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Threshold lights damaged during landing

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The Hague, July 2018

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The Dutch Safety Board

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N.B. The full report is published in the Dutch language. If there is a difference in interpretation between the Dutch report and English summary, the Dutch text wil prevail.

CONTENT

GENERAL OVERVIEW

Identification number:	2017002
Classification:	Serious incident
Date, time of occurrence:	13 January 2017, 18.23 UTC
Location of occurrence:	Amsterdam Airport Schiphol
Registration:	VQ-BLR
Aircraft type:	Boeing 747-8F
Aircraft category:	Freighter
Type of flight:	Freight
Phase of operation:	Landing
Damage to aircraft:	Multiple scratches and dents
Flight crew:	Four
Passengers:	None
Injuries:	None
Other damage:	Three threshold lights disintegrated
Light conditions:	Dark

SUMMARY

On January 13, 2017 a Boeing 747-8F with registration VQ-BLR landed on runway 36R of Amsterdam Airport Schiphol. During this landing the tires of the right main landing gear made contact with the runway threshold lights of runway 36R. The runway threshold lights mark the beginning of runway 36R with the aiming point marking situated 300 meters beyond the runway threshold and in the touchdown zone.[1] Three thresholds lights disintegrated by the aircraft tires weight. Furthermore, the aircraft sustained damage; multiple scratches and dents were visible on the fuselage and wings. While parked at the gate maintenance personnel noticed the damage to the aircraft. The flight crew was aware that a hard landing had been made but didn't experience any control problems while decelerating to a safe taxi speed. Only through the maintenance department the flight crew became aware that they had hit something during the landing.

During a normal landing the runway threshold is passed at an altitude of approximately 50 feet (15 meters)[2] where after the touchdown should take place in the touchdown zone, at least 300 meters from the beginning of the runway. Landings before the aiming point are called short landings. These short landings can cause the landing gear to contact the surface before the beginning of the runway. Outside the runway area the ground surface is not designed to support the weight of the aircraft. Therefore, if the landing gear contacts the soft ground surface outside the runway area there is a potential risk of significant damage to the landing gear likely resulting in control problems. The possible consequences are serious and therefore short landings are deemed to be potentially dangerous.

During this occurrence the difference between the actual landing and a landing before the runway threshold was minimal (see Figures 1 and 2). The Dutch Safety Board classified this occurrence as a serious incident in accordance with ICAO[3] Annex 13.

1 The touchdown zone markings are situated at a considerable distance in front of the aiming point marking.
2 Source: 747 Flight Crew Training Manual, Boeing.
3 International Civil Aviation Organization.

FACTUAL INFORMATION

For this investigation the flight data recorder, interviews with the flight crew and several documents provided by the airline involved were used. Furthermore, the radio communication between the flight crew and air traffic control during the occurrence was analysed. The Royal Netherlands Meteorological Institute (KNMI) provided the measured wind data at the beginning of runway 36R.

The flight crew consisted of a captain and a first officer who were both certified and qualified to fly the aircraft as crew. On the flight deck a third pilot was present on the observer seat. A fourth crew member was seated in the cabin area directly behind the flight deck.

The incident flight was the second leg of the flight from Hong Kong via Novosibirsk to Amsterdam Airport Schiphol (AMS). The captain and the first officer who were flight crew on the second leg to AMS, were resting on the first leg with a flight duration of 6:05 hours. The ground time in Novosibirsk was 1:16 hours. The second leg to AMS had a flight time of 6:15 hours. The captain and the first officer didn't make any reference to fatigue being a factor during the landing at AMS. However, the flight crew had already been on duty for more than 14 hours before landing in AMS. This duty time included the flight preparation time at Hong Kong.

The aircraft concerned was a Boeing 747-8F full freighter. The landing weight was 317.500 kilograms which was well below the maximum certified weight of 346.090 kilograms. According the weight and balance calculation the centre of gravity was within the aircraft limits. The aircraft maintenance log did not mention any technical issues which could have had an effect on the event flight.

