
Landed short, Serious incident occurring January 20th, 1999 at Frankfurt/Main to a Boeing B747-400

Micro-summary: This Boeing 747-400 touched down on the underrun area before the main runway, damaging the main tires and resulting in a go-around in diminishing visibility.

Event Date: 1999-01-20 at 1639 UTC

Investigative Body: Federal Bureau of Aircraft Accidents Investigation (BFU), Germany

Investigative Body's Web Site: <http://www.bfu-web.de/>

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Report

EX002-0/99
September 1999

Translation of the German Investigation Report.

The sole permissible specimen in law is the German Report

Factual Information

Classification:	Serious Incident
Date of event:	20 th January, 1999
Location:	Airport Frankfurt/Main
Aircraft:	Civil Jet Aircraft
Manufacturer / Type:	Boeing B747-400
Injuries to persons:	none
Damage to aircraft:	severe
Third party damage:	Airport Equipment

History of the Flight:

A B747-400 arriving from Delhi, with 311 passengers and 25 crewmembers on board approached runway 25 L at Frankfurt Airport at approximately 16:35 UTC. The approach to runway 25 L was conducted with the intention to perform a manual landing under CAT I conditions. This intention resulted from the ATIS (Automatic Terminal Information Service) of 16:20 UTC which was copied by the crew before starting the approach. The Meteorological Aerodrome Report contained in this ATIS indicated a visibility of 2 500 m and few clouds in 300 ft.

Frankfurt Approach Control vectored the aircraft to a 9 NM localizer intercept for runway 25 L. The glideslope was captured just before the outer marker (FR) at approximately 1 400 ft GND, because the average sinkrate of 1 200 ft/min from FI 110 to 4 000 ft respective 3 000 ft was too low for the remaining distance to the glideslope. When reaching an altitude of 3 000 the autoflight system was switched off and the airplane flown manually.

Apparently the crew did not realise the rapid deterioration of the visibility during the approach caused by fog-banks drifting in from the southwest. The additional special met report at 16:35 UTC indicating a decrease in visibility between 800 m RVR and 400 m RVR did not come to the knowledge of the crew. The landing clearance was issued before passing the outer marker (FR) at 16:37 UTC including the current RVR-readings for runway 25 L - A 300 m, B 550 m, C 375 m - and the advice that still CAT I is in process.

During the intermediate approach the crew dealt with a minor hydraulic pump malfunction in the hydraulic system number 4.

At approximately 800 ft GND the flaps were set from 25⁰ to 30⁰, the aircraft deviated about 100 ft above the glideslope. The sinkrate increased up to 1 450 ft/min and the aircraft went below glideslope at 400 ft GND. According to the flight crew the approach lights were sighted at a height of 300 ft. Because of the high sinkrate the GPWS sounded 8 times „SINKRATE, SINKRATE, SINKRATE...“ and shortly after 16:39 UTC the aircraft touched down unintentionally, approximately 1 000 m prior to the touchdown zone on the hard surface of the old runway in front of runway 25 L. The pilot-in-command immediately initiated a go-around.

Meanwhile the RVR decreased so that at 16:50 UTC CAT II and from 16:54 UTC CAT III was in force. The second landing was performed at 16:58 UTC on runway 25 R as an automatic landing under CAT III conditions. Some of the previously damaged main landing gear tires started to burn, but were quickly extinguished by the fire brigade standing by. The fire

crew had already been alerted by the tower controller because of an explosion-like sound at the time of the go-around.

Weather

At the time of the approach the weather was characterised by low visibility, resulting in operational limitations for approaches and landings. According to the tower's daily report the airport changed from Category I, permitting manually flown approaches, to Category III, where automatic landings are mandatory.

The current airport weather conditions were broadcasted on the ATIS-frequency 118.02 MHz every 30 minutes. The edition „N“ of 16:20 UTC (24003KT 2500 BR FEW 003 02/02 1023) was the last one received by the crew of the B 747 (according to their own statement). Since the weather was deteriorating rapidly during the approach, two further special meteorological reports indicated by „O“ and „P“ were transmitted at 16:35 UTC and 16:38 UTC. These special met reports were not copied by the crew. At 16:37 UTC, during the final approach, the crew received the current RVR (runway visibility range) on Runway 25 L (zone A 300 m, B 550 m and C 375 m) by the tower in combination with the landing clearance (source: voice transcript of the radio communication).

