Bundesstelle für
Flugunfalluntersuchung

German Federal Bureau of
Aircraft Accident Investigation

Investigation Report

Identification

Type of Occurrence:	Accident
Date:	19 March 2008
Location:	Mannheim
Aircraft:	Airplane
Manufacturer / Model:	Dornier Luftfahrt GmbH / Do 328-100
Injuries to Persons:	5 minor injuries
Damage:	Aircraft severely damaged
Other Damage:	Minor field damage
Information Source:	Investigation by BFU
State File Number:	BFU 1X001-08

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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Abbreviations

AAIB	Air Accidents Investigation Branch	Britische Flugunfalluntersuchungsbehörde
AD	Airworthiness Directive	Lufttüchtigkeitsanweisung
AFM	Airplane Flight Manual	Flughandbuch
AGL	Above Ground Level	über Grund
AIP	Aeronautical Information Publication	Luftfahrthandbuch
ALT	Altitude	Flughöhe über MSL
ALT HOLD	Altitude Hold	Höhenhaltung
ALT SEL	Altitude Select	Höhenvorwahl
AMSL	Above Mean Sea Level	über dem mittleren Meeresspiegel
AOM	Airplane Operating Manual	Flugbetriebshandbuch
AP	Autopilot	Autopilot; automatische Flugregelungs- und Steueranlage
APP	Approach	Anflug
APU	Auxiliary Power Unit	Hilfstriebwerk
ATC	Air Traffic Control	Flugverkehrskontrolle
ATIS	Automatic Terminal Information Service	Automatische Ausstrahlung von Lande- und Startinformationen
ATPL	Airline Transport Pilot Licence	Verkehrspilotenlizenz
AZF		Allgemeines Sprechfunkzeugnis für den Flugfunkdienst
BFU	German Federal Bureau of Aircraft Accident Investigation	Bundesstelle für Flugunfalluntersuchung
CA	Cabin Attendant	Flugbegleiterin
CAS	Calibrated Airspeed	Kalibrierte Fluggeschwindigkeit
CCC	Crew Coordination Concept	Konzept für die Zusammenarbeit der Flugbesatzung
CCM	Cabin Crew Member	Flugbegleiter/-in

CLB	Climb	steigen
CPL	Commercial Pilot Licence	Berufspilotenlizenz
CRM	Crew Resource Management	Musterunabhängiges Strategie- und Verhaltenskonzept zur optimalen Nutzung aller im Flugzeug verfügbaren Ressourcen
CTOM	Certified T/O Mass	zugelassene Startmasse
CTR	Control Zone	Kontrollzone
CVR	Cockpit Voice Recorder	Stimmenrecorder
DFDR	Digital Flight Data Recorder	Digitaler Flugdatenschreiber
DME	Distance Measuring Equipment	Entfernungsmessgerät
DOC	Designated Operational Coverage	
EASA	European Aviation Safety Agency	Europäische Agentur für Flugsicherheit
E/P Brake	Emergency/Park Brake	Not-Parkbremse
EICAS	Engine Indication and Crew Alerting System	Elektronisches Flugüberwachungssystem
ELEV	Elevation	Ortshöhe über dem Meer
ENAC	Ente Nazionale per l'Aviazione Civile	Italienische Luftfahrtbehörde
ESET	Emergency Safety Equipment Training	Schulung im Gebrauch der Not- und Sicherheitsausrüstung
FDR	Flight Data Recorder	Flugdatenschreiber
FAF	Final Approach Fix	Endanflugpunkt
FI	Flight Idle	Leerlauf im Flug
FL	Flight Level	Flugfläche; Fläche konstanten Luftdrucks über einem Druckwert von 1013 hPa
FMS	Flight Management System	
FO	First Officer	Copilot, 1. Offizier, zweiter Luftfahrzeugführer
FOI	Flight Ops Information	Information für den Flugbetrieb

ft	Feet	Fuß (1 Fuß = 0,3048 m)
ft/min	Feet per minute	Fuß pro Minute
GDCP	Guidance and Display Control Panel	
GI	Ground Idle	Leerlauf am Boden
GS	Ground Speed	Geschwindigkeit über Grund
HDG	Heading	Steuerkurs
hPa	Hectopascal	Hektopascal
IAF	Initial Approach Fix	Anfangsanflugpunkt
IAS	Indicated Airspeed	Angezeigte Fluggeschwindigkeit
ICAO	International Civil Aviation Organisation	Internationale zivile Luftfahrtorganisation
IFR	Instrument Flight Rules	Instrumentenflugregeln
IMC	Instrument Meteorological Conditions	Instrumentenwetterbedingungen
IR	Instrument Rating	Instrumentenflugberechtigung
JAR-OPS	Joint Aviation Requirements - Operations	
JAR-FCL	Joint Aviation Requirements – Flight Crew Licencing	
kt	knot(s)	Knoten (1 kt = 1,852 km/h)
LBA	(German) Federal CAA	Luftfahrt-Bundesamt
LDA	Landing Distance Available	Verfügbare Landestrecke
LDR	Landing Distance Required	Benötigte Landestrecke
LIDO	Lufthansa Integrated Dispatch Operation	
LM	Landing Mass	Landemasse
LOC (auch LLZ)	Localizer	Landekurssender
LTA	Airworthiness Directive	Lufttüchtigkeitsanweisung
LU	Air Operator	Luftfahrtunternehmen
LuftVG		Luftverkehrsgesetz

MAC	Mean Aerodynamic Chord	Mittlere aerodynamische Flügeltiefe
MAP	Missed Approach Procedure	Fehlanflugverfahren
MCTOM	Maximum Certified T/O Mass	Maximale zugelassene Startmasse
METAR	Aviation Routine Weather Report	Routine Wettermeldung für die Luftfahrt
MHz	Megahertz	Megahertz
MCC	Multi Crew Coordination	Arbeitskonzept für eine optimale Zusammenarbeit der Besatzungsmitglieder
MDA	Minimum Descent Altitude	Sinkflugmindesthöhe
MLM	Maximum Landing Mass	Maximale Landemasse
MSA	Minimum Sector Altitude	Mindestsektorenhöhe über MSL
MSL	Mean Sea Level	Mittlerer Meeresspiegel
MTOM	Maximum T/O Mass	Maximale Startmasse
NAV	Navigation	Navigation
NfL	Notice to Airmen	Nachrichten für Luftfahrer
NM	Nautical Mile(s)	Nautische Meile(n) (Seemeile)
NP	Propeller Speed	Propellerdrehzahl
NWS	Nose Wheel Steering	Bugradsteuerung
OCA/H	Obstacle Clearance Altitude / Height	Hindernisfreiheit über Meeresspiegel / Flugplatz bzw. Schwelle
OFP	Operational Flight Plan	Flugdurchführungsplan
OM	Operations Manual	Betriebshandbuch
OPS	Operations Control	Betriebssteuerung
OZ	Operations Control Center	Flugbetriebslenkung
PA	Passenger Address	Durchsagesystem zur Information der Passagiere
PANS-OPS	Procedure for Air Navigation Services-Operations	

PAPI	Precision Approach Path Indicator	Präzisionsgleitwegbefeuerung
PF	Pilot Flying	Pilot, der das Flugzeug steuert
P/F Check	Preflight Check	Vorflugkontrolle
PIC	Pilot in Command	Verantwortlicher Luftfahrzeugführer
PL	Power Lever	Leistungshebel
PNF	Pilot non Flying	Pilot, der den PF unterstützt
QNH		Luftdruck in Meereshöhe
QRH	Quick Reference Handbook	
RA	Radio Altimeter	Radarhöhenmesser
REV	Reverse	Umkehrschub
RPL	Repetitive Flight Plan	Dauerflugplan
RTO	Rejected Take-Off	Startabbruch
RWY	Runway	Piste
SB	Service Bulletin	
SID	Standard Instrument Departure Route	Standard-Instrumentenabflug
SIGMET	Information concerning en-route weather phenomena which may affect the safety of aircraft operations	Informationen bezüglich Wettererscheinungen auf der Flugstrecke, welche die Sicherheit des Flugbetriebs beeinträchtigen können
SIM	Simulator	
SOP	Standard Operating Procedure	Standard-Betriebsverfahren
TAC	Total Aircraft Cycles	Gesamtzahl der Landungen des Luftfahrzeuges
TAF	Terminal Aerodrome Forecast	Flugplatzwettervorhersage
TAT	Total Aircraft Time	Gesamtflugzeit des Luftfahrzeugs
T/D	Touch Down	Aufsetzen, Landung
T/O	Take-Off	Start, Abheben
TOM	Take-Off Mass	Startmasse
TQ	Engine Torque in %	Drehmoment des Triebwerks in Prozent

TR	Temporary Revision	Vorläufige Änderung
TR	Type Rating	Musterberechtigung
TRI	Type Rating Instructor	Ausbilder für Musterberechtigungen
TRE	Type Rating Examiner	Prüfer für Musterberechtigungen
UTC	Universal Time Coordinated	
V_{APP}	Approach Speed	Anfluggeschwindigkeit
V_{CAS}	Calibrated Air Speed	
V_R	Rotation Speed	Rotationsgeschwindigkeit
V_{Ref}	Landing Reference Speed	
VS	Vertical Speed	Steig-/Sinkgeschwindigkeit
V_{TGT}	Target Speed	Zielgeschwindigkeit im Landeanflug
VMC	Visual Meteorological Conditions	Sichtflugwetterbedingungen
WOW	Weight on Wheels	

Summary

The Do 328-100 had taken off from Berlin-Tempelhof to a scheduled service to Mannheim City. Three crew members and 24 passengers were aboard the airplane. The co-pilot was the Pilot Flying (PF) during this flight. After an uneventful cruise flight the approach to runway 27 was carried out according to the published LOC/DME approach procedure.

A few seconds prior to the touch down the co-pilot handed over the controls to the Pilot in Command (PIC). He continued the approach. Due to an inappropriate engine power setting the main landing gear touched down for the first time after the touch-down zone and the airplane touched down for good in the last 150 m of the runway.

The crew stated that after touchdown the power levers could, at first, not be pulled into idle and therefore no thrust reverse was available. Thereupon the Emergency / Park Brake (E/P Brake) was activated.

The airplane overshot the runway and hit an earth wall about 50 m behind the end of the runway.

The accident occurred at 1745 hrs CET.

The accident was due to

the airplane overshooting the runway and hitting an earth wall at the end of the runway,
the non-initiation of a balked landing,
the fact that the power levers could not be pulled into ground idle or reverse by the PIC (PF),
the fact that the landing was not aborted after the airplane had flown across the touch-down zone,
the fact that the power levers were not pulled into flight idle during the flare which both pilots did not recognise,
the fact that the crew deviated from the SOPs and therefore reached their performance limit and at the end went beyond it.

The following factors contributed to the accident:

Within in the air operator the non-precision approaches and the landings at Mannheim City were conducted with significant frequency not according to the requirements of the OM.

The TRs and FOIs of the aircraft manufacturer were not incorporated into the OM/B or OM/D of the air operator.

The practical training of the crew by the air operator was insufficient regarding the prevention of an erroneous operation of the power levers based on the instruction published by the aircraft manufacturer.

The crew conducted a non-precision approach which did not comply with the air operator's OM requirements and the AIP.

The power lever design was not sufficiently fault tolerant.

The existing risks caused by the problems during the use of the power levers were not recognised correctly and remedied by the responsible authorities and type certificate holders in spite of several occurrences and safety recommendations.

The touch-down zone at Mannheim City Airfield was not marked.

The extent and design of the safety area at the end of runway 27 was not sufficient to ensure the safety level ICAO and the German legislator require for flight operations.

1. Factual Information

1.1. History of the Flight

On 19 March 2008 at 1745 hrs[1] an air accident involving a Do 328-100 occurred at Mannheim City (EDFM). The airplane was on a flight from Berlin-Tempelhof (EDDI) to Mannheim City.

The history of the flight was reconstructed based on the following: Flight Data Recorder (FDR) and Cockpit Voice Recorder (CVR) on board the airplane; radio communications between Mannheim Tower and the Do 328-100 crew recorded on the ground; Air Traffic Control (ATC) radar recordings; statements of the crew members and of witnesses at Mannheim City Airfield and the traces found on and beyond runway 27.

The Do 328-100 flight crew and the airplane belonged to an air operator who undertook flights to and from Mannheim City several times a day.

The PIC, the co-pilot and the Cabin Assistant (CA) reported for duty at 1345 hrs at their Mannheim home base.

Prior to the accident flight the crew had already undertaken one flight from Mannheim City to Berlin-Tempelhof.

Departure from Berlin-Tempelhof was scheduled for 1630 hrs with 24 passengers on board. Estimated flight time was 1 hour 14 minutes.

Before departing Berlin-Tempelhof the crew had knowledge about the weather conditions to be expected en route and in Mannheim. During the briefing in Mannheim they had acquired the necessary meteorological documentation (WX for Flight Group).

The flight from Berlin-Tempelhof to Mannheim City was conducted in accordance with Instrument Flight Rules (IFR) commensurate with the Repetitive Flight Plan (RPL) filed by the air operator.

The PIC occupied the left-hand seat. The First Officer (FO) occupied the right-hand seat and was PF during this flight. The PIC was the Pilot non Flying (PNF). During the whole flight he was therefore, among other things, responsible for radio communications with ATC and monitoring the FO (PF).

On 19 March 2008 the PIC and FO were flying as a crew for the first time.

[1] All times local, unless otherwise stated.

With the acknowledgement to have received the ATIS information Tango of 1620 hrs, the crew asked for the start-up clearance from Tempelhof Ground. ATIS Information Tango advised that in the vicinity of the airport storm clouds and snow showers were present.

ATC gave start-up clearance and simultaneously assigned the Standard Instrument Departure Route (SID) GENTI 1Q.

At 1632 hrs the engines were started.

At 1634 hrs the crew received the instruction to taxi to the taxi-holding position of runway 27.

Due to the design of the Do 328-100 taxiing can only be conducted from the left-hand seat: Therefore the PIC taxied the airplane to the take-off position of runway 27 and then handed the controls over to the FO as PF.

While taxiing to the runway the FO read the taxi checklist and conducted the departure briefing for Berlin-Tempelhof.

After the frequency was changed to Tempelhof Tower the airplane received the clearance to taxi to taxi-holding position 27L.

Tempelhof Tower informed the crew that a delay was to be anticipated since a snow shower which was currently over Berlin Tegel was moving towards Berlin-Tempelhof and would reach it in about 2 - 3 minutes.

At taxi-holding position 27L the PIC made an announcement to the passengers about the anticipated delay due to the weather conditions.

While at taxi-holding position 27L the FO advised the PIC of the visual warning BRK TEMP HIGH on the Engine Indication and Crew Alerting System (EICAS) display. The PIC's explanation was that he had used the brakes quite frequently and it was therefore not a problem. He pulled up the Hydraulic System Page on the EICAS display and asked the FO how high the temperatures of the brakes were and at what time the warning would illuminate. The FO could not give a precise answer: (DE)[1] "It is 124°C?" The PIC corrected the answer with 135°C and added: (DE) "But it is not bad".

He further inquired of the FO how many flight hours he had on the Do 328. The FO answered: (DE) "About 130 hours." The PIC was of the opinion that with 130 hours flown he could conduct a take-off during snow fall. He asked the FO if he wanted to attempt the take-off. The FO: (DE) "I think I will attempt it". Afterwards the PIC advised him of the conduct of the take-off.

[1] (DE) = The following is a translation of the German text.

The PIC said the snow fall had lessened. He recommended a static take-off and to increase rotation speed (V_R) by 10 kt due to icing conditions.

After the line-up clearance for runway 27L the line-up checklist was completed.

When reading the checklist the FO once again indicated the BRK TEMP HIGH warning.

In the take-off position the FO took over controls from the PIC.

After take-off clearance the PIC (PNF) informed the FO what he intended to do regarding the high temperatures of the brakes: Until 1,000 ft had been reached the landing gear was to remain extended to allow the brakes to cool down. In addition, the airspeed should remain at 150 kt so that a steep climb was possible to get out of the clouds as fast as possible.

At 1645 hrs the Do 328-100 took off from runway 27L.

As is routine the FO (PF) called for gear up after take-off. The PIC as PNF did as requested immediately. Only after the landing gear had been retracted did the PIC (PNF) advise the FO (PF) of the fact that they now had forgotten to leave the landing gear extended for some time to cool down the brakes.

Still in the climb phase the PIC appreciated the FO's (PF) performance in the take-off and departure phase with a positive comment.

The airplane was first cleared for Flight Level (FL) 160 and later for cruising altitude FL220.

The flight in cruising altitude was uneventful. The CVR showed that in this phase the PIC (PNF) completed the flight's documentation. Among other things, the expected landing mass for Mannheim City was discussed; the Operational Flight Plan (OFP) documented 13,200 kg.

At 1723 hrs the PIC (PNF) had received the ATIS broadcast November of 1650 hrs which stipulated a LOC/DME approach to runway 27.

At 1723 hrs the crew received the clearance from Langen Radar to descend to FL120.

During descend the FO (PF) conducted the approach briefing according to LIDO approach chart 7-10 (14-FEB-2008). The reason was that an instrument approach procedure to runway 27 according to the standard procedure LOC/DME was expected (Appendix). The altitude at the Final Approach Fix (FAF) was given with 5,000 ft and the Minimum Descent Altitude (MDA) with 760 ft. A flap position of 32° was intended. From the table a Landing Reference Speed (V_{REF}) of 110 kt was selected which corresponded with the expected landing mass of 13,200 kg. The

selection and preselection of the NAV equipment setting commensurate with the selected and discussed approach procedure was only partially addressed. During the approach briefing the decision point for the Missed Approach Procedure (MAP), the Landing Distance Available (LDA) and the Landing Distance Required (LDR) were not referred to.

At 1730 hrs during the approach briefing the crew received the ATC clearance to descend to FL80.

At 17:33 hrs after the approach briefing was complete the CVR recorded the following statement coming from the FO (PF): (DE) Well, ... yeah, my landings in Mannheim are not ... really great." Since the PIC (PNF) had acoustically and verbally not understood him the FO (PF) repeated: (DE) "... my landings in Mannheim ... [2] I have to improve them." The PIC (PNF) replied: (DE) "Don't fret. You will do fine."

At 1733 hrs after a frequency change the airplane received an ATC clearance for 5,000 ft (QNH 1,013) and was scheduled for an approach to runway 27 in Mannheim. ATC advised that ATIS information Oscar was valid. The PIC (PNF) repeated the clearance, the QNH and said they would get information Oscar.

After a short indication about the airspeed the PIC (PNF) wanted to hand over radio communications to the FO (PF) so he could get the ATIS report Oscar. That never happened because the FO (PF) called for the approach checks. The PIC (PNF) began to complete the checklist. At 9,500 ft the altimeter indication was cross checked. The FO (PF) also confirmed the MDA of 760 ft. The PIC (PNF) answered "is checked" and advised that the FO (PF) had to decrease the airspeed to 250 kt below FL100.

Afterwards the PIC (PNF) changed the ATIS frequency to Mannheim. The changes in the ATIS report Oscar only concerned the wind; - 320° with 14 kt.

Neither during the approach briefing nor at any later time was the correction of the final approach speed in connection with the prevailing wind discussed.

At 1736 hrs Langen Radar gave the LOC/DME clearance for runway 27 with the instruction to report established.

At the time the airplane was in approach to the Initial Approach Fix (IAF) KETEG. The Flight Management System (FMS) was used to control the airplane with the autopilot. The airplane had a heading of 243° to the extended centre line. After the LOC/DME approach clearance the FO (PF) changed into the heading mode and armed the approach mode. The airplane remained on course.

[2] … = Text was shortened for better understanding.

After the PIC (PNF) had checked with the CA asking whether the cabin was ready for landing he conducted a fuel check. At the time (about 8 minutes prior to landing) 1,600 kg fuel remained on board.

As the PIC (PNF) changed to the air operator's service frequency for a short time (about 26 seconds) to report the arrival and technical data (among other things 1,530 to 1,540 kg fuel) to Operations Control (OPS) the airplane entered the capture phase.

The FDR recording showed that the airplane had reached the cleared altitude of 5,000 ft when entering the localizer area and went below that in the course of events.

According to radar recordings the airplane passed the altitude of 5,000 ft at 1737:39 hrs.

About 40 seconds after the PIC (PNF) had reported back, the FO recognized the infringement of the cleared altitude and said to the PIC (PNF) : (DE) "... I have made a mistake here." The PIC (PNF) had not recognized the altitude infringement. He said to the FO: (DE) "No problem and correct a little upward by 5,000 ...". The CVR recorded the following remark by the FO (PF) as explanation of the infringement: (DE) "Yes this was clearly my fault. I have ... because we were still in descend I have already set the 760."[3]

In about 3,800 ft the airplane was flared and a climb to 5,000 ft AMSL initiated. At the time, the airplane was about 17 Nautical Miles (NM) away from the airport. In this sector the Minimum Sector Altitude (MSA) was 3,900 ft AMSL.

Langen Radar responded to the infringement and asked the crew about their altitude. The PIC (PNF) apologized and said: (DE) "... Yeah, sorry eh, slowly below 5,000 ft, correcting“.

Shortly before the FAF was reached, which is 12 NM away from the DME HND, the airplane reached 5,000 ft again.

The FO (PF) selected 760 ft on the Guidance and Display Control Panel (GDCP) and the airplane left the 5,000 ft altitude in Vertical Speed Mode (VS) at the FAF and started to descend with a rate of descent of 1,100 ft/min. Lateral the airplane followed the selected landing course of 273° in the approach mode (APP).

Now the PIC 8PNF) said to the FO (PF): (DE) "Oh, one must of course descend faster because ...". It was followed by the request for a rate of descent of 1,200 ft/min or more. At the same time the FO was to decrease the airspeed further. Calibrated Airspeed (CAS) at that time was 197 kt.

[3] Altitude preselect on the GDCP

After the crew reported "localizer 27 established" to Langen Radar they were instructed to change to the frequency of Mannheim Tower.

At 1741 hrs this change was completed by the PIC (PNF): (DE) "Mannheim Tower good evening ... (ENG) ten miles out, established two seven." At that time the airplane had an altitude of about 4,700 ft. The autopilot was engaged. The approach was flown in the APP and VS mode.

Mannheim Tower reported wind 320° with 9 kt, maximum 17 kt and issued the clearance for runway 27. A correction of the V_{Ref} under consideration of the wind did not occur at this time either.

During the approach the PIC (PNF) urged the FO a total of four times to not become hectic or fret.

Based on the distance to the DME the PIC (PNF) checked the target altitude and reported it to the FO (PF). After the PIC (PNF) had visual contact with the Precision Approach Path Indicator (PAPI) he reported this, too. Several times, it was noted that the respective flight altitude was exactly right.

At 9 MN the FO (PF) began to configure the airplane for landing which means landing flap position 12°, later at 4 NM 20°.

The landing gear was extended at an altitude of 2,200 ft (1,800 ft RA) and a distance of 4.5 NM.

The FO (PF) changed from APP mode into Navigation (NAV) mode when passing 1,760 ft.

About 3 NM prior to the runway and in an altitude of 1,400 ft (1,000 ft RA) the flaps were extended to 32° and the final checklist completed and read by the PIC. The checklist positions autopilot, yaw damper and condition levers were not yet completed.

Afterwards the PIC (PNF) asked the FO (PF): (DE) "So now you can descend a little faster ...". “. Then engine Torque (TQ) decreased from about 25% to about 3%. For about 10 seconds this TQ was maintained. CAS decreased from 140 kt to about 118 kt. Afterwards TQ was increased to about 20%.

In about 900 ft the airplane entered the ALT SEL capture area; ALT SEL was selected to 760 ft. The airplane changed from VS mode into ALT HOLD mode. Pitch increased form -5° to 0° and then to +1°.

Two NM prior to the runway the condition levers were moved to maximum.

At 1744 hrs the PIC (PNF) reported to the FO (PF) that the overland power line running almost perpendicular to the airport had been overflown and that he should

descend to a PAPI indication of three red and one white light ("Power liner passed – (DE) descend to three red").

The FO (PF) then disengaged the autopilot in an altitude of about 780 ft which also deactivated the yaw damper. The FO (PF) then controlled the airplane manually. Longitudinal pitch changed to -5° and the sink rate increased to more than 1,500 ft/min.

Commensurate to the wind a carb angle of +3° to +5° was flown.

The call out "approach minimum" did not come from the PIC (PN F).

After the MDA was passed the PIC (PNF) reported to the FO (PF) the selection of the missed approach altitude of 5,000 ft.

Mannheim Tower reported the prevailing ground wind as 330° with 11 kt, maximum 18 kt.

At the time of the landing the runway was dry and free of contamination.

After the PIC (PNF) had advised the FO (PF) at the beginning of the approach that speeds were too high, he said 26 seconds prior to touchdown: (DE) "118 is good, proceed."

The approach briefing the FO (PF) had conducted documented V_{Ref} as 110 kt.

