECKED	LP
Flows	OFF	RP
Transponder	STANDBY	RP
Taxi light	OFF	RP
Avionics	OFF	RP
Generators	OFF	RP
Engines	STOP	RP
Cabin lights	AS REQ.	RP
DV windows	CHECK (PRESSURE)	RP
Beacon lights	OFF	LP
Seatbelts	OFF	LP

Fig. 4: Completion of the after landing and the shutdown and parking checklists

Source: Operator/BFU

Personnel Information

Pilot in Command

The 63-year-old PIC held an EU Airline Transport Pilot's Licence (ATPL(A)) last issued on 1 March 2018 by the civil aviation authority of the Netherlands (Inspectie Leefomgeving en Transport) in accordance with Part-FCL. The licence listed the rating for Jetstream 31/32 and the respective instrument rating; each valid until 31 March 2020. In addition, the following ratings were listed: IR(A), Night(A), SEP(land), MEP(land), and FI(A); all valid at the time of the serious incident. English language proficiency level 6, no expiry date, was also listed.

His class 1 medical certificate with the restrictions to wear glasses (VNL²) and OML³ was issued on 28 May 2019 and valid until 5 December 2019.

² VNL: Have available corrective spectacles and carry a spare set of spectacles

³ OML: Valid only as or with qualified co-pilot

He had a total flying experience of 8,680 hours; of which 767 hours were on Jetstream 32. In the last 90 days he had flown 81 hours on type.

For the operator he was working as Line Training Instructor.

Co-pilot

The 26-year-old co-pilot held an EU Commercial Pilot's Licence (CPL(A)) issued in accordance with Part-FCL by the French civil aviation authority (Direction Générale de l'Aviation Civile) on 14 February 2019. The licence listed the ratings for Jetstream 31/32 and the respective instrument rating; each valid until 30 June 2020. In addition, the following ratings were listed: MEP(land), IR/ME; all valid at the time of the serious incident. English language proficiency level 5 valid until 31 May 2024 and French language proficiency level 6, no expiry date, were also listed.

His class 1 medical certificate was issued on 13 February 2019 and valid until 13 February 2020.

He had a total flying experience of 157 hours; of which 47 minutes were on type. In the last 90 days, he had not flown on type. On 3 July 2019 he had last flown the Jetstream 32 during base training as final step of the type rating. On 30 August 2019 the co-pilot had passed the Operator Proficiency Check (OPC) on a Jetstream 32 simulator. The planned flight on the day of the occurrence was his first under supervision.

Aircraft Information

The BAe Systems Jetstream 32 is a low-wing aircraft equipped with two turboprop engines and a pressurized cabin for up to 21 persons (including the crew).

