SERVICE PUBLIC FEDERAL MOBILITE ET TRANSPORTS

FEDERALE OVERHEIDSDIENST MOBILITEIT EN VERVOER

REPORT ON THE MISHAP OF THE AIRCRAFT BOEING B747-271C REGISTERED 4X-ICM AT LIEGE (BELGIUM) ON 1 OCTOBER 2003

CELLULE D'ENQUETES D'ACCIDENTS ET D'INCIDENT D'AVIATION

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FOREWORD

In accordance with Annex 13 to the International Civil Aviation Organization, Council Directive 94/56/EC, and Royal Decree 9/12/1998, the sole purpose of these investigations is to prevent aviation accidents. It is not the purpose of any such accident investigation and the associated investigation report to apportion blame or liability.

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0 GENERAL

0.1. Place.

EBLG - LIEGE AIRPORT (BELGIUM).

0.2. Date and hour of the mishap.

01/10/03 12.20 UTC[1].

0.3. Aircraft.

B747-271C.

0.4. Owner.

CARGO AIRLINE LTD (CAL).

0.5. Type of operations.

Freight transport.

0.6. Phase of flight.

Landing.

0.7. Persons on board.

03 crew – 02 passengers.

0.8. Short description of the mishap.

Runway overrun.

1 All times in this report are in UTC time. Local time is UTC+2.

1 FACTUAL INFORMATION

1.1. History of the flight.

After an uneventful flight from TEL AVIV and a normal ILS approach on runway 05R of LIEGE, the aircraft touched down. The Captain was pilot flying. Auto speed brakes worked normally and reverses were deployed immediately. Everything being normal during the first part of the landing roll and normal deceleration being noted, the Captain cut off the autobrakes at an estimated speed of 100kts via brake pedals in order to stop the aircraft further by manual braking. At an estimated 3000ft from the runway end, the pilot noted that there was "no feeling of deceleration". At 80kts no slow down of the aircraft was noted despite "full braking". The end of the runway was reached with a speed of 50kts and the aircraft had veered 30° to the right compared with the runway QFU. The aircraft continued its right turn during the slide in the grass and mud behind the concrete runway, to come to a stop against the ILS antennas 500ft from runway end and perpendicular to runway heading. The crew and passengers evacuated uninjured via the right slide.

1.2. Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	0	0	0
Serious	0	0	0
Minor/None	0	0	

1.3. Damage to aircraft.

The left wing as well as both left engines, the landing gear have been seriously damaged.

1.4. Other damage.

Runway 23L approach lighting and 05R localizer antenna out of service.

1.5. Information on the pilots.

1.5.1. Aircraft Captain (pilot flying).

- LICENSE: **Israeli ATPL Nr 5484 Last validation: 26/05/03 (Sim), 14/09/03 (A/C).**
- EXPERIENCE: **Total Flying: 5000hrs. B747: 1800hrs of which 50 as Captain. Last month: 75hrs.**

1.5.2. First Officer.

- LICENSE: **Israeli ATPL Nr 4338. Last validation: 06/08/03.**
- EXPERIENCE: **Total flying: 4000hrs. B747: 600. Last month: 50hrs.**

1.5.3. Flight Engineer.

- LICENSE: **Israeli Flight Engineer Nr 249. Last validation: 05/03/03.**
- EXPERIENCE: **Total flying: 4500hrs. B747: 1700. Last month: 50hrs.**

1.6. Information on the aircraft.

1.6.1. Airframe.

- Manufacturer: **BOEING.**
- Type: **747-271C.**
- Serial NR : **21965.**
- Registration: **4X-ICM.**
- Airworthiness Certificate: **Valid until 29/01/04.**
- Total flight time : **96168.42.**
- Total Nr of cycles **17314**[2]
- Weight at time of mishap: **292194kg. (estimated).**

2 Including the landing at Liège where the mishap happened.

1.6.2. Engines.

- Manufacturer: **GENERAL ELECTRIC.**
- Type: **CF6-50E2.**

1.7. Meteorological information - Weather conditions at LIEGE.

- Wind: 070 03kts.
- Visibility: 6km.
- Ceiling: Sct3000ft/Bkn 4000ft.
- T°/Dew Point: 14/12.
- QNH: 1008 hPa.
- Significant Weather: Moderate rain.
- Trend: Tempo Vis 5km.

1.8. Aids to navigation.

All Nav aids where fully serviceable at the time of the mishap. Anyway they didn't play any role in the mishap.

1.9. Preparation of the landing.

The Captain briefed the crew prior to landing.

- Flaps: 30°.
- Autobrakes setting: "medium".
- Turn-off place at S4, with an alternate at S5.
- Displaced threshold was noted.

During final approach, the tower transmitted the information that the runway was wet. At that moment, the Captain announced his intention to use the full runway length.

1.10. Communications.

There were no radio communication problems between the mishap aircraft (ICL1905) and LIEGE ATC. A transcript of the radio communications between LIEGE tower and ICL1905 is at annex 4. No call was done about any technical or operational problem of any kind.

1.11. Aerodrome information.

The mishap happened during landing on runway 05R of Liège AF. It has a total length of 3287m (10785ft) and a landing distance available of 3051m (10010ft). The runway is 45m (148ft) wide. The downslope from the displaced threshold up to 2500m (8202ft) in the runway is 1.2°, and from there on, it becomes an upslope of 1.2° until the runway end. Airfield maps are at annex 6.

1.12. Flight recorders.

The aircraft was equipped with FDR ALLIED SIGNAL PN 4700-003 SN 3760 and CVR FAIRCHILD model A110 SN 1211. The data of both have been downloaded and analyzed by the Bureau d'Enquêtes et d'Analyse pour la Sécurité de l'Aviation Civile (BEA) (PARIS – FRANCE). BOEING, the aircraft manufacturer, analyzed also the data from the FDR. A copy of this analysis as well as the transcript of the last 99 sec recorded by the CVR are at annex 5.

1.13. Aircraft and accident site information.

1.13.1. Description of the accident site.

The aircraft overran the runway by approximately 120m. A diagram of the site is at annex 1, page 1. A visual inspection of the runway was carried out on October 2, 2003. Special emphasis was put on the roll out zone.

- Some very small rubber particles were found, but no evidence of a blown tire. It was impossible to determine if these rubber particles belonged to the CAL aircraft. No laboratory analysis was done.
- Rubber deposit was noted but considered normal.
- Tire marks were found, but it was impossible to determine if they belonged to the CAL aircraft.
- Braking action measurement done the same day, October 2, 2003, both on dry and wet runway, showed no anomalies - braking action reported "good" with some spots as "medium-good". Runway 05R has a downward slope in the beginning and an upward slope for the last part.
- With heavy rain some standing water could be possible in the lowest part, but meteorological observations before and after the accident exclude a large quantity of rain causing standing water.

1.13.2. Information on the aircraft.

The aircraft showed:

- All flaps/slats in landing position.
- Speed brakes full up.
- All reversers fully closed.
- Several tires showed deep cuts, 6 were deflated.
- No flat spots were visible on the tires.
- Neither special or abnormal wear nor scrubbing was found.
- Nose wheel was straightforward.
- Engines 1 and 2 were damaged by the antenna construction.
- Left wing also damaged at impact.

At defueling of the plane, 15107 kg (18884 l) of fuel was retrieved.

1.14. Fire.

There was no fire.

1.15. Survivability.

The aircraft was at low speed when it left the runway. The mishap was perfectly survivable, nobody was injured.

1.16. Crew and witness statements.

1.16.1. Preliminary

This hearing took place in the buildings of Liège airport. The three crewmembers have been interviewed together. Also present were a delegation of the CAA of the State of Israel, acting as accredited representative according to annex 13 of ICAO and two representatives of BeCA, acting as observers. The investigation is conducted under responsibility of the Belgian CAA.

1.16.2. Statements by the Captain and seconded by First Officer and Flight Engineer.

There was no report in technical log, the aircraft was fully operational. The estimated landing weight was 293 ton.