Speed decreased to about 110 kt because the FO (PF) changed the longitudinal pitch from about -3° to about -1°.

Shortly afterwards the PIC (PNF) once again commented that everything was fine ((DE) "Okay, three red, continue, and the speed is good, ...").

In 135 ft RA TQ increased to about 27%. Until the airplane was 10 ft RA above the runway this value changed only by a few per cent.

The synthetic voice could be heard in the cockpit announcing that according to the radar 100 ft above ground were reached.

After this indication the PIC (PNF) requested: (DE) "... and now down there ....". And 2 seconds later again: (DE) "... and down ...".

The synthetic voice called out "Fifty".

Shortly afterwards the PIC (PNF) made another comment concerning the longitudinal pitch ((DE) "Exactly, nose down").

The FDR data showed a change in pitch from about -2° to about -4°.

The FDR also showed that the threshold was overflown in about 40 ft (radar) with a CAS of 114 kt and a TQ of both engines of about 29%. Above the threshold the pitch

was about -4.4°. Normally the longitudinal pitch of the Do 328-100 during approach in 50 ft with V_{Ref} and a landing flap position of 32° is between +2° and +3°.

One second later the CVR recorded the PIC's (PNF) order (DE) "slowly back". The FDR showed that the FO (PF) did not respond by changing the engine performance parameters nor did he react verbally.

The PIC's (PNF) order was immediately followed by the synthetic voice reporting the altitudes "Forty, thirty, twenty, ten".

The FO (PF) started the flare. The longitudinal pitch changed from about -4° to +3° and vertical acceleration increased to 1.3 g.

The PIC (PNF) then said "Okay".

The airplane did not touch down but continued to float in a low altitude.

The FO (PF) said: „Oh – your control“. The PIC (PNF) answered: "My control" and took over the controls. On the CVR recording both voices sounded calm. At that time the airplane was about 200 m beyond the threshold. The engine torque had decreased to about 20%.

In the next 5 to 6 seconds the PIC tried to get the airplane on the ground by pushing and pulling on the control column. The airplane's pitch varied between -1° and +2.5°.

Witnesses stated that touchdown occurred in the second half of the runway.

The FDR readout showed that initial ground contact occurred about 530 m behind the threshold (about 480 m prior to the end of the runway) with a CAS of 108 kt and a pitch of about -1°. The FDR also showed that at that time the TQ of both engines was about 20%.

Before the entire main landing gear touched down the FDR recorded a short moment of ground signal of the Weight on Wheels (WOW) proximity switch of the right main landing gear. Then almost simultaneously the ground signals for the left and right main landing gears were recorded for about 3 seconds. After this touchdown the ground signals went out for about one second. Then they came on and stayed on. The CAS was 93 kt and pitch about 0° during this final touchdown.

For the next three seconds no significant deceleration was recorded and the CVR showed the following:

The PIC said: (DE) "It does not work"[4] and almost at the same time the FO said: „No BETA“.

The FO repeated: „No BETA“.

[4] Note: During the interview with the BFU the PIC said that the reverser could not be extended.

The PIC ordered "Pull the hand brake! Pull the hand brake!"

The FO did not realise this command.

The PIC stated he then used his right hand to activate the Emergency/Park (E/P) Brake which was located at the right side of the centre pedestal console.

At about that time, a rudder deflection of about 3° to the right occurred. The airplane's heading increased to about 318°. During the interview the PIC voiced the opinion that this did not occur consciously.

The FO stated during the interview on 1 April 2008 in Braunschweig he had the command (DE) "Pull the hand brake! Pull the hand brake" not understood as an order but as an advice.

Without having received an order by the PIC the FO took over the engines' power levers and pulled them into Reverse (REV). During that process they passed Ground Idle (GI)

The FDR data showed that at that time the BETA signal "armed" was triggered and the ground spoilers were fully extended.

The FDR recording also showed that about 10 seconds after the initial ground contact longitudinal acceleration changed significantly from -0.3 to -0.85 g.

The airplane passed the threshold 09 with a speed of about 50 kt and overshot the paved area beyond the end of the runway with about 30 kt. Immediately after the airplane had left the paved area the left main landing gear collided with a utility shaft cover and buckled. The left wing and the left engine collided with an earth wall running at an angle to the runway. The airplane then turned back towards approx. 265° and came to rest at 1745 hrs with the nose directly in front of the earth wall.

The crew did not request the CA to brace for impact.

On the last 150 m of runway 27 deep-black continuing skid marks running parallel to each other were found.

About 8 seconds after the collision the PIC used the Passenger Address System (PA) to give the instruction to evacuate the airplane.

Two minutes and 10 seconds after the collision the TQ of the right engine decreased from 10% to zero. A further 16 seconds later the propeller came to a stop.

About 2 minutes and 45 seconds after the collision the FO received the instruction from the PIC: (DE) "Complete the checklist". The FO completed the ground evacuation checklist from the Quick Reference Handbook (QRH). In doing so, he noticed that the condition lever for the left engine could not be moved. This was

ignored with the remark „*number one is not possible*“ and the completion of the checklist continued. A similar behaviour occurred at checklist point „*in case of fire [evacuate] to nonaffected side only*“. The fact that the left engine emitted smoke and that therefore an evacuation should only occur on the right side was never mentioned. When the PIC requested to complete the checklist together once again this fact was never mentioned either.

While the FO completed the checklist the PIC tried to establish radio communications with Mannheim Tower and communicated with the rescue services already at the aircraft.

At 17:52 hrs the crew switched off the aircraft electrical system and left the airplane after they had made sure all passengers had left, too.

1.2. Injuries to Persons

Injured	Crew	Passengers	Total on A/C
Slight	-	-	5
None	-	-	22
Total on A/C	3	24	27

1.3. Damage to Aircraft

The aircraft was severely damaged. Details see Chapter 1.12.

1.4. Other Damage

There was minor field damage.

1.5. Personnel information

1.5.1 Pilot in Command (PIC)

Age/sex: 47 years, male

Licenses:

ATPL(A) issued on 22 February 1999 by the Luftfahrt-Bundesamt (German civil aviation authority, LBA) according to JAR-FCL German valid until 24 May 2009.

Ratings/checks:

- PIC on 328-100, valid until 21 July 2008
- Instrument rating including CAT II valid until 21 July 2008
- Proficiency check in the simulator in Brussels on 28 November 2007
- Final check as PIC at the air operator's on 3 July 2007
- Periodic Emergency Safety Equipment Training (ESET) for the Do 328-100 on 27 August 2007
- Crew Resource Management (CRM) (recurrent) on 15 February 2008

Flying experience

Total flight time: 4,921 hours

On Do 328-100: 1,661 hours

Thereof as PIC: 542 hours

Flight time in the last 24 hours: 2 hours 27 minutes

Flight time in the last 7 days: 12 hours 19 minutes

Flight time in the last 90 days: 196 hours 45 minutes

Duty time in the last 24 hours: 4 hours

Rest period (according to LuftBO (Regulation on Operation of Aircraft), para 6 at least 10 hours) prior to the flight: 17 hours

Medical: Class 1 according to JAR-FCL 3 German

Speciality: On 3 July 2007 he received a training (first time) for the special operations conditions at Mannheim City Airfield according to AIP GERMANY, EDFM AD 2.20 Local Traffic Regulations.

Flying Training

In January 1991 the PIC began his flying training with the training to obtain a Private Pilot's License (PPL).

On 24 April 1991 he passed the exam for the PPL (A). The flying training took 46 hours and 31 minutes. He passed the skill test on 3 August 1991. On 27 August 1991 the PPL (A) license was issued.

He acquired the General Flight Radiotelephony Operator's Certificate (AZF) on 25 January 1993.

From 12 March 1991 to 7 November 1993 the PIC attended a correspondence course to acquire a Commercial Pilot's License (CPL 2) including Instrument Rating (IR).

He passed the IR exam on 22 March 1994.

On 19 May 1994 he did not pass the exam for the CPL 2. In six out of eight subjects he had attained less than 75%.

On 1 August 1994 he passed the IR skill test on a Piper PA 28.

On 20 September 1994 he passed the re-examination for the CPL 2.

He failed the skill test to acquire the CPL 2 on 2 November 1994 because he entered the control zone Hahn without a clearance.

He failed the skill test for the CPL 2 on 29 November 1994 again despite the practical retraining he had received. The documentation listed loss of orientation as reason.

He passed the skill test on 1 March 1995 after he had received further theoretical and practical training.

He then successfully trained on Piper Seneca PA 34 and Beech Queen Air BE 65.

On 28 February 1996 he signed up for the training to acquire the ATPL.

On 21 September 1998 he passed the ATPL (A2) exam and on 28 January 1999 the Crew Coordination Concept (CCC) in the B 737 simulator.

On 22 February 1999 he attended a Multi Crew Coordination (MCC) training.

On 22 February 1999 the LBA issued the ATPL (A2).

He successfully trained for the Shorts SD2-60 which was entered into his license on 16 July 1999 and then flew as FO on the type. He gathered experience in the two-man cockpit and in commercial air traffic.

In November 1999 he successfully completed the training for the Fairchild SA 226 Metroliner II and SA 227 Metroliner III. On 29 November 1999 these were entered into his ATPL.

Between 2000 and January 2003 he collected about 1,900 hours flying experience as FO on Metro II and III for an air operator.

On 10 January 2003 he applied for an ATPL (A1).

In February 2003 he acquired the type rating for the Saab 340 as FO after completing 32 hours of simulator training. After flight training on 8 March 2003 and the license entry on 12 March 2003 he was cleared for line training under supervision. On 17 September 2003 the type rating for the Saab 340 was extended with the CAT II rating.

On 1 February 2004 he completed the training as PIC on the Saab 340. The entry into his ATPL occurred on 5 February 2004 and included IR and CAT II. He then began to fly under supervision on the type. He could not finish this because the air operator he worked for had to file for bankruptcy.

Selection of the PIC by the Air Operator

In May 2004 the PIC applied for a position as intermediate entry pilot on Do 328-100.

There was no documentation regarding a selection process or qualification test. The former Do 328-100 fleet manager stated that there were only limited qualification tests.

The PIC underwent a day-long psychological test where personality characteristics like concentration and mental fitness were tested,

This was followed by the training according to the air operators program (OM/D).

Do 328-100 Type Rating

On 21 June 2004 the PIC began the qualification course for the Do 328-100 at CAE Aviation Training in Maastricht. The training ended on 12 July 2004.

He successfully passed 5 hours and 15 minutes (4 sessions) in the cockpit mock-up and 10 hours (5 sessions) in the cockpit systems trainer.

From 29 June 2004 until 9 July 2004 he flew five sessions in the fixed base simulator.

Between 14 July 2004 and 21 July 2004 the commanders upgrading programme in the full flight simulator under supervision of a flight instructor of the air operator CAE Aviation Training in Maastricht was flown.

It included six sessions and the final check with a total of 14 hours.

The check documentation listed the following remarks:

Session No 5 on 18 July 2004: „General overview and basic flying skills within limits only."

Session No 6 on 20/07/2004: „See page before."

The final check was passed with Satisfactory (S) and the Type Rating Examiner (TRE) had entered the following remarks: „Improve general overview, system knowledge! General airmanship at lower limit only".

On 24 August 2004 the following entry was made in his ATPL(A): As PIC on Do 328-100 including IR and on Saab 340 including IR and CAT II and as PIC on single engine land.

First Supervision Period on the Do 328-100

After transition training the PIC began his line training at the air operator's on the Do 328-100.

The Operators Manual Appendix D (OM/D) dated 19 September 2001 stipulated a supervision period of 100 flight hours. It was divided into three parts:

Part 1: Orientation with about 25 flight hours. Part 2: Supervision with about 50 flight hours. Part 3: Stabilisation with about 25 flight hours. At the end there was the final check with two flights (legs).

Between 30 August 2004 and 1 December 2004 he completed the first supervision period with 116 hours and 36 minutes (98 flights - legs).

The air operator kept supervision documentation which recorded the PIC's performance.

This documentation showed that his performance varied. Two examples were picked; one of 3 September 2004 and the other of 29 November 2004 which was shortly before the end of the supervision period:

The supervision record (each day) of 3 September 2004 showed under Point 8, Landing: 8.1 Touchdown Speed, 8.2 Directional Control and 8.4 Braking Technique carried the entry U (unsufficient).

Further remarks were:

-Ldg MHG – touchdown behind first half of rwy!!! no reverse + brake action
- some times missing general overview"
The supervision record of 29 November 2004 showed under Point 1 Airmanship: 1.6 Basic Instruments Flying, Point 7. Descent and Approach, 7.4 Approach Stability, carried the entry SI (Should be improved).

The part "Remarks" carried the entry: *Go-Around due to overriding of Limits (IFR-Basics)."*

There was no final line check as PIC after the end of the supervision period.

During an interview conducted on 1 October 2008 two TRIs who had flown with him stated the reasons were his theoretical and practical weaknesses. In summary, the PIC's performance during the supervision period was not sufficient to become a PIC.

Between 15 December 2004 and 16 February 2005 the supervision was extended as FO in the right-hand seat for another 27 hours and 8 minutes. On 16 February 2005 he successfully passed the final line check as FO.

He flew for about two years and for 896 flight hours as FO on the Do328-100 for the air operator.

The TRIs stated they often worked with him on operational issues. He was dedicated and also studied the Do 328-100 technology. His performance improved significantly. He was better than the average FO and showed more and more skills of a PIC.

Second Supervision Period on the Do 328-100

The air operator decided to ask him to begin a second supervision period since his performance as FO had improved and the need for more PICs had arisen.

Between 23 April 2007 and 25 April 2007 he completed the commanders upgrading programme in the flight simulator at CAE Aviation Training in Maastricht with a total of 16 hours. The syllabus stipulated that session 1 include the LOC/DME approach. The supervision records do not show any entries from the flight instructor as to the student's performance.

Between 11 May 2007 and 3 July 2007 the PIC completed the second supervision period with 80 hours 12 minutes flown.

The supervision records show several entries of good performance, good work and good airmanship. Two times the entries read: More leaderwork (8 June 2007) and Don't forget you are a leader (18 June 2007).

The supervision record (each day) of 1 July 2007 showed under Remarks:

8.1 On short fields choose a touchdown point and land the a/c there (PWR-lever in FI to avoid excessive flare) [Landing in Mannheim City];
8.4 Use reverse AND brakes to decelerate a/c".
The fleet manager stated in writing that due to the shown performance and the flying experience the supervision period as PIC was reduced on 4 July 2007 to 81 hours and 70 flights (legs).

The OM/D Appendix 02 stipulates that TRIs fill in a grade slip after every leg. Thus succeeding TRIs are informed as to the PICs training level and possible weaknesses. According to the documentation provided to the BFU this was only adhered to on 3 July 2007 (grade slip line check).

The final check was passed on 3 July 2007. The remarks included: *Good performance, counted as line check".* The line check topics showed that the PIC had as PF performed a LOC/DME approach to Mannheim City Airfield.

The final check on 3 July 2007 was conducted by a TRI who did not have the rating as Type Rating Examiner (TRE) according to the air operator's OM/ D, Training-Appendix 01, Training and Checking Personnel, Chapter 01-A01, Revision 1.

From then on he flew as PIC on Do 328-100 for the air operator.

The simulator training in regard to non-precision approaches down to the MDA could not be determined.

In the last 90 calendar days prior to the accident (21 December 2007 - 19 March 2008) the PIC performed a total of 33 non-precision approaches (LOC/DME) to Mannheim City Airfield with the Do 328-100. How many of these approaches he had conducted as PF or PNF is unknown.

1.5.2 First Officer (FO)

Age/sex: 28 years, male

Licenses:

CPL (A) issued on 28 July 2006 by the Luftfahrt-Bundesamt according to JAR-FCL German valid until 28 July 2008.

Ratings/checks:

- FO on Do 328-100, valid until 28 October 2008
- Instrument rating including CAT II valid until 28 October 2008
- Proficiency check in the simulator in Brussels on 28 October 2007
- Final check as FO at the air operator's on 6 February 2008
- Periodic Emergency Safety Equipment Training (ESET) for the Do 328-100 on 19 February 2008
- CRM Initial Training on 3/4 November 2007
- PIC on multi-engined piston engine airplanes (ME piston land) with IR valid until 15 June 2008
- Single engine airplanes (SE piston land) with IR valid until 1 February 2008

Flying experience

Total flight time: 321 hours 44 minutes

On Do 328-100: 131 hours 27 minutes

Flight time in the last 24 hours: 2 hours 27 minutes

Flight time in the last 7 days: 5 hours 39 minutes

Flight time in the last 90 days: 92 hours 57 minutes

Duty time in the last 24 hours: 4 hours

Rest period (according to Regulation on Operation of Aircraft, para 6 at least 10 hours) prior to the flight: 60 hours

Medical: Class 1 according to JAR-FCL 3 German, has to wear glasses (VDL)

Speciality: On 14 November 2007 he received training as FO for the special operations conditions at Mannheim City Airfield according to AIP GERMANY, EDFM AD 2.20 Local Traffic Regulations.

After finishing his supervision period on 6 February 2008 he flew as FO a total of 22 hours and 56 minutes; nine times Mannheim City Airfield was the destination airport.

Flying Training

On 14 July 2003 the co-pilot (FO) began his training to acquire the ATPL(A) according to JAR-FCL.

On 5 July 2004 he obtained the General Flight Radiotelephony Operator's Certificate (AZF).

On 28 July 2004 he passed the ATPL(A) exam.

He acquired his PPL(A) with the entry SE piston land as PIC on 1 February 2006.

On 15 June 2006 he passed his IR skill test on Piper Seminole PA 44.

Between 9 July 2006 and 13 July 2006 he completed the MCC training and passed the skill test in the Boeing B737-400 simulator.

The CPL(A) was first issued on 28 July 2006 by the LBA.

Selection of the FO by the Air Operator

His qualification was checked before he was employed by the air operator. On 20 June 2007 his flying performance was checked in a Dash-8-FNPT-Simulator for 1 hour and 30 minutes his MCC as FO was checked in a simulator. External examiners performed a psychological test (90 questions) with him. In order to determine his capacity for teamwork the FO had to answer the 16-PF-Questionnaire. A team determined during an interview whether he would fit into the company. His ICAO phraseology knowledge was also tested. Based on the compiled personality profile four recruitment officers conducted an evaluation.

The result was a positive assessment and that the FO fit into the company. He was employed by the air operator.

This was followed by the training according to the air operator's program (OM/D).

On 27 October 2007 he successfully passed a skill test in the Do 328-100 simulator.

Do 328-100 Type Rating

From 20 September 2007 until 28 October 2007 he successfully completed the qualification course for the Do 328-100 at CAE Aviation Training in Brussels.

It included full flight simulator training with 10 sessions and 40 hours between 15 October 2007 and 28 October 2007.

The flight instructors rated the individual sessions four times with S+ (Standard plus) and six times with S (Standard).

According to the syllabus, session 5 specifically trained take-offs and landings on short runways.

The trainee training folder for session 1 (15 October 2007) showed the following remark: […] Make sure PL´s are at flight idle when touching down, then don´t hesitate to select ground idle".

In nine out of ten sessions the FO received the rating S+ for CRM.

The full flight simulator training included non-precision approaches down to MDA; four NDB, two VOR/DME and two LOC only approaches.

Supervision Period on the Do 328-100

The OM/D – Appendix 02 (page 17 of 32), Revision original stipulated for FOs a supervision period on the Do 328-100 of 100 hours divided into two parts:

Part 1: Orientation with about 40 flight hours. Part 2: Supervision with about 60 flight hours. At the end there was the final check with two flights (legs).

From 5 December 2007 until 6 February 2008 the FO completed the supervision period with 110 hours one minute and 91 flights (legs) on the air operator's scheduled flights.

The respective check documentation showed only positive remarks from the TRIs about the FO's work.

Off and on the TRIs criticised that check-lists were not consequently utilised and procedures not adhered to (18 December 2007, 10 January 2008, 17 January 2008).

The supervision records (12 December 2007, 17 December 2007, 18 December 2007, 1 January 2008 and 9 January 2008) showed remarks by the TRIs concerning keeping the direction with the rudder after touchdown.

On 16 December 2007 the TRI criticised the landing with cross wind conditions and recorded: "We have to train x-wind landings."

The supervision record of 1 February 2008 showed the remark: "Generally well flown. Landings need some more exercise."

On 6 February 2008 the final line check occurred and was passed without a remark or recommendation. The check documentation showed for all required subjects the rating S (Satisfactory).

The final check on 6 February 2008 was conducted by a TRI who did not have the rating as Type Rating Examiner (TRE) according to the operator's OM/ D, Training-Appendix 01, Training and Checking Personnel, Chapter 01-A01, Revision 1.

The review of the provided check documentation did not determine the number of non-precision approaches. The recordings in the FO's pilot log book did not give that information either.

The OM/D Appendix 02 stipulated that TRIs fill in a grade slip after every leg. According to the documentation provided to the BFU this was only adhered to during the final line check.

The stipulation in the OM/D – Appendix 02, page 18 of 32 that each item has to be covered at least once during the supervision period was not realised during the training of the FO. Among other things, the following items were not covered: Section

C, Ground operation "Reverse Taxiing", Section F, Approaches "VOR/LOC" and "Visual/Circling" and Section H, Theory "Single Engine Go Around" "Rad. Fail. Procedures" and "Winter Ops Ground".

During the interview by the BFU on 1 April 2008 the FO basically answered the question why he had handed over the controls to the PIC during the flare with: During the flare I noticed that there was something wrong with the airplane. I did not know what it was. I have done such a transferral once before during my supervision period on the Do 328-100.

1.5.3 Cabin Attendant

Age/sex: 38 years, female

Ratings/checks:

Training and completion as CCM on 31 January 2002 on Do 328-100.

Line check as CCM at the air operator's on 27 November 2007

Periodic Emergency Safety Equipment Training (ESET) for the Do 328-100 on 10/07/2007

CRM (recurrent) on 10 July 2007

Duty time in the last 24 hours: 4 hours

Rest period (according to LuftBO (Regulation on Operation of Aircraft), para 6 at least 10 hours) prior to the flight: more than 24 hours.

1.6. Aircraft Information

1.6.1 Type, Manufacture and Maintenance

The Dornier Do 328-100 is a transport aircraft with a maximum take-off mass of 13,990 kg. The airplane is equipped with two Pratt & Whitney PW 119B turboprop engines. Originally, Dornier Luftfahrt GmbH applied for the type certificate and manufactured the aircraft according to JAR 25. From 8 August 2000 on, Fairchild Dornier GmbH was type certificate holder and after 28 July 2003 it was the AvCraft Aerospace GmbH. Since 7 June 2006 the 328 Support Services GmbH was the type certificate holder and had become the production organisation on 4 July 2006.

The accident airplane was manufactured in 1999 by Dornier Luftfahrt GmbH and had the manufacturer's serial number 3107. Total Aircraft Time (TAT) was 13,029 hours

and 13,185 flights. The hold item list did not contain any entries connected to the accident.

The last maintenance check took place on 26 April 2007 at 12,187 hours TAT. On 8 August 2007 a one-year and a two-year inspection and C1, C2, C4, A1, A2, A3, A5, SSI/CP25 were conducted. On 27 July 2007 the last inspection of the power levers according to AMM 76-11-06-200-801-A01 took place.

The technical logbook showed the following checks: 17 March 2008 the last line check at 13,012 hours TAT and 13,169 Total Aircraft Cycles (TAC); 19 March 2008 a Pre Flight Check (P/F) and a service check at 13,028 hours TAT and 13,183 TAC.

1.6.2 Payload and Fuel

The Aircraft Journey Log showed that the airplane had 2,200 kg fuel on board after it had been refuelled in Berlin-Tempelhof with 1,312 litres fuel. The minimum ramp fuel was 1,320 kg according to the provided calculations. Therefore, 880 kg extra fuel were on board. The expected trip and taxi fuel was about 747 kg. Therefore the take-off mass, including payload, was 13,931 kg (MTOM 13,990 kg) and the expected landing mass was 13,214 kg (16 kg below the Maximum Landing Mass (MLM) of 13,230 kg) and on-block fuel was 1,453 kg.

The OFP showed proceeds of 170 USD per ton extra fuel.

The OFP also showed that way point BAMKI was already reached nine minutes earlier than planned. Therefore, extra fuel had reached 1,015 kg because a few shortcuts had been flown. Landing at Mannheim City occurred 15 minutes ahead of schedule. It can therefore be assumed that the amount of extra fuel did not decrease any more. The increase of extra fuel by 135 kg from 880 kg to 1,015 kg also meant that the landing mass had increased by the same value. Therefore, the landing mass of 13,349 kg had exceeded the MLM (13,230 kg) by 119 kg (approx. 1%).

At 1737 hrs (8 minutes prior to landing) the PIC had reported the expected on-block fuel to the air operator in Mannheim and estimated it to be 1,530 to 1,540 kg. With the remaining fuel of about 1,535 kg compared to 1,453 kg, the landing mass was 82 kg higher than planned and therefore 66 kg (0.5%) above the MLM.

