Bundesstelle für
Flugunfalluntersuchung

German Federal Bureau of
Aircraft Accident Investigation

Investigation Report

Identification

Type of Occurrence:	Serious Incident
Date:	8 October 2019
Location:	Münster/Osnabrück Airport
Aircraft:	Airplane
Manufacturer:	BAe Systems
Model:	Jetstream 3200
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

Abstract

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.

Factual Information

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 hrs[1]. On Board were two pilots, one flight attendant, and one passenger. For the co-pilot this was his first line 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 1:15 hour 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. 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 the ground controller and the tower controller, from the radio communication it became clear that the crew was not familiar with the meaning of "ready message". At 1741:01 hrs, Münster Ground issued the clearance: "[…] start up according CTOT[2] of 1601 is approved, advise ready to copy." The slot did not improve and at 1752:42 Münster Ground issued the engine start-up clearance once again.

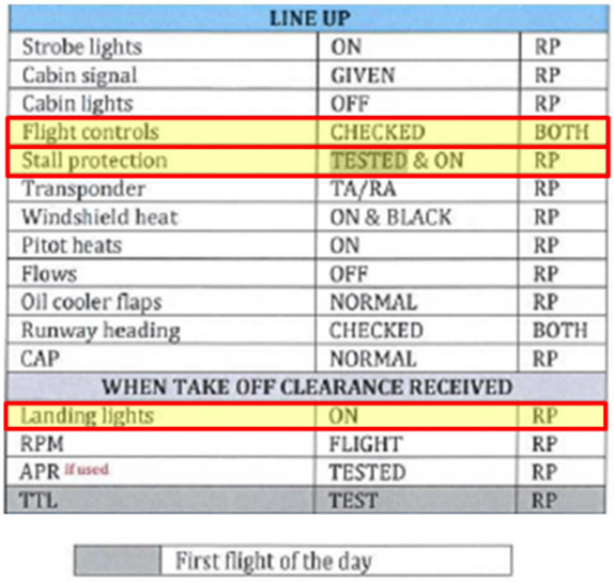
After both engines had been started, at 1758:35 hrs ground control issued taxi clearance via taxiways D and A to the taxi-holding position of runway 25. According to the co-pilot's statement during taxiing, he already felt "[…] a bit lost […] behind the aircraft […]". He attributed this to the fact that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

As the aircraft was approaching holding position runway 25, the co-pilot switched frequency to Münster Tower following the instruction of ground control. At 1801:24 hrs,

[1] All times local, unless otherwise stated.
[2] Calculated Take Off Time

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 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 if used	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 was issued by Münster Tower, the crew began 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). Offside the runway, the aircraft crossed the northern taxiway (connection with the flying club) of runway 25. At that time 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. After about 530 m on unpaved ground the aircraft returned to the runway.

One runway edge light and an information sign (for the glider area) were damaged in the process. The maximum distance to the runway edge was 23 m.

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 engaged. 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.

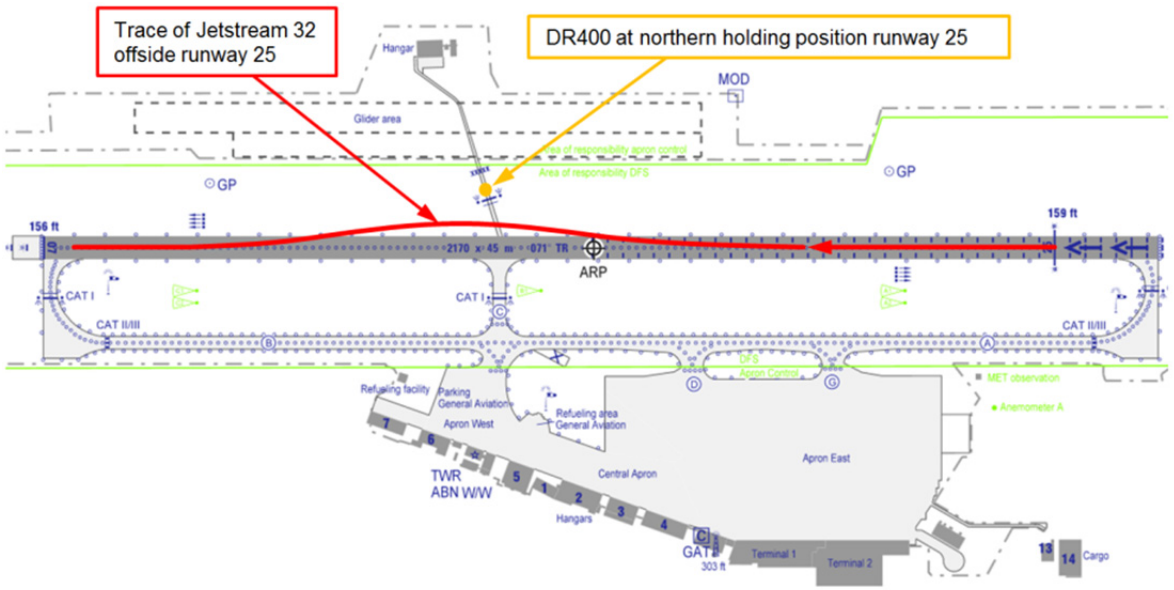
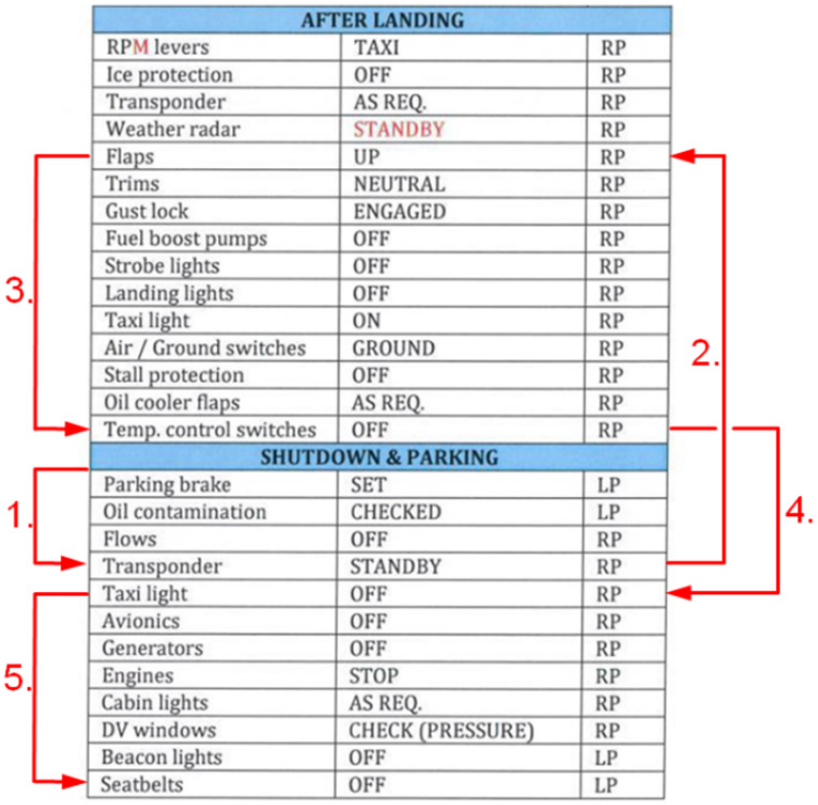


