
Runway overrun, Serious incident occurring January 19, 2004 at Frankfurt-Hahn involving a DC-10-40F

Micro-summary: DC-10 freighter overruns due to a slippery runway.

Event Date: 2004-01-19

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

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

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Investigation Report

EX001-0/04
August 2005

Identification

Kind of occurrence: Serious incident
Date: 19 January 2004
Location: Frankfurt-Hahn
Aircraft: Cargo airplane
Manufacturer/type: Mc Donnell Douglas Corporation / DC10-40F
Injuries to persons: No injuries
Damage to aircraft: Slightly damaged
Other damage: Field damage
Information Source: Investigation by the BFU

Several flight crews who landed after snow removal from the runway at 13:15 hrs reported to the tower controller that they had the impression that the runway condition relating to braking action was "Medium". The tower controller transmitted this information to two other airplanes, which landed immediately prior to the DC10, but not to the crew of the DC10.

The crew had calculated the landing distance for a dry and a wet runway, only. In view of the runway condition information broadcast by ATIS, the landing distance for a contaminated runway had not been calculated.

The approach was made with the autopilot switched on. With the first visual reference to the ground at approximately 300 ft GND, the pilot-in-command took over manual control and the airplane touched down within the touchdown zone of runway 21. Speed was reduced by means of the automatic braking system (Auto brake). When thrust reversal of the three engines was activated, the thrust reverser of the left-hand engine jammed in transition and failed. Thus the pilot had to reduce thrust on the right-hand engine so that only thrust reversal of the centre engine was fully available.

According to statements of the crew, braking action for the second half of the runway was poor; that part of the runway was covered with snow. The crew of a Boeing 737, which had landed four minutes prior to the DC 10, stated that at the time of their landing the first half of the runway was covered with isolated patches of snow whereas the end of the runway was completely covered with snow. The crew of the B 737 had no difficulties in stopping the aircraft as they did not reach the snow covered portion of the runway.

Factual information

History of the flight

On 19 January 2004 at 14:15 hrs¹ the airplane coming from Novosibirsk with about 60 t of cargo aboard touched down on runway 21 at Frankfurt-Hahn airport. Five crew members, two pilots, two flight engineers and one loadmaster, were aboard the airplane.

At the time of landing it was snowing. Based on the braking coefficients broadcast by the airport automatic terminal information service (ATIS) the crew assumed medium braking action on the first third and good braking action on the second third and last third of the runway.

¹ Unless otherwise specified all times are indicated as local time.

Thrust reversal was applied until the airplane came to a stop. On engines 1 and 3 a compressor stall occurred and reflections of fire on the engines were visible. The tower controller observed reflections of fire in the snow cloud whirled up by the engines and alerted the fire brigade who immediately proceeded to the airplane.

The airplane rolled over the 300-meter long overrun area onto an adjacent approximately 300-meter long asphalted area. At the end of this area the pilot-in-command steered the airplane to the left in order to avoid a localizer antenna and a row of red warning lights. During this manoeuvre the airplane got into unpaved terrain with its left main landing gear, the centre and the nose landing gear and was slightly damaged.

Immediately after the airplane had come to a stop, the pilot-in-command, the co-pilot and the flight engineer went to the beginning of the runway in order to establish touchdown. According to their statements, touchdown was within the touchdown zone.

Personnel information

Pilot-in-command: 57 years old, airline transport pilot licence class 1, issued on 25 March 1997 by the aviation authority of the Russian Federation, valid until 7 April 2004. Type rating as a pilot-in-command on DC 10. Instructor rating, instrument flight rating, approaches CAT II, i.e. cloud base 100 ft and visibility 350 m. Unrestricted medical certificate.

Total flight experience:	17,500 hrs
On DC 10:	3,600 hrs
Within the last 90 days:	166 hrs
Within the last 24 hours:	6 hrs
Duty time on the day of the incident:	8 hrs
Rest period prior to the flight:	12 hrs

Co-pilot: 41 years old, airline transport pilot licence class 1, issued on 25 June 1998 by the aviation authority of the Russian Federation, valid until 14 February 2004. Type rating as a co-pilot on DC 10. Instrument flight rating valid until 4 February 2005. Unrestricted medical certificate.

