Bundesstelle für
Flugunfalluntersuchung

German Federal Bureau of
Aircraft Accident Investigation

Investigation Report

The investigation was completed stating facts only, i.e. no analysis and conclusions.

Identification

Type of Occurrence:	Accident
Date:	4 September 2022
Location:	Frankfurt Main Airport
Aircraft:	Airplane
Manufacturer:	Boeing Company
Type:	Boeing 777F
Injuries to persons:	One person suffered serious injuries
Damage:	None
Other Damage:	Airfreight containers
State File Number:	BFU22-0927-1X

Abstract

After a Boeing 777F began taxiing on taxiway N-North of Frankfurt Main Airport, several empty airfreight containers were blown from pallet trailers at parking position F234 by the jet blast.

Factual Information

History of the Flight

The Boeing 777F was to take off from Frankfurt Main Airport to a scheduled cargo flight to John F. Kennedy Airport, New York, USA. On board were the Pilot in Command (PIC), who was pilot flying at the time of the occurrence, and two other crew members (co-pilot and senior first officer). After push back from parking position F235 (Fig. 1) in north-eastern direction towards taxiway N-North, the crew received the taxi clearance from Frankfurt-APRON at 1903:53 hrs[1], to taxi from taxiway N-North via taxiway N17 to taxiway N and stop prior to the intersection of taxiway N. ("[…] N17 hold short N and 124.855").