Fig. 2: Sequence of the aborted take-off on runway 25 Source: AIP/BFU

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 of them were valid at the time of the serious incident. In addition, English language proficiency level 6 (no expiry date) was listed.

His class 1 medical certificate with the restrictions to wear glasses (VNL[3]) and OML[4] was issued on 28 May 2019 and valid until 5 December 2019.

[3] VNL: Have available corrective spectacles and carry a spare set of spectacles
[4] 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 of them were 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 3200 is a low-wing aircraft equipped with 2 turboprop engines and a pressurized cabin for up to 21 persons (including crew).

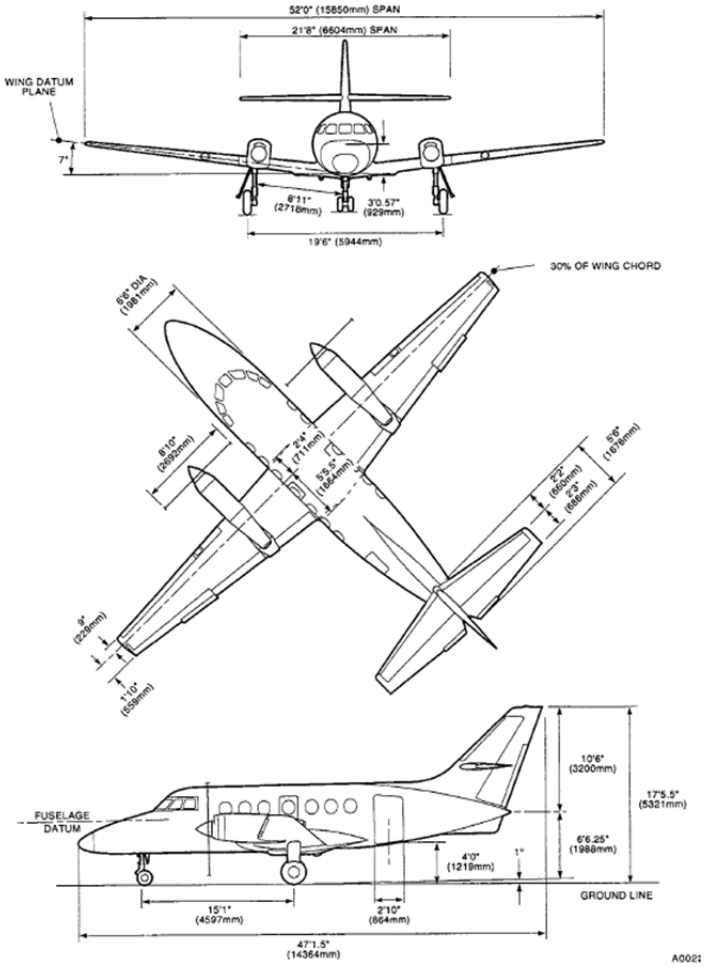


Fig. 5: Three-way view of a Jetstream 3200 Source: BAe

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 to control the aircraft's yaw movement.

Gust Lock System

If the aircraft is parked a gust lock system for the control surfaces is provided. The system shall prevent movement and subsequent damage of the control surfaces due to wind.

The control surfaces are locked in their neutral positions via a gust lock lever. This lever is located on the right-hand side of the center console (Fig. 6). If the lever is in the upper position (IN) (Fig. 6 and 7), spring-loaded locking pins lock, via corresponding cables and levers, the aileron, rudder and elevator controls. In order to prevent take-off with locked 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 locking mechanism of bars and levers. Individually the power levers can be moved to the MAX position.

