SUMMARY REPORT

HCL 49/99	**Incident**		
Aircraft:	Boeing 767-383	Registration:	OY-KDN
Engines:	2 Pratt & Whitney PW 4060	Operation:	Scheduled, IFR
Crew:	10 – no injuries	Passengers:	181 – no injuries
Place:	Copenhagen Airport (EKCH)	Date & time:	24.08.1999 kl.1403 (UTC)

Synopsis

All times in this report is UTC.

The Danish Aircraft Accident Investigation Board (AAIB) was notified about the incident by telephone from the operator on August 24th 1999 at 1952 hrs.

During take-off on runway 22R, the flight crew initiated the rotation. The nose wheel was lifted off the runway, but the aircraft main wheel remained on the runway. The commander took over the control of the aircraft, lowered the aircraft nose and aborted the take-off.

After the aircraft reached taxi speed near the end of runway 22R, the aircraft taxied into the taxiway AK. The aircraft was parked on taxiway AK and the Fire & Rescue Brigade was alerted in case of a brake fire and in order to cool down the brakes. The passengers were disembarked via the normal doors and were afterwards transported to the terminal.

The investigation revealed the following causal factors:
The flight crew used a wrong and too low value as input take-off weight (ACT TOW). The result was that the values for V1, Vr and V2 were too low. The aircraft was rotated at the wrong and too low Vr and the aircraft never got airborne.

Three safety recommendations were made during the course of the investigation.

1. Factual information

1.1 History of flight

The flight was a scheduled flight from Copenhagen (EKCH) to New Tokyo International (RJAA).
The scheduled time of departure was 1340 hrs. The cockpit crew consisted of 1 commander, 1 co-pilot and 1 relief pilot. 7 cabin crewmembers were on board. The relief pilot had no duties on board during take-off or landing, but he was in the cockpit in the jump seat.

1.1.1 Flight preparation

Prior to the flight, the commander spent additional time for briefing the co-pilot. The reason was that the co-pilot was on his final route training. The incident flight was the first in which the co-pilot updated all the aircraft Flight Management Systems.

The flight crew arrived at the aircraft at approx. 1330 hrs. The commander announced a minor delay to the cabin crew and handling personnel.

Before engine start, a take-off data input was sent via the Aircraft Communication and Reporting System (ACARS) to the operator mainframe computer (see appendix 1). The co-pilot entered runway in use, temperature, QNH and so on into the ACARS. The co-pilot did not have the loadsheet and could not enter the take-off weight (ACT TOW). The loadmaster delivered the loadsheet to the commander. The commander checked the loadsheet and accepted it. The commander entered the correct zero fuel weight (ZFW) via the MCDU into the FMS. The co-pilot noted the ZFW (123500 kg), the Actual Take-off Weight (ACT TOW 186800 kg), the planned landing weight, fuel figures and passenger figures. The co-pilot entered ZFW into the ACARS in the space where the ACT TOW should have been entered. The input data was then transmitted to the mainframe computer. The mainframe computer made the take-off performance calculation and transmitted the result back to the aircraft ACARS. The result was printed on paper. (See appendix 2). The relief pilot noticed that the Mean Aerodynamic Cord (MAC) was 7.0% (default value) and commented that this value was not correct for the flight. The MAC was 19.0% according to the load sheet. The print was not checked further. The co-pilot made a new take-off data computation by entering MAC 19% as input (see appendix 2). The flight crew checked the new print and found the data correct. The commander entered the take-off data in the FMS.
V1 = 133 kts
VR = 133 kts
V2 = 139 kts

The FMS displayed the entered values of V1, Vr and V2 on the flight instruments.
None of the flight crewmembers checked the take-off data during the short taxi time to runway 22R A.