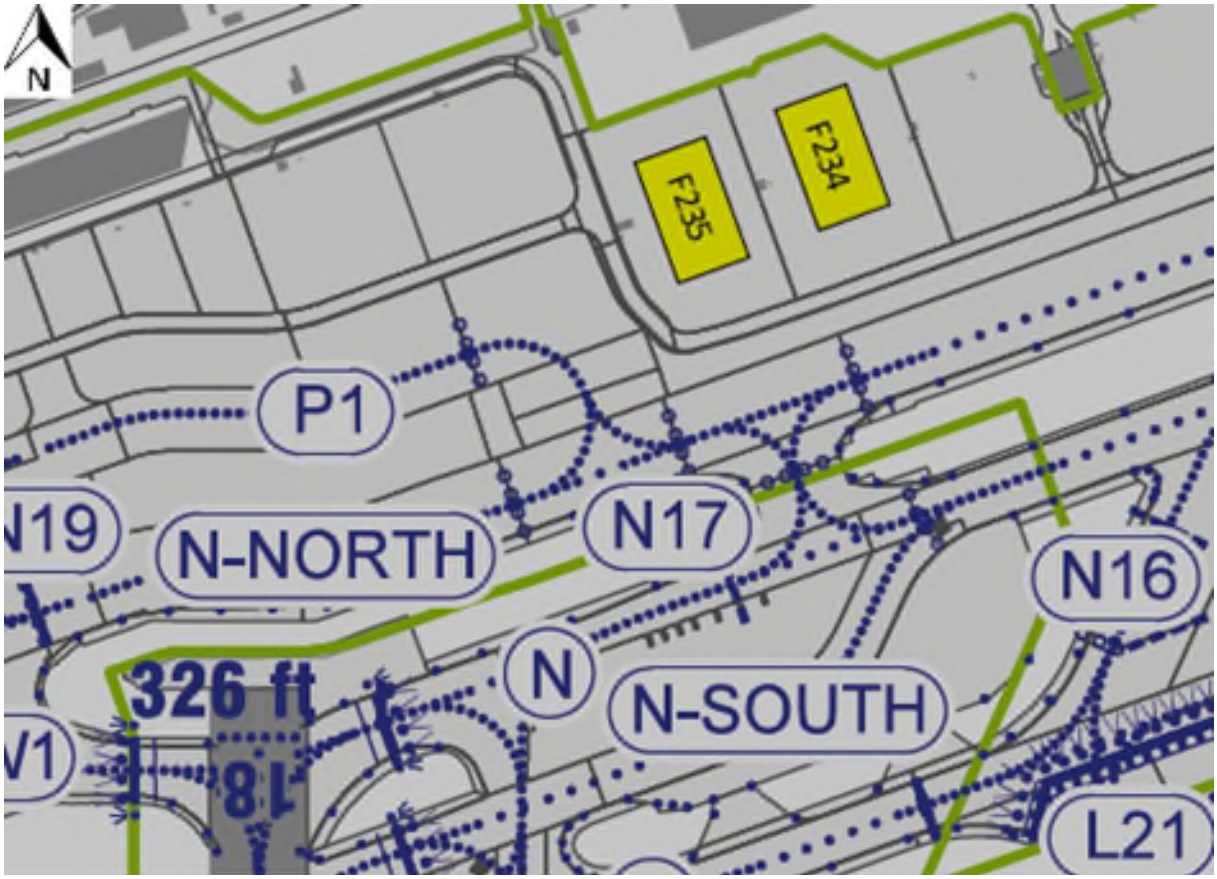

Fig. 1: Excerpt Aerodrome Chart - ICAO, Frankfurt Main Airport Source: AIP, adaptation BFU

[1]All times local, unless otherwise stated

At the time of the clearance, the Boeing 777F was abreast of parking position F234 on taxiway N-North (Fig. 2). The PIC stated that he began to taxi and then realised that a complete left-hand turn by 90° into taxiway N17 was not possible because he had to stay clear of N. Therefore, he stopped about half way and waited for another taxi clearance. After he had received the taxi clearance for taxiway N and runway 18 he began taxiing. He had used the thrust required for taxiing. He had not paid attention to the engine thrust. Neither he nor his other two colleagues had noticed any excessive thrust. To begin taxiing, the thrust of the right engine was increased. The left engine remained in IDLE. The reason the PIC stated was that earlier the aircraft had been stopped in a curve with the nose landing gear turned left and it now had to taxi again. Unconsciously he probably initially increased the right engine thrust in order to resolve the situation.