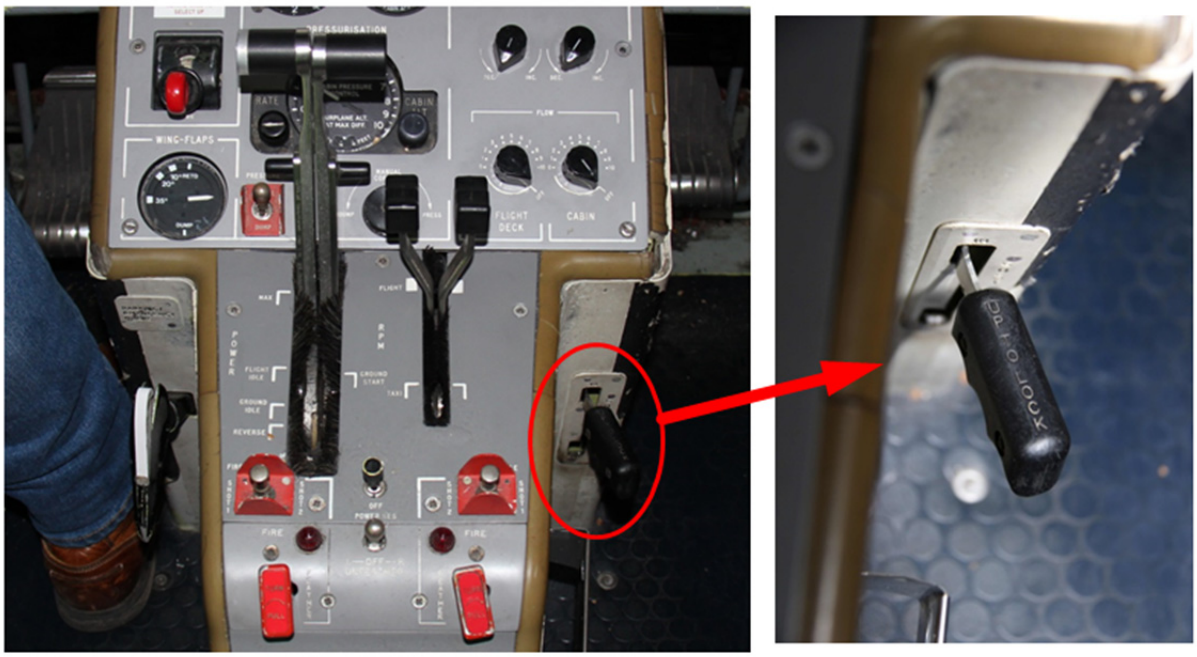


Fig. 6: Cockpit view of the Gust Lock lever Source: BFU

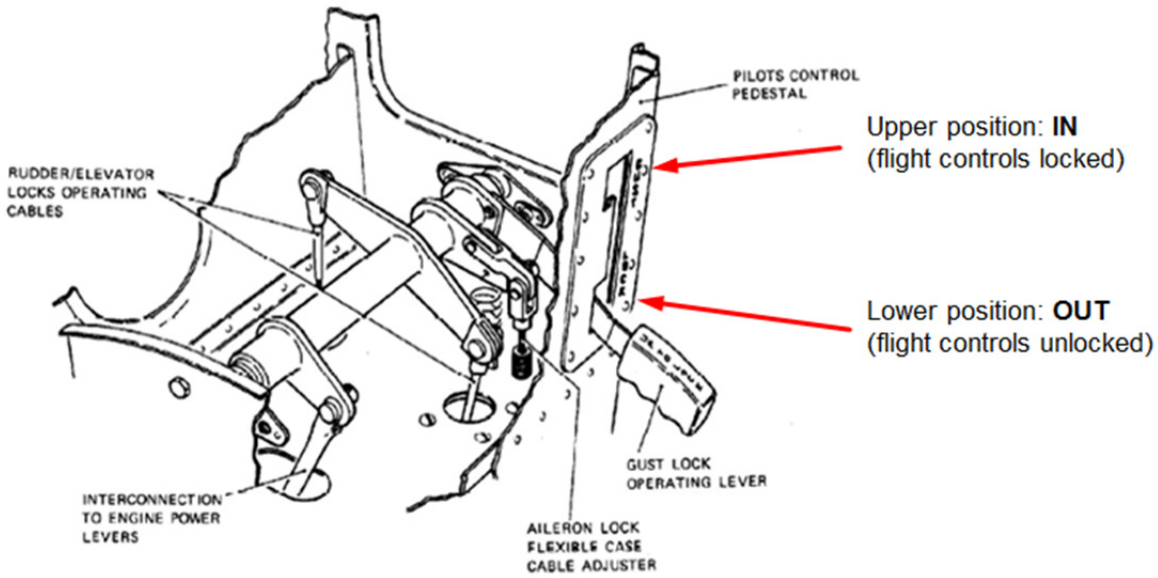


Fig. 7: Gust Lock lever mechanism Source: BAe

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 engaged position (IN) during take-off, so that flight controls were locked. However, it was possible to move simultaneously 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, variable 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 clearance the wind came from 230° with 10 kt.

Radio Communications

Radio communications between the crew and the air traffic control units were held in English. The air navigation service provider recorded the radio communications and made the transcripts available to the BFU.

Aerodrome Information

Münster/Osnabrück Airport (EDDG) is located 20 km north of Münster and 30km 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, 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 heading changed from 241° back to the runway heading.

Between 1603:13 UTC and 1603:27 UTC vertical acceleration increased 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.