The crew compiled a Load & Trim Sheet Dornier 328-100 according to which the centre of gravity was with 24% Mean Aerodynamic Chord (MAC) at take-off in Berlin-Tempelhof and with 23% MAC during the landing at Mannheim City in the forward allowable range.

1.6.3 Operation of Engines and Propeller

The power levers of the Do 328-100 engines are located on the centre console and the respective engine power is adjusted by cables. Whenever the power levers are moved TQ and therefore the thrust changes in a range from maximum to flight idle. The engine speed (NP) is regulated by the value of the condition lever through a commensurate propeller pitch. In order to reach ground idle the power levers must be brought into flight idle and then an additional latch on the respective power lever must be pulled. Then the power levers can be pulled further back towards ground idle. Propeller pitch and engine power are now directly controlled through the use of the power levers. When a propeller has left flight idle (15.5% pitch) the corresponding BETA indication illuminates (once 12,5% pitch are reached) on the EICAS display. The power levers exhibit a recognisable resistance once ground idle is reached. When the power levers are pulled beyond the point of resistance the propeller blades are driven into reverse and engine power is increased. Already in the GI position (-5.1°) the propellers develop a significant aerodynamic resistance during the landing.

If the latch is pulled before FI is reached the power levers can no longer be pulled into FI and TQ can only be decreased to about 20% (according to the manufacturer). TQ in FI is considerably lower. In the past incidents and one accident have occurred due to problems with the handling of this mechanism. The British Aircraft Accident Investigation Branch (AAIB) has conducted an investigation of the mechanism in the scope of an incident investigation. For further details refer to EW/C2006/06/05 of the AAIB.

1.6.4 E/P Brake

All four wheels of the main landing gear are affected by the E/P brake simultaneously and in an undifferentiated manner. The anti-skid system is not active at that time. The braking effect is proportional to the force used on the lever.

1.7. Meteorological Information

The crew had obtained the en-route weather and METAR, TAF and LONG TAF of Mannheim City and alternate airports.

The TAF from 1400 hrs to 2200 hrs read:

Surface wind 300° with 12 kt, horizontal visibility more than 10 km, scattered cloud (SCT) in 4,000 ft. Between 1400 and 1900 hrs TEMPO: horizontal visibility 4,000 m, rain and snow showers, cloud (BKN) in 1,400 ft with Cumulonimbus.

There was no SIGMET for the flight route.

The following METAR (ATIS information Oscar) was broadcast at Mannheim City Airfield at 1720 hrs: Surface wind 320° with 14 kt, varied directions between 290° and 350°, surface horizontal visibility 10 km, in the vicinity of the airfield showers, few cloud (FEW) in 800 ft and scattered cloud (SCT) in 3,300 ft above ground, temperature 6°C and dewpoint -2°C, QNH 1,013 hPa.

At the time of the accident daylight prevailed.

1.8. Aids to Navigation

1.8.1 LOC/DME Approach Runway 27

A LOC/DME approach 27 to Mannheim City Airfield is a non-precision approach.

As aids to navigation the Localizer (LOC) IMAW, frequency 108.55 MHz and the Distance Measuring Equipment (DME) Mannheim MND, frequency 113.55 MHz, channel 82Y were available. Both navigation aids are available 24/7.

The LOC is located 91 m west of runway threshold 09 and 20 m north of the runway centre line. The geographical location is N 49°28'23.56'' and E 008°30'17.62''.

The DME is located at Mannheim City Airfield. The Designated Operational Coverage (DOC) is 15 NM/FL 100.

It is located about 230 m south of and axial to the runway. The geographical location is N 49°28'14.30'' and E 008°30'57.53''.

The last flight inspection of the LOC/DME occurred on 3 March 2008 and showed no anomalies.

South and north of runway 27 a PAPI each is installed. It had a glideslope of 4.0 to guarantee a sufficient altitude to pass the street bordering the airfield. On 19 March 2008 during the time of the approach the aids to navigation operated in normal mode and were fully operational.

The non-precision approach 27 had a maximum allowable mean rate of descend of 6.5% (3.7°). According to ICAO DOC 8168 a higher rate of descend is not allowed for non-precision approaches. The rate of descend has to be increased from 3.7° to the 4° of the PAPI glideslope at the latest at the missed approach point one mile prior to the beginning of the runway.

1.8.2 Radar Control of the Approach to Mannheim City

The airplane was guided by the air traffic control centre Langen Radar.

The radar track was recorded and made available to the BFU.

1.9. Communications

Radio communications were recorded and the recording was made available to the BFU for evaluation. Significant passages were quoted throughout the report.

1.10. Airport Information

1.10.1 General

Mannheim City Airfield is located south-east of Mannheim on an elevation of 309 ft AMSL. There are one tarmac runway with a length of 1,066 m and a width of 25 m and the direction 273°/093° and two grass runways. The airfield is bordered by earth walls on the south-west and east borders with multi-lane streets running directly behind.

The runway has cross grooves. The definition in JAR OPS 1.480 defines a damp runway as dry if it has cross grooves or a porous covering and if it is maintained to retain “effectively dry” braking action even when moisture is present. The airfield operator stated that such a maintenance program was in existence.

Flight operations at Mannheim City Airfield were restricted due to the adjacent urban buildings and the streets directly bordering the airfield. This is the reason why the AIP classified flight operations as difficult as was recommended by the certification authority. The AIP explicitly described the aircraft types allowed, the restrictions regarding flight operations and special operational conditions. Flight crews and air operators had to confirm in writing before take-offs and landings that they had familiarized themselves with the special operations conditions at Mannheim City Airfield (Chapter 1.18).

The investigation revealed that the one-half runway distance remaining sign was not placed exactly at the one-half runway distance and there was no touchdown zone or aiming point marking (Appendix).

In 2007 Mannheim City Airfield had seen about 50,000 flights.

1.10.2 Approval Process

On 19 May 1999 flight operations according to instrument flight rules were approved at Mannheim City Airfield in accordance with LuftVG (Federal Aviation Act), para 6. Since runway length was below 1,200 m it was classified with Code 2 in accordance with ICAO, Annex 14, Volume I.

ICAO guidelines stipulate that Code 2 runways are surrounded with a strip to which a runway end safety area is attached. The strip is to be at least 60 m longer than the runway and should be +/- 75 m wide (from the runway centreline). The runway end

safety areas have to have at least a length of 90 m. Furthermore, a length of 120 m was recommended. The width of these areas was to be the same as that of the strip or at least twice the runway width. Objects which could be dangerous to aircraft should not be within the strip or the safety areas.

The NFL I-267/71 valid at the time of approval and published by the Federal Ministry of Transport (BMV) stipulated for runways used for instrument approaches a strip of 300 m length prior to and behind the runway. This requirement was justified in the "Richtlinie über die Hindernisfreiheit für Start- und Landebahnen auf Verkehrsflughäfen" (Commentary to the guideline concerning the obstacle clearance for runways on airports) by the accident frequency due to touchdowns of aircraft before the threshold and the overshooting of runways.

In 2001 the ICAO regulations were implemented with the NfL I-328/01 which superseded NFL I-267/71.

Both NFLs stipulated that in the strip and end of runway safety areas no buildings or depressions can be tolerated unless these are absolutely necessary for safe and orderly flight operations.

The situation at the end of runway 27 is depicted in the Appendix.

The German Federal Ministry for Transport, Building and Urban Affairs (BMVBS) stipulated during the airfield certification application process for IFR operations that an aircraft arresting system be installed at the end of runway 27 due to the limited safety strip. This was to safeguard the road traffic on the adjacent motorway.

The DFS commissioned an expert opinion with respect to the certification process. Therein, among other things, an aircraft arresting system to safeguard people and material assets against overshooting aircraft is not supported. From the DFS's point of view such aircraft arresting systems are no alternative to sufficiently dimensioned safety areas in which aircraft can come to a standstill without danger to themselves or others. Based on the expert opinion commissioned by the DFS the BMVBW advised of the strict adherence to the PAPI glideslope and the realisation of stabilised approaches. Third party protection from aircraft veering off the runway was still demanded.

The earth wall raised in 1993 at the west runway end was declared a sufficient measure by airfield operator and certifying authority (Regierungspräsidium Karlsruhe). The airfield application for ILS operation was approved with restrictions.

1.10.3 Runway Markings

ICAO, Annex 14, Volume I, stipulated an aiming point for all paved Code 2 runways and above which are used for IFR approaches. According to ICAO this aiming point has to concur with the glideslope if a PAPI is installed. ICAO recommends for Code 2 runways with a non-precision approach an additional pair of touch-down zone markings 150 m behind the aiming point marking (ICAO Annex 14, Volume I, Chapter 5.2.6.5). The NFL I-200/93 valid at the time of the airfield certification referred to the ICAO recommendation but did neither stipulate an aiming point nor a touch-down zone marking for non-precision approach runways. The ICAO guidelines were incorporated into the "Gemeinsamen Grundsätze des Bundes und der Länder über die Markierung und die Befeuerung von Flugplätzen mit Instrumentenflugverkehr" in 2003 and published in the NFL I-95/03.

1.11. Flight Recorders

On 20 March 2008 the memories of the Cockpit Voice Recorder (CVR) and the Flight Data Recorder (FDR) were read out at the BFU in Braunschweig.

1.11.1 Cockpit Voice Recorder

Manufacturer:	L-3COM
Model:	FA 2100
P/N:	2100-1020-00
S/N	00655
Medium:	Solid State
State of the recorder:	No damages (visual examination), service label of RUAG 9 March 2003

Read-out equipment:	Portable Interface PI, OEM for Fairchild Model FA2100
Analysis equipment	PC Software “VEGAS”

Recording configuration:	30 minutes, 4 channels
	2 hours, 2 channels
Recording quality:	Good

Contents:

2 hours:	Channel 1:	Mixed
	Channel 2:	Area Mike
30 minutes:	Channel 1:	Area Mike

Channel 2: PIC
Channel 3: Co-pilot
Channel 4: PA

1.11.2 CVR Transcript

The CVR excerpts relevant for the investigation were incorporated into the report.

1.11.3 Flight Data Recorder

Manufacturer:	Allied Signal
Model:	SSFDR
P/N:	980-4700-001
S/N:	2369
Medium:	Solid State
State of the recorder:	No damages (visual examination), service label of RUAG 22 March 2004

Read-out equipment:	Honeywell Readout Unit Model: RPGSE
Analysis equipment:	Workstation: HP C 240 Software: RAPS 7.0 Readout, analysis and presentation by Flightscape Inc., Ottawa

Recording configuration:	64 data words, 12 bit per word
Recording quality:	Good, low error rate

Contents:	
Recording length:	27 hours flight data
Parameter list:	According to Dornier Document NE10-707/93 93 valid parameters

Usable flight data:	1 landing (oldest flight) 12 complete flights (including accident flight)

1.11.4 Synchronisation of CVR and FDR

It was determined that the DFDR time line did not concur with the ATC (UTC) time line.

The FDR recorded 61 data packages per UTC minute which means one data packages spanned 60/61 seconds.

This problem is true for all Do-328 types and is known to accident investigators. The Dornier company has not solved the problem.

Therefore, the analysis program RAPS developed an error on the x-axis.

It increases with increased distance from the point of synchronisation (time lag).

Since the push-to-talk switch was not pushed during the touchdown a synchronisation in the immediate vicinity of the time of the accident is not possible.

The nearest point was chosen:

ATC transcript:

16:44:12 UTC push-to-talk switch was pushed (no verbal content)

The time period important for the analysis is about one minute away form the point of synchronisation.

The error in the x-axis is therefore only one second at most.

1.11.5 Flight Data Analysis:

Details of the accident flight: (on-board clock, recorded time)

1456:43 hrs on-board clock: T/D in Berlin Tempelhof

The data did not show an interruption during the ground time in Tempelhof

1532:52 hrs on-board clock: Start-up engine No. 2

1545:58 hrs on-board clock: Take Off (T/O) in Berlin-Tempelhof

The on-board clock time almost concurs with UTC, it can, however, deviate from a few seconds up to a few minutes.

16:45:06 UTC: standstill of the airplane

16:50:38 UTC: end of the recording

The FDR data showed that the parameter engine torque was always between 18% and 29% in the last 30 seconds prior to touchdown and 10 seconds afterwards.

The FDR does not record the brake parameters. Only the vertical acceleration allows any conclusion as to the use of the wheel brakes.

Additional relevant flight data was put into graphs and tables (Appendix).

Distance and speeds were calculated with the use of RAPS.

1.12. Wreckage and Impact Information

The airplane was found south of the localizer antennas beyond runway 27. The aircraft nose had contact with an earth wall. The airplane axis was about parallel to the runway and the airplane had a tilted position to the left. The left wing stuck in the earth wall. The left landing gear was buckled. The propeller had been severed from the left engine and lay behind the cockpit beneath the fuselage. Flaps and spoilers were extended. The wing to body fairing was severely damaged.

The power levers for the engines were free. The connection to the engines was severed. The condition lever of the right engine was free. It was no longer connected with the engine. The condition lever of the right engine was jammed. It was in the front third position.

The runway was dry. None of the touch-down traces found on the runway could be assigned to the accident aircraft. On the last 150 m of runway 27 deep-black, continuous skid marks were visible which could be assigned to the accident aircraft. After the runway end the skid marks crossed a utility shaft (electrical equipment). This utility shaft was open and the concrete lid lay about 5 m to the side. Parts of the wheel well doors and the left propeller were found in the immediate vicinity of the utility shaft.

The baggage and carry-on baggage was removed from the Do 328-100 and weighed. The baggage weight 147.3 kg and the carry-on 56.8 kg.

1.13. Medical and Pathological Information

There was no evidence that physiological factors or incapacitation affected the performance of the flight crew members.

The police carried out an alcohol test after the accident which was negative with all three crew members.

1.14. Fire

The examination of the airplane showed no traces of fire. The left engine nacelle showed discolouration on the cowling and melted rubber parts. Witnesses observed severe smoke development on the left engine after the accident.

1.15. Survival Aspects

Of the 31 passenger seats 24 were occupied during this flight (Appendix). During the landing the flight attendant sat in her seat at the front end of the cabin. The

passengers had carry-on luggage which had been stored in the overhead bins and beneath the seats.

At 1745 hrs, about eight seconds after the airplane had come to a standstill, the order "Evacuate, evacuate!" came over the Passenger Address System (PA) from the cockpit. As the flight attendant tried to get a general idea of the situation the passengers already jumped up. The flight attendant asked the passengers emphatically to remain seated.

Witnesses stated that at that time the left engine emitted smoke whereas the right was still running.

The passenger sitting in row 11 opposite the service door opened it on his own initiative and left the airplane. Other passengers followed him. The flight attendant estimated that the other doors were not safely usable for an evacuation and therefore asked the remaining passengers to also use the service door. Two and a half minutes after the standstill the flight attendant left the airplane to take care of the passengers. She had made sure the crew did not need any help.

Three minutes after the accident the first rescue person reached the cockpit and enquired as to the crew's state of health.

The passengers had left their carry-on luggage in the cabin. The passengers were all in good health, i. e. no one was unable to leave the airplane due to physical impairment or injury.

Rescue personnel and the flight attendant took care of the passengers after the evacuation.

Of the 24 passengers and the three crew members a total of five persons were treated for minor injuries. These were exclusively contusions and abrasions and one whiplash injury. All injured people were able to leave the accident site independently. A crisis intervention team offered assistance which several passengers accepted.

Mannheim Tower informed the airfield fire service in the first minute after the accident. Two minutes later one fire truck and a bus with additional personnel arrived at the accident site. At 1755 hrs, 10 minutes after the accident several, ambulances and one emergency doctor’s car arrived. Four minutes later the first vehicles of the Mannheim municipal fire brigade arrived.

At 1753 hrs, eight minutes after the accident, flight operations ceased after a Piper PA 28 had landed on the grass strip.

1.16. Tests and Research

N/A

1.17. Organisational and Management Information

1.17.1 Air Operator

1.17.1.1 The Company's Fuel Management Strategy

The company's OM, Rev 12, Chapter 8.1.7.2.1, Fuel Policy, determined that as a basic principal the necessary fuel quantity for the safe conduct of a flight required by JAR OPS must be aboard an aircraft. In addition, if the OFP shows a profit for any additional fuel it should be considered to take it on board. However, the payload should never be decreased. In addition, prior to refuelling the allowable landing mass should be considered.

Witnesses stated that based on this background the aircraft flying from Berlin-Tempelhof to Mannheim City regularly carried more fuel on board than was necessary according to JAR OPS. Furthermore, due to operational reasons a refuelling in Mannheim was not always possible so that the fuel for the next leg had to be aboard already.

1.17.1.2 Indication of an Increased Brake Temperature

The OM/B, Abnormal and Emergency Procedures, Chapter 3, Page 133, Date 11 April 2001, stated that take-off with a BRK TEMP HIGH warning on the EICAS display is not permissible. The procedure stipulated to wait until the brakes have cooled off and the temperature has returned to its limits and the indications have gone out.

1.17.1.3 Special Regulations of the Air Operator for Mannheim City Airfield

In the OM/D, Training – Appendix 03, Chapter 02-A03, the air operator defined special crew requirements.

Among other things, it stipulated that all pilots have to have at least three IFR approaches and three take-offs in both directions under supervision of an experienced pilot who had already been qualified for Mannheim City Airfield prior to their first scheduled flight to and from Mannheim.

The supervisor had to familiarise the pilot during these approaches with all restricting obstacles around the airfield.

It was further noted that all Do 328-100 crews can use the flight simulator as additional training source.

The PIC completed this training on 3 July 2007 and the FO on 14 November 2007.

1.17.1.4 LOC/DME Approach to Runway 27

The AIP GERMANY, Effective 14 FEB 2008, AD 2 EDFM 4-2-1 stated, among other things, for LOC/DME approaches to runway 27:

- The FAF 12 NM DME MND has to be overflown in 5,000 ft.
- A minimum altitude of 2,650 ft had to be adhered to until a distance of 6.0 NM to the DME MND is reached; a minimum altitude of 1,660 ft was necessary until 3.5 NM to DME MND.
- A go-around has to be initiated at MAP 1.0 NM DME MND; turning to a heading of 259° and climbing to 5,000 ft.
- For a LOC/DME approach an OCA of 760 ft at a ground visibility of at least 1,500 m was stipulated.
- In case of an IFR approach visual contact to the PAPI had to be established when reaching the MDA at the latest in order to continue with the approach.
- After visual contact with the PAPI had been established the final approach was to be continued with a glideslope of 4.0° (maximum allowable deviation downward is three red indications).
- The localizer beam (LOC) does not concur with the runway centre line. It is off by 0.4°.

The air operator's procedural instructions concerning non-precision approaches - flaps 32° (Typical) in the OM/B, Normal Procedures, Chapter 2, Page 73, Revision Original, 14 April 2003 (Appendix) in connection with Chapter 2, Page 55, Revision Original, 11 April 2003 (Revision 1, 25 April 2003) - stipulated that the pilots:

- During the approach to the extended centre line (own navigation or radar vectoring) perform Final NAV setting
- On the down-wind leg or during approach to the base leg reduce speed to 170 kt and extend flaps to 12°
- In the last turn towards the base leg reduce the speed to 140 kt
- If cleared for a LOC/DME approach arm NAV mode
- If inbound for the FAF extend flaps to 20°
- Above the FAF extend the landing gear and flaps to 32°
- After crossing the FAF in the NAV mode and in the VS mode descend with a rate of 1,200 ft/min
- Hold the approach speed on the glideslope VAPP = VREF +10 kt until the MDA is reached
- If a visual contact with the PAPI is not established when the MDA is reached a go-around is to be initiated

According to the OM/A, Chapter 8.4.7.3, MDA is at least the OCA.

During the interview of three TRIs at the BFU on 1 October 2008 it was stated that the procedure described in the OM/B is not flown in reality as described. The reasons especially for Mannheim City could not be presented conclusively. Regarding the final approach the TRIs explained that especially the rate of descend has to be kept constant for this kind of approach. At a distance of 4 NM the airplane should be fully configured.

1.17.1.5 Configuration of the Airplane during a LOC/DME Approach

The procedures of the OM/A, General / Basic, Operating Procedures, Revision 12, Chapter 8.3.20 Stabilised Approach, stipulated that all approaches have to be stabilised at 1,000 ft (IMC) above the aerodrome elevation (AGL). If the criteria for a stabilised approach cannot be reached a go-around must be carried out.

An approach is defined as stabilised if the following criteria are met (Appendix):

- The airplane is on the correct flight path and glideslope.
- Only small changes of heading and pitch are necessary to remain on the correct flight path.
- Indicated Airspeed (IAS) is not higher than VRef +20 kt + wind correction and not lower than VRef.
- The airplane is in the correct landing configuration.
- The rate of descent is not higher than 1,000 ft/min; if the approach requires a higher rate of descent than 1,000 ft/min a special briefing is to be held.
- The engines' power setting is commensurate with the aircraft configuration.
- All briefings and the reading of the check lists have been conducted.

If one of these criteria cannot be adhered to in the further course of the approach a go-around must be initiated.

The OM/B stipulated a speed increase of + 10 kt as wind correction for winds and gusts of 10 to 20 kt; or the use of the rule is applied that half of the cross wind component and the gusts but not more than 15 kt are added.

On 10 April 2008, after the accident on 19 March 2008, the air operator's Director Flight Operations issued the Crew Bulletin No 04/08. Point 3. Information stated among other things:

"3.1 Reminder for application of OM Part A Chapter 8.3.20
With revision 12 of the OM Part A, a detailed description of Stabilised Approach was published and shall be applied in … Airlines Flight Operations.
Please make sure, that you are familiar with the details listed in this chapter and make sure that you strictly adhere to these procedures.

In addition, the gear shall be selected ´down` at 2 000 ft Radio. This change will be implemented in the next revision of OM Part A but shall be applied with immediate effect."

1.17.1.6 Crew Coordination and Standard Call-Outs during the LOC/DME Approach

OM/B, Chapter 2, Normal Procedures, Pages 55 Crew Coordination During Final Approach (Non Precision Approach), and 58 Crew Coordination During Landing, described crew coordination during the final approach and landing (Appendix).

The OM/B Page 52 Standard Call-Out Procedure During Approach, described the necessary crew call-outs (Appendix).

It was determined for the final approach that the PNF monitors the descent and the PF advises on every significant deviation.

1.17.1.7 Sterile Cockpit

The OM/A, General/Basic, Operating Procedures, Revision 12, Chapter 8FD, described the procedure sterile flight deck and stipulated that below FL100 only absolutely necessary tasks can be carried out so that the crew can fully concentrate on flying the aircraft and the traffic.

The following tasks should be avoided according to Chapter 8.3.13.2 (excerpt):

Distractions from Cabin Crew
Radio contact to company and/or Handling Agent
Flight Log and OFP entries.

1.17.1.8 Landing Procedures

The OM/B Chapter 2 Page 57 requires: *"Overfly the beginning of the runway at approximately 50 ft. Flare to a slightly nose-up attitude and retard the power levers smoothly to flight idle. Do not prolong the flare excessively. Normal touchdown speed is between VREF and VREF – 10 KIAS. After touchdown on the main wheels, gently lower the nose wheel. Initially keep the aircraft straight with rudder. Select Ground Idle and use Reverse Power as required after confirmation of both props being in the BETA range."*

The OM/B, Chapter 2, Page 75, required for landings on short runways additionally: *"…, strict adherence to the correct V_{Ref} speed and profile should be observed. Additionally, landing with a minimum flare is recommended to best utilize the*

available runway. Apply smooth constant brake pressure after touchdown to achieve the best performance."

The OM/A, Chapter 8FD, Page 172, 8.3.21 Landing Limitations stipulates under "Touchdown Area":

"The touchdown point is defined as on the centre line of the runway and 1,000' from the runway threshold. An allowance of +/- 500' from the touchdown point establishes the longitudinal limit of the touchdown area. With a 3° approach glide path and a target runway threshold height of 50 ft the touchdown aiming point is 1,000 ft. This point can be identified from the standard runway markings.
[…]
If for any reason the approach path is not maintained and it is likely that the touchdown will occur too short or too far beyond the touchdown area […] then a go-around shall be initiated. "
The OM did not advise what needed to be done if a runway did not have the respective markings.

1.17.1.9 Balked Landing

The Airplane Operating Manual (AOM), Volume I, Flight Techniques, Chapter TR 10-016, Page 2, of 1 August 2006, for the Do 328-100 defined and determined the conditions for a balked landing. It stated: *"Whenever the captain deems it necessary to discontinue landing roll to avoid a catastrophic situation after touchdown, given sufficient runway length is remaining, he may apply the balked landing procedure."* (Appendix)

The OM/B and OM/D did not contain any description of a balked landing. The former fleet manager for the Do 328-100 stated in writing that all technical information of the aircraft manufacturer was made available to the crews. Verifications could not be provided.