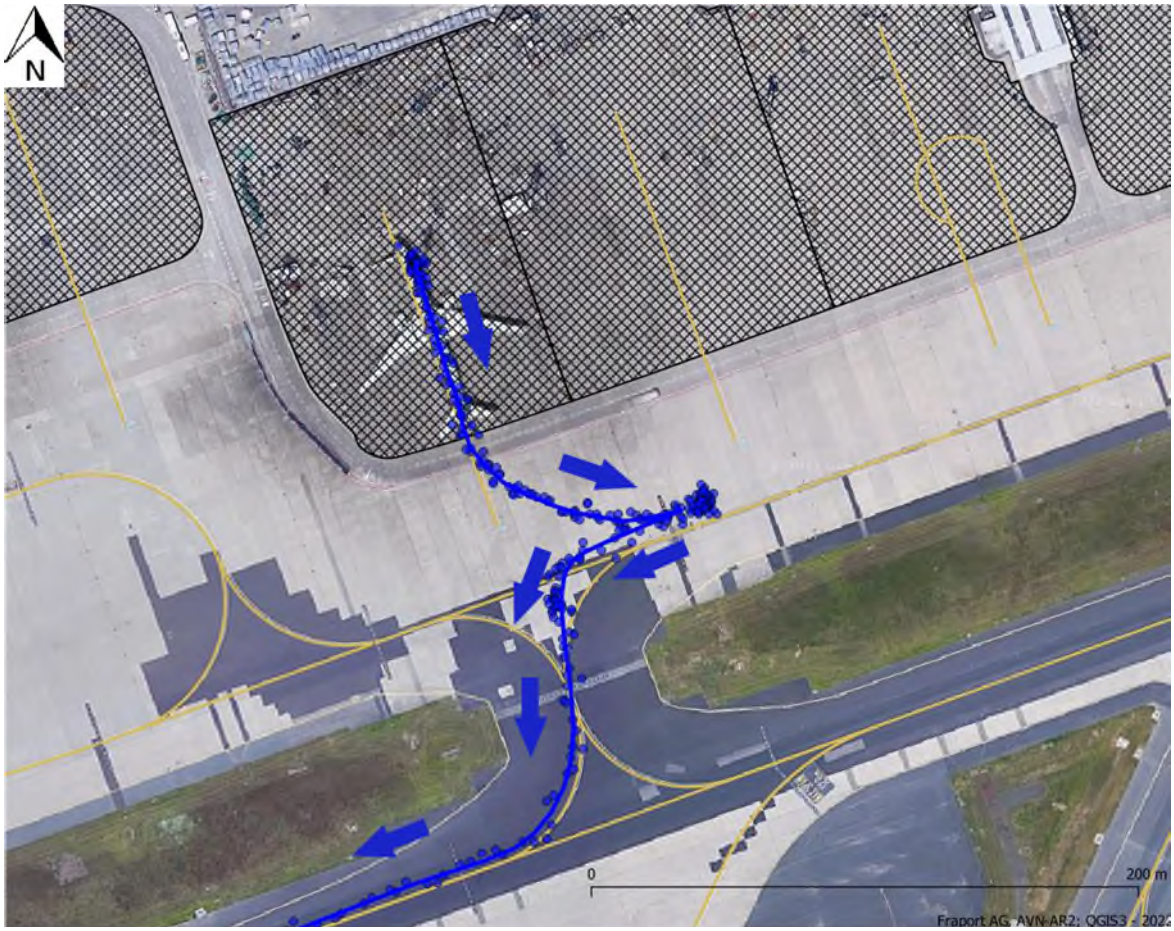

Fig. 2: Ground radar trace Source: Frankfurt Main Airport, adaption BFU

According to the available Quick Access Recorder (QAR)[2] data (Fig. 3), at 1904:55 hrs, the Boeing 777F stood with its nose pointing towards 210°. At the time, the thrust lever of the right engine was pushed forward from IDLE to 47% N1[3] within 7 seconds, while the thrust lever of the left engine remained in IDLE. Once the right engine had reached 42% N1 at 1905:04 hrs, the aircraft began to move and turned left into taxiway N17. At the time, the right thrust lever was pulled back from 42% N1 to 32% N1 within 2 seconds. At 1905:05 hrs, N1 reached a maximum of 46% and then decreased within 7 seconds to 32%. The Boeing 777F was still turning left into runway N17. At 1907:06 hrs, about 2 seconds after the aircraft had begun to move, the left thrust lever was pushed forward from IDLE to 27% N1 and starting at 1905:07 hrs, N1 of the left engine increased within 4 seconds from IDLE to 27%.

While the right engine was running up, its jet blast pointed towards parking position F234 (Fig. 1). Another freighter airplane stood at this parking position being loaded.

At the time of the occurrence, at parking position F234 were four persons. Three of them were busy loading the freighter airplane. According to their statements, two of them were at the tail section of the airplane as the engine thrust of the Boeing 777F was increased. They noticed that an empty container flew from a pallet trailer parked at parking position F234 towards the freighter airplane. As the Boeing 777F continued to turn, they had begun to run to get to safety. A second container had passed them by very closely and came to rest beneath the right wing (Fig. 5). Another container was blown from a transfer trolley and landed beneath the tail section of the freighter airplane. One ground employee stood next to the wing. The jet blast had pushed her to the ground.