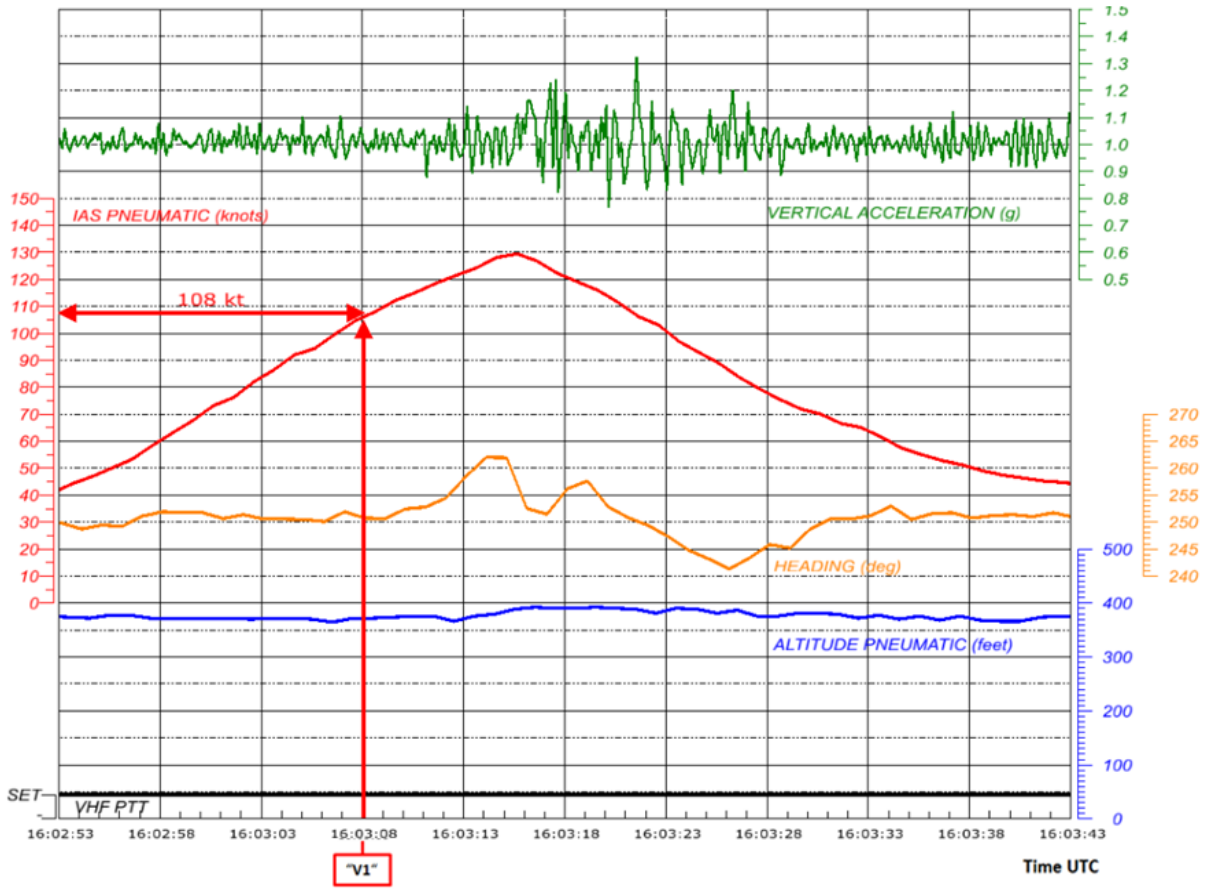


Fig. 8: FDR parameter during the rejected take-off Source: BFU

Findings on the Aircraft

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.

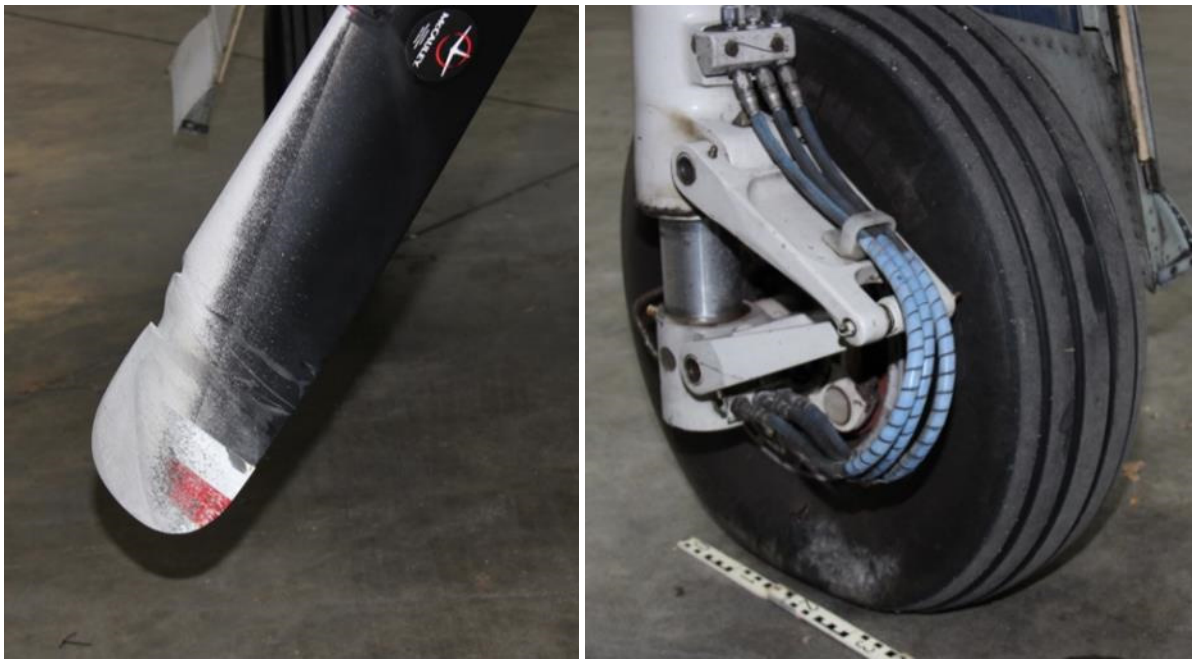


Fig. 9: Damage of the propeller blade and left main landing gear tire Source: BFU

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. locked flight controls, as it was during the time of take-off, it should not be possible to move both power levers simultaneously beyond the flight idle position. The power levers should have been

blocked mechanically. At the lower area of the center console 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). For comparison reasons 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 to 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 flight controls locked, it should be checked if both power levers could be moved only up to the flight idle position and not beyond.

