Tail strike during take-off

Boeing 737-800, registration PH-HZB,
Rotterdam Airport, January 12th 2003

The Hague, November 2006, project number 2003004

DUTCH SAFETY BOARD

The Dutch Safety Board has been established with the responsibility to investigate and establish what the causes or probable causes are of individual or categories of incidents in all sectors. The sole aim of such an investigation is to prevent future accidents or incidents and if the results of this should give cause to do so, to attach recommendations to this. The organization consists of a Board with five permanent members and has a number of permanent committees. Specific advisory committees are formed for specific investigations. A staff that comprises investigators and secretarial reporters as well as a support staff support the Dutch Safety Board.

The Dutch Safety Board is the legal successor to the Dutch Transport Safety Board. The present investigation is initiated and partly carried out by the Dutch Transport Safety Board but published under the auspices of the Dutch Safety Board.

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In accordance with Annex 13 to the Convention of Chicago as well as Directive No.94/56/EC of the Council for the European Communities, which established the fundamental principles governing the investigation of civil aviation accidents and incidents, the investigation of the Dutch Safety Board is not intended to apportion blame or liability.

N.B:
This report is published in the Dutch and English language.
In the event of conflict in interpretation, the Dutch text will be deemed binding.

CONSIDERATION

On January the 12th 2003, a Boeing 737-800 of Transavia airlines departed from Rotterdam Airport. The flight was scheduled for a three leg flight via Maastricht-Aachen Airport and Arrecive, Lanzarote Airport to Amsterdam Airport Schiphol. Immediately after initiation of the take-off, when the aircraft started to roll, the aircraft's nose pitched up. This movement stopped when the aft fuselage and the tailskid assembly touched the ground. After the cockpit crew rejected the take-off, the aircraft's nose touched the ground again and the aircraft was brought to a hold. The occurrence damaged the aircraft considerably. As a result, the crew could not resume the flight. None of the 113 passengers and seven crew members was injured. After the occurrence, the aircraft was taxied to the apron. At this location the passengers left the aircraft.

The Dutch Safety Board investigated the (probable) cause(s) of the above-described tail strike. This investigation revealed that nearly all passengers at Rotterdam Airport were checked in at the rear of the cabin and seated themselves there. To facilitate boarding at the next airport (Maastricht-Aachen Airport) the ground handling company Aviapartner had assigned these rear seats to the passengers at Rotterdam Airport. After all, this allowed passengers at Maastricht-Aachen Airport to seat themselves in front of the cabin. Because of the uneven passenger distribution, the aircraft's centre of gravity was situated far behind the applicable aft limit[1]. As a result the nose of the aircraft pitched up and its tail touched the ground.

Several factors contributed to the occurrence of this serious incident. These factors concern the cockpit crew's centre of gravity awareness, the procedure of loading the aircraft, supervision by Transavia airlines and the ground handling company's quality system. Underneath, these factors are elaborated upon. In addition, Transavia airlines' quality system, which formed an underlying cause of the occurrence according to the Dutch Safety Board, is discussed. To end with, two aspects of the research process itself are discussed.

The cockpit crew's centre of gravity awareness
The passenger seat distribution significantly affects the Boeing 737-800's centre of gravity and controllability. The investigation shows that the cockpit crew, involved in the incident, was unaware of this significant effect. As a result, the cockpit crew failed to respond adequately to the purser's notification of an uneven passenger seat distribution. The analysis of 23 similar Transavia airlines flights indicates that this lack of "centre of gravity awareness" does not apply solely to the cockpit crew involved in the incident. More specifically, this lack of awareness seems to pertain to several Transavia airlines' cockpit crews. The Dutch Safety Board therefore recommends transavia.com to enhance this cockpit crew's awareness. By the re-introduction of the graphical depiction of the flight envelope on the load and trim sheet[2] and the completion by the cockpit crew of the automatically generated load and trim sheet for every flight with actual load data, this recommendation has been met already to a large extent.

The procedure of loading the aircraft
The investigation further reveals that Transavia airlines uses a software program to produce the load and trim sheet for all flights.
This software program is based on the planned number of passengers and assumes an equal passenger distribution throughout the cabin. Before departure, at the Transavia airlines flight dispatch in the main office at Amsterdam Airport Schiphol, cockpit crews obtain printed copies of the computerized load and trim sheet for all legs to be flown. The process of producing the load and trim sheets is separated in time and place from the process of actual loading. Thus, not until the last moment, the cockpit crew verifies the planned figures against the actual figures in the cockpit. This separation in time and place may endanger flight safety. Moreover, the investigation shows that Transavia airlines' procedures for the verification of an equal passenger distribution were inadequate.

Supervision by Transavia airlines
Transavia airlines hired Aviapartner to carry out its ground handling activities at Rotterdam Airport. The investigation reveals that Transavia airlines did not supervise this ground handling company in

[1] The centre of gravity was situated outside the aft limit of the flight envelope (the flight envelope indicates the weight and centre of gravity limits; the aircraft should be operated within those limits).
[2] A load and trim sheet is the form that provides the cockpit crew with information regarding the aircraft weight, the different passenger weights, the cargo (weight), the fuel and the position of the centre of gravity.

an adequate manner. More specifically, Transavia airlines did not ensure that Aviapartner's ground handling personnel was familiar with and sufficiently trained in Transavia airlines' loading procedures. As a result, Aviapartner's ground handling personnel did not know how to assign seats to passengers in the correct way.

The ground handling company's quality system
Aviapartner has committed itself to act according to the ground handling agreement with Transavia airlines. Because Aviapartner did not instruct and train its staff sufficiently this agreement was violated. It should be noted, however, that, according to Joint Aviation Authority regulations (JAR-OPS 1), operators which contract other organisations to provide certain services, retain responsible for the maintenance of proper standards. Stated differently, Transavia airlines remains responsible for the quality and safety of the products or services that are delivered by sub-contractors. Because there is no legal basis for the certification of ground handling companies, this regulation for operators is important in particular. The Dutch Safety Board believes that organizations, such as ground handling companies that carry out safety-critical tasks, should also be responsible for the execution of their own tasks. Therefore, the Dutch Safety Board pleases the development of European quality and safety regulations for ground handling companies. It is the opinion of the Board that by means of these regulations companies are better equipped to bear their responsibilities.

Following on this, it should be noted that the Dutch Transport Safety Board has paid attention to the non-existence of international safety and quality regulations for ground handling companies in two previous investigations. The first occurrence took place in 2001 on an apron at Amsterdam Airport Schiphol. In this accident a technician, who was hired by an operator, was severely injured when he walked into a rotating propeller[3]. As a result of the accident, the operator involved indicated that he had adjusted the quality manual regarding this aspect. The second occurrence involved a serious accident near Turin (Italy). In this occurrence, the operator entered into inadequate agreements with the ground handling company. This ground handling company was responsible for de-icing the aircraft. As a result of the inadequate agreements, pieces of ice made their way into the engines. Consequently, the cockpit crew had to make an emergency landing[4].

Considering the current and the above-described occurrences, the Dutch Safety Board recommends the Minister of Transport, Public Works and Water Management to orchestrate the draft of quality and safety regulations for ground handling companies by the European Aviation Safety Agency (EASA). Furthermore, the Dutch Safety Board recommends Aviapartner to improve its quality system.

Transavia's quality system
To ensure safe operational practices and airworthy aeroplanes, operators are obliged to establish and work according to a quality system. The investigation of the Dutch Safety Board shows that Transavia airlines' quality system fell short at a number of load and balance issues. For that reason, Transavia airlines' quality system plays an important role in the cause of the occurrence according to the Dutch Safety Board.