The weather was reported "CAVOK" with a wind of 140° at 5 Kts. Runway 05R in use with a full ILS procedure.

Captain gave a briefing for the approach and landing.

- 30° flaps landing was planned.
- Autobrakes setting to "medium".
- Turnoff planned at S4, with an alternate for S5.
- Displaced threshold was noted.

The Captain was pilot flying. He estimates a total number of 10 approaches and landings on runway 05R at Liège.

Approach was an autopilot coupled down to approximately 1000ft, where a red autopilot light was noted. This was also experienced on previous flights, and the final approach was carried out manually. Below 1000ft, no drift angle was noted, as wind was almost calm.

The tower reported, with landing clearance, "Runway wet". At that moment, the Captain announced his intention to use the full length of the runway.

The aircraft was in full landing configuration in a timely manner as established in company procedures. The aircraft was well stabilized during the whole approach procedure. There were no callout from the First Officer to announce any anomalies or deviations from speed, localizer or glide slope. Windshield wipers were not used.

The touch down was estimated at 900ft down the runway. The auto speed brakes functioned normally and the reverses were deployed immediately.

The landing was estimated "normal", neither exceptionally smooth nor hard.

During the landing roll, everything being normal (speed brakes, reverse thrust, braking) and normal deceleration was noted, Captain cut off the autobrakes at an estimated speed of 100kts via brake pedals in order to stop the aircraft further by manual braking. This is considered a normal company policy.

At an estimated 3000ft from the runway end, the Captain noted that there was "no feeling of deceleration". The First Officer made calls of speed at 100kts and at 80kts.

At 80kts no slow down of the aircraft was noted despite "full braking". There was no alarm for brake pressure noticed. The reduction of reverse thrust was initiated at 80kts, idle at 60kts. At 60kts the anti-skid was turned off.

The end of the runway was reached with a speed of 50kts, and the aircraft had a heading of 30° to the right compared to the runway QFU.

The aircraft continued its right turn during the slide in the grass and mud behind the concrete runway, to come to a full stop against the ILS antennas installation and perpendicular to the runway QFU. Total distance from end of runway till complete stop is estimated at 500ft.

Engines 1 and 2 were shut down at the end of the slide, before hitting the antennas. As the aircraft was stopped, engine 3 and 4 were shut down.

During the whole maneuver the nose wheel steering was never used and "no correction to stay on the runway centerline" was made. Nor was there any differential braking applied.

The crew did not note the brake temperature.

The evacuation checklist was performed and all members left the aircraft via the right slide. Fireguard cooled the right wing gear with foam as some fumes were observed.

Crew was asked to confirm in a written report the events as described above. Copies of these are at annex 3, these written reports broadly confirm the initial statement of the crew.

1.16.3. ATC controller statement.

He saw the aircraft touch down between the threshold and level 2 (S2). Copy of this statement is at annex 3.

2 ANALYSIS

2.1. Condition of the runway.

Braking action measurements show braking action generally "good" with some spot as "medium good", this for dry as well as for wet runway. The runway was wet at the time of mishap but without standing water. This, combined with the downslope in the first 1300m of the roll degraded slightly the stopping performance of the aircraft but not to an extend preventing it from stopping before the end of the concrete.

2.2. Analysis of the braking system.

The aircraft is supposed to have been fully operational as reported by the crew.

It is not believed that any tire blew on the runway at touch down or during the landing roll. At least no indication of any tire failure prior to runway excursion was detected.

The brake systems, both auto and manual, were working normally. Investigation of the brake system by Honeywell Aircraft Landing Systems (ALS) after the accident didn't show any deficiency. The only remark done was about the installation of NASCO rotors on the brakes. This is covered by STC Nr SA6075NM issued by the FAA on November 24, 1993.

2.3. Weather.

With exception of the rain, weather was not a factor in this mishap.

2.4. Analysis of FDR recordings.

This is an old model of recorder and only a few parameters are recorded. Boeing was asked to make an evaluation of the FDR data (copy of this evaluation is at annex 5).

2.4.1. Analysis of the landing roll.

The aircraft touches down 7006ft (2136m) from the runway end at a normal speed. At 110 Kts, the Captain puts the autobrakes to OFF, at that time there is approximately 4000ft runway remaining. Approximately 3000ft before runway end, the Captain notes that there is "no feeling of deceleration". At 73 Kts, the thrust reversers are closed and the engines are at idle RPM. At that point, there is 1500ft runway remaining. At that moment as well or maybe a little later (in the crew statements the speed of 60 Kts is mentioned), the Captain turns the anti skid to OFF. The large rudder deflection to the right detected by the FDR is made ±330ft (101m) before runway end when the aircraft reaches S5.

2.4.2. Touch down.

A ground speed calculation was made by integrating the longitudinal acceleration after correcting for acceleration bias. The calculated ground speed closely followed airspeed. Based on these assumptions, Boeing calculated that the aircraft touched down on the runway approximately 3000 feet (915m) from the displaced threshold. It is impossible to determine if this late touchdown was due to the fact that the aircraft flew slightly above glide slope as calculations showed or that the aircraft was kept floating during the flare or a combination of both. At this point, remaining runway is 7006ft (2136m). The 1.2° downslope in the first thousands of feet of the runway might have been a factor as well.

2.4.3. Deceleration.

Upon touch down, a deceleration of –0.2 G is established, consistent with the autobrake set to medium and thrust reversers deployed. After 13 sec, the airspeed has decreased to 110 Kts and the deceleration to approximately –0.13 G coincident with the reported initiation of manual braking. 17 sec later, the thrust reversers are closed and deceleration decreases to about –0.10 G.

If a deceleration of -0.2 G were maintained, the stopping distance would be about 6700 feet (1737 m) from touchdown. This should have been enough to stop the aircraft (8804ft – 2683m - behind glide slope and 7006ft – 2136m – from computed touch down point to end of runway is available). The estimated stopping distance derived from the FDR data is about 7500 feet.

2.4.4. Direction.

The FDR clearly shows a large deflection of the rudder to the right at an airspeed of 48 Kts. This might be a trial to turn off the runway at S5.

2.5. Captain's experience.

Captain was only qualified as PIC since 14.09.2003 with 50 hours of flying time as such on the B747. It is reasonable to assume that he underestimated the heavy weight of the aircraft and the influence of the weight on the braking capabilities.

2.6. Analysis of crew actions.

2.6.1. Crew coordination and CRM.

A lack of close cooperation between crewmembers became evident during the interview with the crew. This is confirmed by the few exchanges found on the CVR. As an example, although brake temperature indicators are not monitored during a landing roll, those indicators, with their normal slow response, can indicate an early gear problem after an emergency stop and could be used as an early detection of potential gear problems during emergency evacuation preparation. Apparently this was not done and could indicate some deficiencies in the training procedures.

Another example is the fact that the First Officer, according to he AOM supposed to call out speeds to assist the pilot flying in programming the reverse thrust in function of the runway remaining, stopped calling the speeds at 80 Kts, when the aircraft was at 1600ft (488m) from runway end.

2.6.2. Landing weight of aircraft versus available landing distance.

The aircraft landing weight was 292 tons for a MLW of 302.092 tons, which means almost maximum landing weight. Initially, Captain's intention was to leave the runway via S4 or S5. When the tower announced that runway was wet, this was changed to "we will use full runway" (exit at S5). Landing preparation was insufficient: in that neither mention nor verification was made of landing distance versus available runway length. Although the displaced threshold was noted, the actual remaining runway length was not referred to.

The Captain noted a lack of sufficient deceleration; nevertheless he elected to stow the reverses. Procedure instructs to be in idle reverse at 60kts. In this case idle was reached at 73kts, with a feeling that the aircraft was not braking normally.

2.6.3. Use of the braking system.

2.6.3.1. Autobrakes and manual brakes.

Autobrakes were selected on MEDIUM, which is adequate for the runway length and condition. The Captain put them OFF when reaching 110 Kts (4000ft runway remaining). In the given circumstances, this was certainly too early: "WHEN THE AIRPLANE REACHES DESIRED TAXI SPEED, RELEASE AUTOBRAKES BY APPLYING BRAKE PEDAL FORCE AS REQUIRED" states the AOM. Still, in their initial statement, the crew declared that cutting off the autobrakes at 100 Kts was considered as a "normal company policy". This might indicate wrong habits developed by the crew or informal procedures imposed by the company.