Concerning the Dornier 328 Flight Ops Information "Pilot Information – Selection of Ground Idle/Reverse during RTOs and Landing" (FOI-328-76-001 Revision 1) of 19 December 2006 issued by Dornier 328 Support Services GmbH an email was said to have been sent to all flight crew stations. At the stations a print-out on the bulletin boards was said to have been the means for notifying the crews about it.

During the interview at the BFU on 1 April 2008 the PIC and the FO negated to have received a flight simulator training regarding the balked landing procedure.

The two pilots made different statements regarding the orientation or training for the correct use of the power levers in order to reach FI, GI and REV. The FO affirmed the

question whereas the PIC negated it. The PIC also negated the question whether or not he had received the orientation or training for jammed power levers.

During the interview on 1 October 2008 at the BFU three flight instructors (TRI and TRE) stated that they were familiar with the procedure balked landing and that it was trained in the flight simulator.

1.17.2 ATC / Airfield Operator

The Mannheim City Airfield hazard control and emergency plan stated under

(DE) "Alarm chain:

[…]
4. The Tower has to ensure that all taxiing movement of aircraft on the airfield stops and all taxiing aircraft move into a position where they do not interfere with rescue services.
! The airfield is generally to be closed for all further take-offs and landings!

1.17.3 Aircraft Manufacturer

Because there were several companies who have taken over the responsibility of design organisation and production organisation since the type certification of the Do328-100 the procedures of the manufacturer could not be investigated reasonably.

Chapter "History of the power lever problems" shows the actions initiated by the respective organisations which have, from the BFU point of view, a connection with the accident.

1.17.4 Luftfahrt-Bundesamt

The Luftfahrt-Bundesamt describes its tasks as follows:

"The Luftfahrt-Bundesamt (LBA) is the Federal Aviation Office and directly subordinated to the Federal Ministry of Transport, Building and Urban Development (BMVBS). It takes care of air transport safety long before a flight has begun. By now the LBA has more than 100 registration, approval and supervision tasks and therefore ensures the high personnel, technical and flight operational safety standard in German aviation.
The LBA tasks include:
Approval and supervision of
national design organisations
production organisations
maintenance organisations
maintenance organisations of commercial operators and flight schools

training organisations for technical personnel

The LBA supports the European Aviation Safety Agency (EASA) and also works independently:
Supervision of type investigation and type certification

Approval and supervision of German operators
Flight Operations

In this capacity the LBA regularly receives safety recommendations from air accident investigation authorities issued in accordance with ICAO Annex 13. On enquiry the LBA stated that in general these safety recommendations are processed in-house by the administrative management and transferred to the responsible department and sub-department. If more than one department or sub-department is involved, one department or sub-department receives full responsibility.

This procedure is not documented or concretised as a procedural instruction.

It could not be clarified what had happened with the safety recommendation the AAIB had sent to the LBA on 27 November 2007 (Chapter 1.18.3.2). Witnesses stated that the LBA had received the AAIB Final Report including safety recommendations about the occurrences in Aberdeen on 9 January 2008. This report was distributed within the LBA and in the department B (operations) discussed. Until the accident in Mannheim on 19 March 2008 no actions had been initiated.

On 12 April 2008 the LBA published the Airworthiness Directive D2008-140 to make sure all Do 328 crews are informed about the existing manufacturer information regarding landing techniques and the operation of the power levers.

1.17.5 European Aviation Safety Agency

The European Aviation Safety Agency (EASA) describes its tasks as follows:

"The European Aviation Safety Agency promotes the highest common standards of safety and environmental protection in civil aviation in Europe and worldwide It is the centrepiece of a new regulatory system which provides for a single European market in the aviation industry.
[…]
The agency's responsibilities include:

[…]
type-certification of aircraft and components, as well as the approval of organisations involved in the design, manufacture and maintenance of aeronautical products.

[…]

safety analysis and research."

In this capacity the EASA regularly receives safety recommendations from air accident investigation authorities issued in accordance with ICAO Annex 13. On enquiry the EASA stated that it has established a written procedure regarding safety recommendations and referred to the Procedure for Continued Airworthiness (CAP), Chapter 4.3. It stated:

"Recommendations from Accident Investigation Authorities
EASA maintains a tracking system to record status of safety recommendations addressed to the Agency and their closing actions in a database.
Note: The database should be the means by which feedback is provided to the Accident Investigation Organisations regarding the EASA status and closure of Safety Recommendations arising from reported Accidents and Serious Incidents.
Reference is made to E.P001 Procedure for the coordination of responses to recommendations resulting from accidents and serious incidents."
The procedure description proper was not provided to the BFU.

On enquiry the EASA confirmed that it had received the AAIB safety recommendation of 27 November 2007. A definite date was neither mentioned nor proven. Until the accident in Mannheim on 19 March 2008 no actions had been initiated.

After the accident the type certificate holder and EASA discussed and assessed the situation regarding the power levers. It was determined that the operational reliability of the system did not concur with the design requirements. The EASA required the type certificate holder to modify the design so that the required reliability can be achieved. The implementation of this design-change was supervised by the EASA and ended in the publishing of the EASA AD 2009-0196 in September 2009.

1.18. Additional Information

1.18.1 Certification Requirements of the Power Levers

The design requirements valid at the time of the Do 328-100 type certification JAR 25, Change 12 required for the design of the power levers:

"JAR25.1155 Reverse thrust and propeller pitch settings below the flight regime

Each control […] for propeller pitch settings below the flight regime must have means to prevent its inadvertent operation. The means must have a positive lock or stop at the flight idle position and must require a separate and distinct operation by the crew to displace the control from the flight regime […].”

1.18.2 History of the Power Lever Problem

15 Oct 1993	The LBA issued the type certification for the Do 328 to Dornier Luftfahrt GmbH
5 Nov 1998	Fairchild Dornier published Dornier 328 Service Information SI-328-76-048 "Engine Controls - Power Lever Gate Design" after pilots reported power lever problems.
25 Feb 1999	A Do 328-100 had an accident in Genoa, Italy. The airplane overshot the end of the runway and was partially submerged in the sea; four people died.
25 May 1999	Preliminary report of the Italian investigation authority (in Italian): • The crew's problems when operating the power levers were described clearly. • The lack of an emergency procedure was criticised. • Three more cases were mentioned Safety recommendations (without addressee): • Distribution of SI-328-76-048 among the flying personnel • Emergency procedure, if PL operation is not possible
18 Apr 2000	Dornier Luftfahrt published Dornier 328 Service Information SI-328-00-67 "Pilot Information – Selection of Ground Idle/Reverse during RTOs and Landing".
8 Aug 2000	Fairchild Dornier became the type certificate holder for Do 328.
24 Apr 2001	Fairchild Dornier published Dornier 328 Flight Ops Information FOI-328-76-001 "Pilot Information – Selection of Ground Idle/Reverse during RTOs and Landing".
28 Jul 2003	AvCraft Aerospace GmbH became the type certificate holder for Do 328.
11 Dec 2003	The Italian aviation authority ENAC informed the LBA in written English that the following safety recommendation will be published:

"Dornier to incorporate the text of Safety Information SI.38-78-048 under the Abnormal Procedures Chapter of the Aircraft Flight Manual in order to provide the pilot with appropriate and readily instructions in case of difficulty in selecting the Flight Idle Position"

It asked to pass the letter on to Fairchild Dornier GmbH.

16 Jan 2004 Investigation Report of the Italian aviation authority ENAC (in Italian) including safety recommendation:

Fairchild Dornier should develop a procedure for pilots so that they can handle situations in which the power levers cannot be moved from FI.

01 Mar 2006 Type certification responsibility changed form the LBA to the EASA.

07 Jun 2006 328 Support Services became the type certificate holder for Do 328.

22 Jun 2006 During the landing in Aberdeen, Great Britain, a Do 328-100 overshot the runway by 350 m. The AAIB investigated the incident.

Aug 2006 The AAIB published the Bulletin S7/2006. It stated that it was not possible for the crew to move the power levers back from FI into the BETA position. The Bulletin included the following safety recommendation:

“It is recommended that Avcraft Aerospace GmBH i.I advise all operators of Dornier 328 turboprop aircraft to detail procedures, and provide adequate training, to ensure that their pilots are able to act appropriately if the beta control range on the power levers cannot be selected after landing.”

12 Dec 2006 328 Support Services GmbH issued AOM VOL 2 TR 20-05 "Power Lever Gate – Power Lever Operation" and advised of the possibility of a Balked Landing.

27 Nov 2007 The AAIB sent the safety recommendation to the LBA (2007-103):

	The Luftfahrt-Bundesamt should ensure that a training programme, concerning the operation of the lever/latch combination is developed and distributed.
	and to EASA (2007-104):
	The European Aviation Safety Authority should require the type certificate holder to re-design the power lever system to improve the present arrangement.
Jan 2008	The AAIB issued the investigation report concerning the incident in Aberdeen.
19 Mar 2008	A Do 328-100 had an accident in Mannheim. It overshot the runway and collided with an earth wall. (This is the key part of this report.)
12 Apr 2008	The LBA published the AD D-2008-140 regarding the operation of the power levers and the performance of the landing.
15 Jul 2009	328 Support Services GmbH published the Service Bulletin SB 328-76-486 Engine Controls – Modification of Power Lever Assembly and introduction of Crew Aural Alerting Device.
4 Sep 2009	EASA published AD 2009-0196 Engine Controls – Power Lever Control Box – Modification.

1.18.3 Further Occurrences with Do 328-100 Airplanes during Landings

1.18.3.1 Genoa

On 25 February 1999 a Do 328-100 had an accident in Genoa, Italy. The airplane did not come to a standstill on the 2,285 m long runway and overran the end of the runway and became partially submerged in the sea beyond the runway end. One flight attendant and three passengers died. The Italian Ministry of Infrastructures and Transport carried out an investigation into the accident with the State File Number AZ1553. The report published in Italian determined the following causes:

"The accident, which involved a Dornier 328-100 aircraft and which occurred during the landing phase at Genoa airport, was caused by the pilot being unable to move the power levers from the flight idle position to the ground idle position and then to the reverse thrust position. The power levers remaining in the flight idle position meant that the propellers kept turning which prevented the aircraft from slowing sufficiently and frustrated the use of the brakes and emergency brake."

The Italian investigation commission researched three previous cases where the crew was unable to move the power levers after the landing from FI further back. These incidents did not cause any injuries to persons.

In December 2003 the Italian investigation authority issued the following safety recommendation in English addressed to the aircraft manufacturer:

“Dornier to incorporate the text of Safety Information SI.38-78-048 under the Abnormal Procedures Chapter of the Aircraft Flight Manual in order to provide the pilot with appropriate and readily instructions in case of difficulty in selecting the Flight Idle Position”

In January 2004 it was also published in Italian once the Investigation Report was published:

"To the Dornier-Fairchild company: if this has not already been done, define an emergency procedure allowing the crew to manage incidents where it is repeatedly impossible to move the power levers from the flight idle position during the period of travel after landing, […]”

1.18.3.2 Aberdeen

On 22 June 2006 another serious incident occurred with a Do 328-100. The aircraft overran the about 1,800 m long runway, coming to rest some 350 m beyond the end of the runway. The AAIB investigated this occurrence with the State File Number EW/C2006/06/05. It was determined that during the landing roll, the crew could not decelerate the aircraft sufficiently because they were unable, repeatedly, to select the power levers into the beta range.

On 27 November 2007 the AAIB sent the following safety recommendation to the President of the LBA:

“The Luftfahrt-Bundesamt should ensure that a training programme, fully alerting Dornier 328 crews to the potential for restricted movement and the optimum operation of the lever/latch combination, and detailing appropriate operational procedures, be developed and mandated for all operators in Europe, and through liaison with all relevant National Aviation Authorities, make this information available to all operators of the Dornier 328 worldwide.”

In addition the following safety recommendation was addressed to the EASA:

“The European Aviation Safety Authority should require the Dornier 328 Type Certificate holder to re-design the power lever/beta/reverse latch system to improve the present arrangement.”

1.18.4 Local Flight Operations Restrictions at Mannheim City Airfield

The AIP GERMANY, AD 2 EDFM 1-6 dated 2 August 2007, EDFM, AD 2.20 Local Traffic Regulations, stated for approaches and departures, among other things, the following:

"1. Authorized Aircraft […]
- Do328/110/120/130
[…]

2. Restrictions of Flight Operations
[…]
b) All approaches, IFR and VFR, shall orientate themselves according to the indicator of the PAPI facilities up to overflying the roads B 38a (RWY 27) and the Wilhelm-Varnholt-Allee (RWY 09), located immediately in front of the RWY in order to guarantee the established minimum crossing altitudes above the roads.
[…]
All approaches and departures with multi-engine aircraft as well as all IFR approaches and departures with single-engine aircraft may only take place if pilots have familiarized themselves with the specific operating conditions prior to the first approach and/or departure, and are able to apply the prescribed flight procedures. […] The general decree from the „Regierungspräsidium Karlsruhe", in accordance with § 29 LuftVG, concerning the „Special Regulations During Approaches and Departures for Multi-Engine Airplanes as well as for Single-Engine Airplanes Flying according to IFR to/from Mannheim City Airfield", described under letter f) shall beobserved.
f) Decree in accordance with § 29 LuftVG concerning the special Regulations for Multi-Engine Airplanes during Approaches and Departures to/from Mannheim City Airfield.
Mannheim City Airfield shall be assessed as difficult, from the operational point of view. It is pointed out that the pilot-in-command is obliged to have familiarized himself with the special operational conditions prior to the first approach and/or departure, and that he must be able to perform the prescribed flight procedures with his airplane. Prior to the first take-off and/or approach with multi-engined airplanes (single-engined IFR only), the consent of the „Regierungspräsidium" Karlsruhe – „Luftaufsichtsstelle" Mannheim City Airfield – is necessary. This is considered to have been granted if the pilot-in-command or the operational controller of the aircraft operating agency has issued a declaration in accordance with para 2.
1. Special Operational Conditions

- Approach-to-Land
After establishing visual contact to the PAPI indicator, final approach shall be performed at a glide angle of 4 degrees (during an instrument approach to RWY 27 when reaching the MNM Descent Altitude MDA, at the latest). This pre-supposes that the approaching pilots have been sufficiently trained to perform a smooth approach at this glide angle.
The respective beginning of the threshold is the 50 ft fly-over point for calculating the landing distance.
The PAPI indicator has to be followed until the obstacle „road" is overflown with a max. permissible deviation downwards of 3 red indicator lights. This also applies to instrument approaches RWY 27 with subsequent PAP visual contact.
[…]
- Miscellaneous
Prior to each flight, the pilot-in-command shall provide evidence that the take-off and landing distances required according to the flight manual (including contaminated RWY surface) do not exceed the take-off and landing distances available, and that overflying of the roads at the established
minimum crossing altitude is guaranteed. The evidence shall be carried on board the airplane. …
The pilot-in-command shall consult the chart AD 2 EDFM 2-7 (ICAO Obstacle Chart Type A) about the special obstacle situation within the approach and departure sector.

1.18.5 Calculation of the Flight Performance for Approach and Landing

1.18.5.1 Calculation of the Flight Performance Based on the Operator's Manual

The OM/B, Do 328-100, Mod. 10 Chapter 4, Performance, contained an instruction and the necessary tables to calculate the flight performance.

Based on the OM the air operator had special tables with flight performance data for approaches and landings for all airports on scheduled flights compiled. The Aircraft Performance Group, Inc. (APG) compiled the tables.

The accident crew's documentation included the table for Mannheim City Airfield (EDFM) dated 29 November 2005 for runways 09 and 27.

The landing in Mannheim occurred with a landing mass of 13,200 kg on runway 27. Since flaps were extended to 32° a V_{ref} of 110 kt was necessary according to the copy of page 19 Performance of the QRH dated 1 September 1994 found in the cockpit.

Given the wind conditions prevailing at the time of the landing (ATIS information Oscar: wind 320° with 14 kt), a dry runway and an LDA of 1,013 m (AIP AD 2 EDFM 1-4) the maximum landing mass according to the table compiled by APG with intact ground spoiler was 13,229 kg.

The BFU calculated the required landing distance based on the values of the OM/B, Chapter 4, Actual Landing Requirements, Revision 1, Page 28 to 31, tables 6 and 7.2 with the relevant parameters (aerodrome elevation 306 ft, headwind component 9 kt, operating factor 1.15). The result was a required landing distance for the landing on runway 27 of about 700 m.

1.18.5.2 Calculation of the Flight Performance According to the AFM for Do 328-100, Mod. 10

The AFM described in Chapter Performance – PW119B“, Section 06-04-01, Page 1 the approach and landing procedure for the Do 328-100 which was the basis for the flight performance calculation:

- Final approach and landing are performed with extended landing gear and a flap position of 20° or 32°, respectively.
- In an altitude of 50 ft and a presupposed VRef the power levers are pulled steadily into Flight Idle (FI) until the main landing gear touches down.
- After the main landing gear touched down the wheel brakes are pushed to the maximum and the power levers are pulled back into Ground Idle (GI).

There is a note stating that only the aerodynamic brake resistance of GI is taken into account for the calculation of the landing distance.

The graph in the AFM Section 06-04-01 Page 16 (4-2) showed, among other things, for a landing mass of 13,200 kg a V_{Ref} of 109 kt und der conditions described above.

Section 07-06-04, Pages 6 and 8 (2-2) of the AFM – Supplement 007, Ground Spoiler, described the requirements for the landing distance calculation.

These are based on the associated conditions: use of GI, deployment of all ground spoilers, maximum use of the braking system after touchdown with a ready anti-skid system.

The graph showed a landing distance of about 650 m for the landing on runway 27 for the relevant parameters, aerodrome elevation (306 ft) and without a headwind component. If a headwind component is taken into account the landing distance was about 610 m.

1.18.6 Landing Distance Available (JAR OPS 1)

According to JAR-OPS 1.515 (a) the air operator has to ensure that the required landing distance is commensurate with not more than 70% of the available landing distance. Given the required landing distance from the AOM the minimum available landing distance was 650 m x 1,43 = 930 m.

1.18.7 Wheel Brake Use during the Landing

The OM/B, Chapter 2, Normal Procedures, described the landing in two different places.

1. On Page 57 (Revision: Original, Date 11 April 2003), Normal Landing, described the landing procedure. The use of the wheel brakes was not described for touchdown and roll out (Appendix).

The last paragraph stated in connection with the use of the nose wheel steering for direction control: „*Apply brakes until taxi speed is reached.*“

The following page 58, Section Crosswind Landing, did not include the use of the braking system during landing either.

The SOP, Page 58, Crew Coordination During Landing, contained the use of the braking system as part of the task distribution between PF and PNF:

The tasks of the PF include:

"After mainwheel touchdown smoothly lower the nosewheel to the runway, then retard the Power Levers to Ground Idle.

When BETA LIGHTS are illuminated or called out, retard Power Levers to reverse and use brakes as required, maintain directional control with rudder pedals."

2. On Page 75 (Revision: Original, Date 11 April 2003), Flight Techniques, Landing, described the methods and techniques which are to be applied during landings with or without cross wind and on normal or short runways (Appendix).

It stated, among other things:

"When landing on a minimum length runway, strict adherence to the correct V_{Ref} speed and profile should be observed. Additionally, landing with a minimum flare is recommended to best utilize the available runway. Apply smooth constant brake pressure after touchdown to achieve the best performance."

The use of the wheel brake during touch-down referred in this case to landings on short runways.

This section did not mention the use of the braking system on normal runways with or without cross wind either.

The procedures described in Chapter 2, Normal Procedures, did only contain in the SOPs a remark concerning the use of the wheel brake on a normal runway. The use of the wheel brake was defined: after touch down the power levers are to be pulled to GI, once the indication BETA LIGHTS illuminated the power levers are to be pulled to REV and, if indicated, the brakes are to be activated.

For landings on short runways the use of the braking system after touch-down is required to be applied speedily and with constant brake pressure.

The AFM, Chapter Performance – PW119B, 06-04-01, Page 1 Approach and Landing, required the immediate maximum use of the wheel brake system after touch-down *(„After mainwheel touchdown apply maximum braking“*).

1.18.8 Analysis Results of Similar Flights

In order to assess the landing of the accident flight the FDR data of four additional similar landings of the same airplane at Mannheim City Airfield were analysed (Appendix). These four landings occurred in March 2008.

The aim was to find differences and thus possibly gain evidence regarding the accident flight on 19 March 2008.

The following table shows relevant parameters and deduced influencing factors. Flight No 1 is the accident flight; flights 2 to 5 are similar landings on runway 27 of Mannheim City Airfield.

All crews on all flights had selected flaps position 32°.

The influencing factors barometric air pressure, temperature, wind speed and wind direction were not gathered because their influence was considered to be minor for this comparison.

Flight No	VCAS in 50 ft Altitude	Engine Torque (TQ) in 50 ft Altitude	Time between 50 ft Altitude and Touch-down	Distance between 50 ft Altitude and Touch-down	TQ at the Moment of Touch-down	VCAS at the Moment of Touch-down	Time Between Touch-down and the Signal BETA	Time Between Touch-down and max. TQ at Reverse

	kt	%	s	m	%	kt	s	s
1	117	29	12.0	593	20	108	10	13
2(-2)	109	10	9.3	489	15	95	1	5
3(-4)	113	13	10.2	558	4	96	0	6
4(-6)	116	7	11.5	638	2.5	97	0	5
5(-8)	115	14	10.0	535	6	93	0	4

Except for flight No 2 all other flights had about the same approach speed (VCAS) above the threshold (50 ft altitude).

Flight No 1 (accident flight) differs from all other flights basically in the following:

- In 50 ft altitude engine torque was at 29%.
- The initial ground contact occurred after about 12 seconds and the distance travelled between passing 50 ft until the first touch-down was therefore longer (593 m).
- At the time of the touch-down engine torque was about 20%.
- The touchdown speed (VCAS) was 108 kt and therefore about 10 kt above the average of the other flights.
- 10 seconds after the touch-down the power levers were pulled into GI. With the other flights the BETA signal was active in the phase after the touch-down and with flight No 2 after one second.

The FDR data showed that the flight from Mannheim to Berlin-Tempelhof (the leg right before the accident) on the day of the accident was flown by the PIC as PF. The engine torque at the time of passing 50 ft during the landing on runway 27L was about 6%.

1.18.9 Airworthiness Directives

On 12 April 2008 the LBA issued the AD D-2008-140. The AD was directed to all Do 328-100 operators and contained the following actions:

“1. It is to be ensured that the following revisions have been incorporated in the Aircraft Operating Manuals:

- AOM Volume II: TR 20-006 (Power Lever Gate)
- AOM Volume I: TR 10-016 (Balked Landing)
- AOM Volume I: TR 10-014 (Landing)
- AOM Volume I: TR 10-015 (Landing, for Mod. 30 only)

2. The Dornier Flight Ops Information FOI 328-76-001R1 dated 19 December 2006 must be handed over to all pilots of these aircraft before their next flight whereby attention must be drawn to the problems described therein.

3. Before their next flight, all pilots of these aircraft must be instructed about the contents of AOM 20-01-00 pages 7 and 8 including TR 20-006 as well as about balked landing procedure according to TR 10-016 of AOM Volume 1. This instruction must be proved by documents and countersigned by the pilots. In the future the instruction must also be carried out for new pilots before their first flight on this aircraft type.

4. During the instruction the pilots’ attention must be drawn to the following points: The landing distances published in chapter 06-04-01 of the Aircraft Flight Manual were, among others, calculated under the following conditions:

a) at a height of 50ft and a speed of Vref the power levers are evenly withdrawn to „flight idle“
b) directly after touch-down of the main landing gear the power levers are set into the position "ground idle" and at the same time, the aircraft is decelerated using the maximum braking action (without reverse).

A landing may only be carried out if it is ensured that, at a height of 50ft, the actually remaining landing distance at least complies with the calculated landing distance according to the manual („actual landing distance“ acc. to AFM chapter 06-04-01).

If the conditions under a) and b) are not complied with, the required landing distance may extend considerably (see Note AFM 05-08-00). Furthermore the pilots have to be informed that the aircraft cannot be stopped if the power setting „ground idle“ cannot be activated. Under these circumstances, the braking effect of the propeller thrust reverser is not available and the sole use of the wheel brakes is not sufficient to stop the aircraft in all cases. In this context the pilots’ attentions has to be drawn to the balked landing procedure described in AOM Volume I, TR 10-016.

5. During the instruction, the pilots have also to be informed of the landing technique for landings on short runways published in TR 10-014 or TR 10-015 (only for modification 30).”

On 4 September 2009 EASA published AD 2009-0196. It required the implementation of SB-328-79-486 of 328 Support Services GmbH within the next 15 months.

The SB arranged for a modification of the power lever tracks and introduction of a crew aural alerting device in case the latches are pulled in a position which causes a blockage of the power levers.