1.1.2 The Take-off run.
The Kastrup Tower cleared the aircraft to taxi to the holding position 22R A.
At 13:57:06 hrs, (17 minutes behind schedule) the aircraft started to taxi from the parking stand to holding point 22R A.
Take-off clearance was issued and the aircraft commenced take-off roll at 14:03:03 hrs. The commander (PNF) called “rotate” at a speed of approx. 133 (CAS). The co-pilot (PF) pulled the joke back at 14:03:50 hrs. The nose wheel left the ground at a speed of 143 kts at 14:03:53 hrs. The aircraft main wheel did not leave the ground and the aircraft continued to roll down the runway with a pitch of 9°. The Tail Skid Pad was in contact with the runway during the ground roll. The flight crew noticed that something was wrong during the ground roll. At 14:04:00 hrs, the commander called “stop and my controls”, lowered the aircraft nose and started to abort the take-off at a speed of 158 kts. The joke was moving forward and the thrust levers were at idle at 14:04:02 hrs. The nose wheel was back on the runway at a speed of 146 kts at 14:04:03 hrs. The commander moved the thrust levers to full reverse thrust. The auto brake was activated (RTO) but was deactivated 2 seconds later when the commander started manual braking. The manual braking led to asymmetric braking. The brake pressure was higher to the left brake units. At 14:04:18 hrs, the brake pressure was reduced at a CAS of 61 kts.

1.1.3 Parking and evacuation
The aircraft was taxied off the runway at position 04L A and was then parked on taxiway AK (see map). The relief pilot recalculated take-off data using a portable Take-off Data Computer (TODC). The result from the recalculation were:

Flaps = 5
MAX TOW = 186880 kg
ACT TOW = 186800 kg
MAC = 19,0 %
V1 = 166 kts
VR = 166 kts
V2 = 172 kts
(See the copy of TODC-print nr. 3 Appendix 2).

The flight crew concluded that the take-off data used during the take-off roll were wrong.
The co-pilot contacted tower control and informed them that there was a risk of overheated main wheel brakes. The tower informed the airport's fire brigade. The fire brigade left their station at 14:06 hrs. The fire fighters observed that the brakes were gloving red and smoky. The fire fighters started to cool down the brakes by the use of the fans. Cooling off the main wheels could not prevent three of the four left-hand main wheel tires to deflate (melt fuses were activated). The commander informed the passengers about the incident after the aircraft was parked at the taxiway. The crew and the passengers stayed on board the aircraft until the scale of the damage was unveiled. The passengers left the aircraft by the normal doors.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	-	-	-
Serious	-	-	-
Minor	-	-	-
None	10	181	-

1.3 Damage to aircraft

The aircraft suffered minor damage.
Within 30 minutes after the aircraft was parked on the taxiway AK, three out of the four left-hand main wheels deflated, when the over-temperature-fuses melted. One bolt in the left-hand main wheel rim was broken (the wheel was still pressured). The left-hand brake units were damaged. The Tail Skid Pad was worn beyond its limitations. The Tail Skid Pad's condition prior to the incident was unknown.
The airport personnel inspected the runway and found marks from the Tail Skid Pad.

1.4 Other damage

None.

1.5 Personnel information

The commander	Male Age 54.
License	Type D (ATPL) issued on May 22, 1986. B767 on August 24, 1996.
Medical	Approved on July 7, 1999.

Experience	Within 24 hrs	Within 90 days	Total
All types	1:35	133:40	15901
This type	0	127	2147
Landings	0	22	-

Co-pilot.	Male Age 37		
License.	Type D (ATPL), issued on August 4, 1999.		
Medical.	Approved February 1, 1999.		
Experience.	Within 24 hrs	Within 90 days	Total
All types	0	64:05	6025:05
This type	0	51:40	51:40
Landings	0	11	-

The relief pilot's experience: Total all types: 8901:00 hrs, this type: 677:00 hrs.