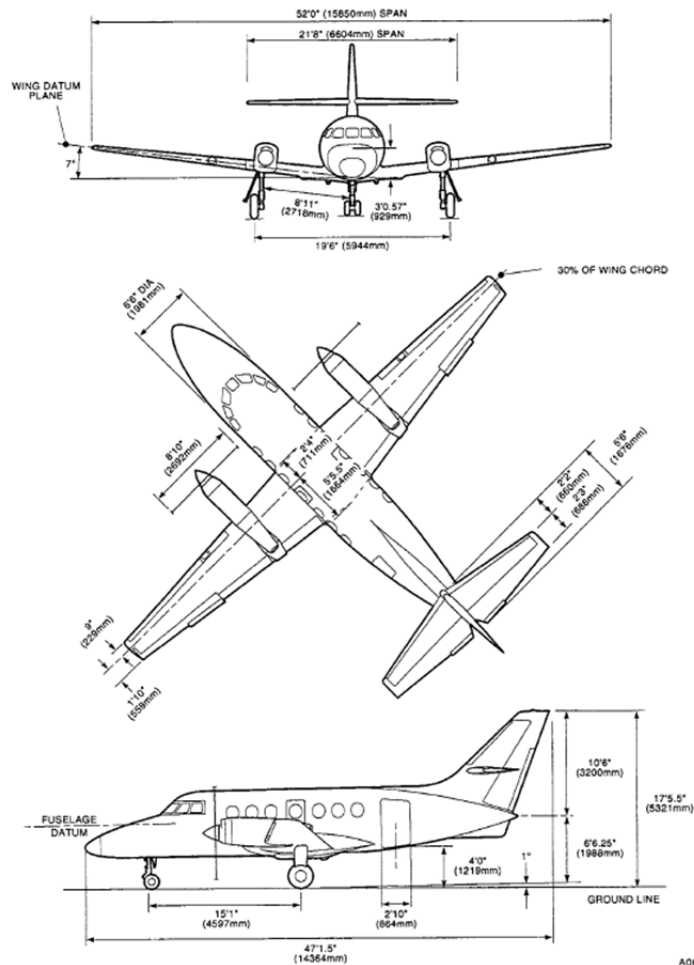


Fig. 5: Three-way view of a Jetstream 32

Source: BAe

Manufacturer	BAe Systems
Year of manufacture	1989
Manufacturer's Serial Number (MSN)	848
MTOM	7,350 kg / 16,204 lb
Maximum landing mass	7,080 kg / 15,609 lb
Operating Time	24,295 hours
Landings	32,241
Engine type	Garrett TPE-331-12 UAR

On 19 January 2016 the aircraft was registered in the Netherlands and operated by a Dutch air operator. On 15 September 2019 the maintenance organisation issued the last aircraft certificate of release to service.

Directional Control of the Airplane on the Ground

The nose wheel steering can only be operated via a lever at the left-hand cockpit side and is independent of the rudder pedals.

During take-off directional control is initially achieved with the nose wheel steering. Therefore, according to the procedure, during take-off the pilot in the left-hand seat is initially PF. At approximately 70 kt IAS the airplane can be controlled with the rudder and therefore via the rudder pedals. From this speed on the nose wheel steering is no longer used.

During landing or rejected take-off, rudder and nose wheel steering are used in reverse order.

Gust Lock System

If the aircraft is parked a gust lock system for the control surfaces is provided. The system shall prevent damages to the control surfaces due to movements caused by wind.

The control surfaces are blocked in their neutral positions via a gust lock lever. This lever is located on the right-hand side of the center pedestal (Fig. 6). If the lever is in the upper position (IN) (Fig. 6 and 7), spring-loaded safety pins block, via corresponding cables and levers, the aileron, rudder and elevator controls. In order to prevent take-off with blocked flight controls it is normally not possible to move both power levers simultaneously beyond the flight idle position. This is mechanically prevented through a special blocking mechanism of bars and levers. Individually the power levers can be moved to the MAX position.