Figure 1: Traces of the main landing gear (marked with a red frame) visible on the runway edge after the occurrence. The three damaged lights had already been replaced. (Photo: Amsterdam Airport Schiphol)

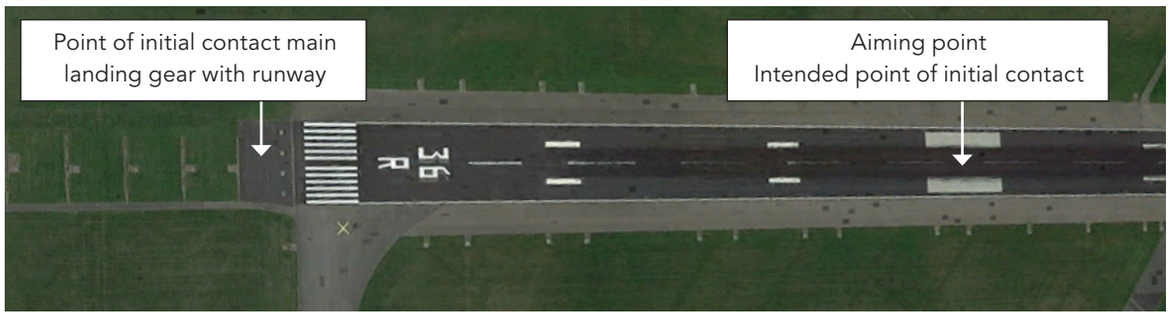

Figure 2: Top view of the first part of runway 36R with the initial point of contact of the main landing gear with the runway and the intended point of initial contact. (Source: Google Earth)

The approach to landing runway 36R

At the time of the approach a strong wind was blowing from the northwest with significant variations in speed and direction. The ATIS[4] weather information at AMS reported a wind coming from 320 degrees varying from 290 to 360 degrees and a windspeed of 26 knots with wind gusts of 38 knots (see Figure 3 for a comparison between the wind direction and speed as measured at ground level and by the aircraft). The flight crew was fully aware of the wind conditions at AMS and were convinced that the landing conditions were within the operational limits of flight crew and aircraft as laid down by the operator. In preparation for the approach and landing, the wind conditions were noted by the flight crew.

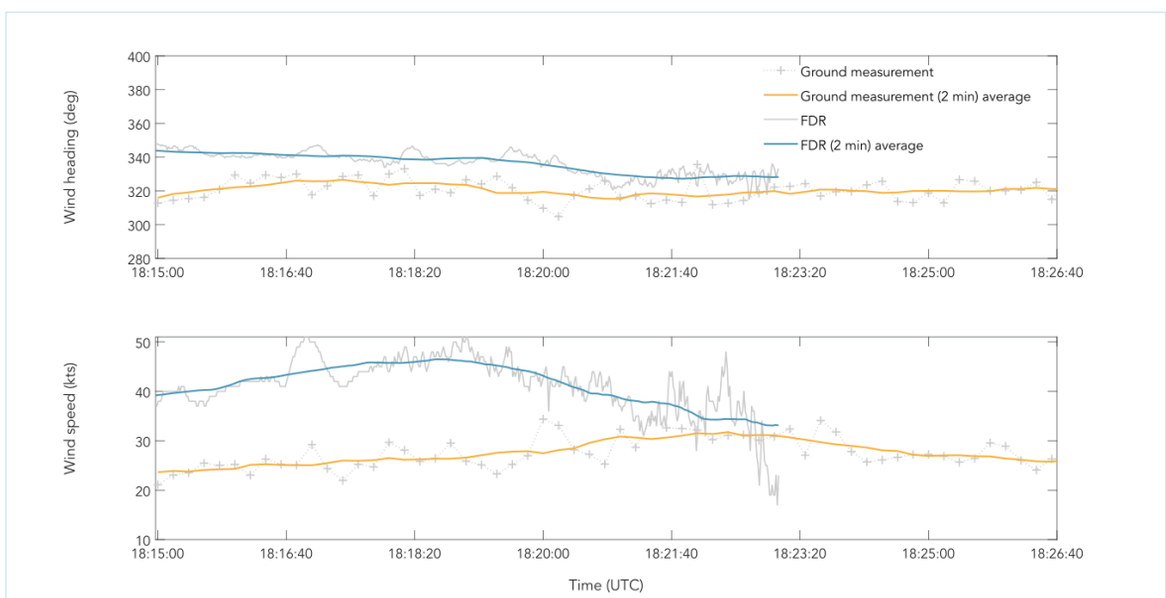

Figure 3: Wind speed and wind direction as measured at the ground and by the aircraft. Because the wind direction and velocity as measured by the aircraft become inaccurate at low airspeeds, measurements after touchdown were omitted.