The investigation shows, among other things, that Transavia airlines, in an internal audit, identified several deficiencies regarding their own load and balance procedures. According to the Dutch Safety Board, the subsequent corrective actions by Transavia airlines were insufficient and, evidently, did not prevent the occurrence from happening.

Another finding that substantiates the conclusion about the failing quality system concerns the way Transavia airlines' cockpit crews reported occurences about incorrect passenger distributions. Transavia airlines provided the Dutch Safety Board 41 reports about erratic passenger distributions. Analysis of these reports reveals that the cockpit crews did not adhere to the reporting procedures regarding passenger loading errors. In particular, these cockpit crews did not use the forms designated to report safety related occurrences. As a consequence, other departments, than the Safety & Quality department, of Transavia airlines received these reports.

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[3] Report no. 2001053 (January 2004) Transportation Safety Board *Contact with propeller during start up of the* KLM Cityhopper Fokker 50, PH-KXM, Schiphol Airport on the 11th of may 2001; www.safetyboard.nl.
[4] Report no. I/1/04 of the Italian Agenzia Nazionale per la Sicurezza del Volo (ANSV) *Final report, serious incident occurred to Fokker 70, registration marks PH-KZH, Torino Caselle airport, 16 February 2002*; www.ansv.it.

Based on these findings, the Dutch Safety Board concludes that Transavia airlines' cockpit crews did not recognize the erratic passenger distribution as a meaningful, and, therefore, safety-related deviation.

The analysis of 23 similar flights[5] confirms Transavia airlines' failing quality system. The fact is that these analyses reveal that in none of the 23 cases, seat assignments occurred in accordance with Transavia airlines' own load and balance procedures. Moreover, although this was obligatory, Transavia airlines' management did not receive any reports about these deviant passenger distributions. As a result, Transavia airlines management was not informed about these deviations, and, consequently, could not take corrective measures. From this the Dutch Safety Board concludes that several of Transavia airlines' pilots were unaware of the substantial effect of the passenger distribution on the Boeing 737-800's centre of gravity (and controllability).

The investigation process

To promote the transparency of the process of investigation, the Dutch Safety Board would like to make two notices. The first notice is about the length of the investigation. The investigation of this occurrence by the Dutch Safety Board should be conceived as an iterative process in which the formulation of research hypotheses, the collection of information and the subsequent analysis relieve each other. Initially, based on the first available information, this iterative process was directed at other possible causal factors than described above. After new information refuted the initial research hypotheses, the direction of the investigation was adjusted. As a result, the Dutch Safety Board had to conduct a part of the investigation once again. The fairly long duration of the investigation can be attributed to this adjustment.

The second notice involves the cooperation and responses during the investigation process of the parties involved. The Dutch Safety Board would like to thank Transavia airlines and Aviapartner for their cooperation and critical responses on the draft report. In this respect, it should be pointed out that Transavia airlines disagrees with the Dutch Safety Board on a number of the above-described conclusions. Transavia airlines' disagreement relates, in particular, to paying too little attention during the investigation to the role of Aviapartner and the captain. Furthermore, Transavia airlines criticises the composition of the report, the analysis of the 23 flights and the lack of attention that is paid in the report to the role of human factors.

[5] Those 23 flights of Transavia Airlines made, like the occurrence flight under consideration, an intermediate stop at Maastricht Aachen Airport.

RECOMMENDATIONS

transavia.com is recommended to:

- Enhance its pilot's awareness about the effect of passenger distribution on the centre of gravity of Boeing 737-800 aircraft, and
- Evaluate its quality system, in particular regarding the:
  - supervision on contracted ground handling companies;
  - results of audits, and the effectiveness of associated corrective actions;
  - procedures about reporting safety-related occurrences.

Aviapartner is recommended to:

- Improve its quality system as such that shortcomings regarding the dispatch of passengers become visible.

The Minister of Transport, Public Works and Water Management is recommended to:

- Orchestrate the draft of quality and safety regulations for ground handling companies by the European Aviation Safety Agency (EASA).

Prof. mr. Pieter van Vollenhoven
Chairman of the Dutch Safety Board

mr. M. Visser
General Secretary

SYNOPSIS

During take-off from runway 24 at Rotterdam Airport a Transavia airlines Boeing 737-800 pitched nose-up just after take-off thrust had been selected. The pitch up movement stopped when the aft fuselage and the tailskid assembly contacted the runway. The crew rejected the take-off, after which the aircraft's nose came down again to the ground.

LIST OF ABBREVIATIONS

AAIB	Air Accidents Investigation Branch	Engelse autoriteit voor luchtvaartongevallen onderzoek
AIG	accident investigation group	ongevalonderzoeksgroep
ALPA	airline pilots association	vereniging van verkeersvliegers
AOC	air operator certificate	vergunning tot vluchtuitvoering
ASM	Airport Service Manual	grondafhandelingshandboek
ASR	air safety report	vliegveiligheidsrapport
ATC	air traffic control	luchtverkeersleiding
ATPL(A)	airline transport pilot licence (aeroplane)	bewijs van bevoegdheid als verkeersvlieger (vleugelvliegtuigen)
BASIS	British Airways Safety Information System	databank voor opslag van veiligheidsrapporten
BFU	Bundesstelle für Flugunfalluntersuchung	Duitse autoriteit voor luchtvaart-ongevallenonderzoek
BKN	broken (5/8 till 7/8 cloud coverage)	gebroken (5/8 tot 7/8 wolkenbedekkingsgraad)
BOM	Basic Operating Manual	standaard vluchtuitvoeringshandboek
BR	mist	nevel
CA	cabin attendant	cabinepersoneelslid
CAA	Civil Aviation Authority	burgerluchtvaartautoriteiten
CAR	corrective action report	rapport inzake aanpassingsmaatregelen
CD-ROM	compact disc - read only memory	compact disc - read only memory
CG	centre of gravity	zwaartepunt
CPL(A)	commercial pilot licence (aeroplane)	bewijs van bevoegdheid als beroepsvlieger
CRM	crew resource management	crew resource management
CSM	Cabin Safety Manual	cabineveiligheidshandboek
CV	limited partnership	commanditaire vennootschap
CVR	cockpit voice recorder	cockpit geluidsopname apparatuur
DSB	Dutch Safety Board	Onderzoeksraad voor Veiligheid
DTSB	Dutch Transport Safety Board	Raad voor de Transportveiligheid
EHAM	Amsterdam Airport Schiphol [ICAO code]	Amsterdam Airport Schiphol [ICAO code]
EHBK	Maastricht-Aachen Airport [ICAO code]	Maastricht-Aachen Airport [ICAO code]
EHRD	Rotterdam Airport [ICAO code]	Rotterdam Airport [ICAO code]
FDR	flight data recorder	vluchtdatarecorder
FEW	few (1/8 till 2/8 cloud coverage)	weinig (1/8 tot 2/8 wolkenbedekkingsgraad)
FMC	flight management computer	vluchtbeheer computer
F/O	first officer	eerste officier
GCRR	Arrecife, Lanzarote Airport [ICAO code]	Arrecife, Lanzarote Airport [ICAO code]
IATA	International Air Transport Association	internationale luchtvaart associatie
ICAO	International Civil Aviation Organization	internationale burgerluchtvaart organisatie
ILS	instrument landing system	blindvliegnaderingssysteem
IVW-DL	Dutch Civil Aviation Authority	Inspectie Verkeer en Waterstaat, Divisie Luchtvaart
JAA	Joint Aviation Authorities	gemeenschappelijke Europese luchtvaart-autoriteiten
JAR-OPS 1	Joint Aviation Requirements –operations (commercial air transportation)	regeling inzake commercieel luchtvervoer, opgesteld door de JAA
kg	kilogram	kilogram
KLM	Royal Dutch Airlines	Koninklijke Luchtvaart Maatschappij
KNMI	Royal Dutch Meteorological Institute	Koninklijk Nederlands Meteorologisch Instituut
kt	knot(s)	knopen (1 kt is 1,852 km/u)
lb	pound	pond (0,45 kg)
LIDO	Lufthansa Integrated Dispatch Operation	Lufthansa Integrated Dispatch Operation
LMC	last minute change	beladingswijziging kort voor vertrek
LT	local time	plaatselijke tijd
LTS	load and trim system	beladings- en trim systeem
MAC	mean aerodynamic chord	gemiddelde vleugelkoorde
METAR	meteorological aerodrome report	luchthaven weerbericht
MHz	megahertz	megahertz