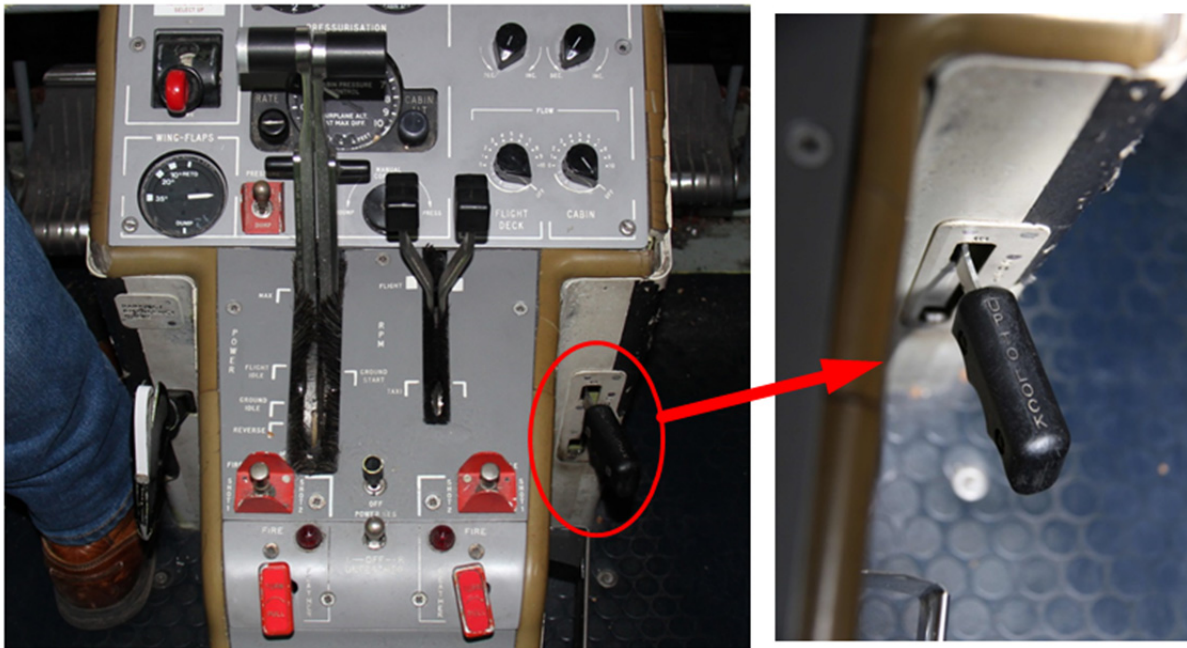


Fig. 6: Cockpit view of the Gust Lock lever

Source: BFU

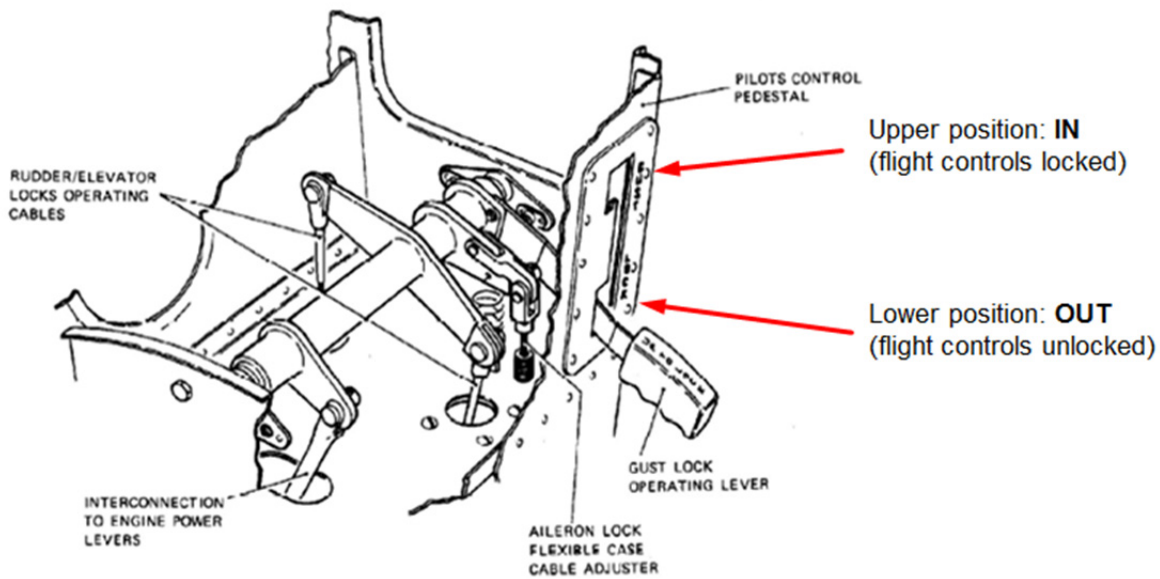


Fig. 7: Gust Lock lever mechanism

Source: BAe

In accordance with OM-B 2.2.2 of the operator, the blockage of both power levers with the Gust Lock in the IN position should be checked in the pre-flight checklist.

According to the PIC's statement towards the controllers, the Gust Lock lever of the aircraft had been in the locked position (IN) during take-off, so that flight controls

were blocked. However, it was possible to move both power levers beyond the flight idle position.

Meteorological Information

At the time of the occurrence it was daylight.

According to the aviation routine weather report (METAR) of 1750 hrs Münster/Osnabrück Airport reported the following weather conditions:

Wind:	210°, 6 kt (varies between 170° and 240°)
Visibility:	More than 10 km
Clouds:	3-4 octas with a lower limit of 2,100 ft AGL
Temperature:	15°C
Dewpoint:	12°C
QNH:	1,005 hPa

At the time of take-off the wind came from 230° with 10 kt.

Radio Communications

Radio communications between the crew and the air traffic control unit were held in English. The recordings were transcribed and made available to the BFU.

Aerodrome Information

Münster/Osnabrück Airport (EDDG) is located 20 km north of Münster and 30 km south-west of Osnabrück. Aerodrome elevation is 160 ft AMSL. It was equipped with one asphalt runway with the directions 070° (07) and 250° (25) and a glider area with the same direction located north of the asphalt runway. The asphalt runway was 2,170 m long and 45 m wide.