1.6 Aircraft information

1.6.1 General.

Aircraft:

Manufacturer:	The Boeing Company
Type:	767-383
Serial no.:	24848
Year:	1990
Engines:	2 turbofan Pratt & Whitney PW 4060
Airworthiness:	Nr. 2538, transport class valid until December 31, 1999
Total hrs:	45653 hrs

1.6.2 Mass and balance.

Weight:

Maximum TOW:	186880 kilo
Actual TOW:	186800 kilo
ZFW:	123500 kilo
Fuel weight:	63300 kilo (at take-off)

Center of Gravity:

% MAC:	19,0 %

1.6.3 ACARS.

The flight crew was using a land-based mainframe computer to calculate the take-off performance.

The input data were entered via the MCDU into the ACARS. The ACARS then radio transmitted the input data to the land-based mainframe computer. The mainframe computer made the take-off calculation and transmitted the result back to the aircraft via ACARS. The printer onboard printed the result from the take-off data (see appendix).

1.6.4 Aircraft Operations Manual 767 (AOM).

Normal Check List, expanded effective from July 15, 1999 page 7 item 8:

"**Take off data calculation CHECKED . P.**

- Complete the ACARS TODC REQ pages, check and SEND. Both pilots are to verify that all take off data input and output are correct."

Flight Procedures, take-off valid from April 4, 1997 page 5 item 8.2:

"Procedure.

P-I-C orders "STOP". The L/P shall take control and:

- Retard both thrust levers to idle and rise the reverse levers to the interlock stop.
- Check auto brakes to come on max *(RTO) or apply maximum manual brakes as required.
- Monitor the speed brake lever for automatic extension or extend the speed brakes manually if necessary.
- Apply maximum reverse thrust."

*Refused Take-Off

1.7 Meteorological information

Meteorological conditions at the time of the incident at EKCH:

Wind direction and velocity:	190°/ 7 kts
Visibility:	More than 10 km
Temperature:	+18°C
QNH:	1022 hPa

1.8 Aids to navigation

Not applicable.

1.9 Communication

No relevance.

1.10 Aerodrome information

Runway 22R at EKCH was 3570 meters with a surface of asphalt.

See appendix.

1.11 Flight recorders

The aircraft was equipped with Flight Data Recorder (FDR), Cockpit Voice Recorder (CVR) and Quick Access Recorder (QAR).

The flight crew did not consider the occurrence as an incident. Consequently, the electrical power to the CVR was not switched off. The CVR tape was an endless loop-type with a recording period of ½ hour. After ½ hour, the data would be overwritten with new recordings. The commander was considering a new take-off after a brake cooling period.

The QAR data was of a good quality and the data was used in the investigation.

Following data were used in the investigation (from 13:56:56 hrs to 14:05:08 hrs):

- CAS (Calibrated Air Speed).
- Pitch (Nose Pitch).
- AOA (Angle of Attack).
- Elev. pos. (Elevator position).
- Cont. col. R / L (Aileron input left or right).
- SP. brk. handle pos. (Speed Brake Liver Position).
- Throtl ResAng. R / L (Thrust Liver Angle).
- Nose gear Squat (Nose Wheel Air / Ground Censors).
- Wheel Brake Appl. R / L (Wheel Brake Application).
- BrkPres Main R / L PSIG (Hydraulic Brake Pressure).
- Autobrakes (Activation).
- Autobrakes Selector (Auto Brake Selection).

1.12 Wreckage and impact information

None.

1.13 Medical and pathological information

No relevance.

1.14 Fire

Fire did not occur.

1.15 Survival aspects

When it became evident that all four left-hand main wheels had to be changed on the taxiway it was decided to disembark the passengers. The passengers left the aircraft through the doors.

1.16 Test and research

None.

1.17 Organizational and management information

The organizational aspect was not relevant to the incident.

1.18 Additional information

The co-pilot had previous experience on McDonnell Douglas MD-80 at the same operator. The procedure on MD-80 was to dial the ZFW into the aircraft fuel system.

On August 28, 1998, a similar incident occurred involving a Boeing 767. The incident was caused due to the ACT ZFW entered as an input to the take-off performance calculation. The input should have been the ACT TOW. The result was too low values of V1, Vr and V2.