Low Visibility Operation at Frankfurt International Airport

On 3rd December 1998, the Federal Minister of Transport, Building and Housing (Bundesminister für Verkehr, Bau- und Wohnungswesen) issued a change to low visibility operations via Notam (Nachrichten für Luftfahrer NfL), which became effective at the 15th January 1999. In parallel, there is an operational agreement between Frankfurt Airport Services (FAG) and the German Air Traffic Control Ltd. (DFS) issued on 1st December 1998 defining the responsibilities at Frankfurt Rhein-Main Airport.

This agreement also regulates the procedure for low visibility operations as follows:

With a runway visual range (RVR) of 1 000 m or less and/or a ceiling of 300 ft or less, the overseer of Approach Control (DFS) informs Central Apron Control (FAG) about the intended implementation of CAT II/III.

Then Frankfurt Airport Service (FAG) will check whether the necessary requirements for CAT II/III operations are met from their side and forward the result to DFS.

The overseer of DFS informs the FAG when actually resuming CAT II/III operations.

The go ahead-message from the FAG has not yet been received by the DFS when the B747 was approaching runway 25 L. Therefore still CAT I was in operation at this time, although weather conditions for CAT II were already prevailing.

Radar Evaluation

The radar plot shows that the airplane was radar vectored from the southeast to intercept the runway centre line of Runway 25 L about 9 NM from touchdown (Enclosure 3). At this time the airplane was still flying above the nominal glidepath.

The lateral navigation on the runway centre line was accurate according to the radar recording of the DFS. The vertical deviations of the airplane from the glide path shortly before touchdown were confirmed by the evaluation of the flight data recorder.

Instrument landing system (ILS)

With the surveillance recordings it was possible to determine that ILS equipment for Runway 25 L was working properly within permissible tolerances and without any deficiencies during the approach of the B747.

Radio Communications

Radio communications had been accomplished in English language and recorded and were evaluated.

The landing clearance was confirmed by the copilot incorrectly with the call sign only, which in turn was accepted by the approach controller.

Damage to Aircraft and Surface Equipment

Tire marks with a length of 85 m maximum were clearly visible - 22 lights of the approach lighting system were damaged or destroyed (Enclosure 4). The localizer antenna for Runway 07 R was broken out at a width of about 16 m. So the approach lighting system 25 L and the ILS 07 R of the southern runway were unservicable until further (Enclosure 5).

The B747 suffered damages to the main gear because of the collision with the surface equipment, its far spread debris causing damage to two engines and the fuselage as well (Enclosure 6).

The aircraft underwent the necessary repair in Frankfurt for a ferry flight to Mumbai.

Evaluation of the Electronic Monitoring Equipment of the Aircraft Systems

After the event the „Present Leg Faults Summary Report“ and „Fault History Summary Report“ of the airborne recording system (CMC - Central Maintenance Computer) were printed out in Frankfurt and evaluated at the BFU in Braunschweig. There was not any clue to a system malfunction that could have contributed to the incident.

Evaluation of CVR and DFDR

The cockpit voice recorder (CVR) was evaluated and a transcript was made. Because of the partially poor quality not all dialogues in the cockpit could be written down. Nonetheless the evaluation gives sufficient clues as to the proceedings in the cockpit of the airplane.

The evaluation of the digital flight data recorder (DFDR) is available in appendix 1 and 2 and gives sufficient insight in the course of the incident in context with the evaluation of the CVR.

Operational Procedures

According to his own statement the approach to Runway 25 L was flown manually by the pilot-in-command. He was orderly licensed for long range flights with the B 747-400 according to his documents.

At the time of the incident the flight crew was rated for CAT I approaches only. The airline concerned is presently about to implement CAT II operations.

According to the statements of the flight crew the autoland-mode was used regularly with this type of aircraft.

The second landing on Runway 25 R was performed automatically under weather conditions requiring CAT II/III operations.. The flight crew did not declare any emergency.

Go-Around Procedure

The go-around procedure and the second landing were not part of the investigation. The evaluation of the CVR during this flight phase however delivered information about the handling of operational procedures.

Analysis

The glideslope intercept from above, increased the workload for the crew definitely and exposed them to pressure of time. When the flight reached the preselected ALT 3 000 ft and the autoflight system brought the airplane to a level off, the autopilot was switched off and the approach was continued manually to facilitate the glideslope interception from above.

A common Crew Co-ordination Concept (CCC) and Crew Resource Management (CRM) was not applied during the approach.

The evaluation of the cockpit voice recorder (CVR) shows that there was no constructive dialogue about the current weather situation.