During the time that the autobrakes were used, the deceleration was good (-0.2 G). When the Captain started using the manual braking, the deceleration decreased to approximately –0.13 G until closure of the engine thrust reversers where it became –0.10 G (see Boeing interpretation of FDR data at annex 5).

2.6.3.2. Anti skid.

The Captain put the anti-skid system OFF at 60 Kts, according to his statement. This might have been done a little bit earlier, in his statement, he associates the closing of reversers and switching the anti skid to OFF. The landing performance charts in the AOM clearly demonstrate that this action was counterproductive. The braking performances of the aircraft are seriously degraded without anti skid.

2.6.4. Thrust reversers.

The AOM states: "MODULATE REVERSE THRUST AS REQUIRED BY RUNWAY AVAILABLE FOR STOPPING. SMOOTHLY REDUCE REVERSE THRUST AS CONDITIONS PERMIT SO THAT 60% N1 OR LESS IS USED BELOW 60 Kts. IDLE REVERSE SHOULD BE REACHED BY APPROXIMATELY 50Kts". Instead, thrust reversers were fully closed with engines on idle at 73 Kts (1500ft - 457m - runway remaining). This means that the pilot started reducing the throttles with 2500ft (762m) runway remaining. Sometimes before, he noted a lack of sufficient deceleration. Nevertheless he elected to stow them.

2.6.5. Rudder.

The pilot apparently tried to leave the runway at a too high speed, resulting in a violent swing of the aircraft, probably due to the rudder deflection and/or differential braking ± 700ft (213m) before S5.

2.6.6. Overall assessment of crew performance.

All of the above tends to show some kind of lack of situation awareness on behalf of the crew. Apparently this landing has been poorly prepared and executed bearing in mind that "the autobrakes are cut off at 100 Kts", "the reversers are stowed at 60 Kts" regardless of aircraft gross weight, runway condition, speed and runway remaining.

All available means and/or techniques to stop the aircraft in a timely and orderly manner were not used as they should have been. The late touchdown although affecting adversely the distance available to stop the aircraft, was not the main factor. It is not clear why the deceleration became significantly less along the landing roll.

Although Captain declared that no correction to maintain runway centerline was made, FDR shows clearly a large deflection of the rudder. A possible explanation is that the captain has tried in the very last part of the roll, to leave the runway at S5, but at a much too high speed, causing the 90°right swung. The asymmetry of the rudder pedals has most likely caused a loss in the feeling of brake pressure applied, resulting in differential braking, again reinforcing the right turn of the aircraft. This explains also the possible heat accumulation in the right brakes.

3 CONCLUSIONS - PROBABLE CAUSES OF THE MISHAP

3.1. Conclusions.

3.1.1. The aircraft was fully operational. No technical defect could be identified on it. In particular the braking system didn't show any deficiency and there was no indication of blown tire during the landing roll.

3.1.2. The aircraft landing weight was close to the maximum authorized.

3.1.3. The crew was adequately qualified and trained. The aircraft Captain had very few experience as a PIC on B747.

3.1.4. With the exception of the light rain that made the runway wet without standing water, the weather didn't play any role in the mishap.

3.1.5. The runway braking action has been demonstrated "good" with some spots as "medium good".

3.1.6. The aircraft touched down at the correct speed with the correct attitude but at 3000ft (915m) from displaced threshold, 7006ft (2136m) from runway end. With a normal deceleration of –0.2G, the aircraft needed about 6700 feet (1737 m) to come to a stop.

3.1.7. The autobrakes were put to OFF at 110 Kts, manual braking was used further. The Captain believes that it is the company policy to put the autobrakes OFF at 100 Kts and to stop the aircraft with manual braking. This is a deviation from the AOM that states that they have to be left engaged until safe taxi speed is reached.

3.1.8. The Captain went out of engine reverse at 73 Kts.

3.1.9. The Captain cut the anti skid at about 60 Kts which has an adverse effect on the braking effectiveness.

3.1.10. He could not manage to stop the aircraft before the end of the runway.

3.2. Probable causes and factors.

The probable causes and factors of the mishap are:

3.2.1. High weight of the aircraft (FACTOR).

3.2.2. Low experience of the Captain as PIC on B747 (FACTOR).

3.2.3. Late touch down (FACTOR).

3.2.4. Poor crew performance and CRM (FACTOR).

3.2.5. Deviation from published procedures (CAUSE).

4 RECOMMANDATIONS

4.1. Review crew training.

4.2. Review with the crew the published landing procedure.

Done in Brussels, on 25 april 2005.

Richard Taverniers
Chief Inspector of Accidents
Chairman

Cpt Marc Marrien
Member

Paul Smeets, Lic
Member

ANNEXES.

ANNEX 1 – Diagram.
ANNEX 2 – Photographs.
ANNEX 3 – Crew and witness statements.
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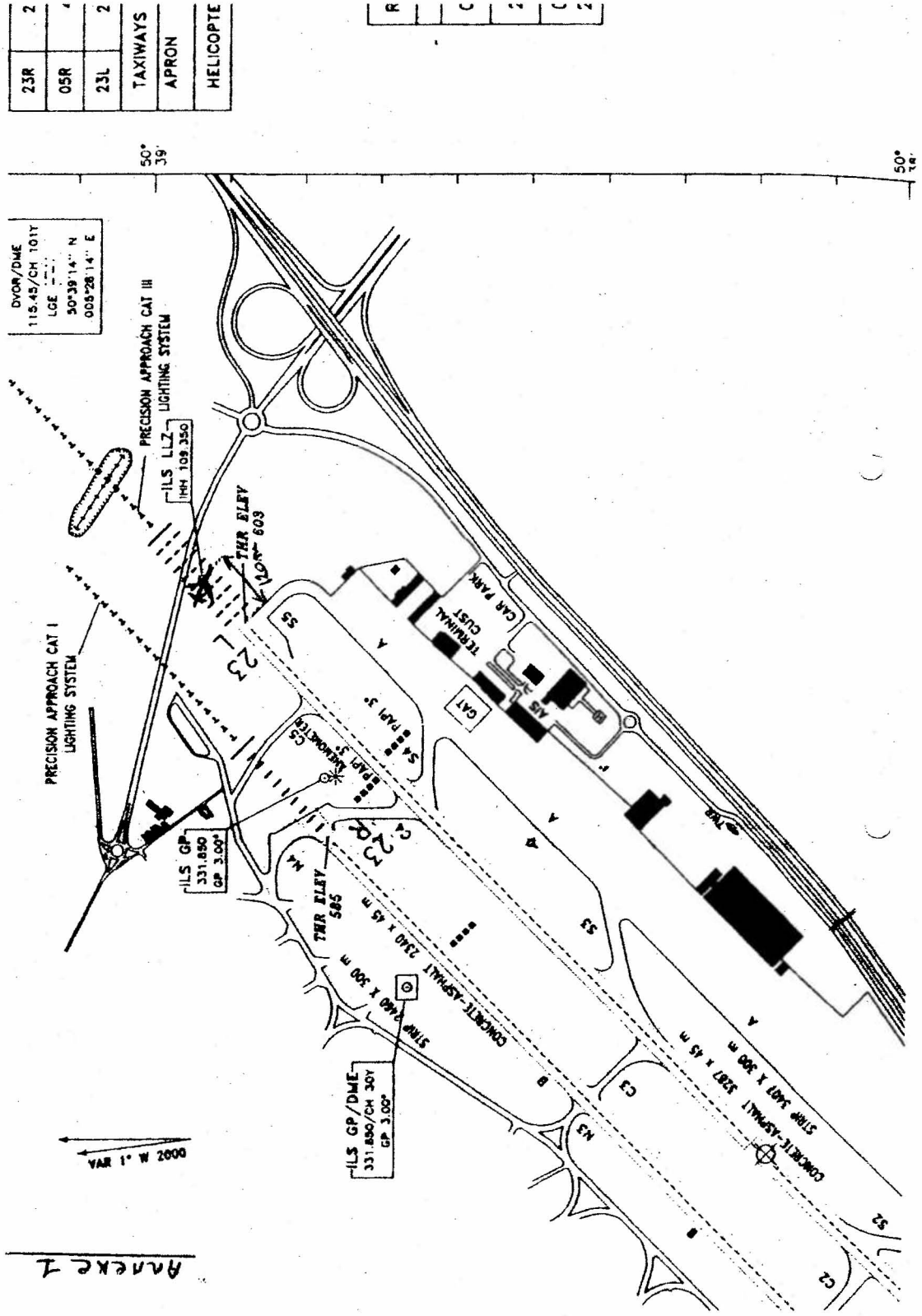
ANNEX 5 – FDR - CVR.
ANNEX 6 – Aerodrome information.