4 Automatic Terminal Information Service.

The flight data recorder showed that the approach was normal until 700 feet altitude was passed (see Figure 4). At 700 feet the captain disconnected the autopilot and flew the remainder of the approach and landing manually. Almost instantly the aircraft was flying below the 3 degrees glidepath of the ILS[5] approach for runway 36R (see Figure 5 for the radio altitude profile and the ILS glidepath from an altitude of approximately 330 feet). The ILS deviation limit is 1 dot. Operator policies prescribe that a go-around must be flown if the deviation exceeds 1 dot below 500 feet altitude during visual flight conditions (VMC). During this incident the glideslope deviation remained within 1 dot until passing 100 feet altitude where after the deviation increased.

The airplane's GPWS[6] provides aural alerts based on radio altitude, glideslope deviation, and rate of descent. Between two and three seconds before touchdown, the glideslope deviation exceeded 3 dots and the "glidescope" aural alert sounded. Shortly thereafter, the rate of descent increased to 1070 feet/minute and the "sink ra te" aural alert sounded. The captain stated that he was unable to execute a go-around because the touchdown followed almost immediately. The flare manoeuver reduced the rate of descent to 500 feet/minute. This resulted in a first touchdown with a load factor of 1,76 g and the threshold lights being hit. The aircraft became airborne again where after a second touchdown followed with a load factor of 1,84 g. Both touchdowns didn't cause any control problems for the flight crew. The aircraft normally decelerated to a safe taxi speed where after the runway was vacated and the aircraft taxied to the assigned parking position.