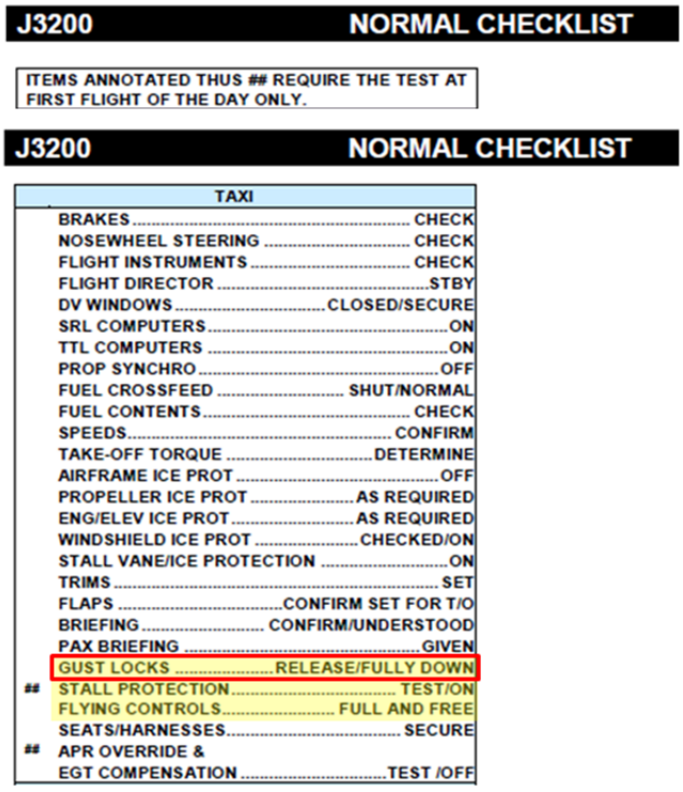
In the extended taxi checklist of the aircraft manufacturer BAe AFM Chapter 6 Normal Procedure, Section 6: Before Take-Off, Taxi 6-6-2 item 16 listed disengaging the Gust Lock:

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's checklists for disengaging the Gust Lock. Only the pre-flight part (OM-B 2.2.2) of the expanded normal checklist included this item as sub-item of the autopilot/flight director test. This test has to be conducted just once prior to the first flight of the day. On the day of the occurrence, the airplane had already completed 2 flights.

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



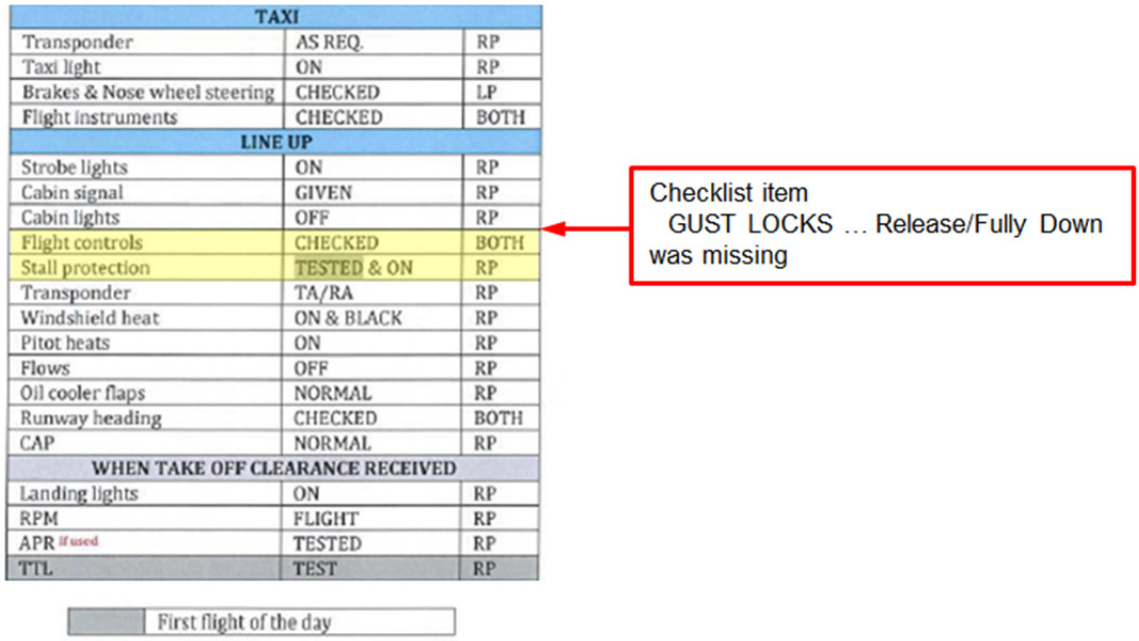
J3200 NORMAL CHECKLIST

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

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 had to be tested after disengaging the Gust Lock system

STALL PROTECTION system … Tested, ON

if it is the first flight of the day. If not, the stall protection system had just 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 disengaging the Gust Lock system.

According to the manufacturer, *if the stall protection system were to be checked with the Gust Lock system engaged (IN position), the locking pin that locks the elevator control would be loaded by activation of the stick shaker. The system was not designed for this scenario but, assuming the locking pin withstands the stick shaker loads (which was evidently the case in this instance), the stick pusher will not be acti-*

*vated. Therefore, with the Gust Lock system engaged, test of the stall protection system would not achieve the required result.*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 disengage 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 disengage the Gust Lock system was missing entirely and other items such as Stall Protection and Flying Controls were part of the line-up checklist instead of the taxi checklist.