ANNEX 1

SITE DIAGRAM.



ANNEX 2

PICTURES.

PHOTO 01

PHOTO 02

ANNEX 3

Copy of the statement of the aircraft captain (pilot flying).

Captain's Declaration of the events during the accident in Liege on 1/10/03

Flight details: - ZFW - 277 Tons, 16 Tons Fuel on landing
- Landing Weight - 293 Tons (Vref 154 knots)
- Runway 05R Liege
- Weather - Clouds broken 5000', wind 140/5, Visibility OK
- 3 crew, 2 passengers

Description

I briefed the crew about landing flaps 30, Medium auto-brakes full ILS procedure for runway 05R.

When cleared to land by the tower received notice that runway condition is wet.

Final leg speed is 159 knots stabilized.

Touch down point about 1500' from Threshold.

Speed brakes deployed automatically, full engine reverse immediately at touch down, brake pressure OK.

Deceleration rate looks normal.

At speed 120-110 knots disconnect the Auto-Brake.

At about speed 100 knots start manual braking - > a feeling of deceleration rate not sufficient (in comparison to other landings) starts to develop --> increase manual brakes up to maximum.

The aircraft speed isn't decreasing enough and at some point the aircraft starts to turn slowly to the right.

When approaching the runway end I start to close the engine reverse and decide to turn anti-skid system off, while continue with maximum manual brakes.

Crossing the runway end at about 50 knots at an angle of about 20-30 degrees to the right, on the centerline.

The aircraft is turning to the right while maintaining the extended centerline.

The left wing is getting closer to the approach light system and I'm shutting down engines 1,2 followed by engine 3,4.

The aircraft stops about 500' from runway end, 90 degrees right of runway heading.

All engines are shut, no indication of fire

I inform the tower that engines are down and I plan the evacuation from the right side.

The crew perform evacuation checklist.

Opening the slide-chute of the right upper deck door.

Evacuate the aircraft - Crew + Passengers - No injuries.

ANNEX 3

Copy of the statement of the first officer.

General information:

Flight ICLI905 TLV - LGG, expected landing weight - 293T Vref 154Kts.
Weather: 150/5Kt Vis. more than l0k BKN5000 light rain.
ILS05R Full procedure

Description:

Flight ICL1905 was routine flight from TLV to LGG.

Captain briefed crew for ILS05R with flaps 30 and MED setting of AUTOBRAKE.

Both - descend and approach - were normal as usual.

While establish on LOC 05R we have received information from TOWER that runway is wet, so, we decided to use full length of the Runway 05R.

Touchdown was made at touchdown zone, about 1500 from the threshold.

SPEED BRAKES AND REVERSES were deployed successfully and I begun to call out the speeds, as it is standard operation procedure. After 120Kts callout and just before 110Kts AUTOBRAKE was released and distance to the end of runway 05R was satisfactory.

Everything was normal.

As we continue to run down on runway, somewhere about 80Kts, I felt few times as Anti Skid system releases the wheels, but we still had enough runway in front of us.

At 60Kts I start worried since rate of deceleration against remaining runway was unsatisfactory - I told to Captain that our speed is 60Kts, few moments later Captain switched off the ANTI SKID system with words (I suppose): "The aircraft does not decelerate".

Short while after this aircraft started turn to the right, developing left skid, but still staying on the centerline of 05R. We crossed the runway end at speed (I assume) 50 + Kts and stopped about 500 ft from threshold.

We talked to the tower ask for emergency assistance, performed "Evacuation" checklist and left the aircraft.

ANNEX 3

Copy of the statement of the flight engineer.

Declaration of FE.

- Flight 1905 from TLV to LGG on the 1.10.03.
- During the flight from TLV - no special events, the airplane doesn't have any special c/o which can influence the landing.
- Weather report from tower, 30 minutes before landing: Rwy 05R, 140/5, B5000, SCT 12000,1009, Vis 10km.
- Briefing for landing - use of the full length, exit at S5, flaps - 30, brakes - MED.
- During APP - tower inform - Rwy is wet
- Normal ILS for Rwy 05R, app at 159Kts, touchdown at the desired point 1500' from beginning of the Rwy.
- From touchdown - everything OK - Speed Brakes (auto spoilers) - deployed, full reverse and brake press - good.
- At 110 – 120Kts disconnect auto brakes and move to manual breaks.
- Deceleration - at this stage - looks normal. With no indication of any problem.
- Reverse - at 80Kts - start to reduce, at 60Kts in idle.
- At that stage - feeling of a problem in braking the airplane. Cpt left hand up, I asked - what are you looking - answer - anti skid to off, airplane is not braking.
- After anti skid to off, 2-3 second crossing end of Rwy with 20 degrees turn.
- Airplane stops at 500' from the end of Rwy, 90 degrees turn to the right on the centerline.
- Engines shut down, no indications of fire or other problems.
- Calling the tower, performing EVACUATION checklist CPT - direct to evacuate from right -upper dock door.
- Opening the slide chute in auto and performing the evacuation in the order of - FO, the two Pax (after a brief) FE and CPT with no injuries

ANNEX 3

Copy of the statement of the local ATC controller.

ICL1905 was authorized to land on runway 05R with information that the runway was wet. He had already got that information on the approach frequency. He touched down between the threshold and level 2. When he reached level 4, his speed looked too high to us. The pilot tried to vacate via S5 but he ran out of the runway and stopped in the overrun. There was no called from the pilot between the moment he confirmed the landing and his complete stop.

At that moment both crash bells (civilian and military) were activated. The civilian and the military fire brigades rushed on the scene. The pilot called a few seconds later to say that the engines were cut off, that there was no injury and that the crew would evacuate the airplane on right side. Seeing the damage on the left wing, the firecrew, threw water on it to prevent any start of a fire. In order to evacuate the aircraft, the pilot asked several times that the vehicles, positioned on the right side were moved to enable the opening of the slide chute. The crew was under shock and the civilian fire crew took care of them.

ANNEX 4

Radio recordings.

Liège Tower (129.25)

Time	Agency	
12h12'58"	ICL1905	Liège Tower, bonjour, ICL1905 fully established ILS 05R.
12h13'04"	LG Tower	ICL1905, bonjour, clear to land runway 05R, runway wet and the wind 120° 5 knots.
12h13'12"	ICL1905	Clear to land 05R 1905.
12h13'18"	AYB835	835, rejoining.
12h13'20"	LG Tower	835, report left hand base leg, runway 05L.
12h13'24"	AYB835	Call left hand base 05L, 835.
12h13'52"	LG Tower	835 will bc final number 2, number 1 Boeing 747, 4 miles final for the main runway.
12h14'00"	AYB835	835, number 1 in sight, we'll call you as final number 2
12h15'50"	AYB835	835, final.
12h15'52"	LG Tower	AYB835, clear to land 05L, wind 120° 12 knots.
L2h15'58"	AYB835	Clear to land on 05L, copy the wind, 835.

Next call, the airplane is in the grass.