Before passing the outer marker (FR) the crew received the landing clearance together with the current RVR-values for Runway 25 L (300 m / 550 m / 375 m) and the additional information that there is „still CAT I in progress.“ In order to comply with the

published procedures it would have been mandatory to discontinue the approach at this point because the visibility requirements were not fulfilled for CAT I any longer. This fact came to the knowledge of the crew before passing the outer marker.

It is unclear whether the crew had comprehended the full contents of the report. The pilot in command did not realize the deterioration of the visibility according to his own statement.

The caution message during the approach referring to the hydraulic system 4, and the subsequent solving of the hydraulic problem by reading the checklist „hydraulic pressure demand 4“ increased the workload of the crew additionally in a high concentration phase.

The selection of flaps 30⁰ was done too late for the weather conditions prevailing. Normally the final landing configuration should be established at 1 000 ft GND the latest and no major thrust changes should be made.

It is not quite apparent why the airplane got above the glideslope during this approach phase because there is no mentionable „ballooning effect“ to be expected when extending the flaps from 25⁰ to 30⁰. It is a fact, however, that the glideslope was left at the very moment when the final flap setting was established so that a coherence cannot be excluded.

The reaction of the crew to the automatic call out of the ground proximity warning system (GPWS, „SINKRATE!“) was too late to avoid ground contact. The go-around procedure was initiated just when touching the ground ahead of the runway.

After completing the go-around procedure the crew did not analyse the situation. The hesitant question of the second pilot whether they possibly had touched approach lights was negated by the commander.

The crew did not pay sufficient attention to the problem that the landing gear could not be retracted after the go-around. A thorough trouble shooting would have been quite probable to lead them to the conclusion that the gear had been damaged during the ground contact.

The information from air traffic control that CAT III was in use was confirmed by the PIC with the words „we do autoland“. There was no further briefing accordingly.

The implementation of CAT II/III operations had been postponed in this case since the go-ahead message as described in the Low Visibility Flight Operations Section had not been received yet. CAT II/III operations require greater separation distances for approaches and departures thus leading to considerable delays in flight operations. For technical reasons, the change to low visibility flight operations always involves a certain delay.

Asking the crew to indicate their personal minima, a procedure usually applied in Great Britain, for example, would have caused them to reconsider their intentions.

An amendment to the German air traffic control procedures should be taken into consideration accordingly.

Conclusions

The ground contact about 1 000 m in front of the touchdown zone (coming short) was the consequence of an unstabilized final approach which was not discontinued by initiating a go-around procedure in a timely manner.

Contributing factors were:

- The glideslope interception from above.
- A hydraulic malfunction during the approach requiring to perform the referring checklist
- The rapid deterioration of the visibility
- The continuation of the manual approach although the flight crew was not qualified for CAT II/III approaches
- Poor crew co-ordination and missing crew resource management

Safety Recommendations

As a result of the investigation of this serious incident the BFU comes to the conclusion that there are major deficiencies with the airline involved concerning flight operations and crew training, especially with respect of

Crew Resource Management (CRM) and Crew Co-ordination Concept (CCC).

Resulting from the investigation the BFU recommends to the operator as follows:

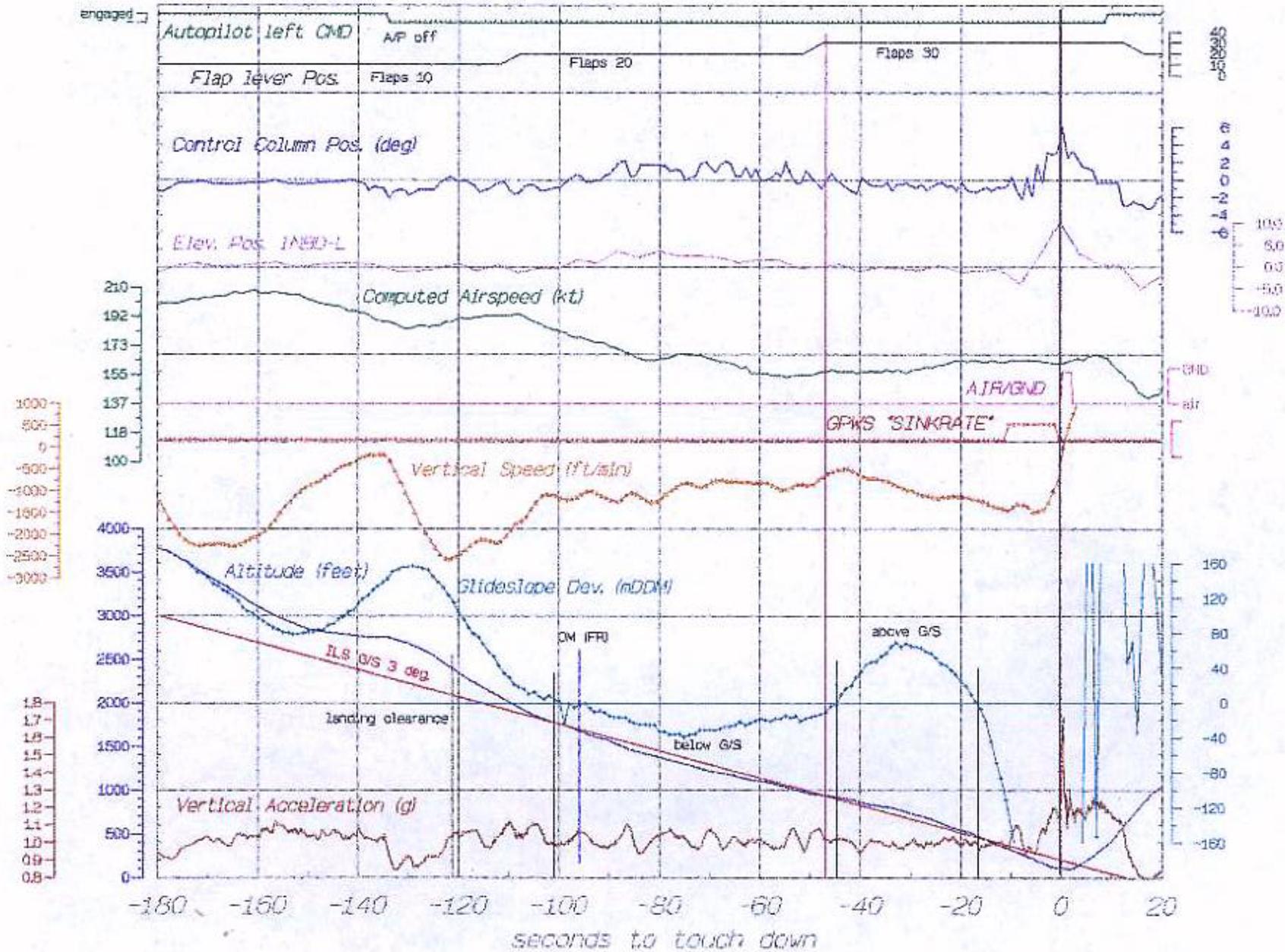
- 10/99 Implementation of low visibility operations and training of crews according ICAO Annex 6, Chapter 4 and 5.
- 11/99 Realization of a CRM-training for all cockpit crews accordingly.
- 12/99 Revision of manuals with respect of CRM and CCC.

The BFU recommends to the Luftfahrt-Bundesamt (Federal Office of Civil Aeronautics) and to the relevant aviation authorities:

- 09/99 Foreign operators should not only be granted entry permissions, but the aviation authorities responsible for the supervision of operators and for air traffic surveillance at aerodromes should also adequately supervise compliance with the requirements (e.g. CAT II / III).

Investigator-in-charge	Mueller
Structures	Leibe
Performance	Blau
Field Investigation	Müller / Leibe

VT-EVA Enclosure 1



Enclosure 1

Evaluation of Flight Data Recorder (DFDR)

The evaluation of the DFDR starts at 183 minutes before touch down.

Time(sec)	Sequence
-183	Descent up to 4 000 ft /QNH with FLCH-mode, Flap setting 10°, IAS =210 kt
-154	Descent up to 3 000 ft/QNH with V/S-mode, with 2 200 ft/min, IAS = 190 kt
-135	ALT Capture / ALT HOLD, A/P off
-123	manual flight with a sinkrate up to 2 500 ft/min, Flight Director (FD) still in ALT HOLD mode till G/S capture
-111	GEAR DOWN
-108	stabilised on GS at appr. 1 800 ft/AGL with IAS = 190 kt, Flaps 20, sel. Speed appr. 170 kt
-103	A/T disconnect, Power idle
-77	fully established at ALT 1 200 ft/AGL, except Final Flap Setting, a/c is coming slightly below G/S, Power Setting 63% N1
-48	At ALT 800 ft/AGL Flaps setting from 25° to 30 °, a/c is coming up above G/S, a/c increased sinkrate
-17	At ALT 400 ft, a/c crossed the G/S with sinkrate of 1 200 ft/min, IAS = 160 kt, Power Setting 48% N1
-10	The Ground Proximity Warning System (GPWS) has been activated, the computer voice announced 8 times „SINKRATE“
-6	Alt 120 ft, Sinkrate 1470 ft/min
-2	Sinkrate 992 ft/min, Power Setting 55% N1, Fuel Flow coming up Target Value
-1	Sinkrate still 728 ft/min
0	Touch Down with 1,7 g, G/A initiated (TOGA)
+1	A/T Throttle moving forward
+3	A/T THR REF
+9	Full G/A Thrust 96,8%, at RA 260 ft A/P ON