Total flight experience:	7,200 hrs
On DC 10:	350 hrs
Within the last 90 days:	90 hrs
Within the last 24 hours:	6 hrs
Duty time on the day of the incident:	8 hrs
Rest period prior to the flight:	12 hrs

Flight engineer: 49 years old. Flight engineer licence class 1, issued on 20 March 1997 by the aviation authority of the Russian Federation, valid until 16 May 2004. Type rating as a flight engineer on DC 10. Unrestricted medical certificate. Duty time on the day of the incident: 8 hours. Rest period prior to the flight: 12 hours.

Aerodrome controller: 44 years old. Ground controller and aerodrome controller licence since December 1994 valid until 22 March 2004. Start of duty on the day of the incident was at 11:35 hrs.

Ground controller: 37 years old. Ground controller licence since April 2002, aerodrome controller licence since June 2002, valid until 8 March 2004. Start of duty on the day of the incident was at 13:55 hrs.

Controller (ATIS recording): 33 years old. Ground controller and aerodrome controller licence since November 1999 valid until 4 March 2004.

Driver of the vehicle (skiddometer/friction tester): 43 years old, shift supervisor in winter service since September 2001. Participation in a training course for the skiddometer performed by the manufacturer on 11 November 2003.

Aircraft information

The aircraft is a transport category airplane McDonnell Douglas DC 10-40F, manufactured in 1976, serial number 46 661. The airplane was registered on the Bermuda Islands. The certificate of airworthiness was issued on 30 September 2003 on the Bermuda Islands and valid until 29 September 2004.

Total operating hours amounted to 54,302 hours with 41,320 completed flight cycles. The last periodic inspection was on 30 September 2003. Maintenance of the airplane was performed by Alitalia-Technical-Operations.

The airplane was equipped with three Pratt and Whitney JD 9D engines. According to the technical flight log, thrust reverser troubles on engine no. 1 had already occurred on previous flights.

Meteorological information

For the landing the crew had obtained the weather information "X" as of 12:20 UTC and the weather information "Y" as of 12:50 UTC on the ATIS frequency 136.35 MHz of Frankfurt-Hahn airport.

Surface visibility was 1,000 m. The electrically measured runway visual range (RVR) was 1,300 m (ATIS "X") and 1,400 m (ATIS "Y") with a cloud base of about 300 ft. Temperature and dew point were -1°C. Wind direction and velocity: 250°/13 kt. Snow had been falling almost all day - more or less intense.

Aids to navigation

The following equipment of Hahn airport was available to the crew:

- A distance measuring equipment (DME) HND 116.95 MHz.
- A landing system ILS "IHAW" 111.3 MHz certificated for CAT III a, with an outer marker (OM) and a middle marker (MM) with an additional NDB "HAN" 376 kHz

All systems were functioning properly.

Communications

Radio communications between the airplane and the tower were recorded and are available to the BFU as a transcription. Communications took place in English. Until the incident, the crew used standard phraseology for all radio communications. Problems with the English language began after the landing while discussing the incident.

A transcription of the radio communications of the different airport services on the common radio frequency is also available to the BFU for the purpose of evaluation.

Aerodrome information

Frankfurt-Hahn is a regional airport. Its asphalt covered runway has a length of 3,045 m and a width of

45 m which includes stop ways of 300 m length on each runway end.

The landing distance available (LDA) for runway 21 is 2,745 m (9,006 ft), which includes 300 m (985 ft) stop way, with runway elevation increasing by 54 ft between thresholds. Adjacent to the stop way of 300 m length in landing direction 21, there is an asphalt covered surface of 300 m length and 45 m width, which does not belong to the official airport operating area and is not shown in any chart. This area is designated as safety strip. At the end of the stop way, there is a row of red warning lights indicating the end of the usable runway. At the end of the safety strip, another row of red lights had been installed for reasons of safety, approximately 25 m in front of it there is the localizer antenna for the landing direction 21.