12h17'26"	LG Tower	ICL1905 from Tower.
12h17'29"	ICL1905	Go ahead, this is the ICL1905, we have performed long landing, can you send the fire team? We don't have any fire but we need them for evacuation.
12h17'40"	LG Tower	OK, sir, no problem. We'll do.
12h18'00"	AYB835	835, request another circuit.
12h18'07"	LG Tower	835 from Tower.
12h18'09"	AYB835	835, can I proceed for another circuit? There arc vehicles on the runway.
12h18'l 4"	LG Tower	Yes sir, could you please perform one check overhead the Boeing 747 at the end of the runway?
12h18'20"	AYB835	I will do sir.
12h18'21"	LG Tower	Thank you very much.
12h18'24"	LG Tower	ICL1905, any other assistance for the evacuation?
12h18'31"	AYB835	1905, is it for the 835?
12h18'35"	LG Tower	ICL1905 from tower?
12h18'48"	LG Tower	ICL1905 Tower?
12h18'51"	ICL1905	Go ahead. Engines are shut down. You have copied? Engines are shut down.
12h18'57"	LG Tower	Roger, engines shut down. Any other injuries?
12h19'02"	ICL1905	Negative, negative. Everything is OK on board. We will vacate the airplane on the right side. Did you copy? Right side.
12h19'11"	LG Tower	Roger, evacuation via the night side. Copy.
12h19'24"	LG Tower	835, if you see any other problems, call us.
12h19'30"	ICL1905	??? Please, tell men on the right side to bc cleared because we open chute on the right side. Slide chute on the right side of the airplane
12h19'46"	LG Tower	Roger, slide chute on the right side, copy.
12h20'02"	LG Tower	AYB835, confirm any other injuries in sight?
12h20'07"	AYB835	No other injuries. The Boeing's wing does not reach the road. The left wing is badly damaged, hits the landing lights of the 23L.
12h20'23"	LG Tower	Roger, thank you.
12h20'38"	AYB835	The 835 is taxiing back in order not to interfere the people who are working in it.
12h20'40"	LG Tower	OK, thank you very much 835. Confirm intentions?
12h20'42"	AYB835	Taxi back, if possible via the 05L back track.
12h20'47"	LG Tower	835, it is approved. Last wind, 090° 3 knots.
12h2l'00"	AYB835	835 is taxiing back, copy the wind.

ANNEX 4

12h21'10"	ICL1905	Tower, 1905.
12h2l'13"	LG Tower	1905, go ahead.
12h21'15"	ICL1905	Please, ask other ground personnel on the right side of the airplane to vacate because we have to open slide chute on the right side. Did you copy?
12h2l'22"	LG Tower	Affirm.
12h21'44"	ICL1905	Tower from ICL1905.
12h2l'48"	LG Tower	1905, go ahead.
12h21'49"	ICL1905	Do we have any problems on the left side because the fire brigade is using water on us?
12h21'54"	LG Tower	Roger.
12h21'56"	ICL1905	Say again please.
12h21'59"	LG Tower	We check with the firecrew, sir.
12h22'17"	LG Tower	ICL1905, there's only for security that the firecrew is sending water.
12h22'26"	ICL1905	OK, we open the slide chute on the right side.
12h22'27"	LG Tower	Copy.
12h23'17"	AYB805	Liège Tower, Belgian 805 is right base 05L.
12h23'22"	LG Tower	805 is cleared to land 05L, wind variable 2 knots.
12h23'27"	AYB805	Clear to land 05L, copy the wind, 805.
12h23'53"	LG Tower	ICL1905 from Tower
12h24'10"	ICL1905	Tower from CAL.
12h24'12"	LG Tower	1905, go ahead.
12h24'14"	ICL1905	The fire brigade is on the right side, we can not open the slide chute. Please, ask him to move away.
12h24'18"	LG Tower	Roger.
12h26'37"	LG Tower	ICL1905, still on this?

ANNEX 5

On board recorders.

CVR.

Voice recorder- ICL 1905

Time (CVR)	Time from landing	Voice of	Normal approach for 2 min
30:52		F/o	*minima*
31:08		F/o	*100*
31:16	:00	Auto	*50,40,20,10 T/D*
31:18	:02	F/e	*Speed brakes up*
31:24	:08	F/o	*130*
31:28	:12	F/o	*120*
31:29	:13	F/e	*Auto brakes off*
31:33	:17	F/o	*110*
31:40	:24	F/o	*90*
31:45	:29	F/o	*80*
31:52	:36	F/e	*It is not stopping?*
31:54	:40	F/o	*We are still 60*
31:57	:41	F/e	*Body gear?*
32:01	:45	F/o	*Shit!...Oh shit!*
32:03	:47		Off R/W Noise of going out of the runway
32:31	01:15		End

Copy of the Boeing Company analysis of the FDR data.

Evaluation of FDR Data
CAL Cargo Airlines 747-200 4X-ICM Runway Overrun at Liege - 1 Oct 03

At the request of the Air Accidents and Incidents Investigation Unit of Belgium, Boeing examined the FDR data from the subject event. The FDR data frame had been modified since delivery of the airplane. The AAIIU provided the data frame definition which was used to evaluate the data.

Figures 1 and 2 show the parameters for the lateral/directional and longitudinal axes, respectively. The data show the aircraft on descent with flaps 30, at an airspeed of ~160 knots. A crosswind from the right of 5 knots was reported. This crosswind is evident in the slight control wheel oscillations +/- 10 degrees. The autopilot was disconnected at time 37350 seconds. Touchdown occurs at time 37395 seconds, as indicated by a spike in normal load factor. The pitch attitude at touchdown is about 4 degrees. Upon touchdown, thrust reversers are deployed and a deceleration rate of approximately -0.2 G is established, consistent with the autobrake medium deceleration target of 6 ft/sec^2 (-.186 G).

At time 37408, the airspeed has decreased to 110 knots and the deceleration rate has decreased to approximately -.13 G, coincident with the reported initiation of manual braking. The FDR does not record the reason for this change in deceleration.

At time 37425, the thrust reversers are closed and longitudinal deceleration has decreased further to about -0.10 G. At time 37427 seconds, right rudder pedal is used and the aircraft's heading remains relatively constant for about 10 seconds, then begins to deviate to the right as additional right rudder is input, at an airspeed of 48 knots. The FDR does not record valid airspeed below 46 knots.

The FDR data frame does not include glideslope deviation, ground speed, drift angle, or ground track information. These parameters affect the runway distance estimates. It was reported that the aircraft came to rest "just right of centerline". Therefore, our estimates of distances are based on the presumption that the aircraft remained on the extended runway centerline from touchdown until it came to rest.