nm	nautical mile	zeemijl (1852 meter)
NTSB	National Transportation Safety Board	onderzoeksinstantie voor transportongevallen van de Verenigde Staten
PA	passenger address	omroepsysteem in cabine
PDC	passenger distribution card	kaart inzake passagiersverdeling
PF	pilot flying	bestuurder
PM	performance manual	prestaties handboek
PNF	pilot not flying	assisterende bestuurder
QNH	pressure setting to indicate elevation above mean sea level	atmosferische druk op het aardoppervlak, herleid tot gemiddeld zeeniveau in de ICAO-standaard atmosfeer
RPM	revolutions per minute	omwentelingen per minuut
RvTV	Dutch Transport Safety Board	Raad voor de Transportveiligheid
SCT	scattered (3/8 till 4/8 cloud coverage)	verspreid (3/8 tot 4/8 wolkenbedekkingsgraad)
SPL	Amsterdam Airport Schiphol (IATA code)	Amsterdam Airport Schiphol (IATA code)
UTC	universal time co-ordinated	gecoördineerde wereldtijd
V_1	take-off decision speed	kritische snelheid voor besluitvorming om de start af te breken
VHF	very high frequency	very high frequency
VNV	Dutch Airline Pilots Association	Vereniging van Nederlandse Verkeersvliegers
ZFW	zero fuel weight	totaalgewicht zonder brandstof

1 FACTUAL INFORMATION

Location	: runway 24 at Rotterdam Airport
Date and time	: January 12th 2003, 1407 hrs UTC[6]
Type of aircraft	: Boeing 737-800
Registration	: PH-HZB
Operator	: Transavia airlines C.V.
Crew/passengers	: 7/113
Type of flight	: commercial air transport, passengers
Flight phase	: take-off
Classification	: serious incident
Type of occurrence	: tail strike during take-off

1.1 HISTORY OF THE FLIGHT

On January 12th 2003, PH-HZB, a Boeing 737-800 passenger aircraft was scheduled for a three leg charter flight from Rotterdam Airport (EHRD) via Maastricht-Aachen Airport (EHBK) and Arrecife, Lanzarote Airport (GCRR) to Amsterdam Airport Schiphol (EHAM). Scheduled departure time for flight HV1277 from Rotterdam to Maastricht was 1400 hrs. The flight had an air traffic control (ATC) departure restriction (slot time) of 1410 hrs. The scheduled arrival time at the end of the schedule at Amsterdam was 0030 hrs on January 13th. The crew reported for duty at 1145 hrs at Transavia airlines flight dispatch in the main office at Amsterdam where the flight preparation took place. A briefing and documents for the flights were received, including computer generated load and trim sheets[7] (see appendix A), for all legs to be flown. A total of 114 passengers was used for the flight preparation of the first leg. At this stage the cockpit crew made the decision to take additional fuel at Rotterdam to enable a quicker turnaround at Maastricht.

The crew consisted of a captain, a first officer (F/O) and five cabin attendants. It was the first day of a work cycle for the pilots. They had been off duty for several days (captain two days, F/O one week). Both pilots and four cabin attendants travelled to Rotterdam by taxi and arrived at Rotterdam 55 minutes before the scheduled departure time. One cabin attendant reported at Rotterdam. After arrival at Rotterdam the crew continued directly to the aircraft parked on the apron in front of the terminal.

A Transavia airlines technician, based at Rotterdam, carried out the pre-flight inspection. The aircraft was released to service without technical complaints. Some ice was observed on sections of the wings. The pilots expected that the ice would melt when adding additional fuel at Rotterdam. However, the ice remained on the wings after refuelling and therefore the aircraft was de-iced.

The F/O stated that the captain had a minor argument with an employee of the ground handling company about the de-icing process, because the employee had stated that de-icing could not be finished before the scheduled departure time.
The purser stated that the captain wanted to depart on time and that it seemed as if he was in a hurry. She also stated that this could have been the result of previous experiences with the ground handling company. During the post occurrence interview the captain stated that he was not in a hurry.

According to post occurrence interviews with both pilots, the atmosphere in the cockpit was good and the co-operation between them was friendly and professional. This was confirmed by cockpit voice recorder (CVR) data. Both pilots stated that they were well rested and fit for duty.

Aviapartner, a ground handling company, was contracted by Transavia airlines at Rotterdam from December 10th 2002.
Aviapartner Passenger Services personnel at Rotterdam had planned the passenger distribution the previous day. It was common practice for multi leg flights that planning was done in consultation with the ground handling company at the next station. According to the Passenger Services personnel the planning, for the flight under consideration, was done such that passengers were seated starting from

[6] All times in this report are universal time co-ordinated (UTC) unless otherwise specified. At the time of the occurrence, local time (LT) at Rotterdam Airport was UTC + 1 hour.
[7] Those load and trim sheets were produced by a Transavia airlines designed load and balance software program which uses figures (e.g. aircraft weight, pantry cabin code, number of passengers, planned baggage weight) automatically downloaded from the flight planning system LIDO (Lufthansa Integrated Dispatch Operation).

the rear of the cabin to keep the front seats empty in order to facilitate boarding at Maastricht. The computer generated load and trim sheet used by the crew assumed the passengers to be equally spread throughout the cabin. One hundred and thirteen passengers boarded the aircraft for the flight to Maastricht. An Aviapartner load controller informed the cockpit crew verbally about the actual passenger count and the weight and distribution of the baggage. Because the load and trim sheet stated 114 passengers instead of the actual 113 passengers on board, it was altered to the actual number of passengers. The baggage figures were also changed from 1,792 kg to the actual 2,021 kg on board. A copy of the load and trim sheet was handed to the ground handling staff.

The purser stated during the post-occurrence interview that she had counted the passengers and noted that four passengers were seated in the first row while the remaining passengers were seated primarily in the aft part of the cabin, after row thirteen. She reported this to the cockpit crew. According to her the captain subsequently looked into the cabin from his position in the cockpit and took no further action. According to the captain the purser had mentioned that the passengers were seated from row eleven and aft. There was no reaction from the F/O to the remark of the purser. The purser stated also that this was the first time she experienced that passengers were seated from row thirteen and aft without reseating them.

After all passengers had boarded the aircraft, doors were closed at approximately 1357 hrs. The F/O performed the pilot flying (PF) duties from the right hand seat whilst the captain performed the pilot not flying (PNF) duties. After the engines were started the aircraft taxied to runway 24, flaps 5 were selected and the pilots completed preparations for take-off. The F/O stated that the taxi-out was uneventful and that the only notable event was that the nose wheel skidded for a moment when the aircraft lined up on the runway. His explanation was that he had turned the tiller too quickly.