The system will return a warning, if a too high ACT TOW was used as an input parameter (higher than MTOW).

2. Analysis

The co-pilot did not enter the values for MAC into the ACARS' take-off performance page. The co-pilot entered the value for ZFW into the ACARS' take-off performance page. It should have been the TOW value. The co-pilot had previous experience on MD-80. The ZFW was used as input parameter on the MD-80. This previous procedure on the MD-80 could lead the co-pilot to enter the ZFW by mistake on the B767 as an input parameter.

The co-pilot could have been stressed by the delayed departure, and consequently force the updating of input data leading to entry of wrong data.

The input data for actual take-off weight (ACT TOW) was 186800 kg, but the co-pilot entered instead the value for zero fuel weight (ZFW) 123500 kg. This value (123500 kg) was sent to the mainframe computer by use of ACARS, and the returned values were based on a take-off weight of 123500 kg and not on the correct take-off weight of 186800 kg. The entered take-off weight was 63300 kg too low.

The returned wrong values were:

V1=133 kts

VR=133 kts

V2=139 kts

The correct values were:

V1=166 kts

VR=166 kts

V2=172 kts

Both pilots must crosscheck the take-off data. The printed take-off data consist of input data and output data. The relief pilot found the wrong MAC (7%) on the first print before a complete check of the take-off data was performed. The wrong take-off weight (ACT TOW) was not found on the first print. The MAC was then corrected to the actual MAC (19.0%) and a new take-off calculation was made. The pilots checked that the MAC value was correct, but they did not check the wrong values of ACT TOW, V1, Vr or V2. The flight crew was focused on the one error they found (MAC) and thought that the check of take-off data was completed. (print no 2).

The correct take-off weight (ACT TOW) of 186800 kg was available on the loadsheet.

The presentation of the take-off data:

Wrong data used Actual TODC-print		Correct data used Correct TODC-print	
Flaps	-05	Flaps	-05
MAX TOW	-186.8	MAX TOW	-186.8
ACT TOW	-123.5	ACT TOW	-186.8
ACT %MAC	-19.0	ACT %MAC	-19.0

The maximum structural take-off weight (MAX TOW) and right below was the actual take-off weight (ACT TOW). On the flight in question, the ACT TOW of 186800 kg was almost the same as the MAX TOW of 186880 kg. The take-off data layout could possibly lead to that the flight crew "found the value

they were looking for", but at the wrong location.

The commander was using the printed values of V1, Vr and V2 and entered these values as input to the FMS. The speeds were then displayed on the flight instruments.

None of the flight crewmembers made any crosschecking of the values during the short taxi time to holding position 22R A.

The values for V1, Vr and V2 resulted in a rotation of the aircraft at a speed 33 knots too low.

The aircraft did not become airborne, but continued to roll down the runway with a pitch attitude of 9° up. The Tail Skid Pad was in contact with the runway.

The flight crew noticed during the take-off run that the visual and sound impressions were wrong. The commander reacted appropriately and aborted the take-off.

The manual activation of the main wheel brakes resulted in an asymmetric braking. The result was damage to the left-hand main landing gear. The auto brake system was armed in RTO and was activated during the rejected take-off, but deactivated when the commander pressed the brake pedals. The auto brake system would have applied full symmetrical brake pressure and allowed the commander a better rudder control.

The normal procedures and routines were interrupted by the intervention from the relief pilot. The relief pilot found the wrong value for the MAC and could thereby have stopped the checking of the remaining take-off data. The relief pilot had no formal duties during take-off or landing.

The electrical power to the Cockpit Voice Recorder (CVR) was not interrupted. Consequently, no useful recordings of the incident were made.