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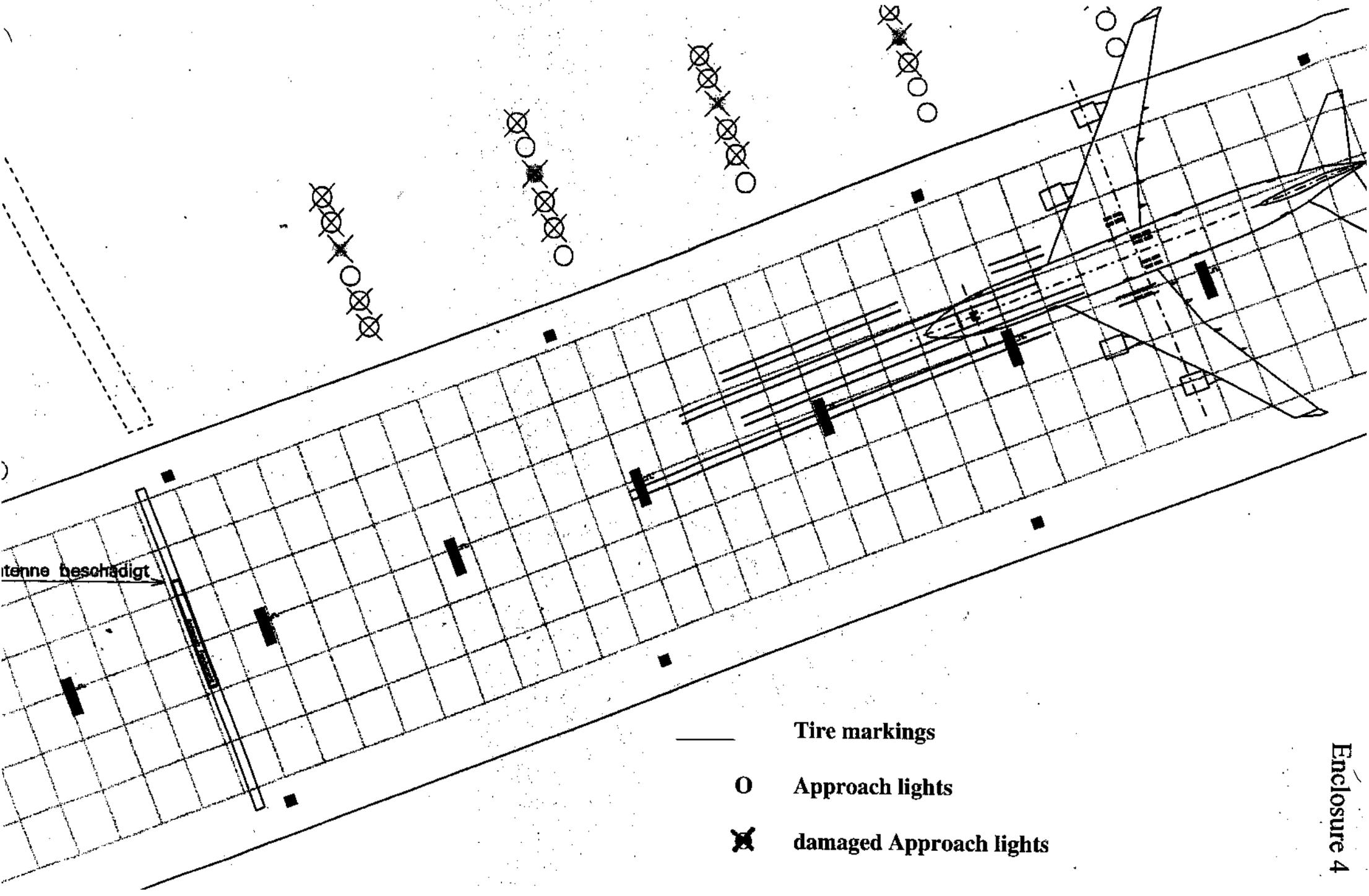
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Antenne beschadigt



Tire markings

O Approach lights

X damaged Approach lights



Destroyed localizer antenna of RWY 07R



Parts of localizer antenna between the approach lights



The damaged L/H Main Gear and L/H Body Gear



Details of L/H Body Gear, burned tires