At 1407 hrs the take-off was initiated. The cockpit crew stated that when the aircraft started to roll, the nose immediately pitched up. The movement stopped when the aft fuselage and the tailskid assembly contacted the ground. See appendix B.

CVR data revealed that the captain instructed the F/O to reject the take-off. The thrust levers were pulled back and brake pressure was applied causing the aircraft's nose gear to touch the ground again. The captain informed ATC that the take-off had been rejected. After the aircraft came to a complete stop the parking brake was set and a call "cabin crew remain seated" was given by the captain. The captain requested the fire brigade to inspect the aircraft. The purser came to the cockpit. CVR data revealed that both pilots expressed their uncertainty about what had caused the pitch up movement. The purser mentioned that she thought that the aircraft might be too heavy in the rear. She asked the captain to inform the passengers via the passenger address (PA) system about the presence of the fire brigade trucks. After the captain had done this the purser informed the passengers again to be sure that everybody had understood the message from the captain.

CVR data revealed that at a later stage the purser came to the cockpit again and told the captain that she had informed him earlier that four passengers were seated in the first row and the remaining passengers were seated aft from row twelve/thirteen. CVR data also revealed that the captain acknowledged that the purser had informed him about the passenger seating.

After the fire brigade had inspected the aircraft no fire or fire hazard was observed. The aircraft taxied back to the apron and the engines were shut down.
After the passengers had left the aircraft, the captain and the purser debriefed the passengers in the terminal. Thereafter the captain arranged a debriefing for the entire crew.

The pilots stated in the post occurrence interview that during and immediately after the occurrence they had no idea what had caused the pitch up movement of the nose of the aircraft. During the post occurrence interview the F/O described the event as an aggressive nose up movement.

1.2 INJURIES TO PERSONS

There were no injuries to persons.

1.3 DAMAGE TO THE AIRCRAFT

The aircraft sustained damage to the lower fuselage area in front of the tailskid, to the tailskid and to the nose gear. The damage was initially assessed by the Transavia airlines technical department at Rotterdam and at a later stage by a Boeing survey team in co-operation with the Transavia airlines technical department. The nose landing gear had a small impact mark on the inner cylinder of the shock strut. A small dent was also found in the aft bulkhead.

The wear shoe of the aircraft was found at the beginning of runway 24. The four bolts of the wear shoe were detached from it. See appendix B for the position of the wear shoe on the tail skid of the Boeing 737-800.

1.4 OTHER DAMAGE

Nil.

1.5 PERSONNEL INFORMATION

1.5.1 Captain

Status	Dutch; male; age 33; joined the airline February 1996 and was promoted to captain in May 2001
Licence	JAR ATPL(A)
Aircraft Rating	B737-300 t/m 900
Proficiency check	August 9th, 2002
Latest CRM training	August 9 th, 2002
Medical Certificate	Valid class 1, last check: March 7 th, 2002
Flying experience	total: 5,130 hours
	B737-800: 1,450 hours
	B737-800 as captain: 1,020 hours
Last 90 days	135 hours
Last 24 hours	None

Table 1: Personnel information captain

1.5.2 First officer

Status	Dutch; male; age 28; joined the airline December 2001
Licence	JAR CPL(A)
Aircraft Rating	B737-300 t/m 900
Proficiency check	November 12 th, 2002
Latest CRM training	November 12 th, 2002
Medical Certificate	Valid class 1, last check: December 28 th, 2002
Flying experience	total: 2,038 hours
	B737-800: 555 hours
	B737-800 as first officer: 555 hours
Last 90 days	93 hours
Last 24 hours	None

Table 2: Personnel information first officer

1.5.3 Purser

The purser had been in service with Transavia airlines since 1986. She was promoted to purser in December 1987. She worked with KLM passenger handling for some time after that date. In 1990 she returned to her position as purser with Transavia airlines. At the time of the occurrence she was rated on the B737-700/800 and the B757.

The purser received her latest crew resource management (CRM) training on November 5th 2002.

1.6 AIRCRAFT INFORMATION

1.6.1 General

Type	Boeing 737-800	
Year built	1998	
Registration	PH-HZB	
Serial Number	28374	
Seat layout	184 seats	
Engines	2 X CFM56-7 27k (27,000 lb thrust rating)	
Overall length	39,47 meters	
Certificate of registration	5578	Issued on June 19th 1998
Certificate of airworthiness	5578	Valid up to and including September 19th 2003

Table 3: General aircraft information

The aircraft had a valid certificate of airworthiness and a valid maintenance release to service.

PH-HZB has a total of 31 seat rows. To facilitate the calculation of the position of the centre of gravity (CG)[8], the passenger cabin is divided into four sections, OA, OB, OC and OD. See also appendix C. At the time of the occurrence the division between the sections was not visibly apparent in the cabin. The Boeing 737 has two lower cargo compartments. A forward cargo compartment, which is divided in hold #1 and hold #2 and an aft cargo compartment consisting of hold #3 and hold #4. The PH-HZB was not equipped with a CG self-sensing system[9].

The Boeing 737-800 was introduced within Transavia Airlines on June 17th 1998.

1.6.2 Weights of PH-HZB

Basic weight	41,840 kg
Basic index	43,8
Maximum take-off weight	78,975 kg
Maximum landing weight	66,360 kg
Maximum zero fuel weight	62,731 kg

Table 4: Aircraft weights

1.7 DOCUMENTATION

1.7.1 Applicable manuals

Particular instructions mentioned in Transavia airlines manuals are related to load distribution. The applicable manuals are:

- Basic Operating Manual (BOM);
- Cabin Safety Manual (CSM);
- Airport Service Manual (ASM);
- Handbook cabin personnel.

The BOM, CSM and ASM are part of the Transavia airlines Operations Manual[10].

A short description of the applicable manuals together with the relevant articles or procedures is presented below.

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[8] The centre of gravity (CG) indicates the point of application of the overall aircraft weight. For balance calculations it is assumed to be on the longitudinal axis. The CG must remain within the limits, defined by the manufacturer. The distance between the forward and aft limits is referred to as the allowable CG range. The position of the CG of the loaded aircraft is determined by the CG of the empty aircraft and by the loading.

[9] Some aircraft like the Boeing 747-400 offer systems that automatically sense the weight and CG of the aircraft. With a self-sensing system on the aircraft the crew must compare the sensed CG to the calculated CG from the load and trim sheet and resolve any differences.

[10] The Transavia airlines Operations Manual consists of the following parts which form one integrated documentation system: Basic Operations Manual, Boeing Aircraft Operations Manual, Route Operations Manual and Jeppesen Airway Manual, Training Manual, Cabin Safety Manual part A and part B, Airport Service Manual and Security Manual.

Basic Operating Manual (BOM)
The BOM is issued to cockpit personnel and describes the general/basic Transavia airlines operating standards. It specifies requirements, limitations and directives which may either be prescribed by the authorities or are based on company policies.

The BOM states: *a load and trim sheet must be made for all line and charter flights and must be carried on board.* This can be a computer generated or a manual load and trim sheet. The computer generated load and trim sheet may be used if all figures on it and the assumed load distribution are in accordance with the actual situation. The crew may prepare a manual load and trim sheet as a substitute for contingencies in the computer load and trim sheet data.