5 Instrument Landing System.
6 Ground Proximity Warning System.

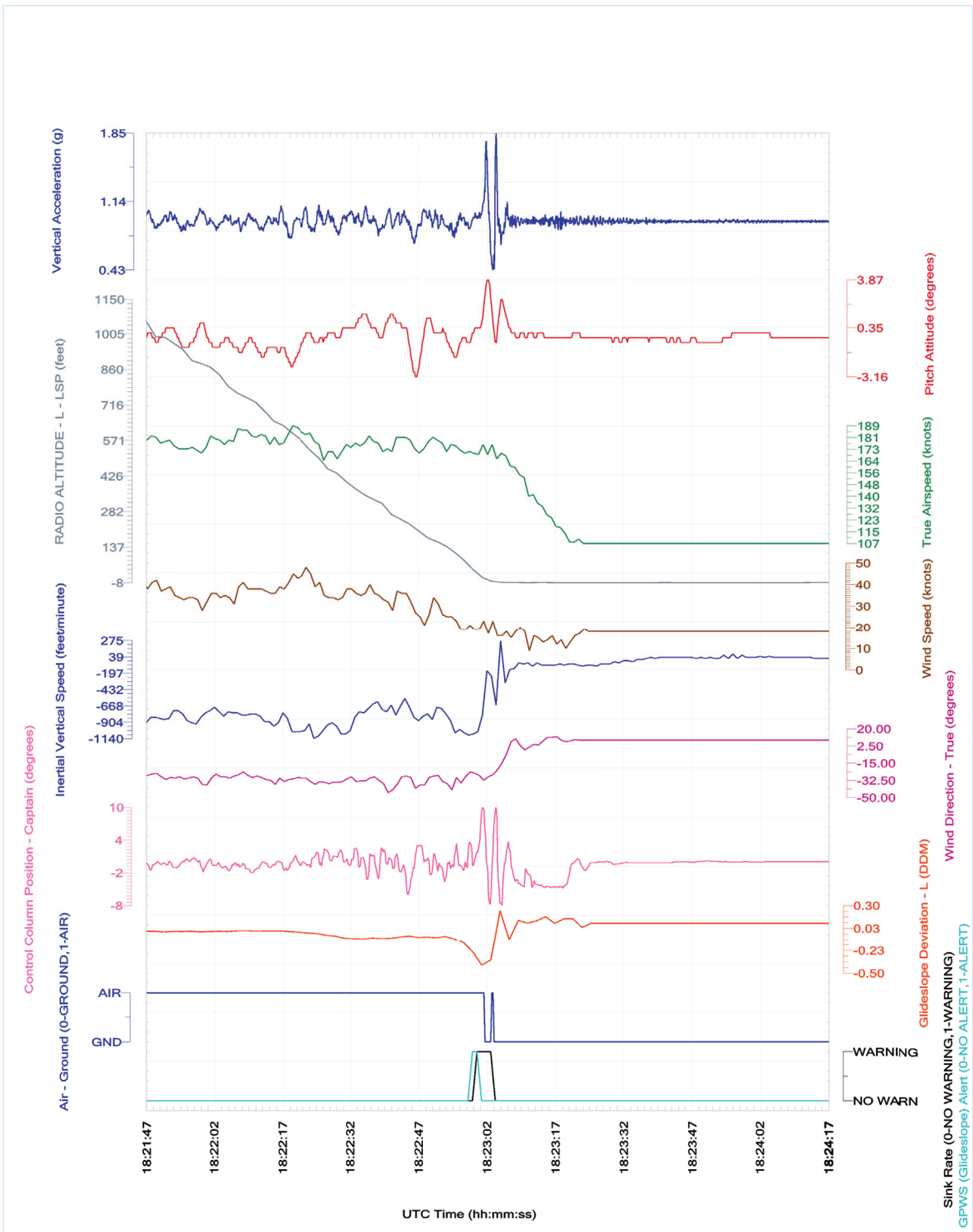

Figure 4: Overview of a selection of parameters obtained from the FDR.

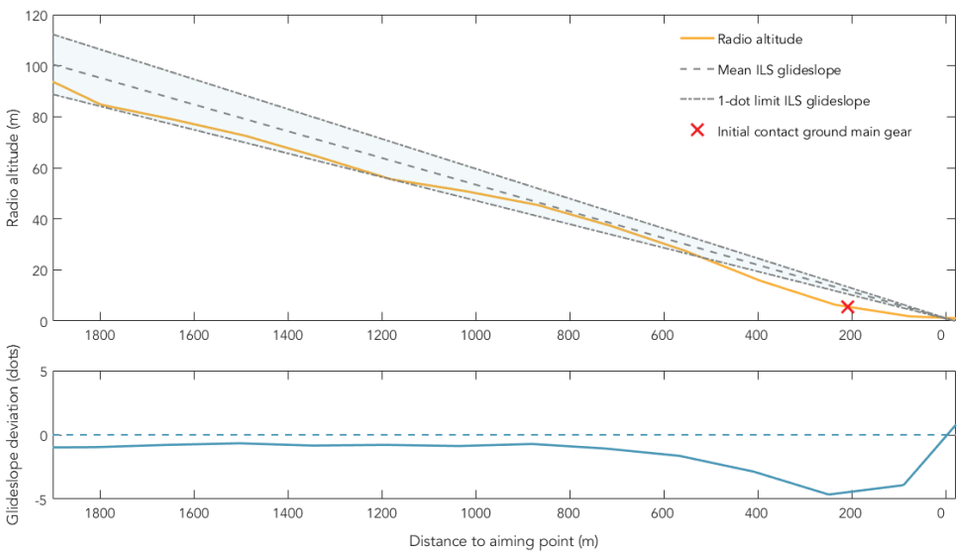

Figure 5: The ILS glide path of runway 36R with the radio altitude profile and the glideslope deviation of the aircraft versus the distance to the aiming point from an altitude of 100 meters or approximately 330 feet.

After the landing the flight crew heard on the ATC frequency that another aircraft in the approach for runway 36R made a go-around following a windshear warning. In the captain's interview, windshear shortly before landing was mentioned as a suspected cause of the event.

The available runway distance for runway 36R is 2825 meters, which is relatively short for a heavy full freighter aircraft. The flight crew calculated a landing distance of 2549 meter for the given landing configuration. Runway 36R is shortened to avoid crossing runway 09/27. Therefore, the last 575 meters for runway 36R is unavailable for landing. In the opposite direction the available runway lengths is 3400 meter for take-offs (for an overview of the runway layout, see Figure 6).

The operator procedure defines a stable approach when the following conditions are met:

- Only small control inputs are necessary to remain on the glideslope and localizer course.
- Indicted airspeed shall not be below the reference speed for the given landing configuration.
- Indicate airspeed shall not deviate more than +10 knots or -5 knots.
- Glideslope deviation shall be within 1 dot.
- The rate of descent shall be within 1000 feet/minute unless operational necessary.
- The landing can be made within the touchdown zone

If one or more of the mentioned conditions are not met, the approach becomes unstable and a go-around must be made. Additionally, if one of the flight crew members judges the approach as becoming unstable the pilot flying must make a go-around regardless of his own judgement.

The above mentioned stable approach conditions are in accordance with international established guidelines.

Windshear reports
After the landing of the Boeing 747-8F another aircraft on approach to runway 36R reported windshear conditions as observed by a "windshear ahead" warning detected by the weather radar system. In compliance with company policies the aircraft aborted the approach. Two other windshear warnings were reported by aircraft on approach to runway 36R that same night. Air Traffic Control the Netherlands has not been able to demonstrate that these reports have led to the adjustment of the ATIS in accordance with its current operating procedures.