The airport operator is responsible for clearing the operating area. As it had been snowing all day, snow removing vehicles had been in operation since morning. The last snow clearing and de-icing of the first section of runway 03/21 took place between 11:45 hrs and 12:50 hrs. For this purpose a chemical de-icing agent with a concentration of approximately 40 g/m² was applied. The application was discontinued on the right-hand side of runway 21 approximately 1,000 m before the end of the runway, as the tank for the chemical de-icing agent was empty. At 13:00 hrs the chemical de-icing for the last 1,000 m of runway 21 was continued and ended at 13:15 hrs. In this case, the chemical de-icing agent applied had a concentration of approximately 20 g/m². Immediately afterwards, the braking action of the runway was measured and recorded by means of the skiddometer BV11 (see Appendix 1).

The braking coefficients were transmitted to the tower according to the sequence of the survey sections "Alpha", "Bravo" and "Charlie". With ATIS "X" and "Y", the following braking coefficients measured at 12:14 UTC were broadcast: „braking action 21 measured at 12:14, Position Alpha 31, Bravo 52, Charlie 58, average 47“.

The runway condition, such as degree of covering or actions accomplished, was not broadcast.

Flight Data Recordings

The flight data recorder was evaluated by the BFU in Braunschweig.

The approach speed (computed airspeed – CAS) was between 150 kt and 160 kt with the flaps extended to 50°. Touchdown speed was 145 kt and corresponded to the pre-calculated values.

For the determination of the point of touchdown, overflight of the middle marker (MM) was used as the reference point. Using CAS data and considering the actual wind and vertical acceleration at the moment of touchdown the main landing gear's point of touchdown was determined to be at 1,480 m from the middle marker, i.e. approximately 530 m behind the threshold. The point of touchdown of the nose landing gear could be determined on the basis of the "air/ground" switch data. The nose landing gear touched down approximately 280 m behind the main landing gear's point of touchdown, i.e. approximately 810 m behind threshold 21 all landing gears of the airplane were on the ground.

After touchdown, deceleration of the airplane reached approximately 2.2 m/sec^2 , which was maintained for 4 seconds. Afterwards, deceleration abruptly dropped by half and continued to drop. 55 seconds after touchdown (approximately 2/3 of the braking distance) deceleration dropped to almost nil (Appendix 2).

Wreckage and impact information

The right-hand tyre of the nose landing gear was damaged when the airplane left the paved safety strip. The thrust reverser of the left-hand engine was jammed in transition. Due to the compressor stall, an engine inspection was conducted after the incident. Neither traces of a fire nor other damage was found on the engine. Further damage to the aircraft was not found.

One lamp of the row of red warning lights at the end of the stop way was damaged.

A tug vehicle towed the DC 10 onto the paved safety strip.

The safety strip with approximately 10 to 15 cm of new snow had not been cleared. Due to this fact the crew had the impression that the runway had not been cleared completely.

Fire

There was no evidence of fire.

Additional information

Information about the friction tester

The friction tester is a skiddometer BV 11, serial number 99208, which is designed as a trailer for motor cars, with a mass of approximately 400 kg. It is used for the continuous measurement of the friction coefficients at aerodromes. Deceleration is measured by means of the friction measuring wheel. The measured data are evaluated and stored by a

computer installed in the towing vehicle. The friction coefficients (μ), test speed, distance, date, time, temperature, runway designation, entire length surveyed, name of aerodrome, etc. are recorded as measuring data. At the end of each friction survey, an average value of the friction coefficients is automatically generated.

As technical test range a speed between 20 and 160 km/h is indicated. The AIP Germany (introduced by German airports via ADV) indicates a test speed between 32 km/h and 95 km/h with 65 km/h being recommended. ICAO Annex 14 recommends a test speed of 65 km/h. The friction measuring wheel was a "Unitester 04:00-8,6 PR" with a tire pressure of 7.0 bar manufactured by "Trelleborg". The ICAO designation is SKH (Skiddometer High Pressure).

The manufacturer's calibration records and inspection / maintenance confirmation are available. The last calibration took place on 11 November 2003. Each time the skiddometer computer is switched on an automatic start-up calibration is made.

Information about the measurement process

Friction surveys were made twice over the test distance of 2,400 m (runway) along two tracks parallel to the runway approximately 3.0 m from the runway centre line. From the threshold of runway 03 on the right-hand side into the direction of threshold 21. Following a turn, the survey took place on the right-hand side from the area of threshold 21 into the direction of threshold 03. Due to acceleration and braking distances required for the friction tester the survey section is shorter than the runway available.