Flight Recorders

Information on Cockpit Voice Recorder (CVR) and Flight Data Recorder (FDR):

Manufacturer CVR	L3
Part Number	2100-1020-02
Serial Number	000134279
Manufacturer FDR	Fairchild
Part Number	S703-1000-01
Serial Number	02200

CVR and FDR were seized by the BFU. Both recorders could be read out.

FDR Graphs

The FDR recorded 5 parameters. The graph in Fig. 8 shows the parameters Vertical Acceleration in [g], Indicated Airspeed (IAS) in [kt], Heading in [°], Pressure Altitude in [ft] and VHF PTT (broadcasting or not) over the time period of the rejected take-off.

According to the CVR recording, at 1603:08 UTC “V1” was declared and since V1 is 108 kt the speed curve was calibrated accordingly.

The speed (IAS) curve shows the acceleration phase until the rejected take-off at 1603:15 UTC at about 130 kt and the subsequent deceleration.

The heading parameter shows that from 1603:09 UTC on, within approximately 5 s the aircraft veered right by about 11° off the runway heading. At 1603:15 UTC, at the time of the rejected take-off, the heading decreased within the next 11 s by 21°. At that time, the PIC counteracted with the nose wheel steering, according to his own statement. At 1603:26 UTC the heading decreases from 241° back to the runway heading.

Between 1603:13 UTC and 1603:27 UTC vertical acceleration increases significantly up to 1.3 g.

The original vertical acceleration values for the non-moving aircraft were 1.1 g. Therefore, they were calibrated by an offset of -0.1 g.