JAR-OPS 1.085; "Crew responsibilities" point C, "The commander shall":

"(9) Not permit:

(i) A flight recorder to be disabled, switched off or erased during flight nor permit recorded data to be erased after flight in the event of an accident or an incident subject to mandatory reporting;

(ii) A cockpit voice recorder to be disabled or switched off during flight unless he believes that the recorded data, which otherwise would be erased automatically, should be preserved for incident or accident investigation nor permit recorded data to be manually erased during or after flight in the event of an accident or an incident subject to mandatory reporting."

ICAO Annex 6, under 6.3.10 "Flight recorders – operation":

"6.3.10.1 Flight recorders shall not be switched off during flight time.

6.3.10.2 To preserve flight recorder records, flight recorders shall be de-activated upon completion of flight time following an accident or incident. The flight recorders shall not be re-activated before their disposition as determined in accordance with Annex 13.

Note 1. - The need for removal of the flight recorder records from the aircraft will be determined by the investigation authority in the State conducting the investigation with due regard to the seriousness of an occurrence and the circumstances, including the impact on the operation."

The wording in JAR-OPS 1.085 could lead to loss of useful recordings resulting in difficulties in the investigation of an incident or accident.

3. Conclusion

3.1 Summary.

The take-off performance calculation was based on a too low ACT TOW. As a result of the wrong value for ACT TOW, the values for V1, Vr and V2 were too low. The wrong values of Vr resulted in the aircraft being rotated at a too low speed.

The check of the take-off performance data was not sufficient.

3.2 Causal factors:

1. The co-pilot entered an ACT TOW value into the ACARS. The value was 63300 kg too low. The co-pilot used by mistake the value for ZFW.

2. The take-off performance computation was using this low value of ACT TOW.

3. The result of the take-off performance computation was used as a speed reference.

4. The result was too low values of V1, Vr and V2.

5. The flight crew checked the take-off data on the second print, but focused only on the correct MAC, not on the wrong ACT TOW and the wrong values of V1, Vr and V2.

6. The printed layout of the take-off data could result in misinterpretation of the values ACT TOW and MAX TOW.

7. The aircraft was rotated at a speed 33 kts too low.

8. The aircraft did not get airborne during the take-off run, but continued to roll down the runway at a pitch of 9° up.

9. The commander aborted the take-off.

3.3 Findings:

1. The flight crew had valid licenses.

2. The co-pilot had limited experience on B767.

3. The relief pilot noticed the wrong MAC on the first print of take-off data. The crew did not continue the checking of take-off data.

4. The Tail Skid Pad was in contact with the runway during the take-off run.

5. The left-hand main wheel was damaged due to asymmetric braking

6. The electrical power was not interrupted to the CVR.

4. Recommendations

4.1 Corrective action

The Danish Civil Aviation Administration was informed about the incident and the draft recommendations. The meeting was held on September 30th, 1999 at the Aircraft Accident Investigation Board (AAIB).

4.2 Recommendations.

AAIB recommends that:

The Danish Civil Aviation Administration ensures that the commander makes an estimate of the flight performance data and flight planning data. The estimate shall as a minimum cover:

a. Estimated en route time.
b. Trip fuel.
c. Zero Fuel Mass.
d. Take-off Mass.
e. Take-off Speeds.
f. Landing Mass.
g. Landing Speeds.
(REK-01-2000)

AAIB recommends that:

The Danish Civil Aviation Administration ensures that the layout of flight data reduces the possibility of mistakes. (REK-02-2000)

AAIB recommends that:

The Danish Civil Aviation Administration, when approving operators FOM, complies with ICAO Standard 6.3.10. (REK-03-2000)

4.3 Preventive corrections.

1. The operator issued information about the possibility of errors when computing the take-off data.
2. The take-off computer software was modified. A warning would be issued, if the take-off weight (ACT TOW) deviated more than 8000 kg from the normal average take-off weight on that route.