The measurement results were printed on a diagram (Appendix 1). The diagram shows the measured friction coefficients from 0 to 100 in percent over sections A, B and C of the test distance. In addition, test speed is recorded. Average values are indicated for each individual section. In summary, an average value is generated for sections A, B and C of both sides of the runway. These values are used for broadcasting the braking action.

During the survey the driver of the towing vehicle can see the actual friction coefficients on a display.

Recommendations in ICAO Annex 14 Attachment A

6.7 It has been found necessary to provide surface friction information for each third of a runway. The thirds are called A, B and C. For this purpose of reporting information to aeronautical service units, section A is always the section associated with the

lower runway designation number. When giving landing information, the sections are, however, referred to first, second or third part of the runway. The first part always means the first third of the runway as seen in the direction of landing...

Calculation of the landing distance

The calculation of the landing distance required (LDR) made by the crew for a dry runway resulting in 6,250 ft and a wet runway resulting in 7,200 ft for a landing configuration with flaps at 50°, the centre landing gear extended and the anti-skid switched on complies with the "Flight-Operations-Manual" (FOM) Section 08-80-21/22.

The crew did not calculate the landing distance for a contaminated runway. Corresponding documents were not carried aboard either. At the request of the BFU the operator made the appropriate documents available.

The BFU calculated the landing distance for a contaminated runway on the basis of the AOM, Section 10-5-(16) of the airplane's former operator.

The real runway friction condition was most probably "Medium" in the first half and "Poor" in the second half. For the calculation a constant value of "Medium to poor" was assumed.

The calculation was based on the following assumptions:

- Fully extended ground spoilers 2.5 seconds after touch down
- Applied braking action 4 seconds after touch down
- Use of all thrust reversers 4 seconds after touch down
- Use of thrust reversal until 70 kt and idle reverse until full stop
- Indicated airspeed 50 ft above threshold = $1.3 V_s + 10$ kt
- Touchdown point 2,500 ft after the threshold

The calculation resulted in an LDR of 8,300 ft with a headwind component of 10 kt. LDA was 9,006 ft for landing direction 21. This LDA already includes 300 m (985 ft) stop way at the end of runway 21.

Additional Information

The following changes were implemented at airport Hahn:

- The schedule for winter services was changed accordingly. Both stop ways 03/21, runway turn pads and the adjacent safety areas of runway 21 were included in the clearing schedule.
- A work order regarding reporting procedure "Release to service of runways" was developed and included into the quality management handbook.
- Two additional snow blower/sweepers were put into service for clearing runways.
- A spreading data acquisition system has been installed in all scheduled de-icers. With this system the cleaned areas can be accurately documented.

Analysis

Reconstruction of the runway condition

It may be assumed that immediately after snow clearing and chemical de-icing the first third of runway 21 was wet due to chemical de-icing except for the right-hand side of the runway in section A and partly in section B. As snow continued to fall, a layer of slush gradually built up which later turned into wet snow in some places because precipitation reduced the chemical de-icing action. Initially isolated patches of slush appeared which then formed continuous areas of slush. The first sections of runway 21 were wet and covered with slush. The end of runway 21 was rather covered with wet snow.

This condition "grey runway (corresponding to transparent slush on a black cover) and increasing areas of snow" corresponds to the landing report of a flight crew approximately four minutes prior to the landing of the DC10.

At the time of the landing of the DC10, the estimated braking action did not comply anymore with the data broadcast via ATIS, as the runway was covered with slush and wet snow.

The runway was not monitored for about one hour after the last friction survey at 13:04 hrs even though snow was falling. Some intermediate inspections could have revealed that the runway condition warranted improvement by winter service actions or that at least the crews of approaching airplanes should be informed about the changed runway condition.

The calculated LDR of 8,300 ft matches the best possible value under ideal use of all available braking options and under compliance with all points mentioned under "Calculation of the landing distance".

It is regulated by law that the LDR has to be calculated without consideration of thrust-reversal. This means LDR must be less than LDA if thrust-reversal is not considered.