[2] The QAR allows quick access to aircraft raw data via USB, mobile network or removable memory cards.
[3] Rotational speed of the low-pressure engine spool in percent RPM

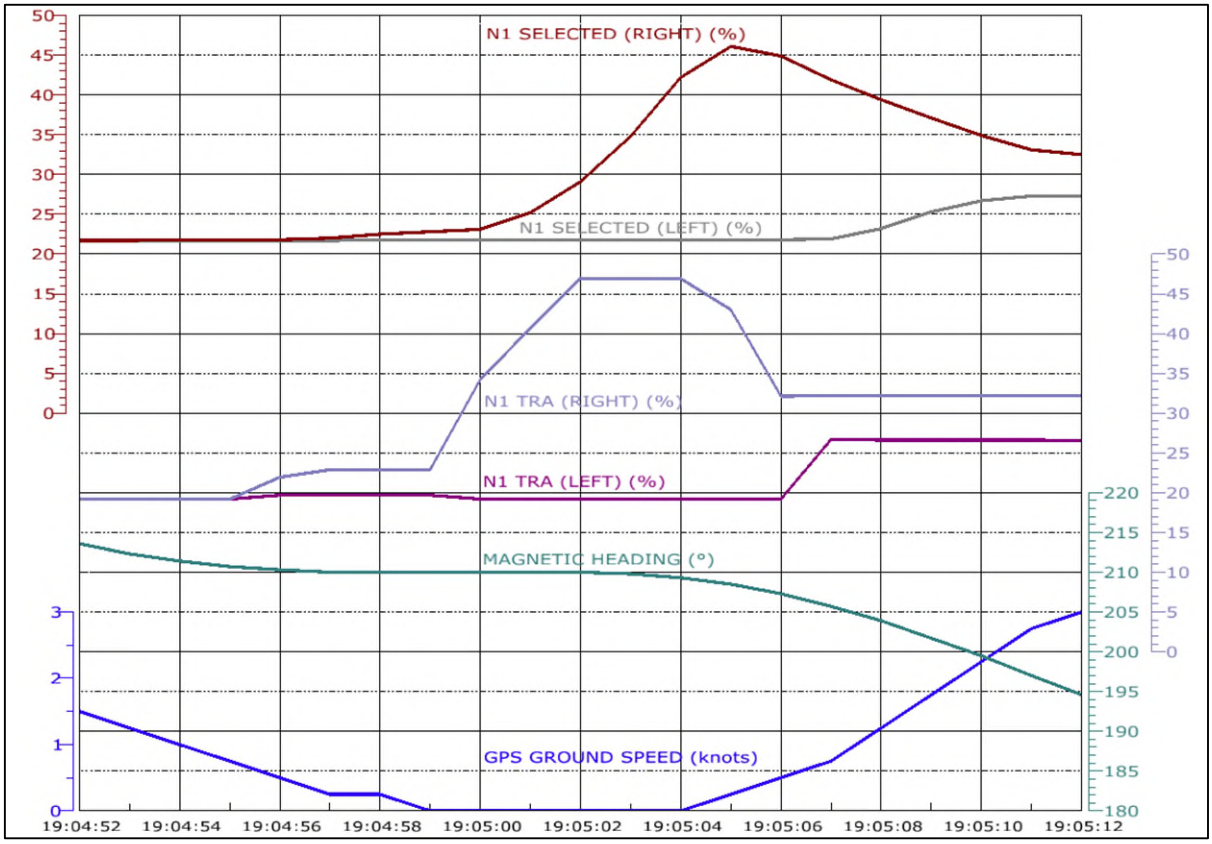

Fig. 3: Selected QAR data Source: BFU

Another witness, who had performed the push back, stated that he had been on his way to the next aircraft when he noticed quite a strong push from the Boeing 777F in his back. Shortly afterwards a container had overtaken him at a distance of about 2 m. He had turned and seen that another two containers had been pushed around. The first container had moved towards the ground employee who fell as she attempted to avoid it and injured herself in the process.

The ground employee involved described the event as follows: As the Boeing 777F began to taxi again, the jet blast had blown some containers around. While trying to avoid one of them, she fell sideways on her hip and shoulder. She suffered injuries at her left shoulder. The container had come to a stop about 3 m from her.