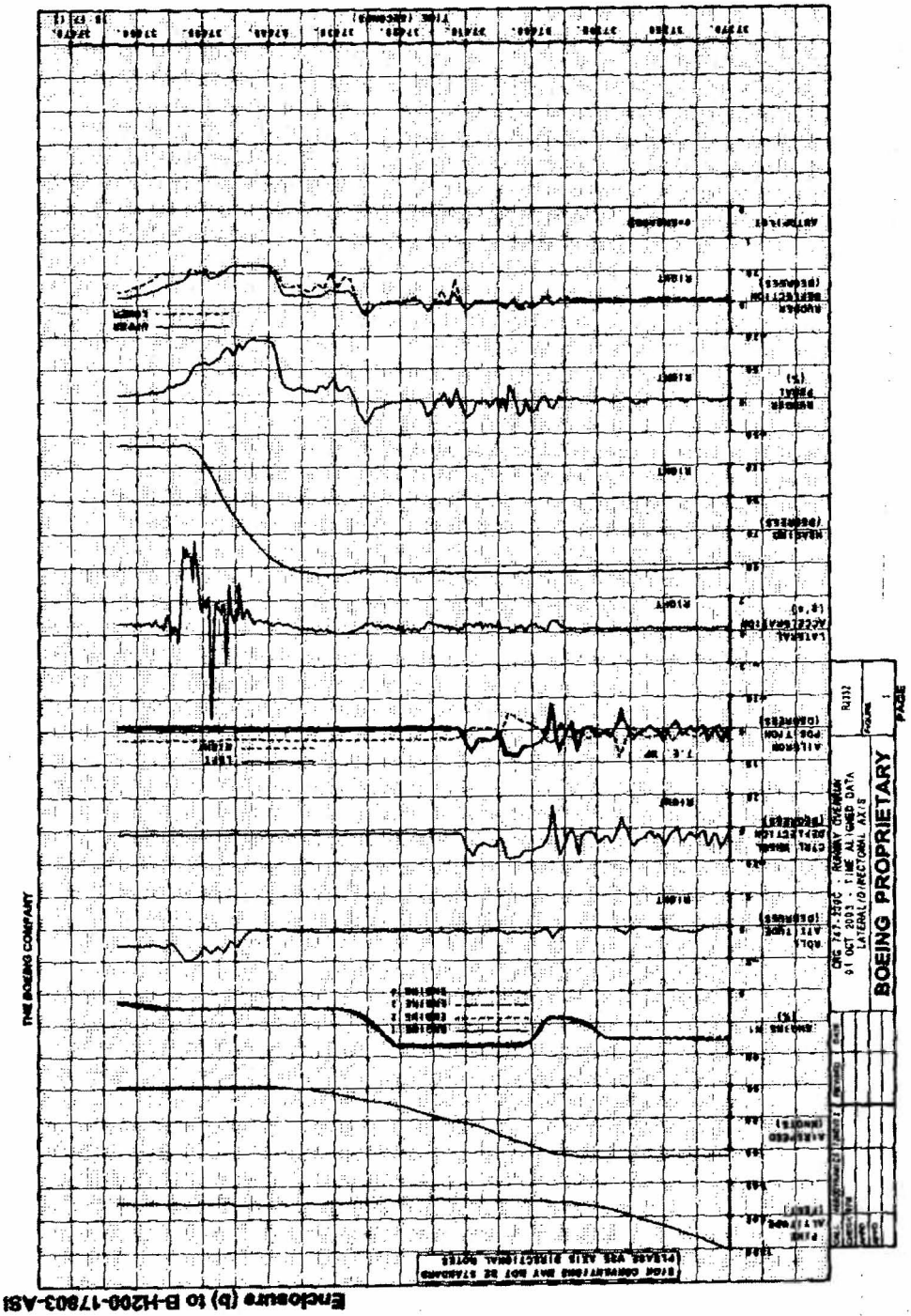
Figure 3 shows estimated longitudinal distance, assuming the airplane did not deviate from the runway centerline. Ground speed was calculated by integrating the longitudinal acceleration (N_x), after correcting for accelerometer bias. The calculated ground speed closely follows airspeed. The aircraft track was set equal to the runway heading of 46°. Based on an abrupt change in the character of all 3 accelerations, it appears that the aircraft departed the runway hard surface at time 37442 seconds and came to rest approximately 470 feet (143 m) beyond the hard surface. Based on these assumptions, we calculate that the aircraft touched down on the runway approximately 3000 feet (915 m) from the displaced runway 05R threshold.

Figure 4 shows the altitude profile of the approach in relation to the 3° glideslope and to the runway. It is important to note that glideslope deviation was not recorded on the FDR. Therefore, the relative position of the aircraft and the glideslope are based on the estimated touchdown point mentioned above. The aircraft was level at 3100 feet until time 37240 seconds, when the descent began. The descent rate (calculated from recorded pressure altitude) reaches a peak value of -1750 ft/min, and then stabilizes at about -1000 ft/min. For the majority of the descent, the aircraft was slightly above the glideslope.
Figure 5 is a comparison of estimated stopping distances. It compares calculated stopping distance based on the recorded deceleration with the stopping distance achieved with a constant deceleration of -0.2 G. The data indicates that if a deceleration of -0.2 G was

Evaluation of FDR Data
CAL Cargo Airlines 747-200 4X-ICM Runway Overrun at Liege - 1 Oct 03

maintained, the stopping distance would be about 5700 feet (1737 m) from touchdown. The estimated stopping distance derived from the FDR data is about 7500 ft (2286 m). The available runway distance after the glideslope intercept point is 8804 ft (2683 m).