Additional Information

Gust Lock systems are part of design requirements applying for the aircraft. The Certification Specifications for Large Aeroplanes (CS25) described in paragraph CS 25.679 regulations and requirements of Gust Lock systems:

CS 25.679 Control system gust locks

(a) There must be a device to prevent damage to the control surfaces (including tabs), and to the control system, from gusts striking the aeroplane while it is on the ground. If the device, when engaged, prevents normal operation of the control surfaces by the pilot, it must –

(1) Automatically disengage when the pilot operates the primary flight controls in a normal manner; or

(2) Limit the operation of the aeroplane so that the pilot receives unmistakable warning at the start of take-off. (See AMC 25.679(a)(2).)

(b) The device must have means to preclude the possibility of it becoming inadvertently engaged in flight. (See AMC 25.679(b).)

Similar Accident with Engaged Gust Lock System during Take-off Run

On 31 May 2014, a Gulfstream G-IV business jet was involved in an accident during rejected take-off at Bedford, USA. The accident investigation showed that take-off run occurred with engaged Gust Lock system. Due to a recommendation by the National Transportation Safety Board (NTSB) the National Business Aviation Association (NBAA) compiled a report: *Business Aviation Compliance With Manufacturer-Required Flight-Control Checks Before Takeoff.* For the report 143,756 flights of 379 business jets between 1 January 2013 and 31 December 2015 were analysed.

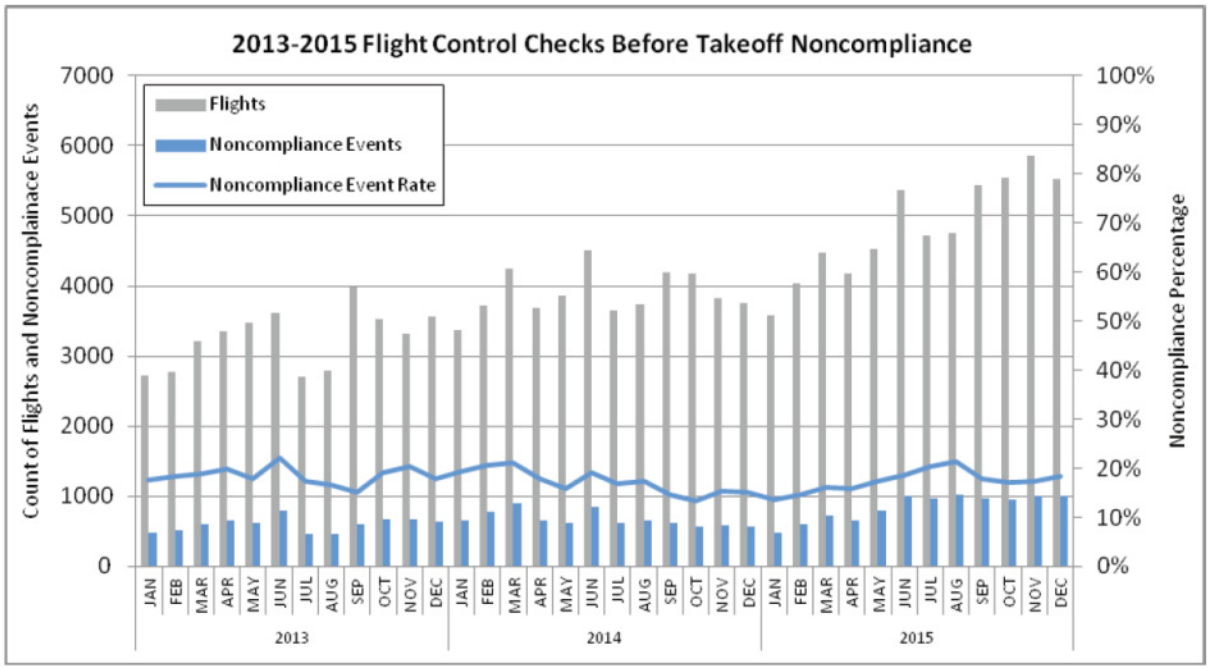


Fig. 15: Number and percentage of incomplete performed ruder controls prior to take-off during the investigation period Source: NBAA

The NBAA came to the following conclusion:

As confirmed by the FOQA data over the three-year period, there was a consistent trend of incomplete or neglected manufacturer-required flight control checks before takeoff. As perplexing as it is that a highly experienced crew could attempt a takeoff with the gust lock engaged, it is equally disturbing that the data highlights a lack of professional discipline among some crews in not accomplishing manufacturer-directed checklists – particularly safety-of-flight critical items. […]

The NBAA issued the following recommendations:

Ensure you have a standard operating procedure (SOP) addressing manufacturer-required flight-control checks before takeoff […]

Conduct flight-control checks before takeoff in accordance with manufacturers' AFM/POH

Emphasize the importance of, and specific procedures for, manufacturer-required routine flight-control checks before takeoff […]

Occurrences with Engaged Gust Lock Systems of the Type Concerned

According to the aircraft manufacturer, in the past there have been 3 occurrences involving a Jetstream 3100 where the Gust Lock system was not entirely disengaged 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 disengaging 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 engaged (IN). Two of these cases had occurred with a Jetstream 3100 and two with a Jetstream 3200. In 2 of these 4 cases the damage was similar 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 control rod (Fig. 16, marked red) including the fork end was 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 3200 was fitted with the reinforced control 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 (MSN 848).