Personnel Information

Pilot in Command

The 61-year-old pilot in command held an Airline Transport Pilot License (ATPL(A)), issued by the Luftfahrt-Bundesamt (German civil aviation authority, LBA) on 17 November 2014, valid until 31 March 2023. He had a total flying experience of about 23,900 hours.

He held a class 1 medical certificate valid until 3 December 2022, with the restrictions TML[4], VML[5], OML[6], SIC[7].

Co-pilot

The 24-year-old co-pilot held a Commercial Pilot License (CPL(A)), issued by the LBA on 25 September 2018, valid until 31 March 2023. He had a total flying experience of about 1,390 hours.

He held a class 1 medical certificate valid until 14 April 2021.

Senior First Officer

The 39-year-old pilot held an ATPL(A), issued by the LBA on 10 March 2015, valid until 31 May 2023. She had a total flying experience of about 2,135 hours.

She held a class 1 medical certificate valid until 8 August 2023, with the restriction VDL[8].

Aircraft Information

The Boeing 777F is a twin-jet freighter airplane for long range operation. The aircraft had a German certificate of registration and was operated by a German operator.

Manufacturer:	Boeing Company
Type:	Boeing 777F
Manufacturer's Serial Number:	35613
Year of Manufacture:	2012

[4]Time limitation, according to entry
[5]Correction for defective distant, intermediate and near vision
[6]Valid only as or with qualified co-pilot
[7]Specific regular medical examination(s) contact licensing authority
[8]Wear corrective lenses and carry a spare set of spectacles

Length:	63.70 m
Wing Span:	64.80 m
Height:	18.60 m
MTOM:	347,814 kg
Engines:	2 General Electric GE90-110B1 (Take-off thrust: 492 kN each)

According to the loadsheet, the aircraft had a total mass of 282,142 kg at the time of the occurrence.

Meteorological Information

The aviation routine weather report (METAR) of Frankfurt Main Airport of 1620 hrs showed the following information:

Surface wind: 190°, 8 kt

Ground visibility: more than 10 km

No significant clouds below 5,000 ft AGL

Temperature: 24°C

Dewpoint: 14°C

QNH: 1,019 hPa

Radio Communications

Radio communications between the Boeing 777F crew and Frankfurt-APRON were recorded and made available to the BFU as transcript for the investigation.

Aerodrome Information

Frankfurt Main Airport (EDDF) is located 6.5 NM south-west of Frankfurt City. Airport elevation is 364 ft AMSL. It was equipped with 3 parallel runways with the directions 068°/248° and one runway with the direction 178°. The apron, where the occurrence took place, is located in the north-west of the airport, about 500 m north-east of runway threshold 18.

Flight Recorders

The QAR recordings of the Boeing 777F were available for the investigation.

Accident site

Aircraft were not damaged. The containers which were blown from the pallet cars and the transfer trolley were damaged and scattered around parking position F234 (Fig. 4 and 5).

Fig. 4: Parking position F234, view direction west, with one of the scattered containers Source: BFU

Fig. 5: Parking position F234, view direction North, one of the containers is lying beneath the right wing

Source: BFU

Medical and Pathological Information

The ground employee involved suffered a humeral head fracture at her left shoulder.

Organisation and Procedures

Operator

The operator of the Boeing 777F involved had made stipulations concerning taxiing in the Flight Crew Training Manual (FCTM) and the Flight Crew Operation Manual (FCOM).

FCTM

2.4.1.2 During Taxi

Be constantly aware of the equipment, structures, and airplanes behind you when the engines are above idle thrust.

2.4.3 Thrust Use

Thrust use during ground operation demands sound judgment and technique. Even at relatively low thrust the air blast effects from the large, high bypass engines can be destructive and cause injury. Airplane response to thrust lever movement is slow, particularly at high gross weights. Engine noise level in the flight deck is low and not indicative of thrust output. Idle thrust is adequate for taxiing under most conditions. A slightly higher thrust setting is required to begin taxiing. Allow time for airplane response before increasing thrust further. The pilot taxiing should keep a hand on the thrust levers as much as possible during ground operations. This action ensures only intended movement of the thrust levers.