The BOM states: *after boarding the captain will receive the final figures from the Transavia ground staff at SPL or from the handling agent at outstations. The load and trim sheet must be corrected for these changes. If the final figures indicate a difference of greater than 1000 kg, a new load and trim sheet must be prepared.* It also states: *the load and trim sheets in use, computer and manual, assume equal distribution of passengers within each cabin section.*

With regard to passenger distribution the BOM states: *before take-off, as soon as possible after embarkation, the purser will verify that passengers are evenly distributed in the cabin as applicable for the aircraft. The purser shall report discrepancies to the cockpit crew. The cockpit crew will verify that the seating of the passengers corresponds with the seating assumptions and will consider the effect of deviations (it may be necessary to reseat passengers).*

A copy of the load and trim sheet, signed by the captain must be deposited with the company's designated representative or handling agent at the airport of departure. For both the manual and computer load and trim sheet the captain shall ascertain that the figures on it are checked and that they are acceptable before signing for compliance with BOM 1.4, "authority, duties and responsibilities of the captain". This paragraph states also: *the captain shall take all reasonable steps to ensure that the aircraft weight and balance is within limits.*

Cabin Safety Manual (CSM)
The CSM is issued to cabin personnel. It prescribes: *in case of a lesser number of passengers than a full load, the purser shall assure that passengers are seated in such way that the passenger weight will be equally spread throughout the cabin (uniform longitudinal distribution).* During the investigation Transavia airlines stated that 'equally spread' is understood to mean an equal distribution of the passengers over the length of the aircraft and within each cabin section. The CSM also states that: *a non equally spread passenger distribution does not correspond with the mass and balance information (load and trim sheet) used by the captain.*

Airport Service Manual (ASM)
The ASM is issued to the contracted handling agents in order to enable such organizations to comply with the rules and regulations of Joint Aviation Requirements Operations (JAR-OPS 1)[11] and with additional Transavia airlines policies intended to ensure the safety of operation.

The ASM states: *seats shall be issued in such a way that an equally spread cabin distribution is obtained.* Passengers shall be distributed according the passenger distribution table of the Boeing 737-800 as published in the ASM (see appendix D). The ASM does not give an allowable deviation from the passenger figures per cabin section. At the time of the occurrence the ASM prescribed a standard load distribution of 20% of the baggage in hold #2 and 80% in hold #3 for the B737-800 aircraft. The captain may decide to deviate from the standard load distribution when circumstances so dictate.

According the ASM the actual number of passengers and baggage shall be presented on a document by the ground handling company to the captain and purser prior to the flight. This document, the flight crew information sheet, shall be signed by the person supervising the loading.

The ASM states: *the handling agent shall ensure (on behalf of Transavia) that all relevant ground operations personnel will be trained, examined, checked and kept proficient to the required standard. General familiarization training about the content of the Transavia ASM shall be given to all relevant*

[11] JAR OPS 1 prescribes requirements applicable to the operation of any civil aircraft for the purpose of commercial air transportation by any operator whose principal place of business and, if any, its registered office, is in a Joint Aviation Authorities (JAA) member state.

ground operations personnel.

Handbook cabin personnel
This handbook is issued to cabin personnel and contains information regarding service in the cabin and general directives. It describes in part 2 that, for boarding in case of an incomplete passenger occupation, the purser must ask the captain how the passengers should be distributed in the cabin[12].

1.7.2 Load and trim sheet
The Transavia airlines load and balance software program uses the passenger distribution tables (see appendix D) as an input. This passenger distribution table is based on an equal spread of the passengers throughout the cabin. The program also assumes a fixed distribution of the baggage over the forward and rear cargo holds. The load and trim sheet is based on the planned number of passengers[13].

The computerized load and trim sheet shows:
- the number of passengers per cabin section;
- the front and aft CG limits;
- the CG positions as MAC[14] % for the planned take-off, zero fuel and landing weight.

Before departure, at the Transavia airlines flight dispatch in the main office at Amsterdam, cockpit crews obtain printed copies of the computerized load and trim sheet for all legs to be flown.

If required, the cockpit crew adjusts the load and trim sheet with the actual passenger and baggage data. This data is obtained from a load controller.

Before departure the purser verifies the actual passenger seating and reports discrepancies to the captain who decides whether action has to be taken or not.

1.7.3 Aircraft weight and centre of gravity
The aircraft weight and the position of the centre of gravity (CG) are essential figures in the operation of aircraft. The combination of the two is generally referred to as weight and balance. The weight is important for performance reasons and the position of the CG (balance) is related to the controllability and stability of aircraft. For airliners the longitudinal CG position is an input for the stabilizer setting.

1.8 FLIGHT PREPARATION

General
In the operation of Transavia airlines the load and trim sheet for all flights is based on assumed loading data and is generated in Amsterdam before loading the aircraft. One of the assumptions is that passengers are equally spread over the cabin.
At each place of departure the actual loading of the aircraft has to be done according to the loading assumptions as stated in the ASM. Actual loading and planned loading are compared for the first time in the cockpit, after the passengers have boarded. As indicated by Transavia airlines, one of the reasons for using this system is that many ground handling organisations at the various destinations are not well equipped for the production of load and trim sheets.

Requirements for weight and balance calculations as part of the flight preparation are given in JAR-OPS 1, subpart J, 'mass and balance'. Relevant paragraphs are shown in appendix E. BOM 8.1.8 'Mass and Center of Gravity' describes the principles and methods involved in the loading and in the mass and balance as required by JAR-OPS 1.

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[12] The procedures with regard to passenger distribution were removed from the handbook cabin personnel in October 2004.
[13] Beside this system, which uses the planned passenger numbers, there is also a system which uses the **actual** passenger seating and baggage distribution for the calculation of the CG and then produces a computer generated load and trim sheet. This system, which uses the actual figures, is not used by Transavia airlines.
[14] The mean aerodynamic chord (MAC) is a theoretical mean chord of the wing and is used to express the longitudinal position of the CG. The position is given as a percentage of the MAC, from the wing leading edge.

Figures used in the computer generated load and trim sheet
In the computer generated load and trim sheet, obtained by the cockpit crew in Amsterdam, the planned number of 114 passengers plus the standard baggage per passenger were used.

The planned (as printed on the load and trim sheet) and actual number of passengers per cabin section are depicted in the table below.

cabin section/row numbers	number of available seats	adults *planned/actual*	children *planned/actual*	infants *planned/actual*	total *planned/actual*
OA (1-7)	42	25 / 4	1 / 0	0 / 0	26 / 4
OB (8-15)	46	27 / 13	1 / 0	1 / 0	29 / 13
OC (16-23)	48	28 / 43	1 / 3	1 / 2	30 / 48
OD (24-31)	48	28 / 47	1 / 1	0 / 0	29 / 48
				total:	114/113

Table 5: Planned and actual distribution numbers of passengers

Following are values on the load and trim sheet, as it was prepared:

Planned zero fuel weight	53,130 kg
Take-off fuel	8,100 kg
Planned take-off weight	61,230 kg
Planned take-off MAC	24,8%

Table 6: Values on the computer generated load and trim sheet

The computerised load and trim sheet indicated a front and aft limit of the MAC for take-off of 9% respectively 29.2%.

Last minute changes
The actual number passengers was 113 (46 males, 61 females, 4 children and 2 infants). The number of baggage pieces, as counted by Aviapartner, was 118 with a total weight of 2,021 kg. These values were used by the cockpit crew in the LMC (last minute change) box on the load and trim sheet resulting in an actual zero fuel weight (ZFW) of 53,283 kg. The difference between this actual ZFW and the planned ZFW, as printed on the load and trim sheet (53,130 kg), was 153 kg. A flight crew information sheet was neither provided nor asked for by the cockpit crew.