The windshear system onboard the Boeing 747-8F did not generate a warning.

There is no ground equipment on AMS that detects the presence of windshear. For information about windshears, an air traffic controller is dependent on the windshear reports from pilots.

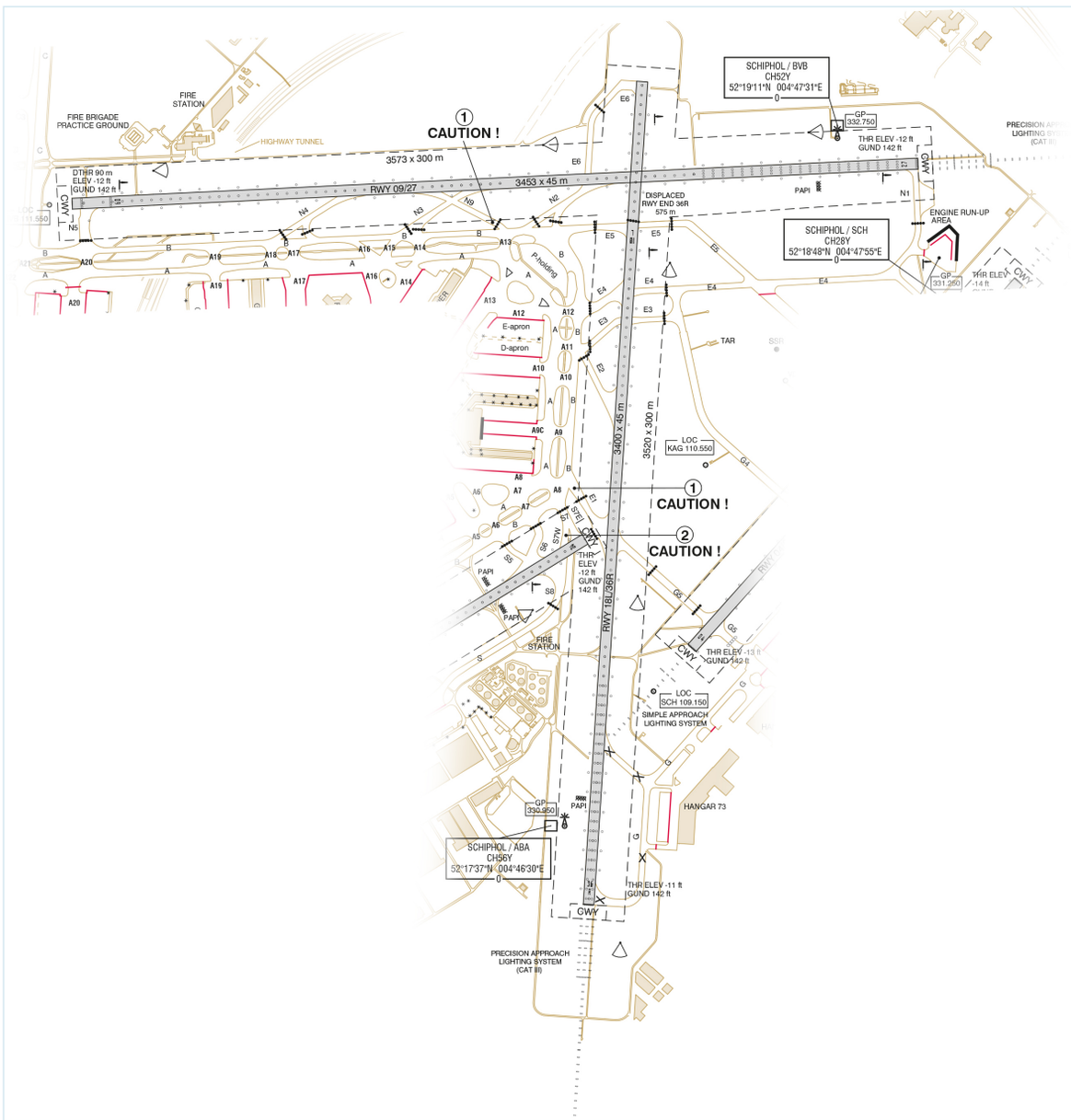

Figure 6: Overview of runways 09/27 and 18L/36R at AMS. (Source: AIS the Netherlands)

Accuracy of the wind report runway 36R
The wind data recorded by the flight data recorder and the wind measurement at the beginning of runway 36R were in agreement with each other. Shortly before landing the flight crew received the measured wind at the beginning of runway 36R from air traffic control. During the subsequent approach and landing the wind didn't deviate significantly from the reported wind conditions.