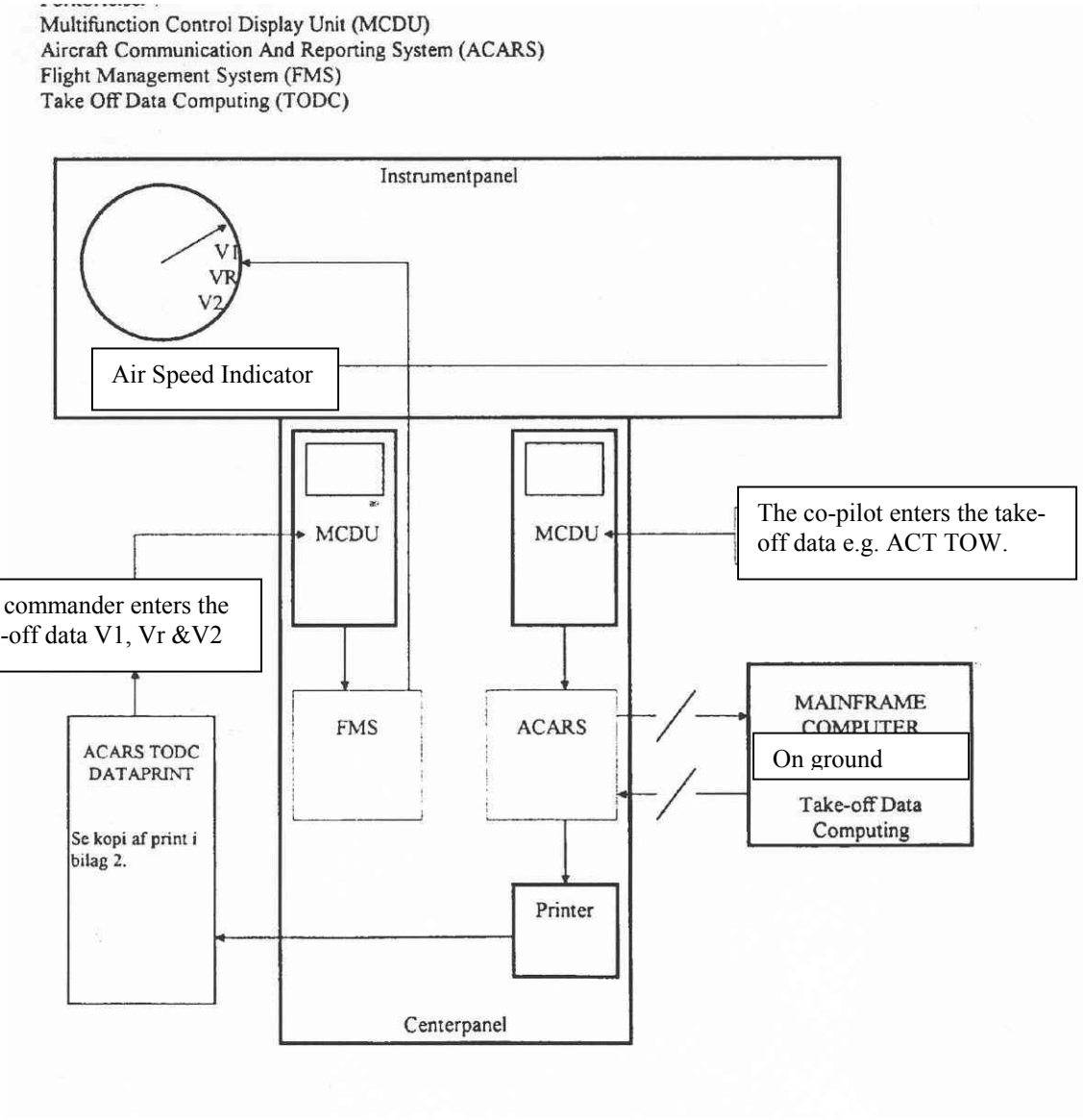
5. Appendix

Appendix 1. Process-diagram indicating the data-route from the MCDU to V1, Vr and V2 indication on the flight instruments.