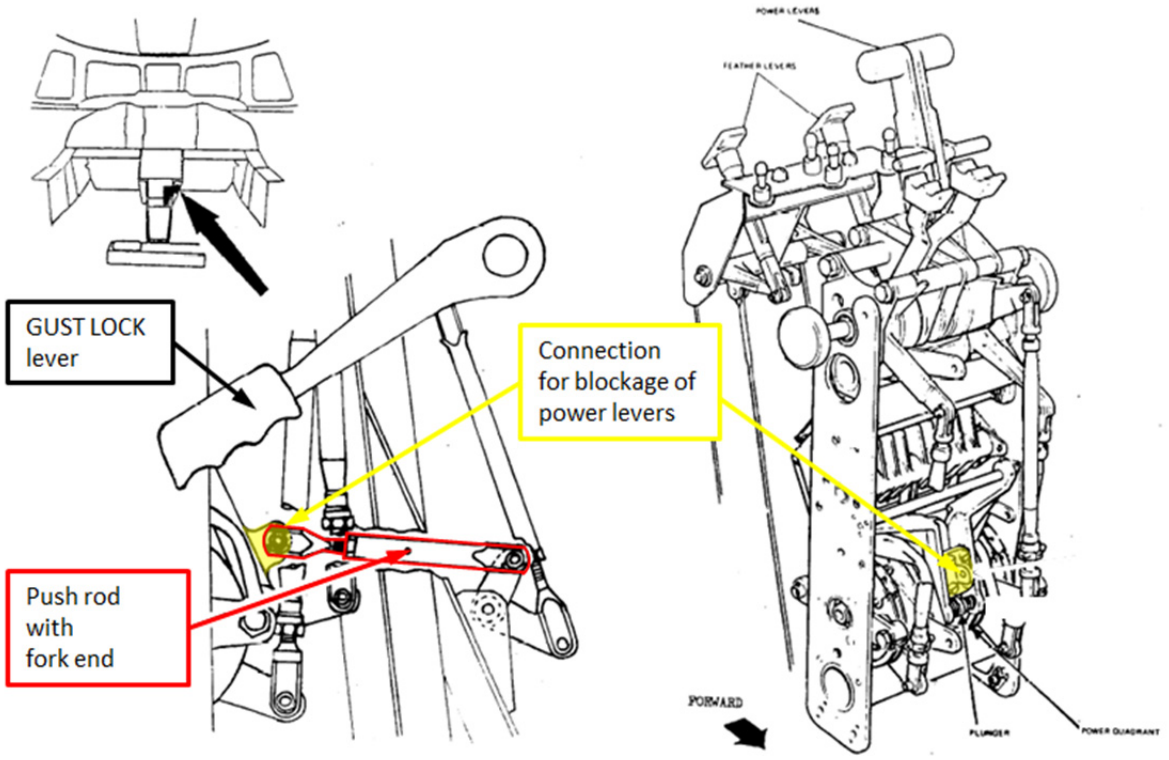


Fig. 16: Control rod and connection to lock the power levers Source: BAe

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 description of airframe and flight controls in the BAE Systems MOM 2 contains the following Caution: “DO NOT TRY TO ENGAGE CONTROL LOCK WHEN POWER LEVERS ARE IN THE FLIGHT RANGE. THIS WILL RESULT IN DAMAGE TO THE MECHANISM”.

The British civil aviation authority published DIGEST 89/D/32 to ensure that pilots and flight mechanics brought the power levers in the correct position before they engage the Gust Lock system. According to the CAA, they no longer have the document available, as original or copy.

Analysis

The serious incident, take-off run with engaged Gust Lock system during commercial scheduled services, and veering off the runway, occurred involving a flight crew who was very different in regard to age, years of professional experience, flying and type experience.

The 63-year-old PIC has to be viewed as very experienced in regard to his total flying experience and the number of years working in aviation. The major part of his flying experience he acquired as flight instructor during training flights in flight schools. He had been flying the type concerned since 2018. The operator deployed him as Line Training Instructor, i.e. as someone, who is training, instructing, and monitoring new pilots to adhere to the company's procedures. The BFU is of the opinion that especially during Line Training it should be self-evident that checklists are completed item by item and that the required time for all actions is taken. The exemplary function during training and especially preparation of scheduled services should be clear to everyone at all times. The BFU is of the opinion that for a young or new pilot of a company good practices of an experienced PIC or Line Training Instructor are formative and important for the safety culture and flight safety.

Compared with the PIC the 26-year-old co-pilot was very inexperienced. His real-time-flying experience on type was less than one hour. The day of the occurrence was his first day of work for the operator, in commercial air operations and after acquiring his type rating. The BFU is of the opinion that due to the time gap between finishing his type rating and the first flight, intensive attention of the Line Training Instructor would have been required to prevent asking too much of the co-pilot and compromising Crew Resource Management. The BFU is of the opinion that the inexperience and the large age and experience gradient within the flight crew made an equal flight-safety-improving CRM difficult.

At the day of the occurrence, the crew met sufficiently early to have enough time for the first Line Training flight and to ensure a safe conduct of flight. The BFU is of the opinion that the slot arrangement and the relatively late engine start-up in spite of early clearance at their own discretion 20 minutes prior to the intended slot resulted in unnecessary haste. Within 10 minutes engine start-up occurred, taxi instructions and clearances were received, taxiing to the runway and line-up were conducted. During the same time Before Start, Start Up, After Start, Taxi and Line-up checklists should have been completed. Especially during the first flight of the Line Training sufficient time would have been required. The CVR recording showed that during Line-

up the checklist items Flight Controls … CHECKED and Stall Protection … TESTED & ON were not completed. Therefore, the engaged Gust Lock system was not detected during Line-up.

The meteorological conditions did not limit the intended flight. Neither visibilities, clouds nor the prevailing wind should have resulted in distraction during the preparation, taxiing or take off run.