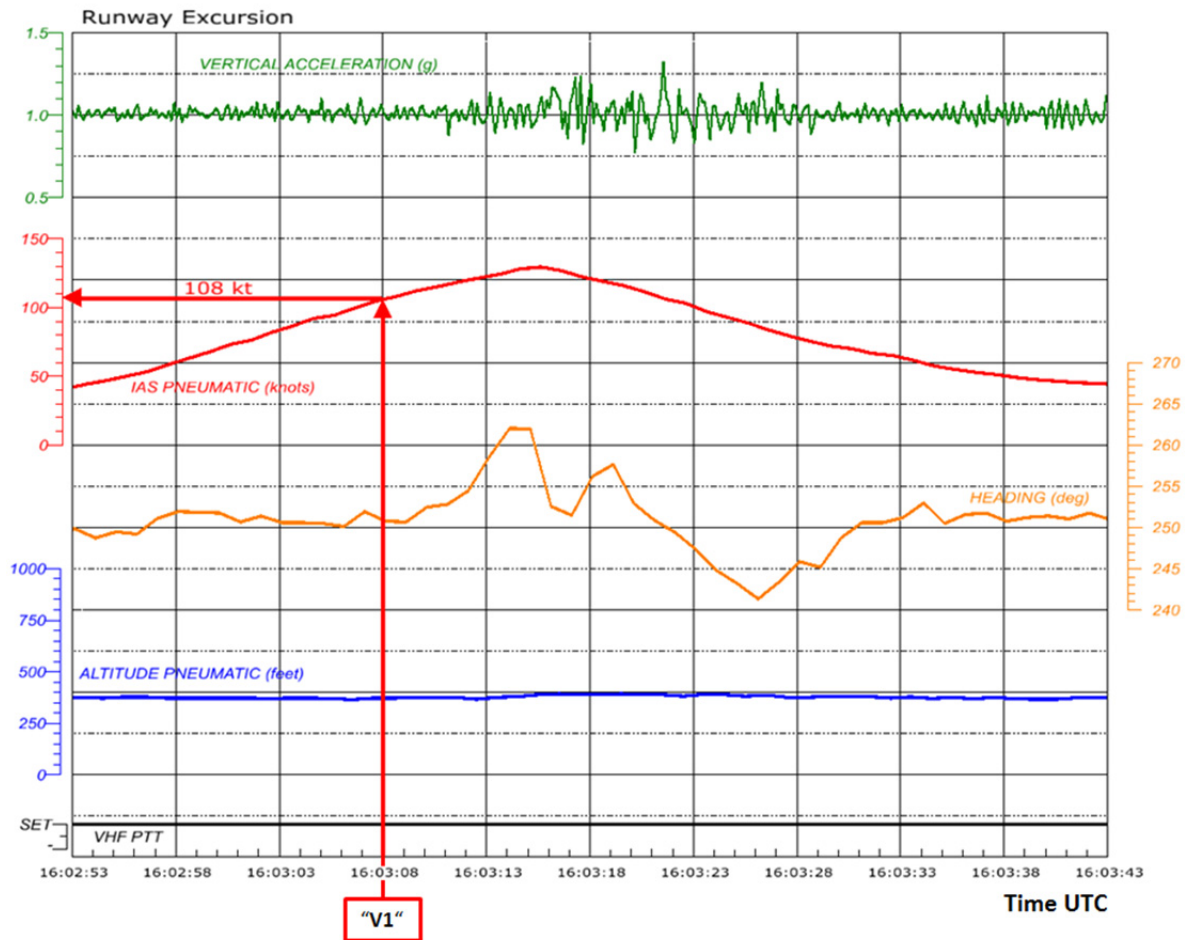


Fig. 8: FDR parameters during the rejected take-off

Source: BFU

Findings on the Aircraft

Damage

One propeller blade of the right engine (Fig. 9), the left main landing gear tire (Fig. 9), and a small area of the right lower side of the cargo compartment (Fig. 10) were damaged.

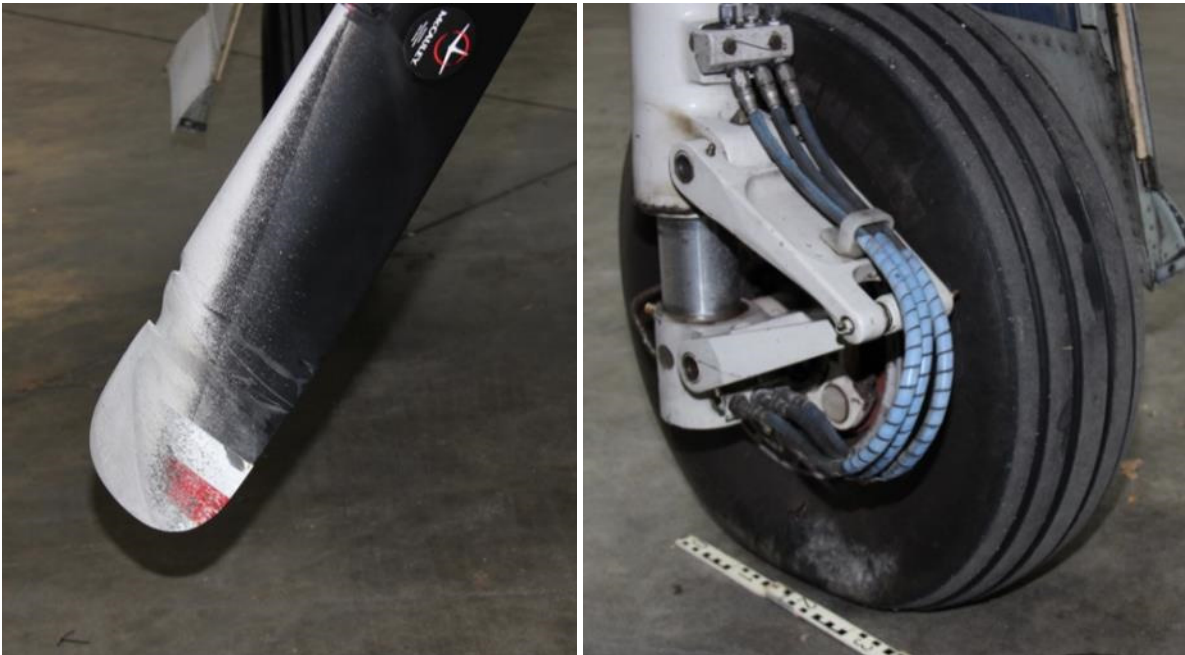


Fig. 9: Damage propeller blade and left main landing gear tire

Source: BFU



Fig. 10: Damaged area at the lower right side of the cargo compartment

Source: BFU

Fuel leakages were found in the area of the left and right main landing gear mounting to the wing structure.

Examination of the Gust Lock Mechanism

With the Gust Lock lever in the upper position (IN), i.e. blocked flight controls, as it was during the time of take-off, it was possible to move both power levers simultaneously beyond the flight idle position. This should have been blocked mechanically. At the lower area of the center pedestal the fork end of a control rod to block the power lever was located. This fork end was bent by about 45° in relation to the control rod (Fig. 11). Compared to that, Fig. 12 shows an undamaged connection of another aircraft of the same type. The bent connection made it possible to move both power levers simultaneously into the MAX position, even though the Gust Lock lever was in the upper position.