Analysis from Boeing
Boeing analysed the incident based on the available flight data. The data analyses concluded that the flight experienced several vertical and horizontal wind variations which can be described as turbulent flight conditions. The flight data showed that the captain made several control inputs but they were insufficient to recapture the glideslope signal. After the autopilot was disengaged the flight continued the approach below the glideslope signal with shortly before landing a "glidescope" warning which was generated by the aircraft systems. The "glidescope" warning is activated when the glideslope deviation is more than 1 dot.

Shortly before landing the aircraft mainly experienced updrafts and to a lesser degree downdrafts which decreased in magnitude while approaching the runway. From 200 feet altitude the glideslope deviation continuously increased. Three seconds before landing the aircraft sink rate increased to 1070 feet/minute which triggered a sink rate warning. The captain pulled on the control column where after the "sink rate" reduced to 500 feet/minute. This was however insufficient to avoid a hard landing. Boeing concluded in their analysis that windshear could not be confirmed with the data available as cause for the increase in sink rate shortly before landing.

Stable approach
During the approach the aircraft was continuously flying below the glideslope but to a degree that a go-around based on the stable approach criteria was not necessary. While the aircraft approached the runway the deviation from the 3 degree glidepath increased. At an altitude of 100 feet the glideslope deviation exceeded 1 dot whereby one of the stable approach criteria was not met. This should have been a trigger to execute a go-around.

Shortly before landing the automatic generated GPWS warnings ("glideslope" and "sink rate") were also indications for a go-around.[7] The captain stated in his interview that before he realized that a go-around was necessary the aircraft already had touched the runway. From the interviews with the flight crew it could not be determined that the first officer had communicated to the captain that the approach became unstable nor that a go-around was necessary.

The damage to the aircraft was caused during the first initial contact with the runway while hitting three runway threshold lights of runway 36R.

Runway allocation
With the actual wind conditions the usage of runway 36R as the active landing runway was in accordance with the operational procedures of LVNL. With the given wind conditions other runways at AMS were less favourable. Shortly after the event flight has landed an Airbus A380 also landed on runway 36R. This flight crew didn't experience any difficulties during the landing when so asked by the investigation team. Also, other operators which landed shortly before and after the incident flight were asked if they received any reports from their flight crews about difficult landing conditions. It was learned that such reports were not filed.

Internal investigation
After an internal investigation by the involved operator it became known that the captain and the first officer received additional training. Firstly, they underwent eight hours of simulator training with self-study on the following topics before the simulator sessions:

- The reason for a hard landing.
- Landing in the touchdown zone.
- Documentation on the topic of visual illusions.

Secondly, the two crew members flew eight legs line training followed by a line check where after they were fully qualified.

The involved operator also informed all flight crews of the importance of following the glideslope until landing as well as the importance of making a go-around when the approach becomes unstable.

7 The "glideslope" warning is generated when the glideslope deviation exceeds 1 dot and the "sink rate" warning when the rate of descent exceeds 1000 feet/minute.

CONCLUSION

The hard landing was caused by a high rate of descent. The flare manoeuvre was insufficient to reduce the sink rate satisfactorily.

The fact that the aircraft hit the runway threshold lights was a combination of the continued flight below the glideslope, from the moment the captain disconnected the autopilot at 700 feet and took over the controls manually, and a high sink rate shortly before the touchdown. There was a stable approach until just before the landing.

Right before landing two automatic GPWS warnings were generated ("glideslope" and "sink rate") whereby the stable approach criteria were exceeded. This should have been a reason to make a go-around. However, this was not carried out by the captain, although the procedures required it

According the Operations Manual of Air Traffic Control the Netherlands, ATIS messages should include any reported windshear conditions. Flight crews are hereby made more aware of sudden wind changes and the necessity to make a go-around in case the approach becomes unstable. Air Traffic Control the Netherlands has not been able to demonstrate that the windshear conditions reported by aircraft crews did result in the ATIS being modified.

The measures taken by the operator after the event are necessary to avoid occurrences like hard landings as well as landing short. Those measures underline the importance of adhering to international established guidelines concerning the stabilized approach criteria and the importance of making a go-around when the approach becomes unstable.

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