Braking performance for all Boeing airplane models was certified with brakes that were supplied to Boeing by the original brake manufacturer. As noted in the reference (a) report, Nasco rotors were found to be installed on some of the brakes on the airplane. Boeing has not been involved in any manner with the development of the Nasco rotor nor the Nasco approval process. The stopping performance capability of brakes containing Nasco components is not known to Boeing. Therefore, we cannot comment further on the brake system performance during this event.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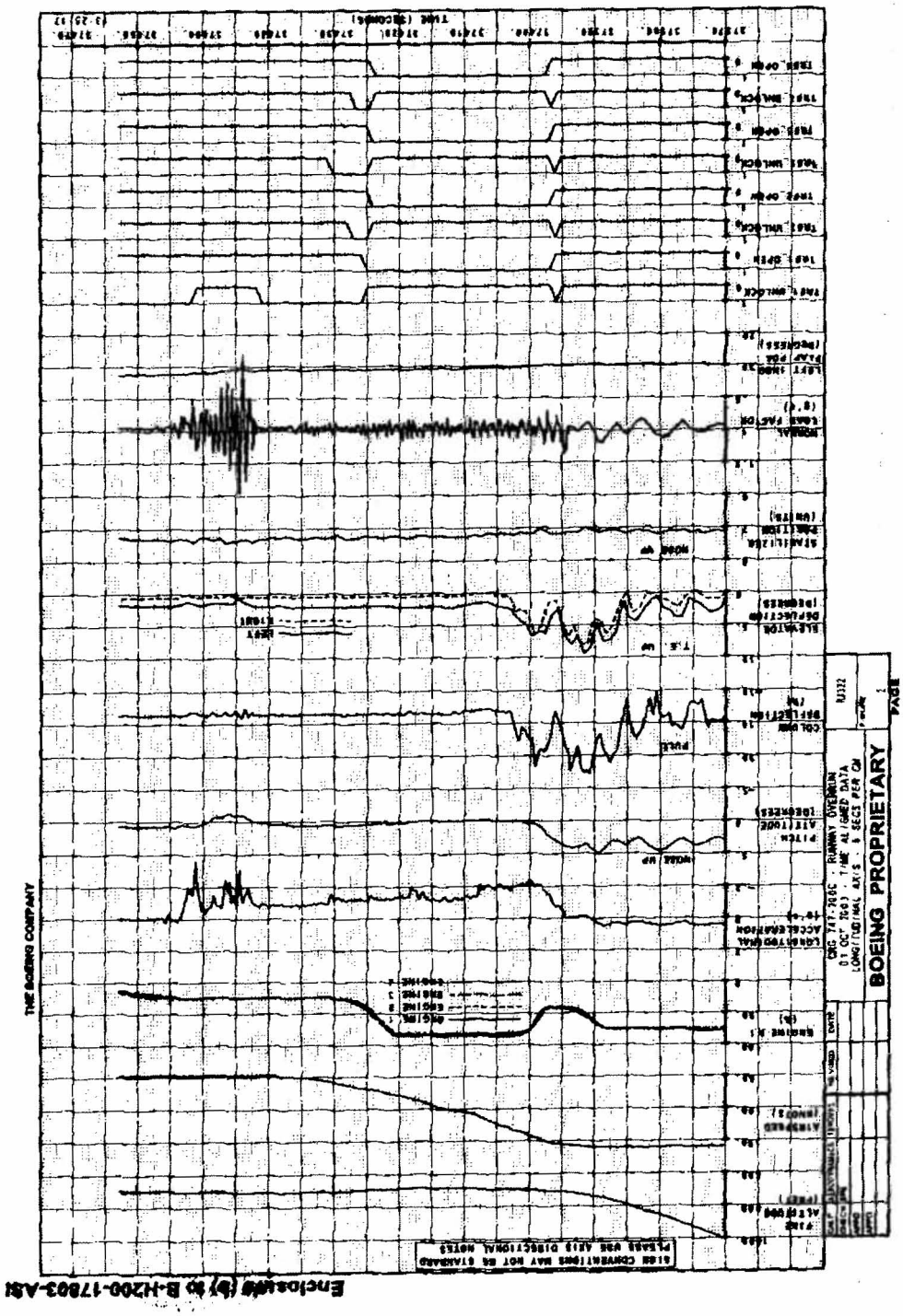
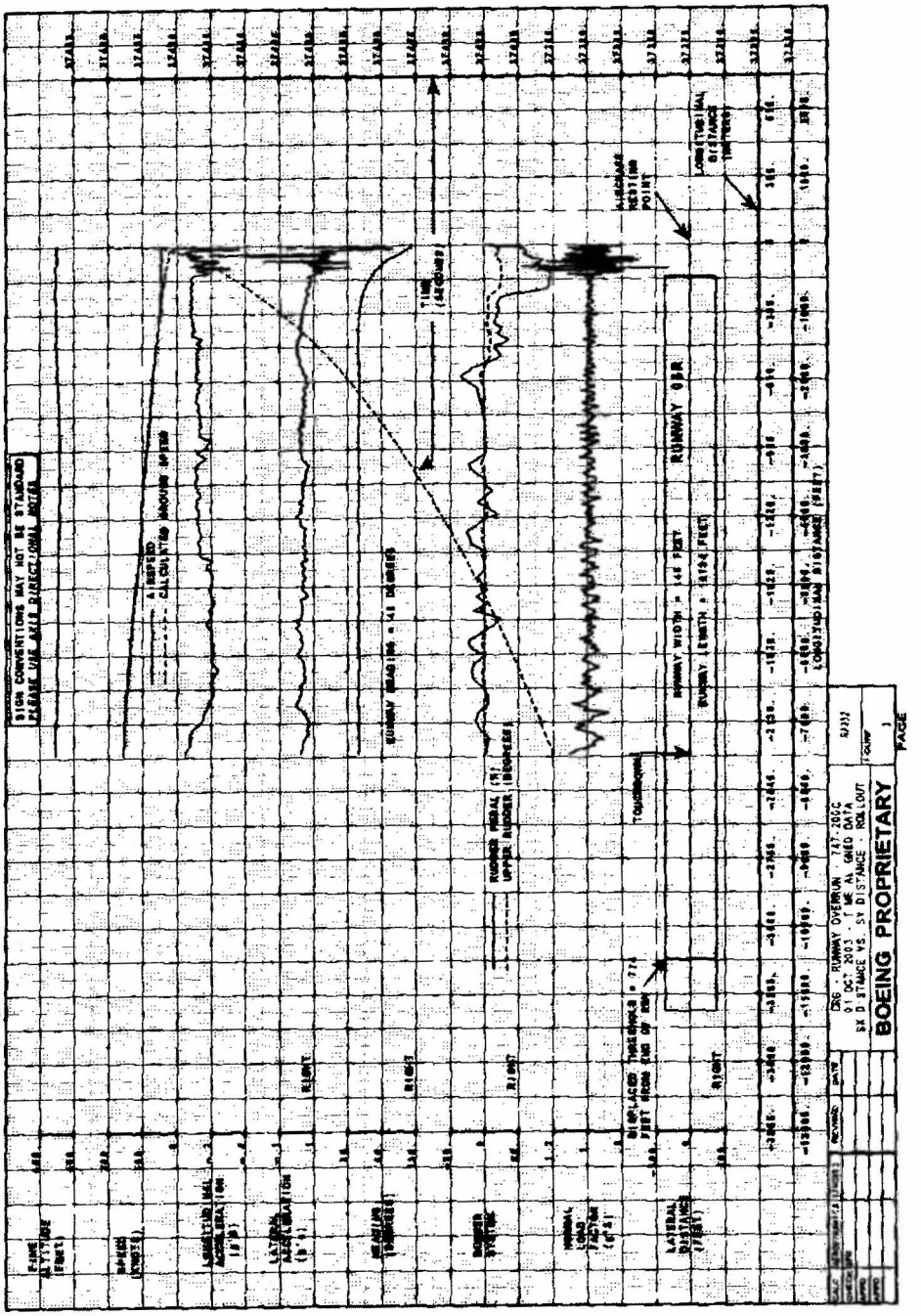
Enclosure (b) to B-H200-17803-ASI