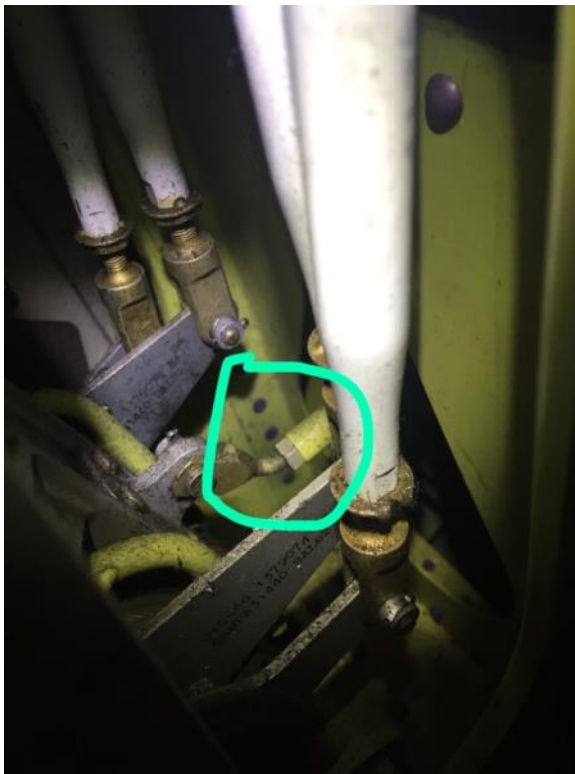


Fig. 11: Bent Connection

Source: Operator



Fig. 12 Connection intact

Source: Operator

On 19 March 2019 the function of the Gust Lock system was checked during a 1,200-hour-inspection. There were no findings.

Organisational and Management Information

Checklists

The following is a comparison of the checklists of the operator and the aircraft manufacturer.

The BAe Aircraft Flight Manual (AFM), the Manufacturers Operating Manual (MOM)–Part 1 and the OM-B of the operator stipulated for the pre-flight check the following item:

POWER levers ... Full and free

Among other things, with locked flight controls, it should be checked if both power levers could be moved only up to the flight idle position and not beyond.

In the extended taxi checklist of the aircraft manufacturer BAe AFM Chapter 6 Normal Procedure / Section 6: Before Take-Off / Taxi 6-6-2 item 16 listed the unlocking of the Gust Lock:

GUST LOCK lever ... Confirm in OUT position

The same item was also part of the abbreviated taxi checklist of the aircraft manufacturer MOM-Part 1 Chapter 18 / Normal Checklist: Taxi 18-2-3.

There was no dedicated checklist item in the operator checklists for unlocking the Gust Lock. Only the pre-flight part (OM-B 2.2.2) of the expanded normal checklist included this item as subitem of the autopilot/flight director test. This test has only to be conducted once prior to the first flight of the day. On the day of the occurrence, the airplane had already completed two flights.

According to the operator, it was common practice to keep the Gust Lock locked during taxi preventing the flight controls from moving.

J3200 NORMAL CHECKLIST

ITEMS ANNOTATED THUS ## REQUIRE THE TEST AT FIRST FLIGHT OF THE DAY ONLY.

J3200 NORMAL CHECKLIST

TAXI		
BRAKES		CHECK
NOSEWHEEL STEERING		CHECK
FLIGHT INSTRUMENTS		CHECK
FLIGHT DIRECTOR		STBY
DV WINDOWS		CLOSED/SECURE
SRL COMPUTERS		ON
TTL COMPUTERS		ON
PROP SYNCHRO		OFF
FUEL CROSSFEED		SHUT/NORMAL
FUEL CONTENTS		CHECK
SPEEDS		CONFIRM
TAKE-OFF TORQUE		DETERMINE
AIRFRAME ICE PROT		OFF
PROPELLER ICE PROT		AS REQUIRED
ENG/ELEV ICE PROT		AS REQUIRED
WINDSHIELD ICE PROT		CHECKED/ON
STALL VANE/ICE PROTECTION		ON
TRIMS		SET
FLAPS		CONFIRM SET FOR T/O
BRIEFING		CONFIRM/UNDERSTOOD
PAX BRIEFING		GIVEN
GUST LOCKS		RELEASE/FULLY DOWN
## STALL PROTECTION		TEST/ON
FLYING CONTROLS		FULL AND FREE
SEATS/HARNESSES		SECURE
## APR OVERRIDE &		
EGT COMPENSATION		TEST /OFF