Figures determined during the investigation by the Board
After the occurrence all luggage was offloaded and weighed. The total of the luggage from hold #2 was 364 kg for 21 bags and buggies. The total of the luggage from hold #3 was 1,550 kg for 97 bags. Aviapartner provided the passenger seat assignment of flight HV1277. See appendix C.

With these figures and using standard passenger weights, the take-off weight was calculated as: 61,276 kg.

The planned baggage weight, the baggage weight as provided to the cockpit crew by Aviapartner and the actual baggage weight (as weighed after the occurrence had taken place) are depicted in the table below.

Cargo hold	Weight *planned*	Weight *as provided by Aviapartner*	Weight *Actual*
1	0 kg		0 kg
2	358 kg	2,021 Kg	364 kg
3	1,434 kg		1,550 kg
4	0 kg		0 kg

Table 7: Baggage weights

The CG of the aircraft at take-off was obtained by completing manually a load and trim sheet. Extrapolating outside the CG envelope gave a value of approximately 41% MAC, as shown in appendix

F. The figure in appendix F shows that the CG (at take-off) was well behind the aft CG limit for take-off. Calculations by Boeing gave a CG value of 41.7% MAC. Calculations by Transavia airlines, using the airlines' load and trim sheet program, gave a CG value of 40.8% MAC[15].

1.9 METEOROLOGICAL INFORMATION

The meteorological aerodrome report (METAR) of Rotterdam was obtained from the KNMI and is presented below:

Station	Observation time	Wind	Visibility	Weather	Clouds	Temp/ Dewpoint	QNH
EHRD	1325hrs	220/10	8000	-	SCT022 BKN220	02/00	1032
EHRD	1355hrs	220/12	8000	-	FEW018	03/00	1032
EHRD	1425hrs	220/11	7000	BR	FEW018	02/00	1032

Table 8: METAR information of Rotterdam

1.10 AIDS TO NAVIGATION

Not applicable.

1.11 COMMUNICATIONS

The following very high frequency (VHF) frequencies (in MHz) were in use when the occurrence occurred:
"Rotterdam Ground" : 122.175
"Rotterdam Tower" : 118.200

1.12 AERODROME INFORMATION

Rotterdam Airport is situated 2.8 nm north-northwest of the city of Rotterdam. The airport has one runway (06/24) with a take-off distance of 2200 meter and a width of 45 meter. Runway 24 is equipped with an instrument landing system (ILS).
The elevation of the airport is -15 feet.

1.13 FLIGHT RECORDERS

A solid state flight data recorder (FDR) and a cockpit voice recorder (CVR) were removed from the aircraft after the occurrence.

The FDR data was copied from the recorder to a CD-ROM. The raw data was subsequently converted into engineering format for the parameters specified by the investigators.
The installed CVR is an audio recorder with a 30 minutes duration continuous-loop magnetic tape, recording four tracks. CVR data of the occurrence was available for investigation and a transcript was made.

1.14 WRECKAGE AND IMPACT INFORMATION

Not applicable.

[15] The exact difference with the value calculated by Boeing could not be explained by either party.

1.15 MEDICAL AND PATHOLOGICAL INFORMATION

Not applicable.

1.16 FIRE

There was no fire.

1.17 SURVIVAL ASPECTS

Not applicable.

1.18 TESTS AND RESEARCH

Not applicable.

1.19 ORGANISATIONAL AND MANAGEMENT INFORMATION

In this chapter an investigation of dispatch records of similar flights as the flight under consideration, is described. Thereafter the quality system, the flight safety program and the internal audit system of the airline are discussed. The chapter ends with a description of the ground handling activities by Aviapartner and the supervision of the airline by the CAA of the Netherlands.

1.19.1 Transavia airlines

Transavia airlines[16] provides air transport for charter flights and scheduled services on a route network from its home bases Amsterdam and Rotterdam and from regional airports.

1.19.2 Investigation of dispatch records

To determine whether the occurrence under investigation was an isolated case or not, dispatch records of similar flights were investigated. These records were made by the ground handling company, responsible for the ground handling of Transavia airlines at Maastricht. Special attention was given to the seat assignments. The period from December 15th 2002 till up to March 3rd 2003 was chosen. A total of 12 flights originating from Amsterdam and 11 flights from Rotterdam with an intermediate stop at Maastricht and continuing to the Canary Islands were analysed. Those flights included all Transavia airlines multi leg flights that departed from Rotterdam and Amsterdam (which made an intermediate stop at Maastricht) during the chosen period. It was checked whether the seat assignment at the departure aerodromes was done according to the passenger distribution table in the ASM.

A survey is given in appendix G. The 23 above-mentioned flights and the incident flight under consideration are arranged in chronological order. The table shows:

- A seat assignment exactly according the passenger distribution table did not take place for any of the investigated flights;
- One flight (number 15) had all deviations below 10 percent (seat assignment almost according the passenger distribution table);
- For three flights, from which two originated from Rotterdam, the calculated MAC take-off value[17] was behind the aft limit. See table 9;
- Two of the three flights, of which the calculated MAC take-off value was behind the aft limit, took place after the occurrence had taken place (of which one was at Rotterdam). See table 9;

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[16] On January 1st 2005 the new brand name transavia.com was introduced.

[17] For the determination of the MAC take-off value, using the airlines' load and trim sheet program, the following figures were used: the basic weight and the basic index of the aircraft involved, a standard load distribution (20/80), the planned transit baggage, the take-off fuel, a catering index of 0.1, a passenger weight of 84 kg and a passenger distribution according to the seat assignments.

- After the date of the occurrence incorrect seat assignments took place, despite the actions taken by Transavia airlines. See paragraph 1.20.3;
- Incorrectly spread seat assignments were found both for flights originating from Rotterdam and from Amsterdam.

It could not be determined whether the flights actually had departed with an incorrect spread of passengers. No air safety reports, trip reports or flight reports (see 1.19.4) were received by the Safety & Quality Assurance department for those flights regarding the incorrect spread of passengers.

In the table below the four flights, including the occurrence flight under consideration (printed bold and in italics), are depicted for which the calculated MAC take-off value was behind the aft limit [18].

Departure	Date	MAC take-off (%)	Aft MAC take-off limit (%)
EHRD	29.12.2002	30.8	27.2
EHRD	***12.01.2003***	***40.8***	***29.4***
EHRD	16.02.2003	29.1	28.0
EHAM	24.02.2003	34.8	29.4

Table 9: Flights with a MAC take-off value behind the aft limit

1.19.3 Quality System

General
JAR-OPS 1.035 (a) requires Transavia airlines to have implemented a Quality System: *an operator shall establish one Quality System and designate one Quality manager to monitor compliance with, and the adequacy of procedures required to ensure safe operational practices and airworthy aeroplanes. Compliance monitoring must include a feed-back system to the accountable manager to ensure corrective action as necessary.*

JAR-OPS 1.035 (b) requires Transavia airlines to have implemented a Quality Assurance Programme: *The Quality System must include a Quality Assurance Programme that contains procedures designed to verify that all operations are being conducted in accordance with all applicable requirements, standards and procedures.*

A quality system and quality assurance programme, as described in JAR-OPS 1, were implemented. The relevant parts of the quality system are described in various manuals. The airline did not have a separate Quality manual.