Enclosure (3) to B-H200-17803-ASI

Enclosure (b) to B-H200-17803-ASI



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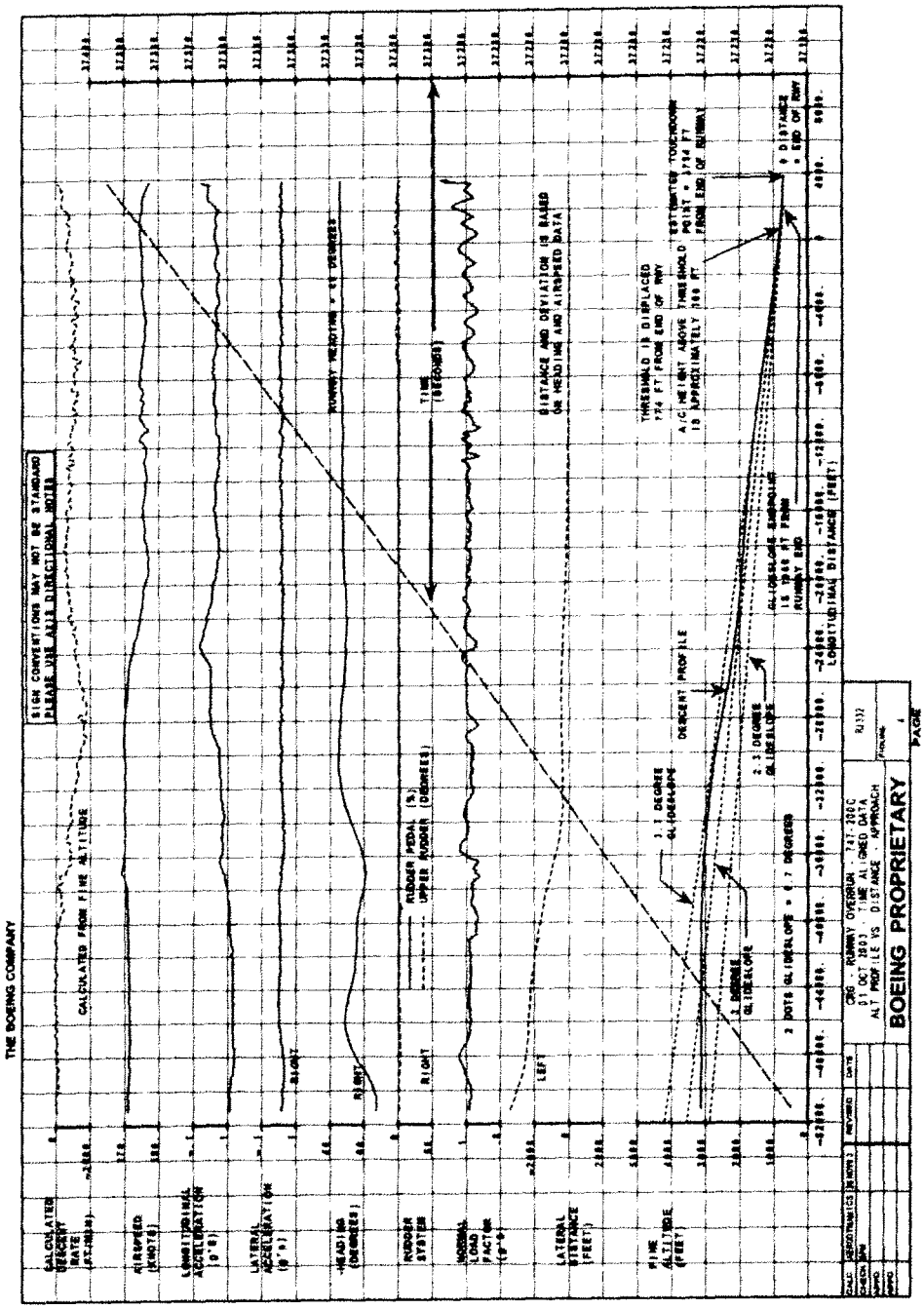
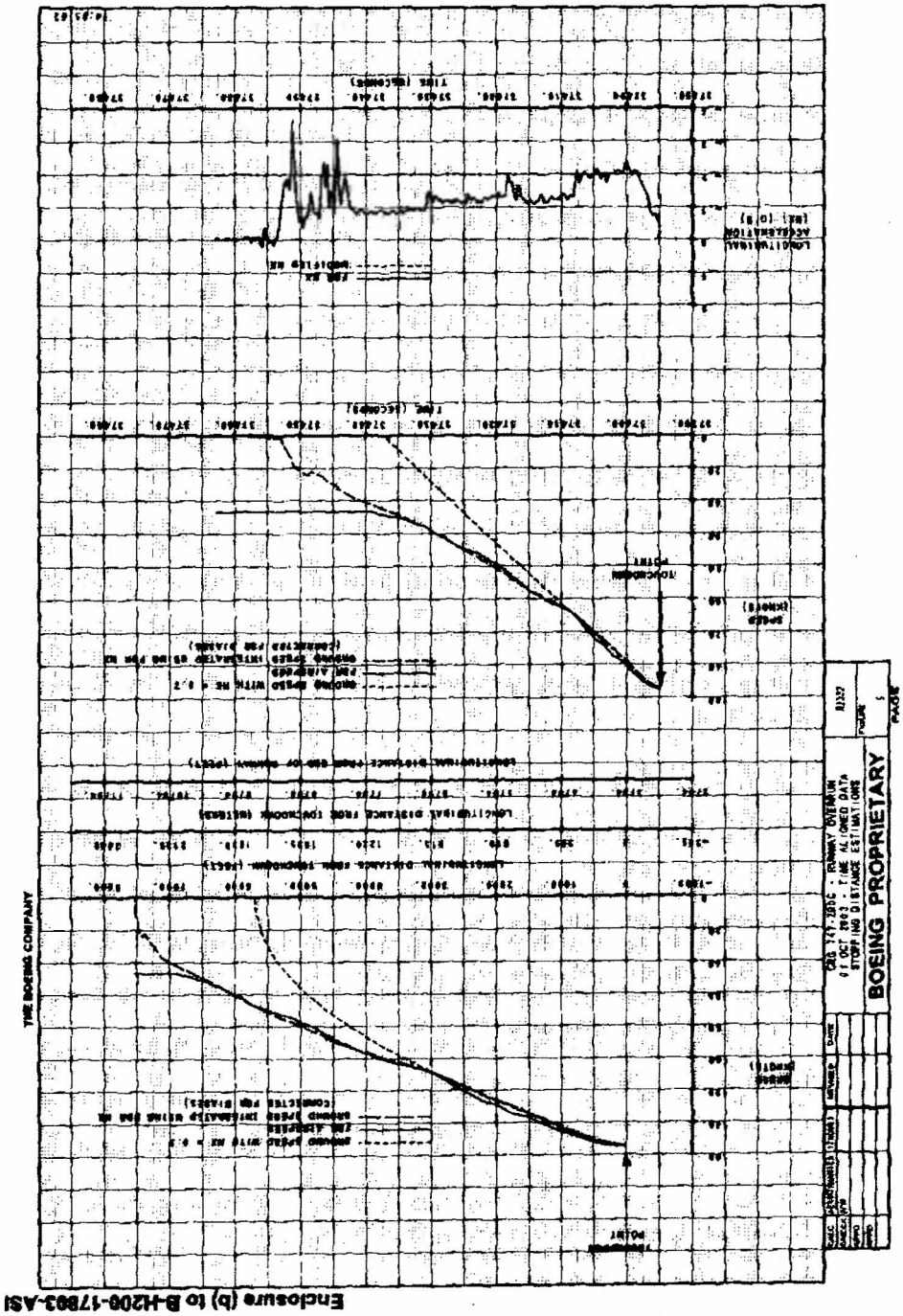


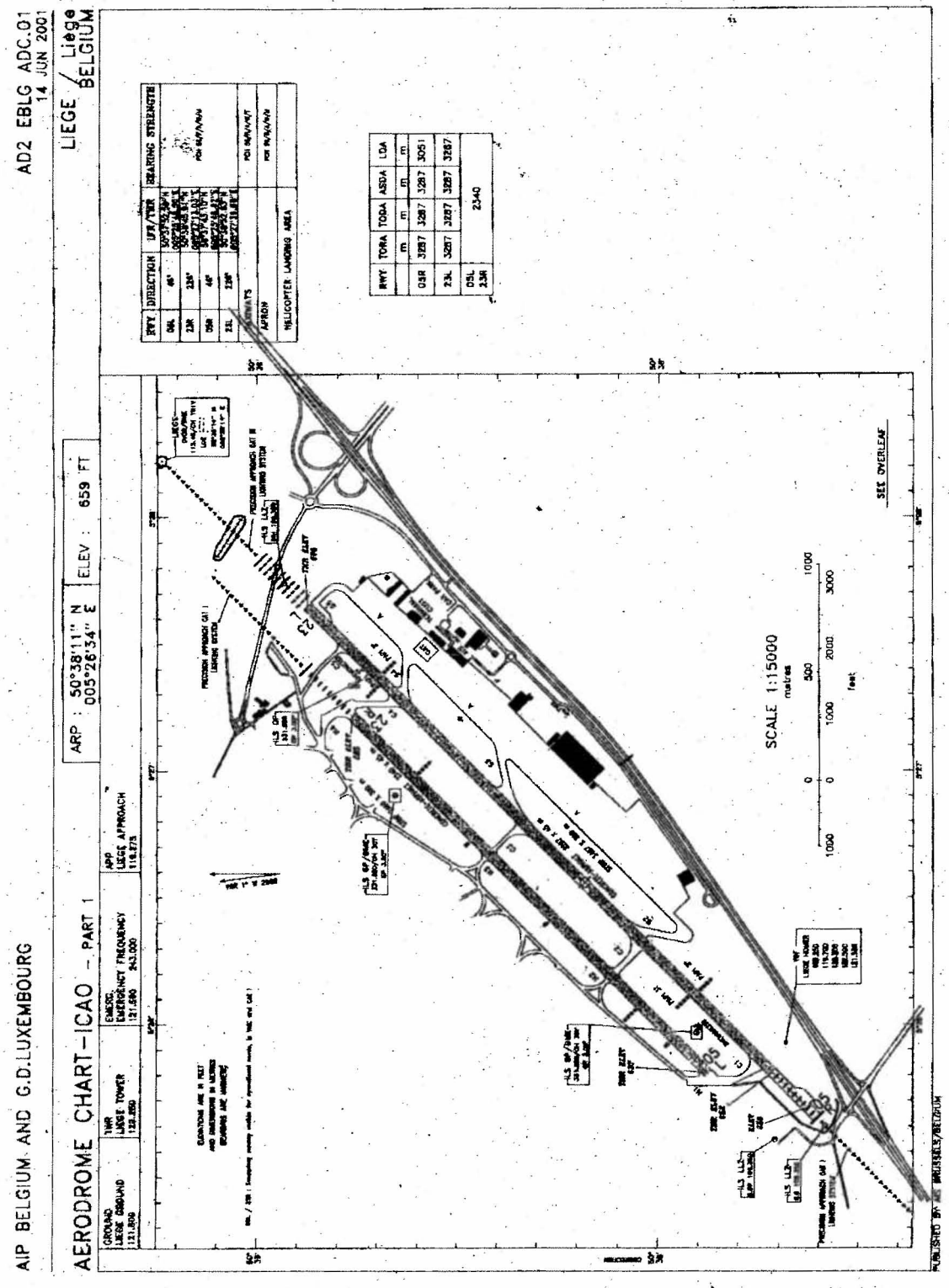


Enclosure (b) to B-H208-17803-ASI

ANNEX 6

AERODROME INFORMATION.

LIEGE airfield map.



ANNEX 6

Liège Airfield Obstacles Map.