Fig. 13: Taxi Checklist of the aircraft manufacturer

Source: BAe

TAXI		
Transponder	AS REQ.	RP
Taxi light	ON	RP
Brakes & Nose wheel steering	CHECKED	LP
Flight instruments	CHECKED	BOTH
LINE UP		
Strobe lights	ON	RP
Cabin signal	GIVEN	RP
Cabin lights	OFF	RP
Flight controls	CHECKED	BOTH
Stall protection	TESTED & ON	RP
Transponder	TA/RA	RP
Windshield heat	ON & BLACK	RP
Pitot heats	ON	RP
Flows	OFF	RP
Oil cooler flaps	NORMAL	RP
Runway heading	CHECKED	BOTH
CAP	NORMAL	RP
WHEN TAKE OFF CLEARANCE RECEIVED		
Landing lights	ON	RP
RPM	FLIGHT	RP
APR if used	TESTED	RP
TTL	TEST	RP

First flight of the day

Checklist item
GUST LOCKS ... Release/Fully Down
was missing

Fig. 14: Taxi and line-up checklists of the operator

Source: Operator

According to the extended taxi checklist item 17 (AFM) and the abbreviated version (MOM Part 1) of the aircraft manufacturer, the stall protection system has to be tested after unlocking the Gust Lock system

STALL PROTECTION system ... Tested, ON

if it is the first flight of the day. If not, the stall protection system has only to be switched on.

The operator's OM-B showed this item in the line-up part (OM-B 2.2.7) of the expanded normal checklist and in the abbreviated version the pilots were using (OM-B 2.2):

Stall Protection ... Tested & ON

The system was to be checked if it was the first flight of the day, if not just switched on. The steps prior do not contain any item about unlocking of the Gust Lock system.

According to the manufacturer, if the stall protection system were to be checked with locked Gust Lock system (IN position) the safety pin of the elevator control would be loaded by the activation of the stick shaker for which the pin was not designed and the impact on it not assessed yet. The stick pusher would not be activated. Therefore, the test would be incorrect.

According to the extended taxi checklist item 18 (AFM) and the abbreviated version (MOM Part 1) of the aircraft manufacturer, flight controls were to be tested for full and free movement:

Flying controls ... Full and free

The operator's OM-B showed this item in the line-up part (OM-B 2.2.7) of the expanded normal checklist and in the abbreviated version the pilots were using (OM-B 2.2):

Flight controls ... CHECKED

The expanded normal checklist of the operator contained a warning after this item that it was necessary to unlock the Gust Lock system and then check the full and free movement of the flight controls. This warning was not part of the abbreviated line-up checklist the pilots were using.

There were some differences when comparing the checklists of the operator with those of the aircraft manufacturer. The checklist item to unlock the Gust Lock system

was missing entirely and other items such as Stall Protection and Flight Controls were part of the line-up checklist instead of the taxi checklist.

OM-B 3.2.2 Rejected Take-off of the operator described the procedure for a rejected take-off.

Additional Information

Occurrences involving locked Gust Lock Systems

According to the aircraft manufacturer, in the past there have been 3 occurrences involving a Jetstream 31 where the Gust Lock was not entirely unlocked and the flight crew had not checked the full and free movement of the flight controls. In 2 of these cases the airplane veered off the runway.

After the first case the Crew Manual was amended which now points out the absolute necessity to check the free movement of all control surfaces after unlocking the Gust Lock system ([...] CREW MANUAL AMENDMENT RAISED TO EMPHASISE ABSOLUTE NECESITY OF VERIFYING FULL & FREE [...] FLYING CONTROLS [...] IMMEDIATELY FOLLOWING GUST LOCK RELEASE. [...])

There were 4 cases where it was possible to move both power levers simultaneously beyond the flight idle position, even though the Gust Lock system was locked (IN). Two of these cases had occurred with a Jetstream 31 and two with a Jetstream 32. In 2 of these 4 cases the damage was identical to the current case.

Due to these occurrences, in February 1992 the aircraft manufacturer had published the Service Bulletin (SB) 27JM-5350. With this SB the original push rod (Fig. 15, marked red) including the fork end were replaced by a reinforced version in order to prevent bending of the transition area at the fork end.