1.18.10 Flight Data Analysis and Monitoring

ICAO Annex 6 of 18 November 2010, Chapter 3.3.5, recommended that all operators of aircraft with a MTOM of more than 20,000 kg introduce and maintain a flight data analysis program as part of their safety management system.
Chapter 3.3.6 required that all operators of aircraft with a MTOM of more than 27,000 kg introduce and maintain a flight data analysis program as part of their safety management system.

EU OPS 1.037 (a), 4 required that all operators of aircraft with a MTOM of more than 27,000 kg introduce and maintain a flight data monitoring program as part of their accident prevention and flight safety program. According to this regulation the implementation of a flight monitoring program means the proactive use of flight data from routine flights to improve flight safety.

1.19. Useful or Effective Investigation Techniques

N/A

2. Analysis

2.1. General

The flight from Berlin-Tempelhof to Mannheim City was a scheduled flight of an air operator. The flight was conducted under JAR OPS 1 (now EU OPS) with an aircraft certified according to JAR 25 (now CS 25) to a certified airfield. Therefore, safety standards were in place which, even under unusual circumstances or conditions, should ensure a safe conduct of the flight.

Nevertheless, the airplane overshot the end of the runway and collided with an earth wall. The following analysis shows that the accident was the result of a multitude of systemic safety deficits. These deficits were mostly the results of an inadequate realisation of existing regulations.

2.2. Flight Operations

2.2.1 Chronology and Analysis of the Landing

The recording and witness statements showed that during the flight the Standard Operating Procedures (SOPs) of the air operator were not always adhered to. In the end the airplane overflew the threshold at Mannheim City in 40 ft with a CAS of 114 kt, a rate of descent of less than 1,000 ft and an engine torque of about 29% of both engines. The aircraft's longitudinal pitch was -4.4°. Compared with the landings before (+2° to +3°) this is relatively large. Therefore, the criteria for a stabilised approach as stipulated in the OM/A were, at that time, not entirely met. As a result, the flare-out was relatively narrow and the vertical acceleration reached up to 1.3 g. Engine torque of both engines remained at more than 20% since the power levers were not pulled into FI contrary to the guidelines in the OM. The resulting thrust was the reason why the airplane did not - as is usual and required in the AFM - have ground contact but continued the flare in a low altitude. The FO (PF) noticed the discrepancy between the expected reaction of the airplane to the control inputs and the exhibited behaviour without recognising the cause. Since the airplane was only at the beginning of the touchdown zone, a control of the power setting by consciously pulling the power levers into FI and checking the engine torque indication would have been appropriate and realisable. From the BFU point of view, the transfer of controls to the PIC was not a reaction appropriate to the situation.

Had the PIC pulled the power levers immediately into FI the remaining runway length would have been sufficient. The FDR data showed that this did not occur. It is likely that during the transfer of controls the power levers were moved involuntarily and therefore the engine torque decreased from 28% to 20%. The aircraft continued to flare for more than 300 m just a few feet above the runway before the right main landing gear touched down briefly with very little pitch and a speed 10 kt above normal. This touchdown occurred a significant distance behind the touch-down zone. According to the air operator's SOPs a go-around procedure should already have been initiated earlier. Therefore, it was not investigated in detail up to which point the aircraft's performance would have allowed a go-around after the touchdown.

Between the initial ground contact (proven by the right main landing gear's ground signal) about 450 m prior to the end of the runway and the final touch-down about 150 m prior to the end of the runway the air - ground signals changed repeatedly; CAS was between 108 kt and 93 kt, engine torque above 20%. Therefore, it is to be assumed that a go-around according to the AOM's balked landing procedure would basically have been possible in this phase. The BFU is of the opinion, that the crew did probably not know about the balked landing procedure since it had not been

adequately distributed within the company. Hence it could not be applied in this situation.

With the comparison flights engine torque was far below 20%. This is especially demonstrated with flights No 3 - TQ 4%, No 4 - TQ 2,5% and No 5 - TQ 6%. With flight No 2 TQ was 15% and the discrepancy was therefore not so big. Besides, this flight accelerated shortly before touch down because they had been to slow. Shortly after touch-down the power levers were selected into FI so that a TQ of 5% was given before the settings were set to GI. Selection of the thrust reverse always occurred in the first second after touch-down.

During the accident flight, TQ was above 20% for another 10 seconds after touch-down. Approximately 4 seconds after the initial touch-down the PIC (PF) remarked: (DE) "... it does not work". Therefore, it is to be assumed that he had tried to pull the latches and select the power levers into reverse in those 4 seconds. However, by design this is not possible in this position.

After the PIC realised the power levers were jammed, he commanded: (DE) "Pull hand brake! Pull hand brake!" This command did not correlate with any regular procedure and did not seem sensible especially since there were no indications that the regular braking system did not work properly. Therefore, it is understandable that the FO did not realise the command. That the FO did try to select the reverse position once the PIC had let go of the power levers was, on the other hand, appropriate and conducive. However, this was only possible because the PIC had released the power levers in order to activate the E/P brake.

Both actions were spontaneous reactions to the situation and not the result of following standard procedures. At this time there were no more alternatives and overshooting the runway was inevitable. This situation could have been averted only by a timely go-around as stipulated in the SOPs.

When the PIC activated the E/P brake a rudder deflection to the right occurred as the FDR showed and as a result the aircraft's longitudinal axis turned to almost 318°. In order to activate the E/P brake the PIC had to bend down and to the right. By doing so he probably activated the rudder inadvertently.

Only about 50 m prior to the end of the runway the wheel brakes were activated by the E/P brake and shortly afterwards thrust reverse and ground spoilers were activated. The airplane collided with relatively low speed with an earth wall behind the end of the runway.

The investigation could not clarify whether the wheel brakes were activated through the pedals immediately after the touch-down and therefore helped to decelerate the aircraft.

According to the AFM and taking JAR OPS 1.550 (a) into account including the relevant influencing factors the minimum landing distance available was 930 m. The available runway length was 1,013 m. Therefore, the landing was basically possible. A precondition for the calculated landing distance and the available landing distance to correlate is the adherence to standard procedures. Since these procedures do not arrange for the reverse to be used the actual landing distance can normally be reduced considerably.

However, since the engine torque was not reduced to FI after passing the threshold - as stated in the SOPs - the landing distance calculation was invalid. The position of the power levers was the cause for the later apparent problem when selecting the GI position and reverse. In theory, the long flare should have been an indication for the crew that something was amiss.

Under the assumption that the threshold was passed in 50 ft altitude the table showed for all four comparison flights (see table in Chapter 1.18) that touch-down occurred behind the touch-down zone. According to the OM, all these flights would have had to be aborted with a go-around procedure. The same is true for the PIC's approach during his supervision. Instead the remark *"Ldg MHG – touchdown behind first half of rwy!!! no reverse + brake action"* was entered into his supervision records. That it did not happen showed that within the company the SOPs were not adhered to with significant frequency and without understandable reasons. It was therefore not uncommon that flights were continued although the touch-down zone had been passed. This practice resulted in a significant reduction of the safety level because flight crews are generally not capable in the few seconds of flare phase to decide whether a situation is harmless or critical. On the day of the accident the crew could not recognise the problem and continued the landing.

What exacerbated the situation was the fact that the touch-down zone was not marked which would have been a visual indication of its end. Instead the crew had to consciously estimate the end of the touch-down zone.

For this purpose the one-half runway distance remaining sign and the taxiway B which was about 400 m behind the threshold only qualify to a limited extend and were obviously not taken into account.

That the marking was not 500 m but 390 m behind the threshold played only a marginal role. However, the wrong position of a one-half runway distance remaining

sign was basically a significant safety deficit because it can lead to misinformation of pilots.

In addition, the investigation revealed that the landing procedures described in the OM deviate in details (i.e. use of braking system) from the ones described in the AFM and AOM. Nevertheless, the OM uses the same parameters for the landing distance calculation. Since neither of the described procedures was used completely the investigation abstained from investigating all the discrepancies.

2.2.2 Evacuation Process

About 8 seconds after the collision the PIC made an PA announcement giving instruction to evacuate the aircraft. The ground evacuation checklist was not completed and there was no immediate danger evident to necessitate such a quick action. Point 8 of the checklist required to check the emergency exits for possible restrictions due to fire. Since the checklist was not completed the exits were not checked. The instruction for evacuation should have been accompanied with a remark concerning the usability of emergency exits since the left engine emitted smoke and the right was not yet shut down which made the evacuation through all exits without significant danger to the passengers impossible.

The resolute instruction of the flight attendant that all passengers should remain seated was in this situation appropriate. It was necessary to get a clear picture of the situation. It was to be assured that the passengers do not use all the available exits and then are exposed to considerable dangers outside the aircraft. The opening of the aft right service door by a passenger acting on his own initiative led, by accident, to the only safely usable emergency exit. The flight attendant asked the crew whether everything was alright before she left the airplane.

The air operator's manuals did not contain any procedure for the flight attendant regarding the evacuation of passengers. The flight attendant behaved prudent, target-oriented and correct. The BFU is of the opinion that this behaviour is rooted in her personal characteristics.

The right engine continued to run for another 2 minutes and 26 seconds after the collision before the crew shut it down. An instruction to shut down the engine was not given. The BFU is of the opinion that it was shut down by pushing the fire button.

After about 2 minutes 45 seconds the PIC instructed the FO: (DE) "Complete the checklist.” This imprecise instruction did not correspond with the SOPs. The FO completed the ground evacuation checklist according to the QRH. At the same time the PIC tried to establish radio communications with Mannheim Tower or communicated with the rescue personnel.

When completing the checklist the FO realised that the condition lever for the left engine could not be moved. This was not followed up by a corrective measure but was ignored with the remark „*number one is not possible*“ and the checklist was completed. A similar behaviour occurred at checklist point „*in case of fire [evacuate] to nonaffected side only*“. The fact that the left engine emitted smoke and that therefore an evacuation should only occur on the right side was never mentioned. When the PIC requested to complete the checklist together once again this fact was never mentioned either.

The crew's behaviour during this phase was neither target-oriented nor coordinated. It did not concur with the OM procedures and showed once again that they were overwhelmed by the situation.

The fact that flight operations at Mannheim City Airfield did not cease as was stipulated in the emergency plan was not acceptable; Mannheim Tower cleared another airplane to land a few minutes after the accident. The emergency plan gave clear-cut instructions for such cases. This is absolutely necessary. On the one hand, the controller cannot comprehensively assess the situation at an airport after an accident. On the other hand, the emergency services are busy and not available for any other emergency situation which might arise. The continuation of flight operations after an accident is therefore affiliated with considerable dangers.

2.2.3 Cooperation in the Cockpit

The conversations in the cockpit and with the flight attendant were mainly conducted in German. The spoken German in the cockpit was not always correct since neither PIC nor FO were native speakers. There are, however, no indications concerning misunderstandings. Communication concerning checklists and procedures and radio communication with ATC were conducted in English.

The different air operators the PIC and the FO had worked for had confronted them with various CRM trainings. It is the aim of such trainings to optimise the cooperation of the crew members by improving their behavioural patterns and attitudes.

The air operator ensured that during the Do 328-100 training both pilots received the initial CRM training according to JAR OPS 1.945. The aim was that both pilots should work according to the same company philosophy.

This was also true for the recurrent CRM training the PIC had completed in the meantime.

The BFU did not investigate the content of these CRM trainings.

One aspect of an efficient CRM is the handling of SOPs which play an important role in any air operator company to ensure a safe conduct of flights.

The SOPs regulated the precise cooperation between individual crew members in the cockpit throughout different flight phases. They stipulated how the individual tasks are to be distributed and realised.

The O/MB for the Do 328-100 contained the SOPs for all flight phases. The crew cooperation when monitoring and cross checking regarding the conduct of the flight was one part of the SOPs.

The BFU investigation concentrated on the adherence to SOPs (OM/B, chapter 2) during final approach (Crew Coordination During Final Approach – Non-Precision Approach) and landing (Crew Coordination During Landing) and the call-outs (Standard Call Out Procedure During Approach).

The CVR analysis showed the following deviations from the SOPs:

During the approach briefing the FO (PF) did not mention the NAV setting for the approach and during the approach to FAF the call-out final NAV setting did not occur. The PIC (PNF) did not report the identification of the aids to navigation either.

When the clearance for the LOC/DME approach was given the FO (PF) did not call out the ARM NAV Mode. That is why the FO (PF) did not notice that he had mistakenly set the APP Mode instead of the NAV Mode until they were in 1,800 ft and corrected it.

The SOPs stipulated that the PNF calls out the minimum in 100 ft above the minimum, i.e. in 860 ft. The PF has to acknowledge it with "Checked". The OM/B intended this to also be an Incapacitation Check; it did not occur. The PF did not react to the missing call-out.

When the airplane approached the MDA of 760 ft the autopilot began to steer the aircraft into horizontal flight and therefore the airplane left the glidesope upward. The FO (PF) did not notice this. After the high voltage power lines had been passed the PIC (PNF) instructed the FO (PF) to steer towards the PAPI's three red and one white indications. Now the FO (PF) disengaged the autopilot and pushed the control column forward. During the manually controlled descent between about 780 ft AMSL and about 100 ft AGL the airplane's pitch oscillated and with it the rate of descent. The maximum sink rate determined in the OM/B for this altitude was 1,000 ft/min. It was exceeded several times and temporarily reached more than 1,500 ft/min. With it the limits for a stabilised approach were significantly exceeded and a missed approach procedure should have been initiated.

The OM/A, Chapter 8.3.20 stipulated only for approaches in IMC a minimum height where criteria for a stabilised approach have to be met permanently. There were no specifications for approaches in Visual Meteorological Conditions (VMC). The BFU is of the opinion that this is not acceptable and was a safety deficit.

The FO (PF) did not initiate a missed approach procedure nor did the PIC (PNF) instruct him to do so. The BFU does not understand what hindered the crew to initiate a go-around after the unstabilised approach in 1,000 ft AMSL.

The BFU is of the opinion that the non-adherence or partial adherence to the SOPs during the approach was one cause for the significant decrease of the safety level. This deviation resulted in an insufficient cooperation especially concerning the two-way monitoring.

The most significant example was the infringement of the cleared altitude of 5,000 ft during the approach to Mannheim City Airfield. The PIC's (PNF) reaction ((DE) "No problem and correct a little bit upward ...") did neither correspond with a professional attitude nor with adequate leadership behaviour because it was not appropriate to the extent of the deviation.

The BFU is of the opinion that the tasks the PIC carried out below FL100 which did not have anything to do with the conduct of the flight had a significant share in it.

A further example was the insufficient monitoring of the PF by the PNF (PIC). As the FOt (PF) showed clear insecurities during the approach to land (e.g. infringement of the altitude, letting the autopilot finish the approach, non-compliance with the instruction to decrease the power) the PIC did not react pro-actively by taking over the controls or initiating a missed approach procedure.

The PIC (PNF) did not intervene with the incomplete approach briefing by the FO (PF). The conduct of a non-precision approach and the stipulated approach profile of Mannheim City Airfield demanded detailed specifications regarding the planned approach profile especially since the crew approached Mannheim for the first time in this team constellation.

2.2.4 Relationship PIC - FO

The PIC's total flying experience was 15 times higher than the FO’s and he was also considerably older. The FO was inexperienced on the Do 328-100.

These facts made the difference in experience clear. This was also illustrated when the PIC asked and instructed the FO in Berlin-Tempelhof about the temperature of the braking system and therefore put him in a pupil position.

The CVR recordings showed that during the entire flight the conversations between the PIC and FO were calm and business-like.

Before the approach the FO told the PIC that he still felt insecure concerning the landing in Mannheim. The PIC answered: (DE) "It will all work out". He said he would assist him. However, in the further course of the approach the PIC (PNF) did not recognise different mistakes the FO (PF) had made and failed to correct them (infringement of the 5,000 ft, use of the APP mode during final approach, ALT SET Capture of the autopilot when reaching the MDA).
During the approach the PIC (PNF) assisted the FO (PF) by telling him the values of the sink rate profile. In addition, he commented the descent and gave him advice about the control of the airplane. This was not done in accord with a two-way monitoring as is to be expected with a professional two-man flight crew. The relationship was that of a flight instructor and his student pilot.

The FO (PF) accepted this type of teamwork and showed a mainly reactive behaviour during the remainder of the approach.

At the beginning of the flare-out the airplane showed a kind of behaviour unfamiliar to the FO because the power levers had not been pulled back completely. He handed the control of the aircraft over to the PIC with the words: "Oh, - your control". The BFU is of the opinion that during line operation this kind of behaviour in such a situation is not acceptable; it might be logically consistent in a instructor / student relationship. The only appropriate action would have been to initiate the missed approach either by the FO (PF) or the PIC.

The BFU assesses the PIC - FO relationship as one in which the PIC assumed the role of a flight instructor rather than of a PIC. In this role he accepted the FO’s mistakes instead of expecting to act and intervene according to MCC procedures as would a regular two-man crew do.

Since there never were any hectic actions in the cockpit the PIC's (PNF) repeated comment (DE) "take it easy" can be viewed as an agreement with the FO (PF). The FO (PF) who seems to have been mentally challenged during the approach counted on his “flight instructor”.

The BFU is of the opinion that the cooperation of both pilots did not correspond with the cooperation of a flight crew in line operation.

2.2.5 Training and Qualification of the PIC

The commercial pilot's license could only be issued after re-examination because the theoretical exam was failed once and the skill test twice. The BFU is of the opinion

that these facts do not contest the PIC's skills entirely even though acquiring the necessary skills did not come easy for him in the beginning.

The subsequent training to acquire the Airline Transport Pilot's License (ATPL) was successful.

In May 2004 the PIC applied for a position as pilot on Do 328-100.

He could not successfully complete his first training as PIC on the Do 328-100. The reasons were theoretical and practical deficiencies. The air operator then trained and used him as a FO. For the next two years he flew as FO for the air operator and accumulated 896 hours flying experience.

His performance increased steadily and became better than the average of the FOs within the air operator.

His improved skills made the assignment as PIC once again an issue and in connection with the need for PICs a second training phase was initiated.

He successfully completed this supervision period. In the reports there were two comments concerning his leadership qualities as PIC (*"More leaderwork" and "Don't forget you are the leader"*).

Even though his flying skills had improved sufficiently his skills as PIC were not always without fail. This leadership shortcoming connected with the remark of a TRI *"... on short fields choose a touchdown point and land the aircraft there (PWR lever in FI to avoid exessive flare), ... use reverse AND brakes to decelerate aircraft"* show a significant similarity to the day of the accident. The BFU is of the opinion that the characteristics beneath this deficiency hindered him in developing sufficient leadership skills.

For the BFU the final positive assessment of the TRE at the end of the second supervision period was not very convincing. It would have been helpful had the TRIs and TREs filled in these supervision records (each day) more conclusively. The fashion in which these documents were filled in raised the question as to the value of such supervision records. For example, supervision records for the PIC dated 15 June 2007 and 29 June 2007: What had been entered on both days under 7. Descent & Approach could never have been flown in practice. (See Appendix)

After the supervision period, the PIC flew for about eight months on the Do 328-100 for the air operator; no anomalies had become known during that time. With a total flying experience of almost 5,000 hours the PIC was experienced.

2.2.6 Training and Qualification of the FO

The FO had straight-forward training to acquire the Commercial Pilot's License including instrument rating IR(A) and passed the exam for the ATPL (A) successfully.

His total flying experience was 321 hours and 44 minutes and therefore low. He had flown 131 hours and 27 minutes on the Do 328-100.

The air operator conducted a systematic qualification test before employing him as FO.

At the end of his training on the Do 328-100 his performance was considered to be mostly good. Except for a few exceptions his supervision records were not very conclusive. Off and on the TRIs criticised that checklists were not consequently adhered to, procedures not adhered to and landings still required some practice.

He passed the final check six weeks prior to the accident. There was no remark from the TRE or recommendation concerning the future work of the FO in the documentation. Therefore, for the air operator he met the criteria for a safe and economic conduct of flights in all respects.

The BFU had considerable doubt concerning this estimation given the FO’s reaction during the accident flight. The BFU did not understand that the TRI's remark during the the last flight before the Final Line Check - landings need more practice - did not result in any further actions like extension of the supervision period.

It could not be determined how many non-precision approaches to Mannheim City Airfield the FO had conducted. It could be proven that the PIC trained this kind of approach a total of eight times in the flight simulator in Brussels. It could not be determined to which airports these approaches were flown.

After finishing his supervision period on 6 February 2008 he flew as FO a total of 22 hours and 56 minutes; nine times Mannheim City Airfield was the destination airport. The FO’s pilot's log book did not show how many flights were flown according to IFR.

According to the OM/A, Qualification Requirements, the FO was considered to be an inexperienced crew member with his 22 hours and 56 minutes flying experience on the Do 328-100 (not counting the supervision period).

2.2.7 Fuel Management

The OFP showed that the actual ramp fuel was 2,200 kg. The amount intended on the OFP by the air operator was 1,400 kg. It is to be assumed that the PIC decided to get an additional 800 kg which, according to the OFP, would result in 170 USD earnings per ton. This concurred with the company's philosophy and made re-fuelling

in Mannheim unnecessary as documented by the CVR. It apparently played no part that with the additional fuel the airplane might have reached or even exceeded its maximum landing mass once Mannheim was reached. This indicated that a landing in Mannheim with maximum landing mass was not uncommon.

In general, the company's strategy to analyse the regionally different fuel prices and take advantage was sensible. It is, however, not understandable that at an airfield which allows for very little leeway when it comes to landings the performance limits were barely adhered to without any cogent reason and that it was possibly accepted when limits were exceeded. The BFU is of the opinion that the special requirements at Mannheim City Airfield were not taken into sufficient consideration when the company's strategy concerning fuel management was established.

The fact that the maximum landing mass was marginally exceeded at the day of the accident did not play any role in the actual course of events.

2.2.8 Airfield

Mannheim City Airfield is spatially limited by the two streets running east and west of the airfield and by urban buildings. In favour of a maximum runway length a limited safety area was accepted by the responsible regional civil aviation authority in spite of expert opinions to the contrary (DFS) and regulations which should have been applied. The insufficient safety area at the end of runway 27 was accepted with the information that the earth wall would protect third parties from aircraft overshooting the runway. The protection of aircraft occupants was, however, not taken into consideration.

To ensure a sufficient crossing altitude for the street a PAPI was installed with a steeper glideslope than that of the instrument approach. This required an intervention with the flight controls during the transition from IFR flight to VFR flight and is contradictory to the aviation authority's own references concerning the importance of a stabilised approach.

The pages in the AIP for Mannheim City Airfield stated that pilots must be sufficiently trained to be able to conduct a stabilised approach with a glidesope of 4°. The criteria for a stabilised approach and at which point they are to be adhered to were not mentioned.

In spite of the conclusion that from a flight operational point of view the approach to Mannheim City was difficult the runway markings did not comply with the respective regulations. There was neither the required aiming point marking nor the recommended touchdown zone marking. Such markings would have given the crew some support concerning the distance and the glidesope and, if necessary, been an

additional visual indication whether the approach was stabilised or not. The required but missing aiming point marking was therefore a safety deficit. The landing zone markings would have improved the safety level of the runway and the existing safety deficit caused by the missing safety areas would have been somewhat lessened.

The responsible certifying authority accepted significant safety area limitations when issuing the LOC/DME operations certificate. The expert opinion (DFS) and international regulations required larger safety areas. This resulted in a significant decrease in safety level. The additional operational requirements contained in the approval could not counterbalance it.

Landings with aircraft which need the entire runway length can, therefore, only be conducted with a safety level far below the one required by ICAO or other regulations. This becomes even more important the smaller the safety factors are which are taken into account for the calculation of the landing distance required. Therefore, the risk for non-commercial air traffic, e.g. the non-commercial corporate business aviation, is significantly higher than for commercial air transport operating according to JAR and EU OPS 1.

Since the airplane collided with relatively low speed with the earth wall about 50 m beyond the runway, it is highly likely that the accident could have been avoided by a slightly larger safety area.

2.3. Aircraft:

2.3.1 Aircraft Maintenance

There were no findings resulting from the review of maintenance documents. The crew statements and the analysis of the FDR data did not show any indication for a technical defect.
At about 2 NM the engine torque was reduced from about 25% to 3% and this showed that at that time the power levers were fully functional.

2.3.2 Power Lever Design

The requirements for the power lever design at the time of certification required a latch in the flight idle position and a separate mechanism to leave flight regime (JAR 25.1155). The power levers met this requirement. The problems which occurred during the operation of the DO 328-100 showed that the method was not sufficiently fault-tolerant concerning the operation of the power levers. The accident made clear that especially when a crew is under subjective stress the design of the power levers can prevent a swift and easy operation.

The power lever history showed that the actions by the different production organisations and design organisations were not suitable to reliably counterbalance this deficiency.

2.3.3 Certifying Authorities

The responsible certifying authorities did not recognise the danger the problems with the power levers created in spite of several occurrences and safety recommendations. The BFU could not determine the exact reasons.

In general, the civil aviation authorities have the tasks to ensure safe air traffic. To do so regulations and procedures are developed, implemented and supervised.