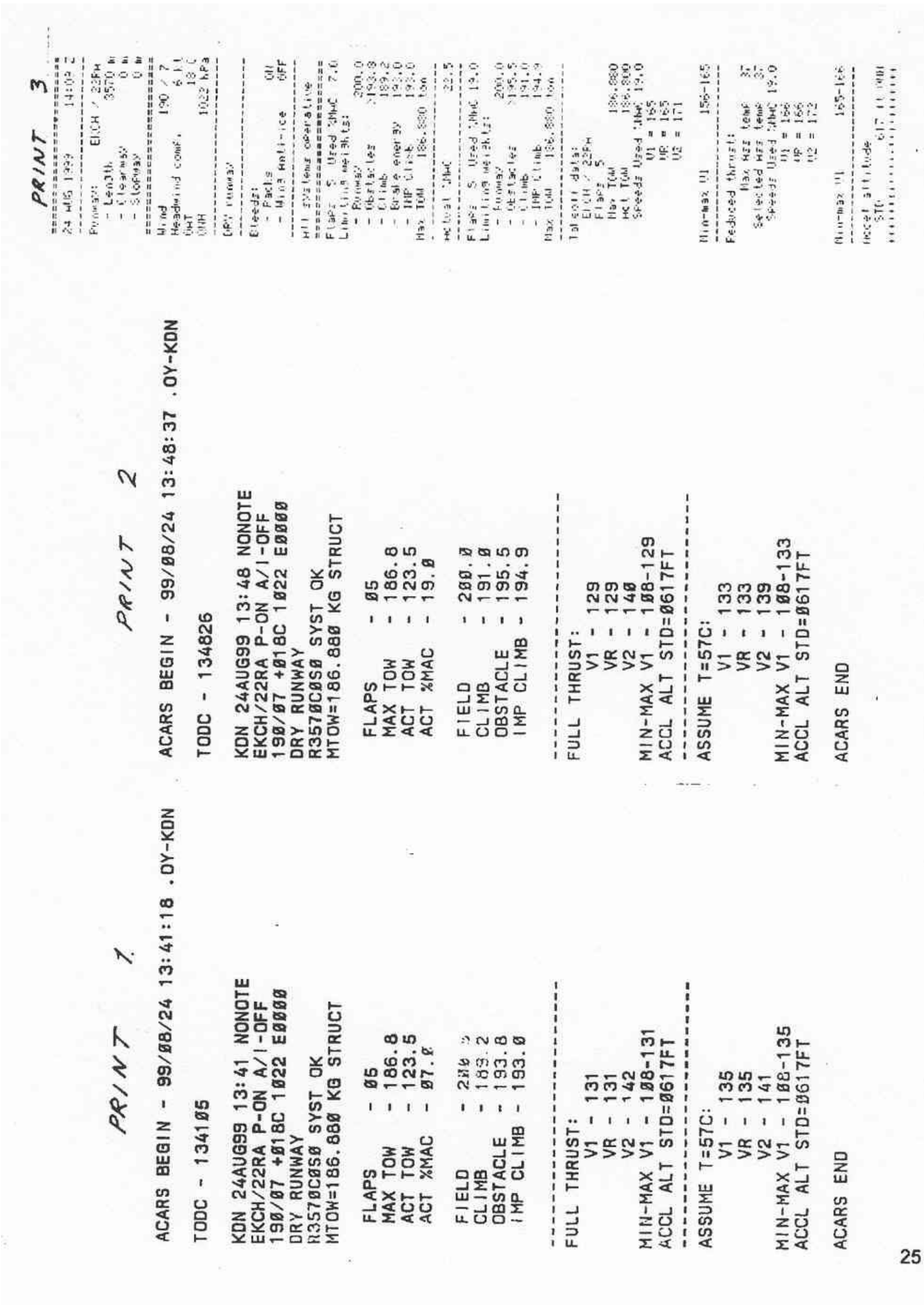
Appendix 2. Print of the 3 copies of the take-off data.