In May 1994 the status of the SB was changed from Optional to Highly Recommended.

As a standard, the Jetstream 32 was fitted with the reinforced push rod from MSN 937 on, according to the aircraft manufacturer.

The maintenance organisation of the operator stated that the SB 27JM-5350 had not been implemented in the airplane involved.

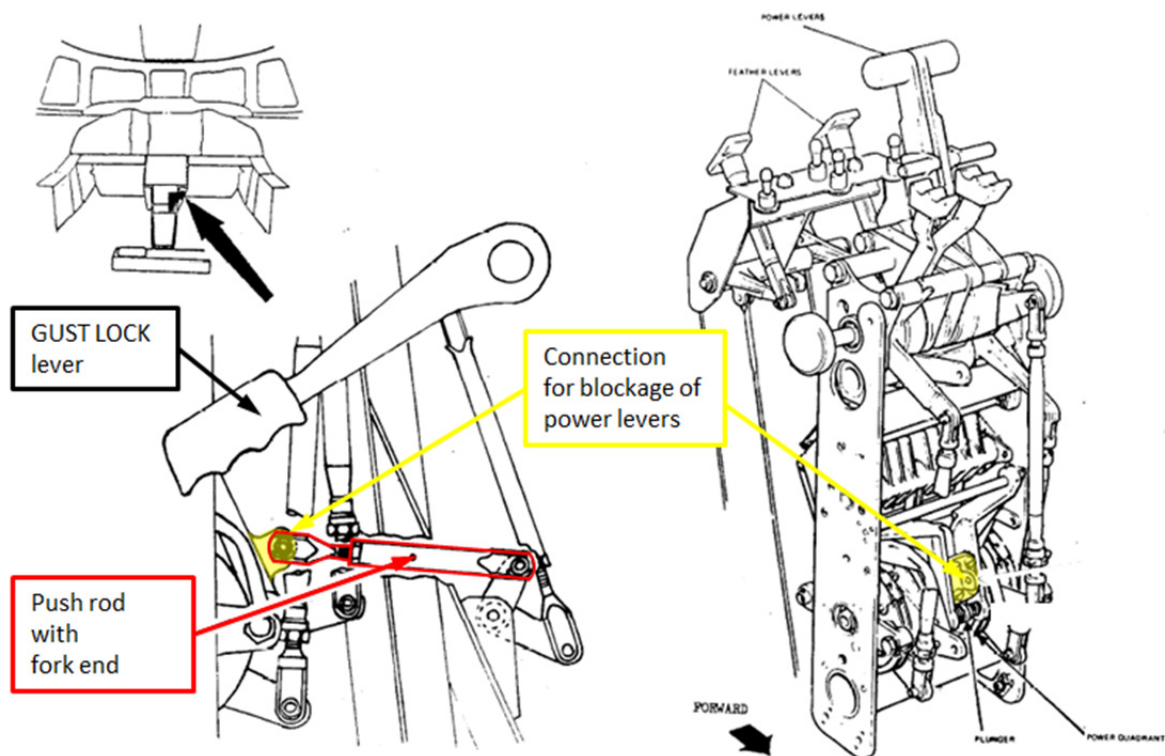


Fig. 15: Push rod and connection to lock the power levers

Source: BAe

The manufacturer assumed that the damage (Fig. 11) was caused by moving the Gust Lock lever into the locked position (IN) while both power levers were above flight idle. The British civil aviation authority published DIGEST 89/D/32 to ensure that the pilots and flight mechanics brought the power levers in the correct position before they lock the Gust Lock system. According to the CAA, they no longer have the document available, as original or copy.

Investigator in charge:	Axel Rokohl
Field Investigation:	Thomas Kostrzewa, Paul Kirchner, Uwe Berndt, Matthias Weber
Assistance:	Holm Bielfeldt, George Blau, Berndt Dreyer, Michel Buchwald

This investigation is conducted in accordance with the regulation (EU) No. 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and the Federal German Law relating to the investigation of accidents and incidents associated with the operation of civil aircraft (*Flugunfall-Untersuchungs-Gesetz - FIUUG*) of 26 August 1998.

The sole objective of the investigation is to prevent future accidents and incidents. The investigation does not seek to ascertain blame or apportion legal liability for any claims that may arise.

This document is a translation of the German Investigation Report. Although every effort was made for the translation to be accurate, in the event of any discrepancies the original German document is the authentic version.

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