The aim of investigations by air accident investigation authorities according to ICAO Annex 13 is to discover, name and address safety deficits. The investigation results shall support the work of the civil aviation authorities. Given this background information, the BFU did not understand why neither the EASA nor the LBA had clearly defined written procedures as to how to deal with safety recommendations and ensure that they are processed, assessed and answered with each step being documented. This held the considerable risk that already identified safety deficits are not rectified in time.

2.4. Human Factors

The determined factors showed that this flight was a regular scheduled flight with no unusual circumstances such as uncommon weather phenomena or technical defects. But the crew reached their performance limit during the approach and at the end of the flight went beyond it. The training documentation of both pilots showed individual signs of below-average performance but all in all the pilots had sufficient skills.

A reason for the high stress level was primarily the non-compliance with the air operator's SOPs. The pilots could, in several instances, not put their full attention on the respective flight phase because they had deviated from the SOPs (e.g. radio communication with the company below FL100) or implemented them too late (e.g. the aircraft was configured after the FAF instead of before the FAF). The fact that the approach was not aborted once it had become unstabilised in only a few hundred feet contributed significantly. The BFU thought it highly unlikely that these deviations were just an isolated case or limited to this particular flight or crew. Especially the remarks by the TRIs on the supervision records concerning LOC/DME approaches *("Ldg MHG – touchdown behind first half of rwy!!! no reverse + brake action")* made it highly likely that during flight operations of the company's DO 328 fleet significant

deficits regarding the adherence to SOPs existed. The BFU is of the opinion that these deficits resulted in a non-justifiable decrease of the safety level.

3. Conclusions

3.1. Findings

3.1.1 Crew and Flight Operational Aspects

During the flight from Berlin-Tempelhof to Mannheim City, the FO was pilot flying and the PIC was pilot non-flying.

Take-off in Berlin-Tempelhof occurred in spite of a brake temperature beyond the limit stipulated in the AFM.

During the entire flight several deviations from the company's SOPs occurred.

The deviation from the SOPs resulted in a higher workload for the flight crew.

The approach briefing for Mannheim City the FO (PF) conducted was incomplete.

In 1,000 ft RA the defined conditions for a stabilised approach were met.

Between about 780 ft and about 100 ft the approach was not stabilised which did not result in a go-around procedure.

The runway threshold was crossed in about 40 ft with a feasible VCAS of 114 kt and a pitch of -4.4°.

Engine torque was not reduced to flight idle after the threshold had been crossed.

Since the engine power had not been reduced to FI prior to touch-down the flare phase was unusually long.

The crew did not realise that the relatively high engine power prevented the aircraft from touching down as usual.

During the flare-out the FO (PF) handed the controls over to the PIC (PNF). The PIC continued the landing.

The touch-down zone was crossed but no go-around procedure initiated.

After the touch-down the power levers remained above the FI position for another 10 seconds.

After the touch-down the PIC (PF) unlatched the latches and tried to pull the power levers into ground idle. This resulted in a jamming of the levers which was construction-conditioned.

Only about 50 m prior to the end of the runway the deceleration options of the aircraft became effective, i.e. the braking system triggered by pulling the E/P brake, the aerodynamic effect of ground idle, the ground spoiler and then the reverser.

The airplane collided with relatively low speed with an earth wall about 50 m beyond the runway and was severely damaged.

The PIC gave the instruction to evacuate the airplane eight seconds after the collision without first clarifying the situation and shutting down the right engine.

After the accident the crew was overwhelmed by the situation.

The flight attendant behaved prudent, target-oriented and correct.

3.1.2 Crew

The flight crew members were licensed and qualified for the flight in accordance with the existing legal requirements.

There was no evidence that physiological factors or incapacitation affected the performance of flight crew members.

It could not be determined whether the air operator had conducted a qualification test with the PIC.

The orientation to approach and depart Mannheim City Airfield was conducted by the air operator for both pilots during their training.

The required rest periods for flight crew and cabin crew were adhered to.

At the time of the accident duty time for the crews was 4 hours.

On the day of the accident the flight crew flew for the first time together.

The investigation determined that efficient crew cooperation management (CRM) was inadequate.

The role distribution did not comply with a professional two-man crew but with a flight instructor / student pilot relationship.

With a total flying experience of almost 5,000 hours the PIC was considered to be experienced.

He had sufficient flying skills. His leadership skills as a PIC were not always without fault.

The FO did not have much experience on Do 328-100. At the time of the accident he had the status of an inexperienced flight crew member.

His performance shown during the accident flight did not comply with the estimation of the Final Line Check and allowed doubts as to its result.

The pilots reached their performance limit and at the end of the flight went beyond it caused by the deviation from the SOPs especially during the approach.

3.1.3 Aircraft

The centre of gravity was within prescribed limits. The exceedance of the maximum landing mass did not contribute to the accident.

The review of the maintenance documentation resulted in no findings.

There were no indications of a system malfunction prior to the accident.

It was proven that the power lever mechanism was fully functional shortly before the landing.

The power lever design complied with the requirements for a separate mechanism to leave the flight regime.

The power lever design was not sufficiently fault tolerant regarding their handling.

Since the type certification in 1993 the type certificate holder changed repeatedly and the certification responsibility changed from the LBA to the EASA.

Since the type certification one accident and several incidents occurred in which the handling of the power levers played a part but the design of the power levers was not changed

The actions initiated by the different production organisations and design organisations prior to the accident at Mannheim City were not suitable to counterbalance this deficit permanently.

3.1.4 Airfield

The aids to navigation (LOC/DME) and PAPI of the airfield were in service and fully functional.

Contrary to guidelines the aiming point and touch-down zone markings were missing.

The required but missing aiming point marking of runway 27 of Mannheim City Airfield was a safety deficit.

The recommended but missing touch down zone marking of runway 27 of Mannheim City was the waiving of a possible and necessary increase of safety level.

The insufficient safety area at the end of runway 27 resulted in a considerable reduction of the safety level.

The measures stipulated by the certification authorities were not suited to compensate the lack of sufficiently dimensioned safety areas.

The one-half runway distance remaining sign did not mark the actual half of the runway.

Contrary to the Mannheim City Airfield hazard control and emergency plan flight operations did not cease right away which resulted in substantial danger.

3.1.5 Air Operator

The compilation of the supervision records (each day) by the TRIs and TREs was not very conclusive.

The instructions in the air operator's OM concerning the use of the wheel brake during landing were inconsistent, incomplete and partially contradictory.

The TRs and FOIs of the aircraft manufacturer were not incorporated into the OM/B or OM/D of the air operator.

The operator's OM did not include the balked landing procedure which the manufacturer described in case of jammed power levers and the crew had not trained said procedure.

Within the air operator it was not uncommon that landings were continued at Mannheim City although the touchdown zone had been passed; this was contradictory to the SOPs.

Significant deficits in the adherence with the SOPs were probable during flight operations with the Do 328 fleet.

The BFU is of the opinion that the special requirements at Mannheim City Airfield were not taken into sufficient consideration when the company's fuel management strategy was established.

3.1.6 Miscellaneous

The weather conditions at Mannheim City Airfield did not contribute to the accident.

At the time of the landing runway 27 was dry and it was daylight.

Both aviation authorities, LBA and EASA, did not have clearly defined written procedures as to how to deal with safety recommendations and ensure that they are processed, assessed and answered with each step being documented.

The responsible certifying authorities did not recognise the danger the problems with the power levers created in spite of several occurrences and safety recommendations.

3.2. Causes

The accident was due to

the airplane overshooting the runway and hitting an earth wall at the end of the runway,

the non-initiation of a balked landing,

the fact that after touchdown the power levers could not be pulled into ground idle or reverse by the PIC (PF),

the fact that the landing was not aborted after the airplane had passed the touch-down zone,

the fact that the power levers were not pulled into flight idle during the flare which both pilots did not recognise.

the fact that the crew deviated from the SOPs and therefore reached their performance limit and at the end went beyond it.

The following factors contributed to the accident:

Within in the air operator the non-precision approaches and the landings at Mannheim City were conducted with significant frequency not according to the requirements of the OM.

The TRs and FOIs of the aircraft manufacturer were not incorporated into the OM/B or OM/D of the air operator.

The practical training of the crew by the air operator was insufficient regarding the prevention of an erroneous operation of the power levers based on the instruction published by the aircraft manufacturer.

The crew conducted a non-precision approach which did not comply with the air operator's OM requirements and the AIP.

The power lever design was not sufficiently fault tolerant.

The existing risks caused by the problems during the use of the power levers were not recognised correctly and remedied by the responsible authorities and type certificate holders in spite of several occurrences and safety recommendations.

The touch-down zone at Mannheim City Airfield was not marked.

The extent and design of the safety area at the end of runway 27 was not sufficient to ensure the safety level ICAO and the German legislator require for flight operations.

4. Safety Recommendations

The BFU issued the following safety recommendations:

Recommendation No.: 26/2012

The air operator should, in order to qualify and quantify more accurately and permanently remedy the existing deficits in the adherence with the SOPs within the Do 328 fleet, extend the existing flight data analysis program for aircraft with a MCTOM of more than 27 t in accordance with ICAO Annex 5 and EU OPS 1 requirements to the Do 328 fleet. With this program particularly data which document the adherence with the criteria for stabilised approaches and the touch-down zone should be collected.

Recommendation No.: 27/2012

The Mannheim City Airfield operator should mark the runway in accordance with the ICAO recommendations.

Recommendation No.: 28/2012

The Mannheim City Airfield operator should extend the runway end safety areas according to existing regulations and recommendations or carry out suitable constructional measures like the installation of energy absorbing surfaces or shorten the runway distance available.

Recommendation No.: 29/2012

The Luftfahrt-Bundesamt (LBA) should define a written process for the handling of safety recommendations which ensures that they are processed, assessed and answered in a documented fashion.

Recommendation No.: 30/2012

The European Aviation Safety Agency (EASA) should define a written process for the handling of safety recommendations which ensures that they are processed, assessed and answered in a documented fashion.

Recommendation No.: 31/2012

The air operator should modify its fuel policy such that the special requirements of Mannheim City Airfield are sufficiently taken in to account. Special attention should be paid to the adherence of the maximum allowable landing mass.

Recommendation No.: 32/2012

The Luftfahrt-Bundesamt should ensure that in all air operators' operations handbooks distinct criteria for stabilised approaches for all kinds of approaches, including in VMC, are described.

Recommendation No.: 33/2012

The air operator should ensure that in its operations handbooks distinct criteria for stabilised approaches for all kinds of approaches, including in VMC, are described.

The BFU abstained from issuing a safety recommendation to the type certificate holder of the Do 328-100 regarding the modification of the power lever design to minimise the risk of an operating error because the type certificate holder had already developed a modification before the end of the investigation. The modification was part of the Service Bulletin SB 328-76-486 Engine Controls – Modification of Power Lever Assembly and introduction of Crew Aural Alerting Device. EASA has issued a respective Airworthiness Directive (EASA AD No.: 2009-0196)

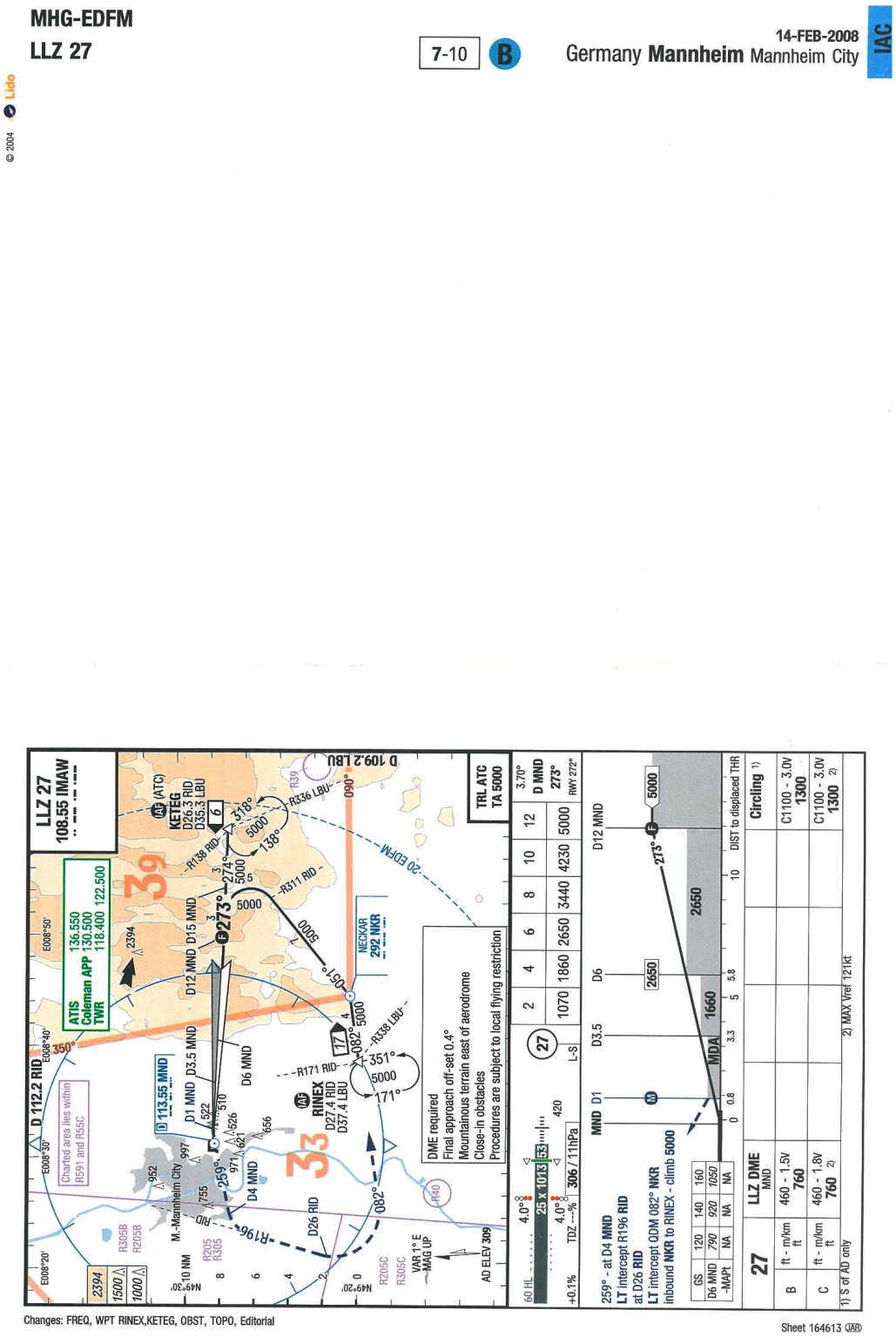
The BFU abstained from issuing a safety recommendation to the Mannheim City Airfield Operator to put the required aiming point markings in place since they had already been painted on the runway.

Braunschweig, 8. August 2012

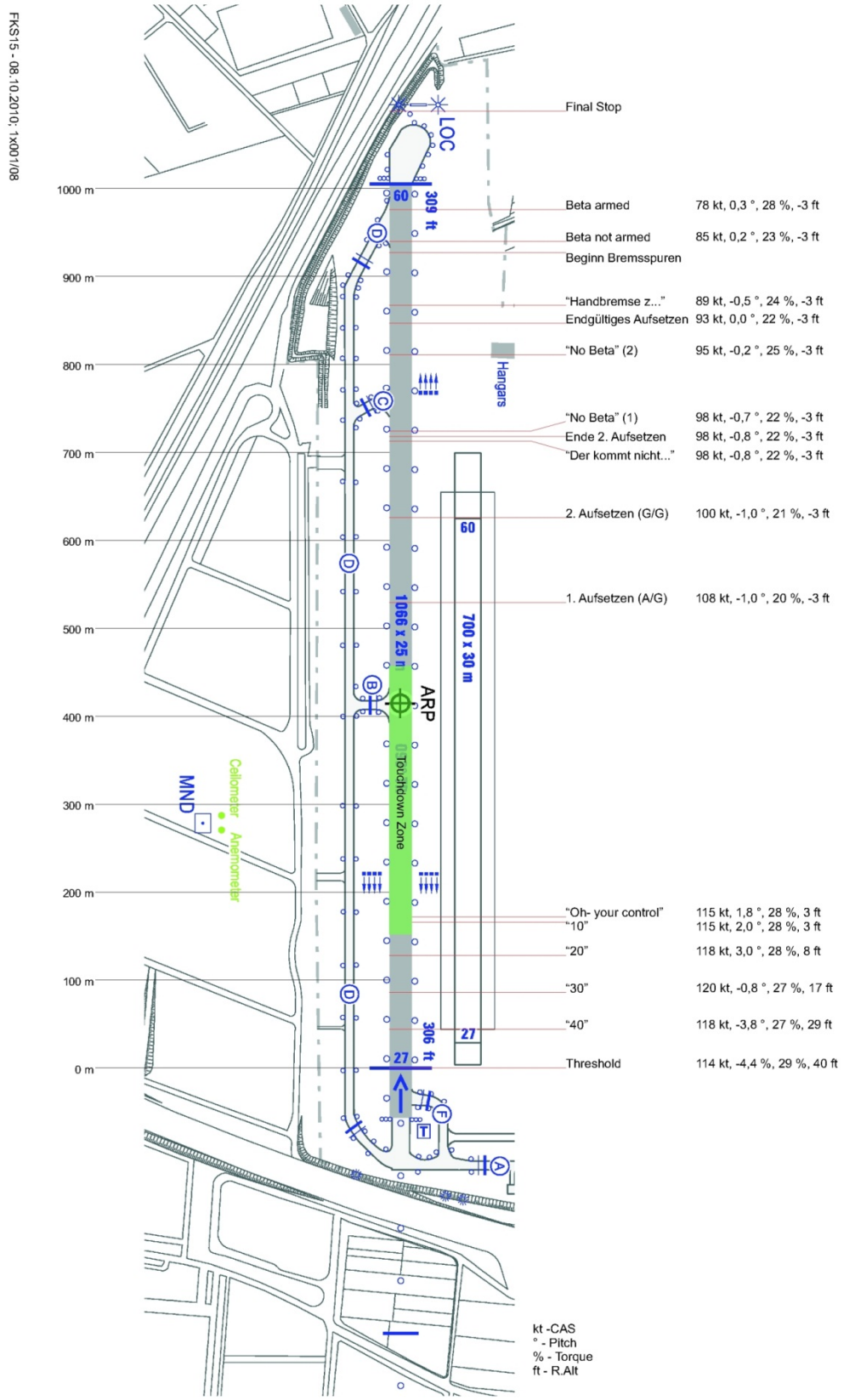
Investigator in Charge:	Kostrzewa
Assistance:	Hempelmann (Flugdatenauswertung)
	Himmler (Flugdatenauswertung, Flugbetrieb, Flugleistungen)
	Krupper (Flugbetrieb, Meteorologie)
	Lampert (Flugdatenauswertung)
	Link (Flugdatenauswertung, Flugleistungen)
	Ritschel (Flugdatenauswertung)
	Rokohl (Flugplatz)
	Severin (Flugbetrieb, Menschliche Faktoren)

5 Appendices

1. Standard Operating Procedures LLZ 27, Page 7-10, 14-FEB-2008, MHG-EDFM, Mannheim City
2. Graphic depiction of the course of events
3. Mechanism of the power levers
4. Situation at the end of runway 27 at Mannheim City Airfield
5. Runway markings at Mannheim City Airfield
6. Photos of the accident site
7. Seating plan of the passenger cabin
8. OM/B, Normal Procedures, Chapter 2, Page 73
   Non-Precision Approach – Flaps 32° (Typical)
9. OM/B, Normal Procedures, Chapter 2, Page 55
   Crew Coordination During Final Approach (Non-Precision Approach)
10. OM/B, Normal Procedures, Chapter 2, Page 58
    Crew Coordination During Landing
11. OM/B, Normal Procedures, Chapter 2, Page 52
    Standard Call-Out Procedure during Approach
12. OM/A, Operating Procedures, Chapter 8FD, Page 171
    Stabilized Approach
13. OM/B, Normal Procedures, Chapter 2, Page 57
    Landing
14. OM/B, Normal Procedures, Chapter 2, Page 75
    Landing
15. AOM Volume 1, TR 10-016, Balked Landing
16. FDR – Analysis of the accident flight and other similar flights
    Flight No 1, Accident flight
    Flight No 2 (-2)
    Flight No 3 (-4)
    Flight No 4 (-6)
    Flight No. 5 (-8)
17. Supervision Records of the PIC of 15 June und 29 June 2007