There was little traffic at the airport. The general procedures and the taxi procedures at the airport were clear and not demanding or distracting, as it could be at, for example, large airports with confusing procedures and designations, several run- and taxiways and high traffic volume.

The serious incident occurred during the take-off run for the third flight of the aircraft of the day. The BFU does not have any information of technical limitations which would have resulted in distraction or impairment of the flight crew to complete all checklist items and adhere to procedures.

The aircraft type has been operated in commercial air transport for decades, especially for short-distance flights in feeder operations. As a result, compared with the operating time, this type of flight creates a high number of flight cycles. The aircraft involved also had a higher number of flight cycles than operating time. In comparison to some other aircraft the design of the Gust Lock system to lock the flight controls during parking of this aircraft type was complex. The Gust Lock lever was installed in a slightly unfavourable position in the cockpit, i.e. a location easily overlooked by pilots. According to the manufacturer's check items of checklists for engine start-up, taxiing and last checks prior to take-off (POWER levers … Full and free, GUST LOCK lever … Confirm in OUT position, STALL PROTECTION system … Tested ON, Stall Protection … Tested & ON, Flying controls … Full and free) it should have been ensured that a flight crew realises in time prior to take-off run that the Gust Lock system was not disengaged. In addition, as a last technical barrier it should not have been possible to increase engine power with both power levers simultaneously. The BFU is of the opinion that it is probable that other flight crew did not check the proper function of the Gust Lock system during pre-flight preparation or cockpit checks and that the technical deficiency had existed for some time.

Procedures and checklists of the operator of the aircraft involved deviated in some items and choice of wording from the published procedures and checklists of the aircraft manufacturer. The checklist item GUST LOCK … RELEASE / FULLY DOWN

was missing in the Taxi and Line-up check. The checklist item FLYING CONTROLS … FULL and FREE was shortened to Flight Controls … CHECKED. Checking the full and free movement of the flight controls was moved from the Taxi check to the Line-up check.

The BFU is of the opinion that the missing checklist items regarding the Gust Lock system and the choice of wording for checking the flight controls is not acceptable. Checking the flight controls should occur prior to Line-up as it was intended by the manufacturer, and as it is commonly practised. In general, at airports there is usually no time for time-consuming Line-up checks on the runway. In spite of the deviations, the correct completion of all checklist items of the operator should have ensured that the Gust Lock system was disengaged and the full movement of flight controls checked.

The current and similar occurrences in the past involving this aircraft type show that several flight crews forgot to disengage the Gust Lock system and/or did not detect an incomplete unlocking due to insufficient check of flying controls prior to the take-off run, and that several control rods for blocking the power levels were bent. The BFU is of the opinion that EASA should change the Highly Recommended Service Bulletin (SB) 27JM-535 of the manufacturer to a mandatory Airworthiness Directive to ensure that the power levers of all aircraft of this type are locked if the Gust Lock system is engaged.

Incidents during take-off run due to engaged Gust Lock systems occur around the world time and again. This is surprising since the problem has been known for decades. The BFU can only support the findings of the multiple investigations of forgotten Gust Lock systems and refer to the importance of extensive flying training, compliance with and adherence to procedures and checklists and mutual monitoring as part of flight-safety-improving CRM. The maintenance personnel should understand the importance of a fully functional Gust Lock system, which does not allow take-off in the engaged position, and check the proper function regularly.

Ultimately, only a complete check of flight controls prior to a take-off run can ensure that all flight controls are full and free.

Conclusions

Veering off the runway during take-off run occurred due to the engaged Gust Lock system which locked the control surfaces and resulted in the pilots loosing temporary control of the aircraft.

Contributing Factors:

- Insufficient supervision, support and monitoring of the Line Training Instructor
- Inexperience of the young co-pilot and long time gap between type rating and the first commercial scheduled flight
- Insufficient Crew Resource Management of the flight crew
- Pressure of time created by the crew between engine start-up and take-off
- Non-stringent application and erroneous completion of the checklists
- Checklist items, procedures and choice of wording in the checklists of the operator which did not completely correspond with the ones of the aircraft manufacturer

A mechanically deficiency in the Gust Lock system, which allowed the engine power of both engines to be increased simultaneously, was also a contributing factor.

Safety Recommendations

06/2020:

The European Aviation Safety Agency (EASA) should convert the Highly Recommended Service Bulletin (SB) 27JM-5350 „Modified Push Rod Assembly at Gust Lock / Power Lever Baulk Mechanism" into a mandatory Airworthiness Directive in order to safe-guard the function and prevent take-offs with engaged Gust Lock for all aircraft of the type Jetstream 3100 / 3200.

Safety Actions

Due to the occurrence, the operator involved performed the following actions:

The Gust Lock systems of all other airplanes of the operator's fleet were checked. There were no other defective Gust Lock systems.

All pilots were instructed via an internal memo (Memo 2019-22) to regularly check the Gust Lock system: *As result of this incident, with immediate effect and until fur-*

ther notice, all pilots shall make a double check of the correct functioning of the gust-lock in compliance with the prescribed procedures prior to take-off.

The checklists were checked and amended. The Line-up Checklist now contains the item *Gust Lock Handle … Full Down* and *Flight Controls … Full Free*.

All pilots were trained regarding the amended checklists and the handling of the Gust Lock system.

On 13 January 2020, the Dutch CAA (ILT) conducted several flight inspections and checked the use of the new checklists. The agency came to the following conclusion: *[…] concerning the recent updates of the normal checklist and the associated training provided by the operator: the flight crew carefully followed the checklist procedures through all stages of the flights and included all checks, challenges and responses prescribed. […]*

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Braunschweig	24.11.2020

This investigation was 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 - FlUUG*) 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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