2.4.5 Taxi Speed and Braking

To begin taxi, release brakes, smoothly increase thrust to minimum required for the airplane to roll forward, and then reduce thrust as required to maintain normal taxi speed.

FCOM

NP.2.27 After Landing Procedure

Single Engine Taxi In (if applicable)

To reduce fuel consumption and emissions as well as to reduce brake wear, one engine shall be shut down during prolonged taxi after the following conditions are met:

- *Expected taxi way has no excessive up slope*
- *APU is operative, but need not yet run*
- *Taxi in does not require a thrust setting exceeding 40% N1 N1 on the remaining engine, to avoid FOD on the engine*
- *No icing conditions exist (to prevent fan blade icing)*

Note: Shut down the left engine to power the normal brakes using the right engine driven pump and to avoid undesired hydraulic fluid transfer, due to valve operation for the alternate/reserve brakes.

SP.12.3 Cold Weather Operations

SP.12.3.5 Taxi–Out

Caution: Taxi at a reduced speed. Use smaller tiller and rudder inputs, and apply minimum thrust smoothly. Differential thrust may be used to help maintain airplane momentum during turns. At all other times, apply thrust evenly. (…)

SP.12.6 Operation in a Sandy or Dusty Environment

SP.12.6.5 Taxi–Out

Do the following, if conditions allow, to minimize sand and dust ingestion by the engines and to improve visibility during taxi:

Use all engines during taxi and taxi at low speed. Limit ground speed to 10 knots and maintain thrust below 36% N1 whenever possible to avoid creating a vortex during ground operations

Neither the FCTM nor the FCOM included stipulations when single-engine taxiing is possible in normal conditions.

Airport

The Aeronautical Information Publication (AIP) AD2 EDDF 1-32 item 4.6 stipulated taxiing on the apron.

4.6.1 Aircraft are permitted to taxi on the apron at the indispensable minimum engine speed.

4.6.1.1 In order to avoid damage, aircraft types of the category "HEAVY" are not allowed to increase engine power considerably beyond idle motion speed, especially when taxiing close to buildings or within the cul-de-sacs.

[…]

4.6.1.4 When taxiing into aircraft stands,

aircraft shall generally not stop in curves between the centrelines of apron taxiways or aircraft stand taxi lanes and the centrelines of aircraft stands so as to avoid the further appliance of break-away power.

4.6.1.5 If in the course of a manoeuvre as described in para 4.6.1.4 an aircraft inadvertently comes to a stop, prior to increasing engine power again to continue the pilot shall notify apron control and await further instructions.

There were no explicit regulations as to how to proceed if an aircraft has to stop during taxiing in the area of the parking positions and then continue.

Additional Information

Freight Container Transport

Pallet cars were used to transport freight containers. Hinged safety locks prevented the containers from sliding around during transport (Fig. 6 and 7). According to witnesses' statements, these safety locks were open at the time of the occurrence.