Appendix 3. Map over Copenhagen Airport (EKCH).

Appendix 1. Process-diagram indicating the data-route from the MCDU to V1, Vr and V2 indication on the flight instruments.



Appendix 2. Print of the 3 copies of the take-off data.



PRINT 1.

```
ACARS BEGIN - 99/08/24 13:41:18 .OY-KDN

TODC - 134105

KDN 24AUG99 13:41 NONOTE
EKCH/22RA P-ON A/I-OFF
190/07 +018C 1022 E0000
DRY RUNWAY
R3570C0S0 SYST OK
MTOW=186.880 KG STRUCT

  FLAPS      - 05
  MAX TOW    - 186.8
  ACT TOW    - 123.5
  ACT %MAC   - 07.0

  FIELD      - 200.0
  CLIMB      - 189.2
  OBSTACLE   - 193.8
  IMP CLIMB  - 193.0
-------------------------
FULL THRUST:
         V1 - 131
         VR - 131
         V2 - 142
MIN-MAX V1 - 108-131
ACCL ALT STD=0617FT
-------------------------
ASSUME T=57C:
         V1 - 135
         VR - 135
         V2 - 141
MIN-MAX V1 - 108-135
ACCL ALT STD=0617FT

ACARS END
```

PRINT 2

```
ACARS BEGIN - 99/08/24 13:48:37 .OY-KDN

TODC - 134826

KDN 24AUG99 13:48 NONOTE
EKCH/22RA P-ON A/I-OFF
190/07 +018C 1022 E0000
DRY RUNWAY
R3570C0S0 SYST OK
MTOW=186.880 KG STRUCT

  FLAPS      - 05
  MAX TOW    - 186.8
  ACT TOW    - 123.5
  ACT %MAC   - 19.0

  FIELD      - 200.0
  CLIMB      - 191.0
  OBSTACLE   - 195.5
  IMP CLIMB  - 194.9
-------------------------
FULL THRUST:
         V1 - 129
         VR - 129
         V2 - 140
MIN-MAX V1 - 108-129
ACCL ALT STD=0617FT
-------------------------
ASSUME T=57C:
         V1 - 133
         VR - 133
         V2 - 139
MIN-MAX V1 - 108-133
ACCL ALT STD=0617FT

ACARS END
```

PRINT 3

```
=========================
24 AUG 1999       14:09 Z
-------------------------
Runway:       EKCH / 22RH
  - Length         3570 m
  - Clearway          0 m
  - Stopway           0 m
=========================
Wind             190 / 7
Headwind comp.       6 kt
OAT                  18 C
QNH              1022 hPa
-------------------------
DRY runway
-------------------------
Bleeds:
  - Packs              ON
  - Wing Anti-ice     OFF
-------------------------
All systems operative
=========================
Flaps  5  Used %MAC  7.0
Limiting weights:
  - Runway          200.0
  - Obstacles      >193.8
  - Climb           189.2
  - Brake energy    193.0
  - IMP Climb       193.0
Max TOW    186.880 ton
-------------------------
Actual %MAC          22.5
-------------------------
Flaps  5  Used %MAC 19.0
Limiting weights:
  - Runway          200.0
  - Obstacles      >195.5
  - Climb           191.0
  - IMP Climb       194.9
Max TOW    186.880 ton
-------------------------
Takeoff data:
  EKCH / 22RH
  Flaps  5
  Max TOW         186.880
  Act TOW         186.800
  Speeds Used %MAC 19.0
           V1 = 165
           VR = 165
           V2 = 171

Min-max V1        156-165
-------------------------
Reduced thrust:
       Max Ass temp    37
  Selected Ass temp    37
   Speeds Used %MAC 19.0
           V1 = 166
           VR = 166
           V2 = 172

Min-max V1        165-166
-------------------------
Accel altitude
   STD          617 ft
```

Appendix 3. Map over Copenhagen Airport (EKCH).