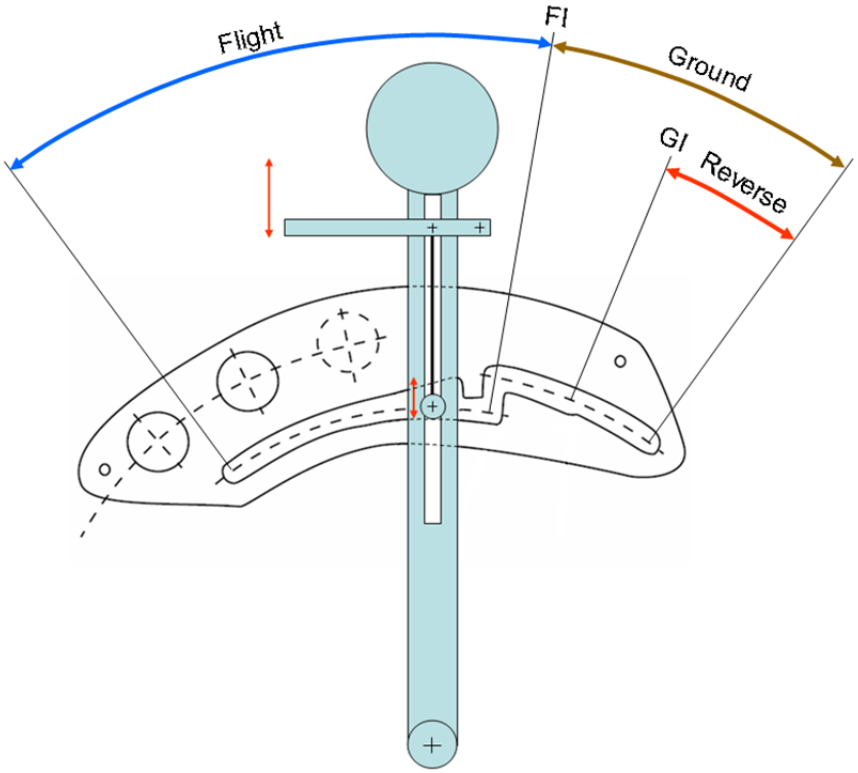


Mannheim City Approach Chart LLZ 27 Source: LIDO

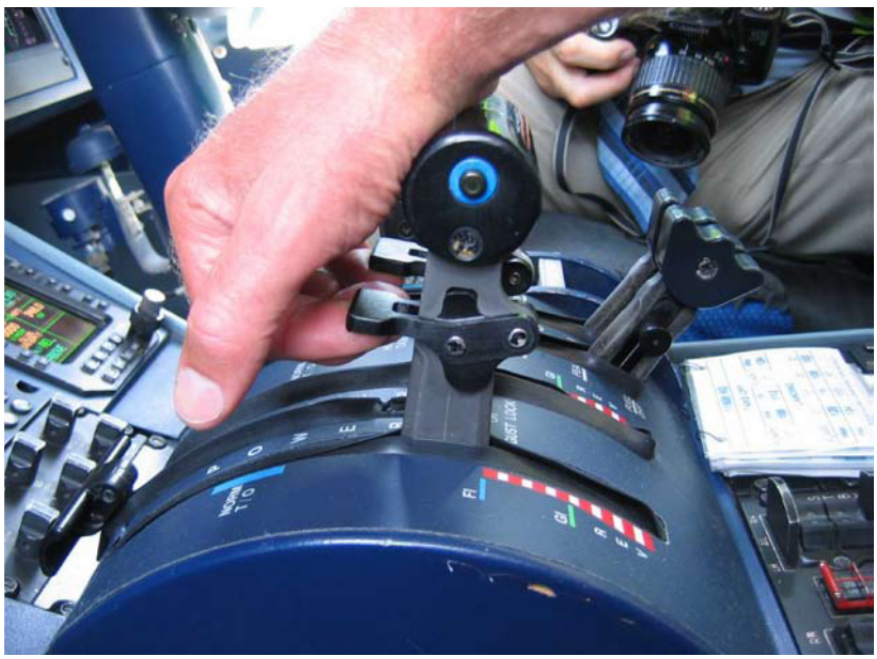


Graphic depiction of the course of events

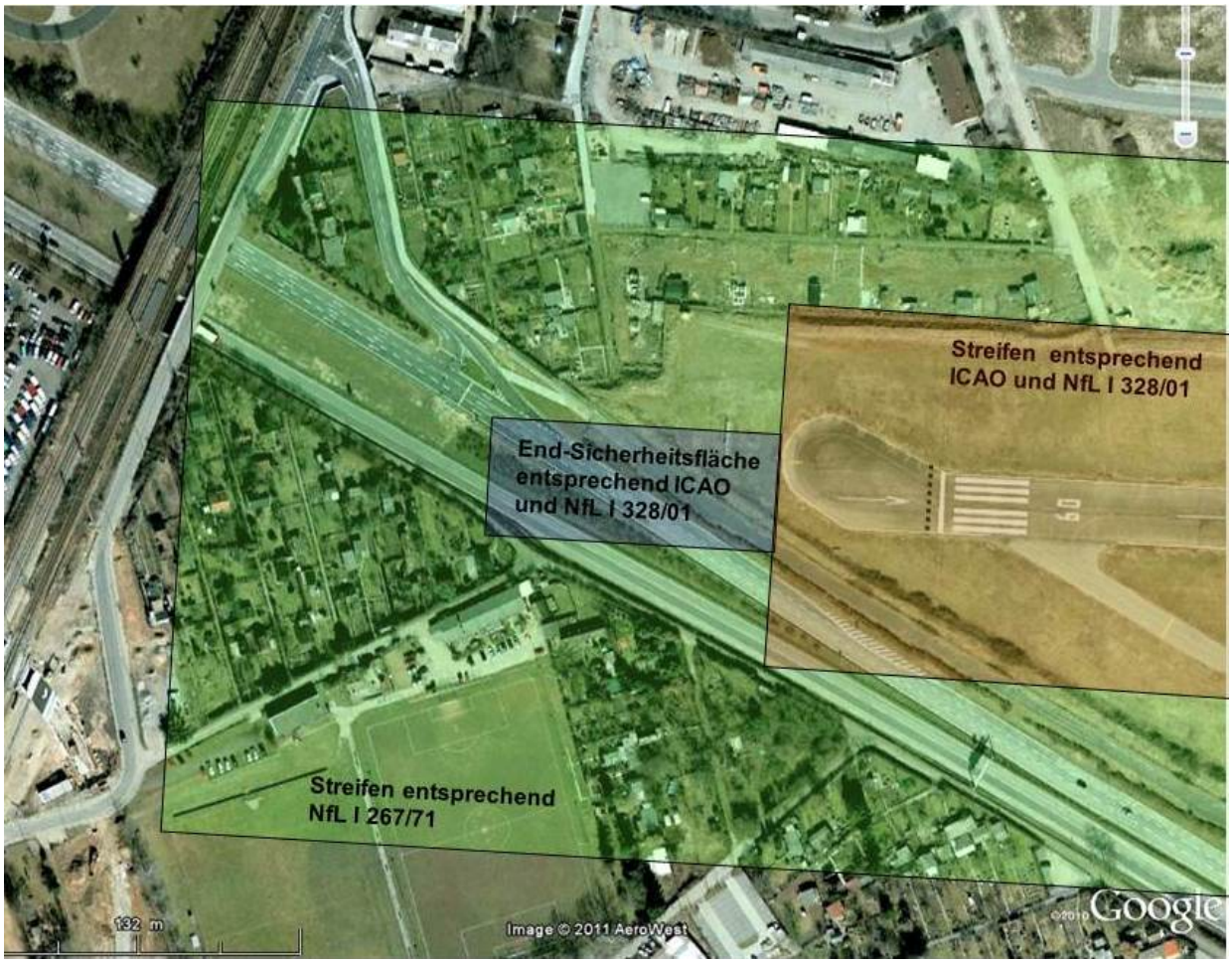
Source: BFU



Mechanism of the power levers Source: BFU



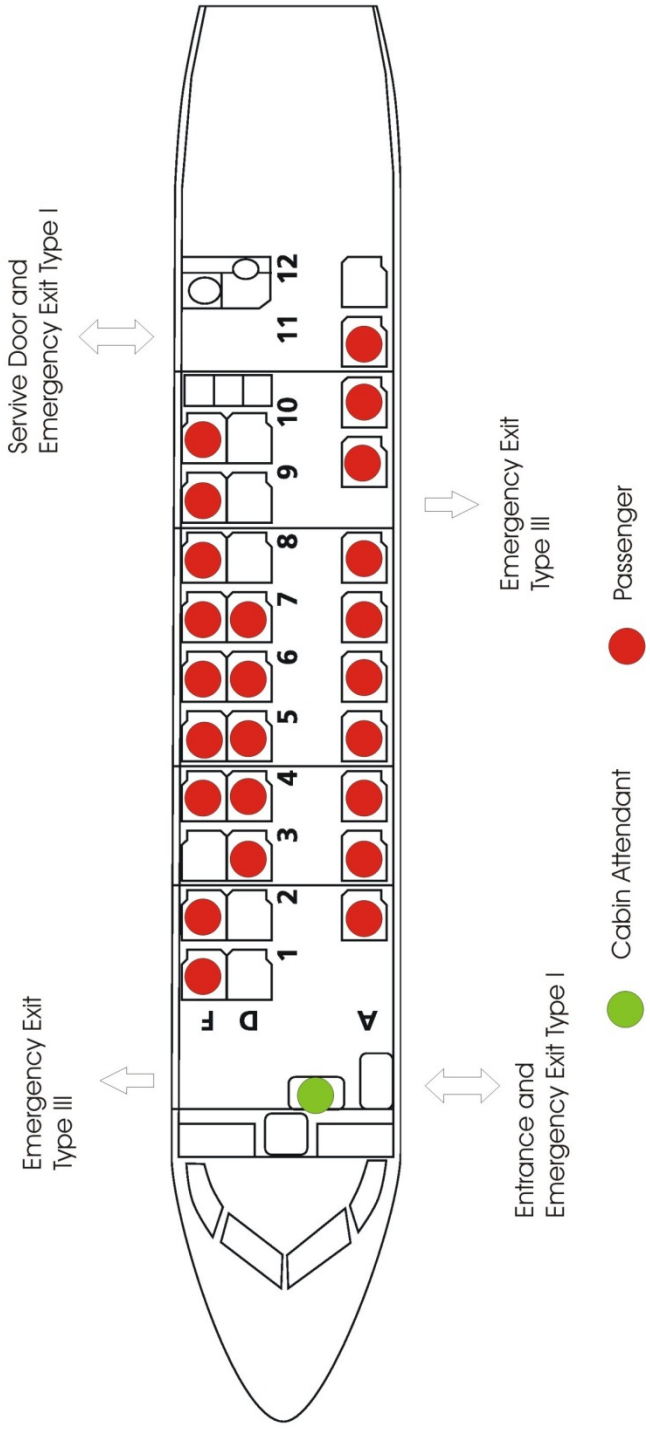
Power Lever und Latches Source: AAIB



Intended safety areas of runway 27 at EDFM Source: Google, BFU

Runway markings at EDFM Source: Google, BFU

Accident site Pictures: unknown

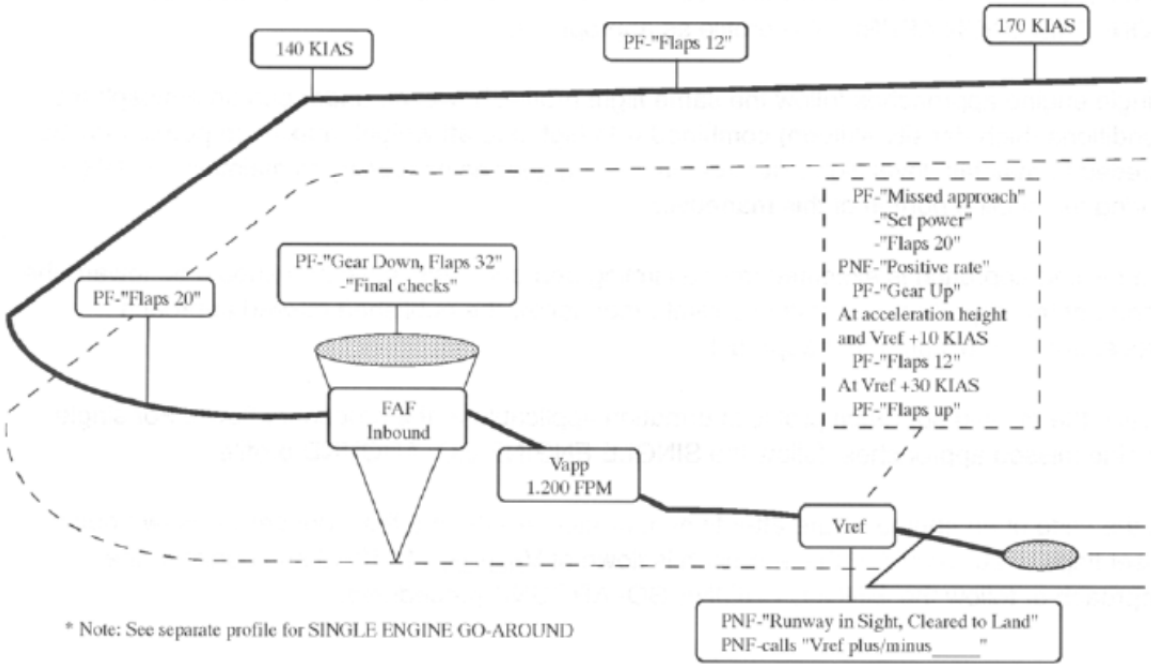


Seating plan of the passenger cabin

Source: BFU

AO's Logo	**Operating Manual** PART B Normal Procedures	Chapter : 2 Page : 73 Revision : Original Date : 11.04.03

Non-Precision Approach – Flaps 32° (Typical)



Non-Precision Approach – Flaps 32° Source: AO OM/B

AO's Logo	**Operating Manual** PART B Normal Procedures	Chapter : 2 Page : 55 Revision : Original Date : 11.04.03

Crew Coordination During Final Approach (Non-Precision Approach)

Established on initial approach, speed 210 KIAS, HDG, ALT or VS selected.

Condition	PF	PNF
When on heading to intercept the final track or earlier when being radar vectored	„Final NAV setting	- Perform final NAV setting, report completed and stations identified
On downwind leg or approaching base leg	- Reduce to 170 KIAS	
	„Flaps 12“	- Select 12° flap setting
Latest turning base leg	- Reduce to 140 KIAS	
When cleared for the approach (VOR / DME or LOC / DME)	„Arm NAV Mode“	- Perform and report: „Localizer / VOR armed“
When established on final track	„Set Missed Approach Heading“	- Set both heading bugs according to the published missed approach
At Final Approach Fix	„Gear down“	- Select gear lever down
When gear is down and locked	„Speed checked, Flaps 20“	- Check speed and select 20° flaps
	„Speed checked, Flaps 32“	- Check speed and select 32° flaps
Starting descend	- Select Vertical Speed	
Descending	„Set Missed Approach Altitude“	- Perform and report: „MALT set“
Descend with V_{APP} ($V_{APP} = V_{REF} + 10$ KIAS)		- Monitor descend and call out any significant deviation
Approaching distance / altitude check point	„Copied ..... ft“	„Approaching .... NM, altitude should be ..... ft“
Passing distance / altitude check point	„Checked“ or: „Correcting“	„... NM now, on glide path“ (or: ... ft high / low)
When convenient	- Request „FINAL CHECKLIST“	- Read FINAL CHECLIST and report completed or open items
100 ft above MDA	„Checked“	- Call: „Approaching Minimum“
At Minimum Descent Altitude	- Continue at MDA to the Missed Approach Point (MAP)	- Call: „MINIMUM“

If visual reference with runway or approach lights is established at MDA, continue at MDA to the visual descent point (VDP) and start final descent from this point while reducing speed to V_{TGT}.

If no visual reference can be established at MDA, continue at MDA to the MAP and execute published missed approach.

Crew Coordination Approach Source: AO OM/B

AO's Logo	**Operating Manual** PART B Normal Procedures	Chapter : 2 Page : 58 Revision : Original Date : 11.04.03

PROCEDURE:
- Trim to be established at 1.000 ft on final approach speed on glideslope or visual glidepath.
- At approximately 200 ft reduce speed to cross the threshold at V_{REF}.
- Aim for a positive touchdown at the normal touchdown point.
- Anticipate increased floating, only a slight pitch increase is required for the flare.

NOTE: An extensive and long flare may result in a tail skid by touching the runwav.

- Lower the nose to the runway and select ground idle without delay.
- Apply reverse power and brakes as required.

Crosswind Landing

During final approach maintain runway alignment by crabbing into the wind.

When crossing the threshold, apply rudder to align the aircraft with the runway centerline and bank into the wind to counteract drift. Do not delay touchdown after decrabbing is completet. After touchdown keep straight initially with rudder and counteract the tendency of the upwind wing to lift by decisive use of aileron by CM2.

If reverse is required, apply reverse power slowly and symmetrically. If directional control can not be maintained, reduce reverse power or apply ground idle.

Crew Coordination During Landing

PF	**PNF**
	In preparation of the FINAL CHECKLIST the PNF shall keep his / her hand on the CONDITION levers until the CONDITION levers are finally set to MAX
When landing is assured, call: „CONDITION LEVERS MAX" and at approximately 20 ft height retard the POWER levers to Flight Idle	Advance the CONDITION levers to MAX when directed by PF
After mainwheel touchdown smoothly lower the nosewheel to the runway, then retard the POWER levers to Ground Idle	When both BETA lights are illuminated, call: „BETA-LIGHTS"
When BETA lights are illuminated or called out, retard POWER levers to reverse and use brakes as required, maintain directional control with rudder pedals	
CM1	**CM2**
In the event the first officer is landing the airplane, CM1 should assume control of the airplane at not less than 60 KIAS by calling „I HAVE CONTROL"	Confirm transfer of controls to the captain by calling: „YOU HAVE CONTROL"
At safe speed CM1 will call: „CONDITION LEVERS TO MIN / HIGH TAXI" (as required by winds)	Retard the CODITION levers to MIN or HIGH TAXI when directed

Crew Coordination Landing — Source: AO OM/B

AO's Logo	**Operating Manual** PART B Normal Procedures	Chapter : 2 Page : 52 Revision : Original Date : 11.04.03

APPROACH - Checklist (Non-APU)

APPROACH		
External Lights	On	PNF S
Parking Brake	Off	PNF S
Autofeather	Armed	PNF S
ALTIMETERS	**SET**	**B**
DH / MDA	**SET**	**B**

Standard Call-Out Procedure During Approach

Condition	PF	PNF
Passing NDB/VOR/OM inbound at correct check altitude		„Passing NDB / VOR / OM, altitude checked"
Passing NDB/VOR/OM inbound and deviating from correct check altitude more than 100 ft	„Correcting!"	„Passing NDB / VOR / OM, ... ft high / low"
At 500 ft above THR elevation (precision and visual approaches)	„Checked"	„Five Hundred"
At 100 ft above DA / MDA (barometric altitude)	„Checked"	„Approaching Minimum"
At Decision Altitude or MDA	„Contact" or: „Negative Contact"	„MINIMUM" (precision apps.) or: „Missed App Point" (nonprecision)

After PF reports „Contact" or „Negative Contact" CM1 must announce further intentions by calling „Continue" or „Go-around". If CM1 himself / herself is PF he will add his intentions to the initial callout in the following way:

„Contact – Continuing" or „Negative Contact – Going around"

The callouts „Approaching Minimum" and „Minimum" may be omitted if runway is clearly visible and PF has confirmed „Contact". Durning nonprecision approaches however, the callout „Approaching Minimum" remains mandatory, as it replaces the the „Five hundred" incapacitation check.

Whenever PNF acquires visual contact with runway or approach lights, he / she shall announce: „Runway / Approach Lights in Sight"

Standard Call-Out Approach Source: AO OM/B

AO's Logo	**Operations Manual** **General / Basic** Operating Procedures	Manual: OM/A Chapter: 8FD Revision: 12 Page: 171 of 202

8.3.20 Stabilised Approach

Maintaining a stable speed, descent rate, and vertical/lateral flight path in landing configuration is commonly referred to as the stabilized approach concept.

Fleet specific criteria for desired speed/configuration at 1,000 ft Radio are promulgated, and consideration should be given to a go-around in the event of the 1,000 ft criteria not being achieved.

All approaches shall be stabilized by 1,000 ft (IMC) above airport elevation. If the criteria for a stabilised approach are not achieved at these altitudes, an immediate Go-Around shall be flown.

During approach, any assigned Flight Deck Crew Member can call for go-around whenever deemed to be necessary. Independent from who has made such call out, a go around shall be flown, immediately.

An approach is considered stabilized when all of the following criteria are met:

- the aircraft is on the correct flight path/vertical profile
- only small changes in heading/pitch are required to maintain the correct flight path
- the aircraft speed is not more than VREF + 20 knots + wind correction indicated airspeed and not less than VREF
- the aircraft is in the correct landing configuration
- sink rate is no greater than 1,000 fpm; if an approach requires a sink rate greater than 1,000 fpm, a special briefing should be conducted
- power setting is appropriate for the aircraft configuration
- all briefings and checklists have been conducted.

Note: *These conditions should be maintained throughout the rest of the approach for it to be considered a stabilized approach. If the criteria listed above cannot be established and maintained below 1000 feet AAL, initiate a go-around. Do not attempt to land from an unstable approach.*

Note: *Unique approach procedures or abnormal conditions requiring a deviation the above elements of a stabilized approach require a special briefing.*

Note: *Where an approach is made over terrain which results in a significant difference between Radio height and the height above runway threshold, e.g. an approach over sea to a cliff top aerodrome, an appropriate adjustment should be made to the 1000 ft Radio decision point.*

When manoeuvring below 1000 feet, be cautious of the following:

- descent rate change to acquire glidepath
- lateral displacement from the runway centerline
- tailwind/crosswind components
- runway length available.

Stabilised Approach — Source: AO OM/A

AO's Logo	**Operating Manual** PART B Normal Procedures	Chapter : 2 Page : 57 Revision : Original Date : 11.04.03

LANDING

General

Once the final approach is established, the aircraft configuration remains fixed and only small adjustments need to be made to the glide path, speed, power and trim. This results in an stabilized approach and landing under all normal and abnormal conditions regardless of weather. Good technique and discipline will allow the pilot to repeat the proper approach and landing under all conditions.

Plan ahead and be established on the centerline early in the landing configuration, with a proper rate of descent to give a constant glide path. This together with good airspeed control will ensure a perfect touchdown at the 1.000 ft point on the runway centerline.

Final Approach Speed
The recommended final approach speed is V_{REF} + 10 KIAS.

Correction for Actual Wind and Gust
The final approach speed shall be increased for gusty or strong winds as follows:

- Wind less than 5 kts	NO CORRECTION
- Wind between 5 and 10 kts	ADD 5 KTS
- Wind and gust 10 to 20 kts	ADD 10 KTS
- Wind and gust more than 20 kts	ADD 15 KTS

or:
- apply basic rule to add half of the crosswind component and all of the gust, but a maximum of 15 kts.

Normal Landing

Overfly the beginning of the runway at approximately 50 ft. Flare to a slightly nose-up attitude and retard the power levers smoothly to flight idle. Do not prolong the flare excessively.

Normal touchdown speed is between V_{REF} and V_{REF} – 10 KIAS. After touchdown on the main wheels, gently lower the nose wheel. Initially keep the aircraft straight with rudder. Select Ground Idle and use Reverse Power as required after confirmation of both props being in the BETA range.

NOTE: Do not select ground idle until nose wheel is on the ground. The rudder is not very effective for directional control with reverse power.
Unless runway length is limiting it is recommended to cancel reverse at 60 kts to reduce the probability of damaging the propeller or fuselage by foreign debris and to improve directional control at low speed.

Use nose wheel steering for directional control. CM2 should hold the ailerons into the wind. Apply brakes until taxi speed is reached.

Zero-Flap Landing

To prevent unnecessary tail skid damage on touchdown, Zero-Flap Landings shall not be performed during normal line operation.

Exceptions:
- Flight training requirements
- System malfunctions (e.g. Hydraulic or Flight Controls)

The landing distance for zero flap landings increases by 1.59 times the distance for flaps 32. See QRG tables for actual landing distance.
During the approach, the pitch is approximately 3°-4° nose up.

Normal Landing Source: AO OM/B

AO's Logo	**Operating Manual** PART B Normal Procedures	Chapter : 2 Page : 75 Revision : Original Date : 11.04.03

LANDING

This maneuver describes methods and techniques to be employed during a landing with and without crosswinds, to normal and minimum length runways. Zero flap (flapless) landing information is also provided.

Information pertinent to normal landings is contained in the profile for CIRCLING / CONTACT APPROACHES.

When established on final the aircraft should be crabbed into the wind to maintain the runway centerline. Crossing the threshold the aircraft should transition to a slip keeping the aircraft aligned with the centerline. As ground contact is made on the main wheel on the windward side the controls should be displaced to allow smooth contact with the runway as the aircraft speed decreases.

When landing on a minimum length runway, strict adherence to the correct V_{REF} speed and profile should be observed. Additionally, landing with a minimum flare is recommended to best utilize the available runway. Apply smooth constant brake pressure after touchdown to achieve the best performance. On slippery runways with the anti-skid functioning use full brake pedal after touchdown, do not attempt to modulate braking action through the brake pedals.

Judicious use of reverse thrust will improve landing distance performance. Reverse thrust should be used very carefully on wet, or slippery surfaces. Reverse thrust should be discontinued below 60 knots.

If landing in a flapless configuration, operate the aircraft with the following additional considerations:

1. Fly the correct reference speed for the flapless configuration
2. Extend the pattern when possible to allow more time for speed reduction
3. Plan for longer than normal landing distances. See performance charts.

In flight selection below flight idle is prohibited.

GO-AROUND

Simultaneously apply go-around power, call for flaps and rotate towards 8° degrees pitch attitude. At a positive rate of climb call "gear up" and climb at V_{REF} or at 15° pitch whichever is higher. If a turning missed approach is required, accomplish the missed approach procedure through gear up before initiating the turn. Delay further flap retraction until a safe altitude and appropriate speed are attained.

The minimum altitude for flap retraction during takeoff is not normally applicable to a missed approach; however, obstacles in the missed approach path must be taken into consideration.

Landing

Source: AO OM/B

Dornier *328 – 100*
Airplane Operating Manual – VOL 1
Flight Techniques

GO–AROUND

Simultaneously apply go–around power, call for flaps and rotate towards 8° degrees pitch attitude. At a positive rate of climb call "gear up" and climb at V_{REF} or at 15° pitch whichever is higher. If a turning missed approach is required, accomplish the missed approach procedure through gear up before initiating the turn. Delay further flap retraction until a safe altitude and appropriate speed are attained.
The minimum altitude for flap retraction during takeoff is not normally applicable to a missed approach; however, obstacles in the missed approach path must be taken into consideration.

TOUCH AND GO

Once the airplane has touched the runway with all three gears the following steps and actions shall be executed by the instructor pilot while the student pilot maintains airplane control:

Flaps	12°
Ref Data	Select takeoff (T/O)
Trim	Re–position trim bug within green takeoff range
Check Flaps	12°
Power	TOGA
Normal takeoff sequence	PERFORM

Touch and go manoeuvres are to be performed for pilots training only, and with required air crew on board (no passengers).
This manoeuvres may only be accomplished if either pilot is a certified flight instructor.
Re–configuration of airplane including trim, flaps, ground spoilers (if installed) and ref data is accomplished by the flight instructor, while the student pilot maintains airplane control on the runway. Re–configuration shall be initiated once the airplane has touched the runway with all three landing gears. Takeoff power shall be applied after re–configuration is completed and flaps are set and indicating takeoff position (12°).
Touch and go manoeuvres shall be performed on runways which cover the total sum of landing distance plus accelerated–stop–distance for the given airplane weight and the actual atmospheric conditions.

BALKED LANDING

Whenever the captain deems it necessary to discontinue landing roll to avoid a catastrophic situation after touch down, given sufficient runway length is remaining, he may apply the following balked landing procedure:

POWER lever latch handles (both)	Released

NOTE: Upward pressure on latch handles prevents Power Lever movement into flight regime.