In this case only the use of the thrust-reverser of the middle engine was possible due to technical problems.

With the wind coming from 250° and with 13 kt, the airplane had crosswinds of approximately 8 kt. The pilots reported that it was difficult to stay on course. They had to reduce thrust-reversal repeatedly in order to stay on the runway. Here the weathervane effect effected the airplane and contributed to the extension of the braking distance.

Analysis of the skiddometer diagrams:

The measuring records for both sides of the runway, when compared to each other, are acceptable up to 1,400 m. Results between 50 and 60 (Good) suggest that the measurements took place on contaminations, e.g. slush, wet snow.

Somewhat peculiar is the fact that after a test distance of approximately 1,400 m, the friction coefficients abruptly drop to 25 (Poor) on the right-hand side. On the left-hand side of the runway, the measured values drop only moderately (Appendix 1). The reason for the difference was obviously the reduced concentration of the chemical de-icing agent to 20 g/m². Therefore the snow in this section could not melt as much as it did in other areas of the runway thus leading to an increased slush and wet snow contamination.

This high degree of friction coefficient variation between the two runway sides, i.e. left and right of the centre line, may become critical for the stopping and manoeuvring performance of an airplane. As this is of flight operational relevance, the runway condition would have had to be improved by winter services, at least this condition would have had to be made known to the aviation system.

As the friction coefficients were determined on a wet runway, probably also on slush these measured values are to be used with utmost caution, as they may be misleading. This applies to pilots as well as to airport staff. The reliability of tests by friction measuring devices conducted in conditions other than compacted snow and/or ice may be compromised due to non-uniform conditions. In such cases the friction

measuring wheel may penetrate the runway contaminant layer differently.

The skiddometer used and the configured test distance were in conformity with ICAO.

The runway condition, type of chemical de-icing, wetness and/or slush, were not adequately broadcast via ATIS even though this was relevant to flight operations. It would have been necessary to indicate the type, depth and distribution of the existing contaminations.

ATIS braking action data was broadcast in an order opposing the landing direction because ICAO procedure was not applied. According to ICAO recommendations the test results would have to be arranged to reflect the three runway sections in landing direction.

Considering ATIS friction coefficient, temperature and snow fall data broadcast by ATIS as "Y" 12:50 UTC, the crew of the approaching DC 10 could have been expected to ask ATC for further information about the runway condition, e.g. snow height and degree of coverage.

Due to visibility the crew was not in a position, at the decision height, to see the complete runway. Thus it was not possible to detect the snow layer in the rear section of the runway. According to statements of the crew of the Boeing, which had landed prior to the DC10, the surface of the first two thirds of the runway looked grey so that under optical aspects there was no reason for the DC10 crew to initiate a go-around.

According to the calculation of the landing distance on a contaminated runway it was not possible, due to the actual runway condition, to stop the airplane on the landing distance available.

Conclusions

Findings

- The airplane was properly certificated, its equipment was in compliance with the legal provisions.
- The landing mass of 190 t was within the allowable range (maximum allowable landing mass 192.3 t).

- Clearing and de-icing of the runway had been concluded approximately 1 hour prior to the landing.
- The chemical de-icing agent was applied to the runway section by section with different concentrations.
- At the time of the landing it was snowing; the runway was partly covered with snow.
- The values of runway surface friction had been broadcast by ATIS in the wrong order (opposite to the landing direction) with the section designation letters of the measurement.
- Information that the runway was contaminated with snow or slush had not been given.
- A calculation of the landing distance required on a contaminated runway had not been made. The calculation documents were not available to the crew.
- The calculation of the LDR congruent with the actual runway condition determined that the LDA was only sufficient if thrust reversal of all three engines was applied.
- The left-hand thrust reverser jammed during extension and thus was not available as a braking support.
- As a result of the asymmetric braking action the right-hand thrust reverser could not be fully used.
- A go-around procedure had not been taken into consideration by the crew.
- The DC10 overran the end of the runway and the 300-meter stop way onto an asphalt covered area of 300 m length, which did not belong to the published runway length and which had not been cleared of snow.
- During a manoeuvre to avoid a localizer antenna the airplane veered to the left of the runway into unpaved terrain causing damage to one wheel of the nose landing gear.