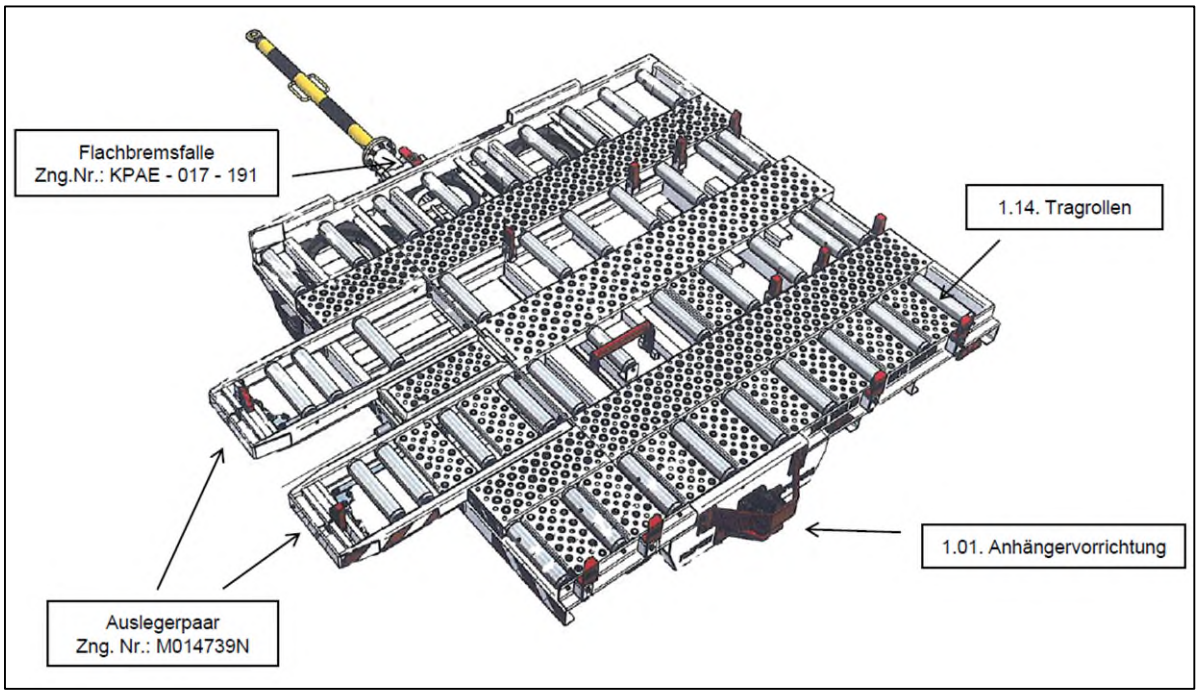

Fig. 6: Schematic drawing of a pallet car Source: Aerodrome operator

Fig. 7: Example of a pallet car with open safety locks Source: Aerodrome operator

Engine Thrust Effect while Taxiing

When the aircraft type involved begins to taxi wind speeds of up to 80 km/h occur up to about 60 m from the aircraft (Fig. 8). These values are based on the use of both engines. Is only one engine used, the rpm required is significantly higher, which subsequently results in higher wind speeds behind the aircraft.