Responsibility for the subcontracting ground handling company in Rotterdam
Inspection of ground handling companies is arranged by JAR-OPS 1. JAR-OPS 1.175 'General rules for Air Operator Certification (AOC)' states: *The operator must have nominated post holders, acceptable to the Authority, who are responsible for the management and supervision of (amongst others) ground operations.*

JAR-OPS 1.175, appendix 2 'The management and organisation of an AOC holder' states: *An operator contracting other organisations to provide certain services, retains responsibility for the maintenance of proper standards. In such circumstances, a nominated post holder must be given the task of ensuring that any contractor employed meets the required standards.*

BOM, chapter 3, Quality System, item 3.3 describes the Transavia airlines quality assurance responsibilities for sub-contractors. It describes ground handling as one of the services, which is sub-contracted by Transavia airlines. It states: *when Transavia is using sub-contractors, the ultimate responsibility for the quality of the product or service, always remains with Transavia. Written agreements between Transavia and the sub-contactors clearly define the safety-related services and quality to be provided.* It also describes: *the sub-contractor's safety related activities relevant to the agreement will be included in the Transavia Quality Assurance Program.*

[18] This value was read out of the graphical part of the load and trim sheet.

Transavia airlines had nominated a post holder Ground Operations. In the BOM, chapter 1, Organization, item 1.2.8 states that the post holder Ground Operations is responsible for all ground operations of Transavia aircraft. The post holder shall:

- *arrange appropriate ground handling facilities to ensure safe handling of all flights;*
- *ensure that ground handling departments are staffed by trained personnel who have a thorough understanding of their responsibilities within the organisation;*
- *ensure that any contractor employed meets the required standard.*

1.19.4 Flight safety program

General
In accordance with JAR-OPS 1.037 Transavia airlines has established an accident prevention and flight safety programme. This programme includes an occurrence reporting system for crew members to enable the collection and assessment of reports in order to identify adverse trends or to address deficiencies affecting flight safety. The air safety report (ASR), the trip report and the flight report are forms that can be used by crew members to report occurrences.

Reporting procedure
A procedure for guidance in administrative reporting of occurrences is described in the BOM. The BOM states that *Incidents*[19] *shall lead to an Air Safety Report (ASR) being filed. Incidents which have been occurred in the cabin (reported to the purser by any of the cabin crew members) shall lead to an Air Safety Report (ASR) being filed by the purser. […] The filing of the report by the purser shall be communicated to the captain. The captain is exempted from filing the incident by signing the ASR drawn up by the purser.*
Occurrences not being an incident shall be filed by a trip report.

The reporting procedure in the BOM indicates: *a significant load sheet or (passenger) loading error or load insecurity must be reported to the company by an air safety report. ASRs are stored in the Transavia airlines occurrence reporting database BASIS.*

The reporting procedure in the CSM indicates: a *significant load sheet or (passenger) loading error or load insecurity* must be reported to the company by a flight report ("vluchtrapport") and an air safety report. The CSM also states that: *Occurrences not being an incident shall be filed by a "vluchtrapport"* (flight report). Flight reports have to be filled in by the cabin crew after each flight. These reports have the possibility to indicate, by ticking a box, that deviations took place from prescribed procedures regarding a list of subjects (purser briefing, crew transport, cleaning, catering, in-flight entertainment, boarding etc). Under the subject boarding, incorrect passenger distribution can be ticked. On the back of the report the deviation can be explained by a note.

Database reports
As part of the investigation, the database BASIS was searched to investigate whether occurrences regarding incorrectly spread passengers and subsequent reseating, ordered by the crew, had been reported before the date of the occurrence. One database report regarding an occurrence with a Boeing 737-800 was found. The ground handling agent abroad who was involved in this occurrence (that took place on November 9th 2002) had been contacted by the Ground Services department of Transavia airlines and was made aware of the instructions in the ASM.

Trip and flight reports
Transavia airlines handed over six trip reports and 35 flight reports to the investigation team. These reports referred to flights relating to incorrect passenger distribution in the period November 1st 2002 till March 31st 2003 (during which 7880 legs were flown by Transavia airlines). The trip reports were filed by cockpit crew members and the flight reports by cabin crew members. Procedures did not require trip and flight reports to be forwarded to the Safety & Quality Assurance department. The reports were therefore not stored in the database BASIS. Neither were ASRs received regarding those occurrences.

One trip report regarding a flight from Alicante with a Boeing 737-800 took place before the date of the occurrence. In this case passengers were reseated. In two of the other five trip reports reseating was mentioned as well.

[19] Definition of an incident according BOM 11.1.2: An occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation.

Nine of the 35 flight reports were filled in before the date of the occurrence of which in seven cases reseating of the passengers was reported. Of the 26 flights which took place after the occurrence, 13 cases of reseating were reported. One of the 35 flight reports concerned a three leg flight. In three reports it was mentioned that reseating took place in consultation with the cockpit crew.

Three occurrences were reported by both a trip report and a flight report.

1.19.5 Internal auditing by Transavia airlines

In accordance with the JAR-OPS 1.035 requirements and as part of its quality assurance program Transavia airlines has set up an internal audit schedule. All aspects of the operations are reviewed within every period of 12 months.
Observations, recommendations and findings of the audits are presented in an audit report to inform the responsible manager(s). If corrective actions are required, these findings are given in a Corrective Action Report (CAR).

According to Transavia airlines documentation *the CAR is a clear description of the finding, the reason of non-compliance against the requirement(s) and the seriousness of the finding in a level indication. The CAR is a form used per finding in order to have proper means between the responsible manager and the audit team, to keep track of the corrective actions taken by the responsible department and the response by the audit team.*
After receipt of the finding the responsible manager shall prepare an initial reply taking the response time frame into account. The lead-auditor shall comment on the proposal. Additional comments to the proposal may be made by the lead-auditor. The responsible manager shall give a final reply containing the corrective and if applicable preventive actions within the time frame applicable to the finding level. The audit team may close a CAR provided it is proven that the finding found is corrected and that sufficient measures are taken to prevent repeating.

On September 4th 2001 an audit was performed by the Safety & Quality Assurance department to observe the translation of JAR-OPS 1, subpart J, 'mass and balance', into Transavia airlines documentation.

Two relevant audit report findings, relating to distribution of passengers, are given below:

Finding FO-06-040901-01 stated:
It is not shown in the CSM B 1.1.1-4 towards which criteria the purser can verify if the passengers are evenly distributed as required in the BOM 8.1.8-4. It is also not clear if verification should be done per cabin section. The role of the purser is not clear in the BOM statement: ……the number of passengers actually must correspond with the final figures…….. (appendix 1 to JAR OPS 1.605 (d)(1)).
In the CSM the principles of mass and balance are not clearly described with respect to the tasks and responsibilities of cabin crew and the communication about this subject to the cockpit crew. (JAR OPS 1.610).
It is not shown in the CSM how the cabin crew should act in case of extreme passenger weight situations. (JAR OPS 1.620 (b)).

Finding FO-06-040901-02 stated:
It is not demonstrated that the number of passengers actually must correspond with the final figures of the actual distribution per cabin section. (BOM 8.2.2-3 and appendix 1 to JAR OPS 1.605(d)(1)).
It is not shown that the cockpit crew is able to check the assumption that the passengers are equally spread per cabin section and how to act in case of deviations. (JAR OPS 1.610).

The CARs following on the two findings mentioned above were analysed by the Board. They are depicted in appendix H. In the CARs the two corrective actions were declared closed. The corrective actions listed below had been implemented two months before the occurrence took place:

- On October 5th 2002 a temporary instruction for the CSM was issued in which the equally spread distribution of passengers was included as a condition for the 'cabin ok' message. This message must be given by the purser to the captain when the cabin is ready for departure;
- On November 18th 2002 the instruction was put, as an amendment, in the BOM and on December 15th 2002 in the CSM.