Cause

Due to the contamination and the resulting poor braking action, the landing distance available was not sufficient. The crew was insufficiently or incorrectly informed about the runway condition.

Safety recommendations

Immediately following the occurrence, the BFU issued safety recommendation 01/2004 to the airport which has already been implemented.

Recommendation no. 01/2004

All staff members of the airport air navigation services charged with recording the braking coefficients for ATIS should be instructed in accordance with the DFS operational instruction FVK, number 524,4. Especially it is to be pointed out that with a change of the landing direction, the braking coefficients in the ATIS must be published always in landing direction independent of the measurement.

Following the conclusion of the investigation the BFU issued the following safety recommendation:

Recommendation no. 01/2005

BMVBW should see that all airport personnel responsible for identifying and assessing runway conditions is trained, before each winter, to ensure uniform assessment and broadcasting of runway conditions in ATIS, SNOWTAM etc. in accordance with the provisions of ICAO Annex 14, Chapter 2.9, 9.4, Attachment 6, and Airport Services Manual Part 2, Pavement Surface Conditions Chapter 4.5.6.7.

Investigator in charge	Müller
assisted by:	Dorner-Müller Ritschel

Appendices

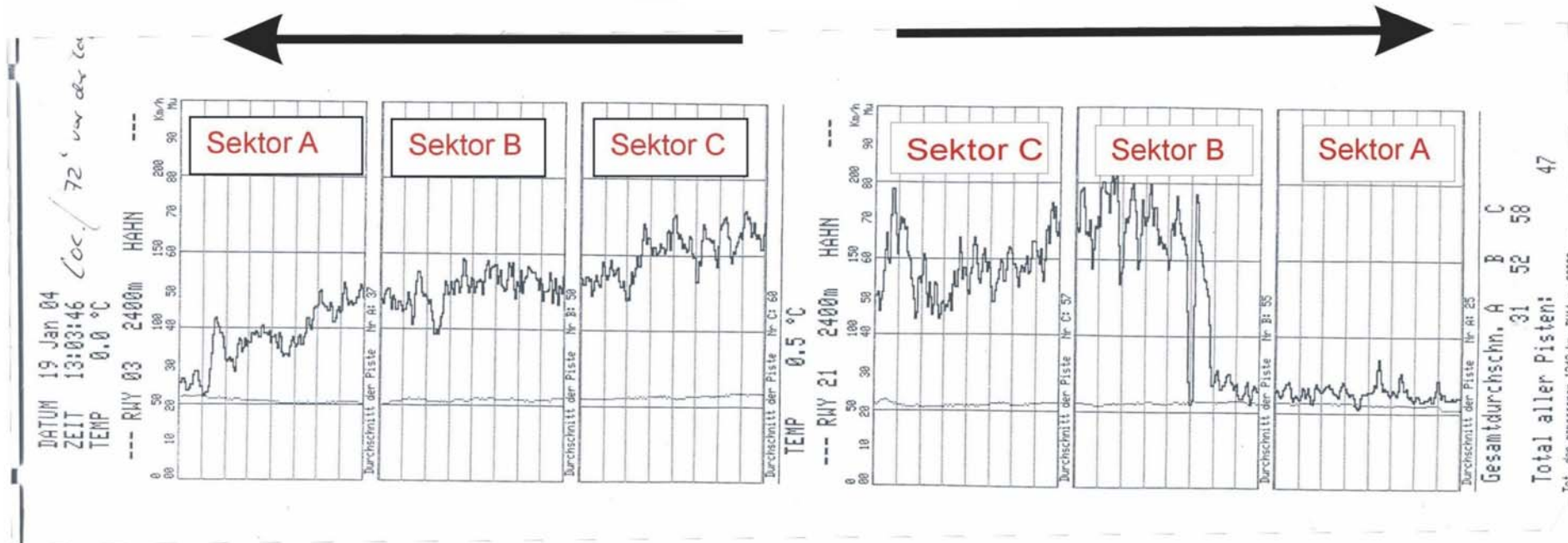
Appendix 1. Skiddometer B11 measurement strip