POWER levers (both)	Set GA TQ
GA button	Press
T/O config warning	Disregard
Accelerate airplane	V_{REF}
Airplane	Rotate to GA–FD bar (8°)

Once airborne:

GO–AROUND procedure	Apply

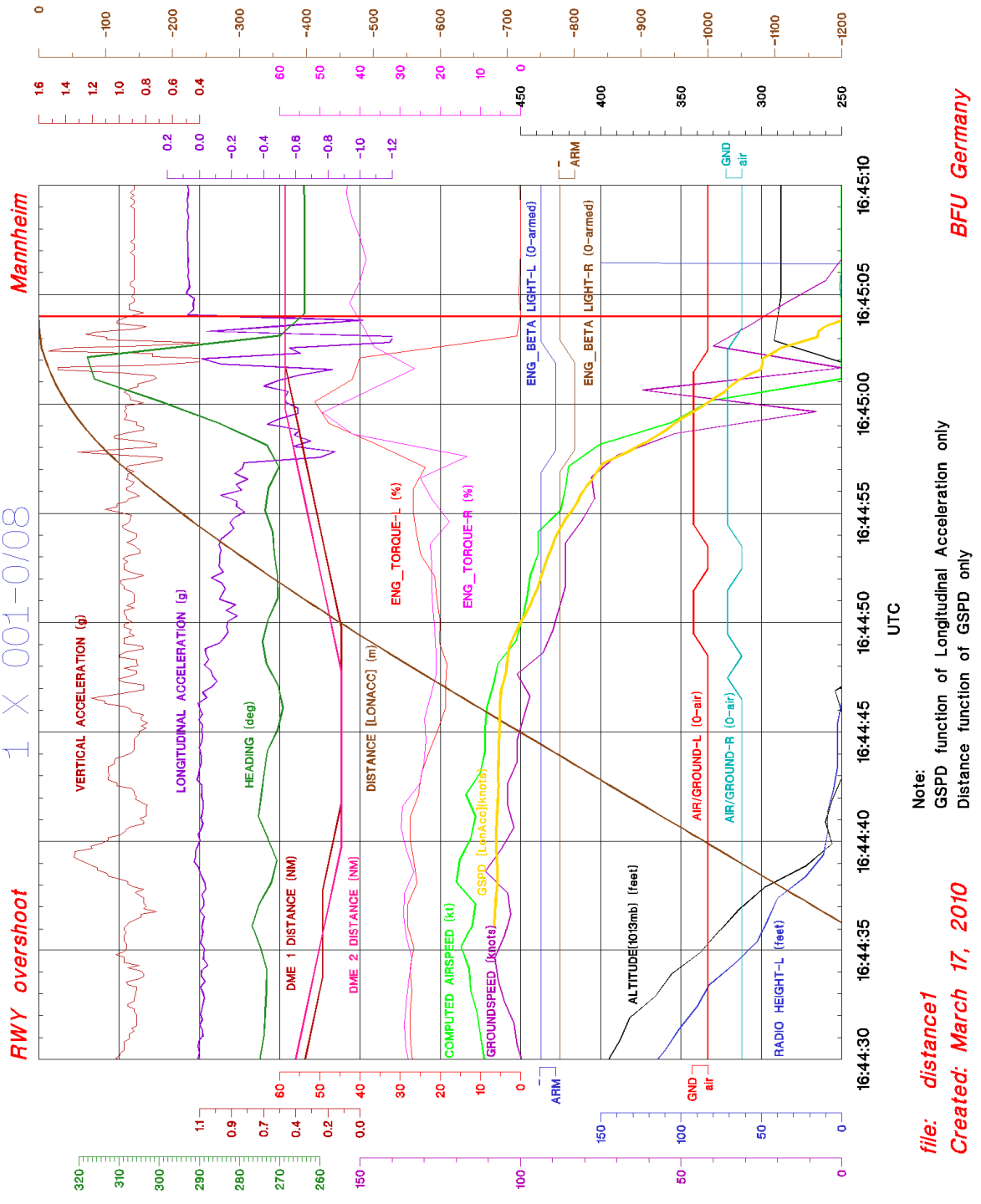
This manoeuvre is an emergency evasive action and may be practised in the simulator only.

TR 10–016
Page 2 of 2

10–06–00
Page 1
Aug 01/06

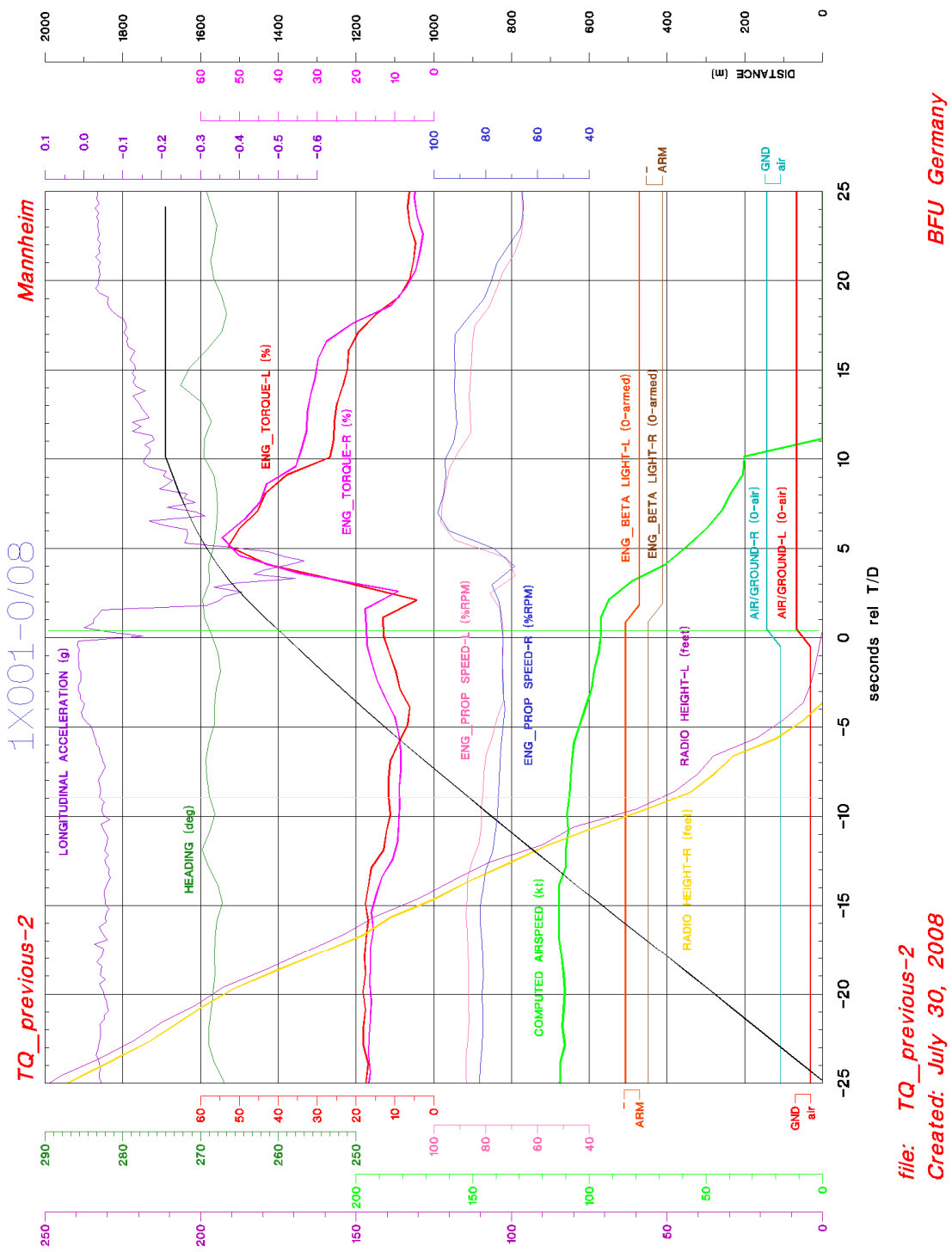
EFFECTIVITY: ALL

Balked Landing Source: AOM Volume 1, Flight Techniques, TR 10-016



Flight No 1, Accident Flight

Source: BFU



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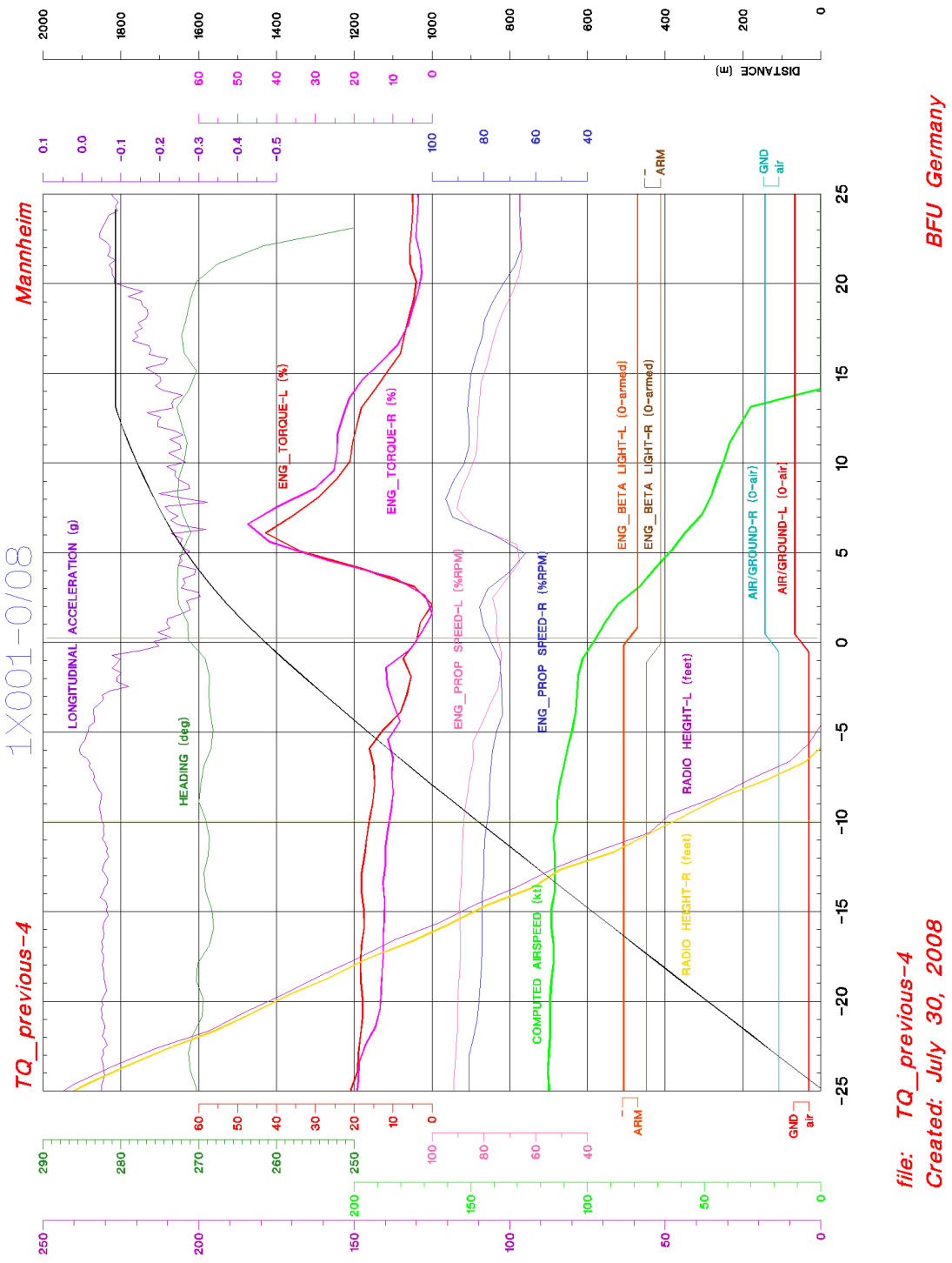
Source: BFU



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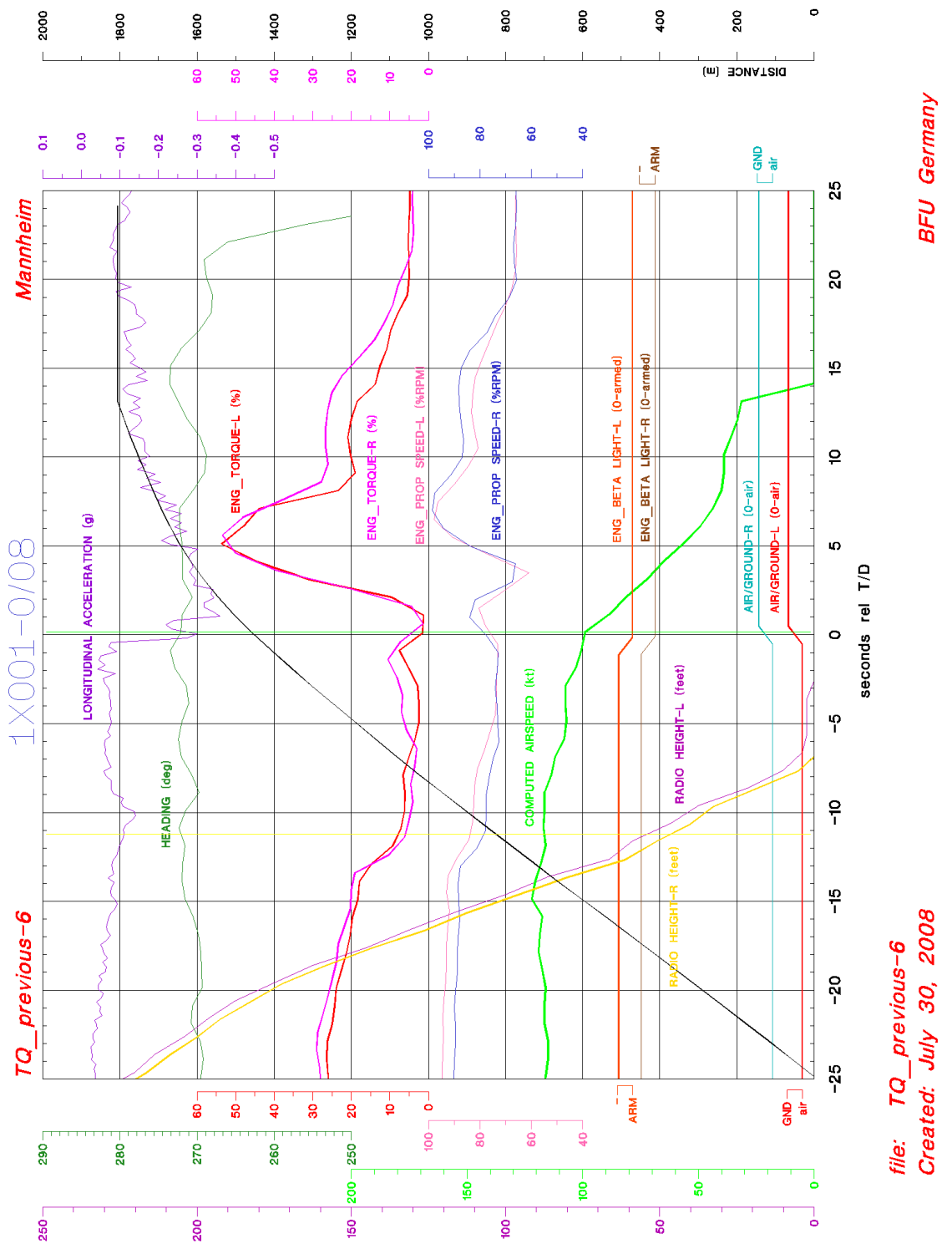

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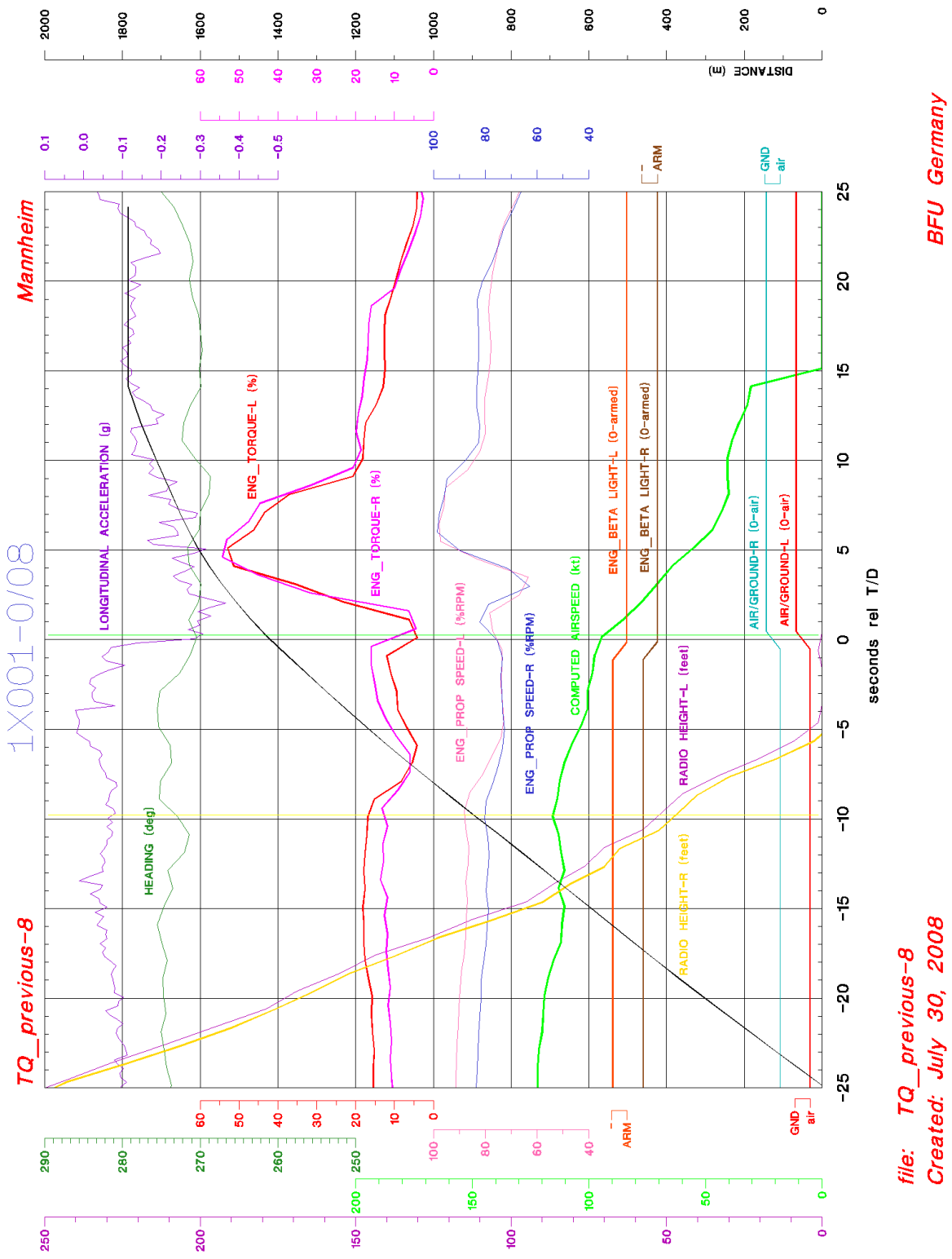
Source: BFU



Flight No 5

Source: BFU

AO's Logo	Appendix OM Part D **Ausbildungsleitfaden** **Supervision**	CHAPTER: Appendix 9 PAGE: 7 REVISION Original :

Supervision-Record (Each Day)

Name of Trainee:	[redacted]	Date:	15.06.07
SV Captain:		Aircraft:	[redacted]
Training as:	CPT	Blockhours:	02:42
Routing:	MHG-HAM-MHG		

	Routing Line Check
	Final Line Check
✓	Line Training
	Ready for Final Line Check

1. Airmanship	NO	A	S	ST	SI	U
1.1 AOM&OM Familiarity				✓		
1.2. R&S Procedures				✓		
1.3. Checklist Procedures				✓		
1.4. System Knowledge				✓		
1.5. System Monitoring				✓		
1.6. Basic Instruments flying				✓		
1.7. Airspace Observation				✓		
1.8. Co-Operation with ATC				✓		

2. NAV/COM Procedures	NO	A	S	ST	SI	U
2.1. Station Identification				✓		
2.2. FMS-Operation				✓		
2.3. RT-Procedures				✓		
2.4. EFIS OPS&Revisionaries				✓		

3. Preflight	NO	A	S	ST	SI	U
3.1. Company Flight Plan				✓		
3.2. W&B				✓		
3.3. WX, Notams				✓		
3.4. Fuel Calculation				✓		

4. Start-UP & Taxi	NO	A	S	ST	SI	U
4.1. Engine Starting				✓		
4.2. System-Check				✓		
4.3. Take-Off Briefing				✓		
4.4. Taxi, Brakes & Power				✓		

5. Take-Off & Climb-Out	NO	A	S	ST	SI	U
5.1. Directional Control				✓		
5.2. Adherence to Limitations				✓		
5.3. Noise Abatement				✓		
5.4. Climb Speed				✓		
5.5. Adherence to SID				✓		
5.6. Call-Outs & Items				✓		

6. Enroute	NO	A	S	ST	SI	U
6.1. Fuel Checks				✓		
6.2. Approach Briefing				✓		

7. Descent & Approach	NO	A	S	ST	SI	U
7.1. Holding Procedures				✓		
7.2. Descent Planning				✓		
7.3. Speed Control				✓		
7.4. Approach Stability				✓		
7.5. Transition to Visual Flights				✓		
7.6. Call-Outs & Items				✓		
7.7. Missed Approach				✓		

8. Landing	NO	A	S	ST	SI	U
8.1. Touchdown Speed and Point				✓		
8.2. Directional Control				✓		
8.3. Call-Outs & Items				✓		
8.4. Breaking Technique				✓		
8.5. After Landing				✓		
8.6. Shutdown				✓		

	NO	A	S	ST	SI	U
Crew Coordination				✓		
Decision Making				✓		
Stress Resistance				✓		
Judgement				✓		
Self Control				✓		
Self Reliance				✓		

Remarks:
Good performed
ready for Cap'Cot
Phase 3

NO – Not Observed	AS – Above Standard	ST – Standard	SI – Should Improve	US – Unsatisfactory
Not observed or unable to access efficiency	Performance above standard or extraordinary performance	Satisfactory performance, no serious mistakes were made	Performance does not meet required standard in every respect and/or on all occasions. Additional training is required	Performance does not meet standard; minimum requirements are not meet in significant items, additional training is mandatory

Supervision Record of the PIC of 15 June 2007 Source: LU

AO's Logo	Appendix OM Part D Ausbildungsleitfaden Supervision	CHAPTER: Appendix 9 PAGE: 7 REVISION Original

Supervision-Record (Each Day)

Name of Trainee:	[redacted]	Date:	29.06.07
SV Captain:	[redacted]	Aircraft:	[redacted]
Training as:	CDT	Blockhours:	04:38
Routing:	MUC-THF-MUC		

- Routing Line Check
- Final Line Check
- X Line Training
- Ready for Final Line Check

1. Airmanship	NO	A	S	ST	SI	U
1.1. AOM&OM Familiarity				✓		
1.2. R&S Procedures				✓		
1.3. Checklist Procedures				✓		
1.4. System Knowledge				✓		
1.5. System Monitoring				✓		
1.6. Basic Instruments flying				✓		
1.7. Airspace Observation				✓		
1.8. Co-Operation with ATC				✓		

2. NAV/COM Procedures	NO	A	S	ST	SI	U
2.1. Station Identification				✓		
2.2. FMS-Operation				✓		
2.3. RT-Procedures				✓		
2.4. EFIS OPS&Revisionanes				✓		

3. Preflight	NO	A	S	ST	SI	U
3.1. Company Flight Plan				✓		
3.2. W&B				✓		
3.3. WX, Notams				✓		
3.4. Fuel Calculation				✓		

4. Start-UP & Taxi	NO	A	S	ST	SI	U
4.1. Engine-Starting				✓		
4.2. System-Check				✓		
4.3. Take-Off Briefing				✓		
4.4. Taxi, Brakes & Power				✓		

5. Take-Off & Climb-Out	NO	A	S	ST	SI	U
5.1. Directional Control				✓		
5.2. Adherence to Limitations				✓		
5.3. Noise Abatement				✓		
5.4. Climb Speed				✓		
5.5. Adherence to SID				✓		
5.6. Call-Outs & Items				✓		

6. Enroute	NO	A	S	ST	SI	U
6.1. Fuel Checks				✓		
6.2. Approach Briefing				✓		

7. Descent & Approach	NO	A	S	ST	SI	U
7.1. Holding Procedures				✓		
7.2. Descent Planning				✓		
7.3. Speed Control				✓		
7.4. Approach Stability				✓		
7.5. Transition to Visual Flights				✓		
7.6. Call-Outs & Items				✓		
7.7. Missed Approach				✓		

8. Landing	NO	A	S	ST	SI	U
8.1. Touchdown Speed and Point				✓		
8.2. Directional Control				✓		
8.3. Call-Outs & Items				✓		
8.4. Breaking Technique				✓		
8.5. After Landing				✓		
8.6. Shutdown				✓		

	NO	A	S	ST	SI	U
Crew Coordination				✓		
Decision Making				✓		
Stress Resistance				✓		
Judgement				✓		
Self Control				✓		
Self Reliance				✓		

Remarks:

Good Luck [redacted]

NO – Not Observed	AS – Above Standard	ST – Standard	SI - Should Improve	US – Unsatisfactory
Not observed or unable to access efficiency	Performance above standard or extraordinary performance	Satisfactory performance, no serious mistakes were made	Performance does not meet required standard in every respect and/or on all occasions. Additional training is required.	Performance does not meet standard; minimum requirements are not meet in significant items, additional training is mandatory

Supervision Record of the PIC of 29 June 2007 Source : LU