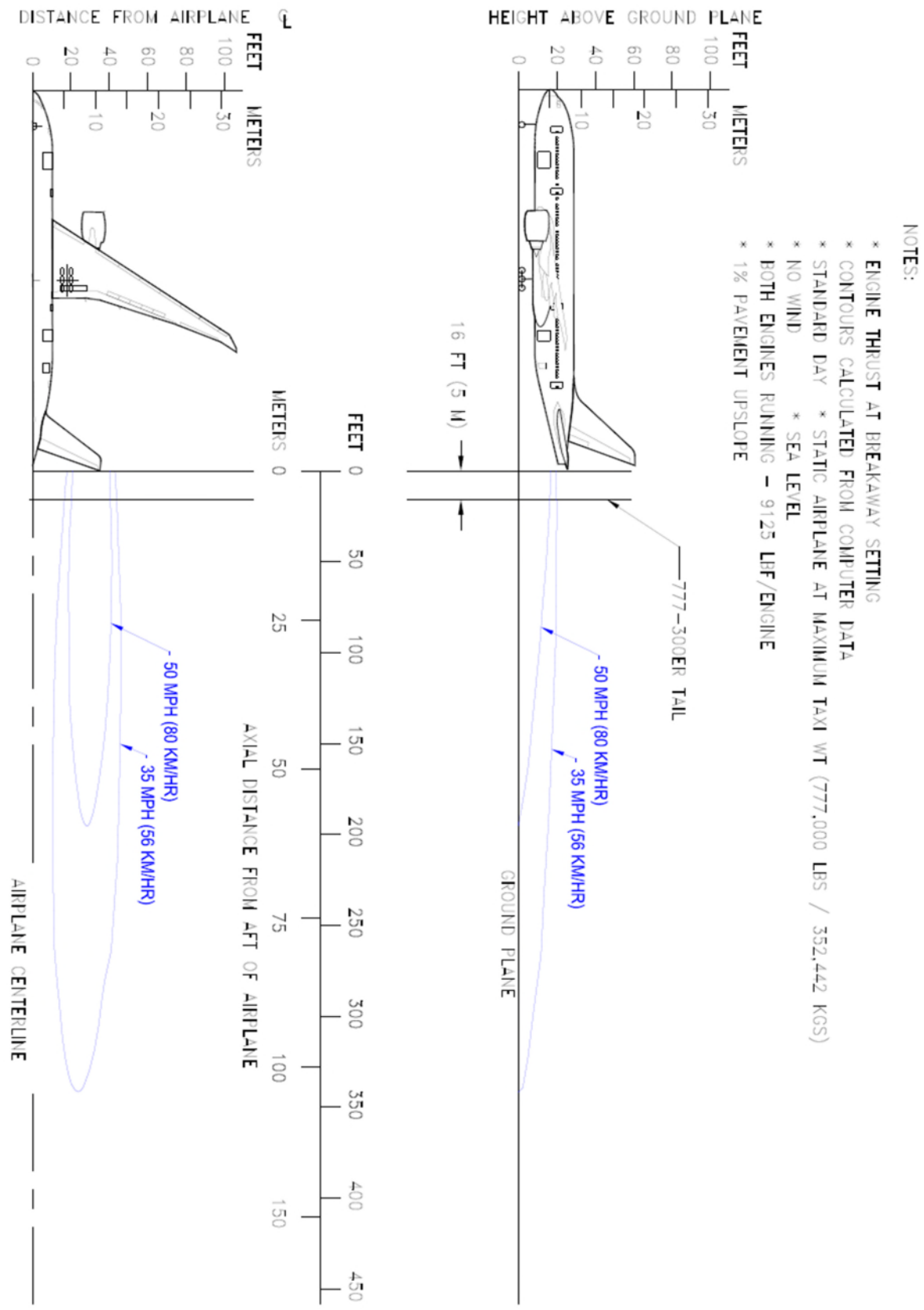

Fig. 8: Predicted Jet Engine Exhaust Velocity Contours - Breakaway Thrust: Model 777-200LR, -300ER, 777F

Source: 777-200LR / -300ER / -Freighter Airplane Characteristics for Airport Planning

Similar Occurrences

In the past, occurrences involving taxiing traffic of transport aircraft and jet blasts have occurred time and again. On 2 September 2015 at Dublin Airport, Ireland, an incident involving a Boeing 737-8AS occurred. While parking, two ground employees were blown down by the jet blast and suffered abrasions. The safety investigation authority Ireland closed the incident with a Factual Report (AAIU 2016 – 012).

On 11 August 2015 at Frankfurt Main Airport an incident involving a Boeing 747- 800 occurred. While parking, two passenger buses were damaged by the jet blast. About 70 passengers were on board of one of the buses who had just left an aircraft parked south of the taxiing Boeing. One passenger suffered minor injuries. The BFU investigated the incident and closed it with a factual report (BFU15 -1075-5X).

Safety Actions

The operator has taken the occurrence as opportunity to concretise the procedural instructions for taxi out stipulating taxiing with synchronous thrust of all engines at all times.

Due to the occurrence, the aerodrome operator will concretise the respective chapter of the AIP for Frankfurt Main Airport: *Aircraft may taxi on the apron only with the absolutely required minimum engine thrust. As a matter of principle, when taxiing (especially in turns) attention should be paid to an engine thrust, which has to be as synchronous as possible, of all operating engines.*

Investigator in charge:	Blanke
Assistance:	Buchwald

Braunschweig, 22 December 2022

The report has been amended due to new information regarding the degree of injury to the ground employee.

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 - 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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