Appendix 2. Evaluation of the flight data recorder

Measurement strip of Skiddometer BV-11

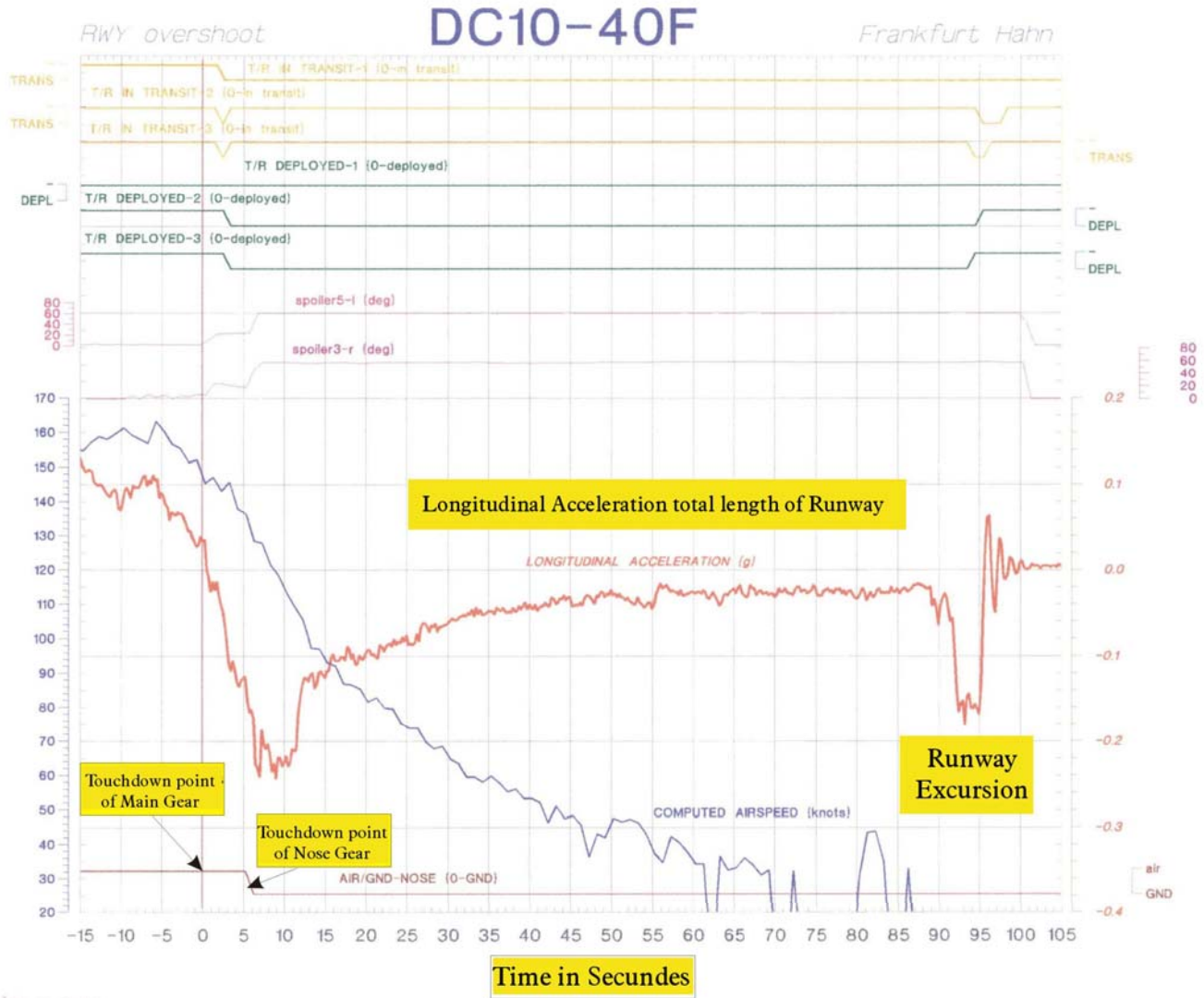
last measurement 72 minutes before landing

Landingdirection



Survey direction of the Skiddometer, rightsite of the centreline beginning from threshold 03 to threshold 21 and back

Braking action of the Aircraft



file : rwy
Created: January 23, 2004

BFU Flight Recorders