In these CARs no measures are mentioned to monitor the effectiveness of the corrective actions. There is no standard procedure for individual cases within Transavia airlines.

In CAR number FO-06-040901-01 reference is made to the LTS (load and trim system) project. This project focussed on the improvement of the management of the load and balance software program used by Flight Operations Engineering. The re-introduction of the graphical representation of the CG envelope on the load and trim sheet (as a result of the occurrence) was integrated in this project. No other relation with the occurrence is apparent in this project.

The de-icing/anti-icing process at Aviapartner in Rotterdam was audited on December 12th 2002. In that audit it was observed that the copy of the ASM, available at Aviapartner, was the one previously used by Servisair[20] and that it was outdated. An updated ASM copy was provided to Aviapartner.

1.19.6 Ground handling by Aviapartner

General
In the summer of 2002 Aviapartner[21] was selected to become the ground handling company for Transavia airlines at Rotterdam. A ground handling agreement was signed between Transavia airlines and Aviapartner on December 10th 2002 which became effective on the same day. The agreement stated that *the handling company acknowledges to have full understanding of the most recent version of the carrier's ASM and the IATA Airport Handling Manual and agrees to act accordingly*.

The task of Aviapartner is the ground handling of aircraft. Ground handling for Transavia airlines at Rotterdam included, amongst others, passenger- and baggage check-in, de-icing, baggage loading and offloading.

The Transavia Safety & Quality Assurance department normally performs a pre-assessment audit on newly contracted ground handling companies. Transavia airlines stated that no pre-assessment audit had been performed before the agreement with Aviapartner was signed, because:
- the airline already had experience with Aviapartner at Brussels airport and at several French airports;
- of the results of a benchmark and a study (of the Aviapartner organisation at Amsterdam) that had been performed;
- at the moment negotiations took place with the parent company of Aviapartner at the head office, Aviapartner did not operate at Rotterdam.

Start of Aviapartner operation
On November 25th 2002 a meeting was organized by Transavia airlines for Aviapartner personnel and was attended by some of its personnel. It was not compulsory to attend. During this meeting, which had an informative character and took about one hour, the product 'Transavia airlines' was introduced. According to the station manager of Aviapartner at Rotterdam the ASM was not discussed during the meeting. According to a Transavia airlines senior purchaser, who was one of the two hosts during the meeting, it was mentioned that the ASM is leading. The contents of it were not discussed in detail. The senior purchaser stated that:
- he was not sure if handouts had been distributed after the meeting;
- it is not his task (as a senior purchaser) to indicate which employees of a ground handling company have to be familiar with which part of the ASM;
- it is not his task to provide safety training or discuss safety related aspects with ground handling companies;
- according to him it is usual that ground handling companies train their own employees.

Several Passenger Services employees of Aviapartner used to work for Servisair before they joined Aviapartner and had experience with passenger handling activities. They stated in interviews performed by the aviation police that they had learned their activities by "on the job" training.

[20] Servisair was the predecessor of Aviapartner at Rotterdam airport and was providing ground handling services for Transavia airlines.
[21] transavia.com stated in a commentary on the second draft report that the report contains an extensive description of transavia.com's quality and safety management system, as well as analyses of their functioning in relation to the incident. By comparison, no description of the ground handler's organisation is provided at all. Consequently, transavia.com is of the opinion that it is not possible to place the (in)actions of ground handling employees and their management in perspective. The Board's view is that an operator has final responsibility for the safety of their crew members and passengers. However, a subcontractor has its own responsibility to have businesses in good order.

The former employees of Servisair had not been previously trained by Transavia airlines. Other Aviapartner employees used to work for the company at Amsterdam and some were newly hired. Most Passenger Services employees (of Aviapartner) were not familiar with the contents of the ASM. Two employees stated they had never seen the passenger distribution table in the ASM.
The following data was derived from statements given in interviews to the aviation police:

- the station manager of Aviapartner at Rotterdam stated that between December 10th 2002 and January 12th 2003 about four Transavia airlines flights were checked in with a similar seat assignment as the flight on January 12th 2003;
- the lead agent (passenger handling employee) who made the seat assignment on January 11th for the occurrence flight stated that she had done that on her own without consulting colleagues. It was the first time she assigned seats on her own. She used the seat assignment of a previous flight (of two weeks ago) as example. Thereafter she sent the assignment proposal by telex to the ground handling company at Maastricht. The next day the seat assignment was checked by the lead agent who took over her duty;
- another lead agent, who started working on the morning of January 12th, confirmed that she had checked the seat assignment and had approved it, because it looked normal to her. She stated that four or five flights had been checked in with a similar seat assignment on Sundays between December 10th 2002 and January 13th 2003. She said that she had learned the 'trick' of assigning the seats this way in daily practice;
- the general director of Aviapartner stated that for practical reasons it seemed logical to him, that in view of the intermediate stop at Maastricht all passengers had been seated in the aft part of the cabin. He did not know that the lead agent had never performed this method of assigning seats before.

During a post occurrence interview by investigators of the Safety Board the station manager stated that Aviapartner provided an in-house Passenger Services training 'basic check' at Rotterdam in December 2002. The concept of equally spread passenger distribution was not a part of this training. He also stated that he was convinced that Aviapartner was ready to start providing ground handling services to Transavia airlines in December 2002.

The station manager stated that after the occurrence he became aware that Transavia airlines was using computer generated load and trim sheets which assumed the passengers to be equally spread throughout the cabin.
The load controller[22] who passed the actual passenger count and the baggage figures to the cockpit crew had not been working for Transavia airlines before. He was also not aware of the equally spread passengers concept being used by the airline.

On December 10th and 11th 2002 Ground Service Inspectors of Transavia airlines visited Rotterdam and assessed the ground handling. The focus of the assessment was on check-in procedures. In their report no particulars with regard to flight operation were mentioned.

1.19.7 Supervision by the CAA of the Netherlands

Audits/inspections by the CAA of the Netherlands
The Civil Aviation Authority (CAA) of the Netherlands monitors Transavia airlines regularly by performing audits within the organization and by inspecting simulator sessions and actual flights. The CAA is not inspecting ground handling companies regarding flight dispatch related activities, as the flight dispatch licence, as described in ICAO Annex 1 (Personnel Licensing) has not been implemented in the Netherlands.
In the year 2002, before the occurrence happened, one integral inspection (system audit), four training inspections (in flight simulators) and 14 inspection flights were performed with Transavia airlines.
The audit and inspection reports indicated no observations were found that could be linked to the occurrence.

Quality standards of ground handling services
In 2003 the quality standard of ground handling services at Amsterdam Airport Schiphol was assessed by the CAA in the Netherlands by means of a verification and approval measurement. The ensuing

[22] The Aviapartner load controller was responsible for the baggage loading and the hand over of the load figures to the Transavia airlines cockpit crew.

report[23] of the CAA indicates a lack of clear and specific regulations for ground handling services. This situation contrasts with the quality standards for technical handling and maintenance. In this field comprehensive regulations and procedures have been established and incorporated into legislation for the commercial aviation sector. In this respect adequate technical quality and safety standards are assured.
Since there is no legal basis for the certification of ground handling companies, no uniformity in quality and safety assurance of ground handling services exists. The safety of ground handling services therefore depends on the standards set by the airlines and the airport authorities. In this way safety standards could be affected by economical, environmental and occupational safety considerations. The CAA report concludes that the ability for self control of the ground handling sector is insufficiently assured, specifically with regard to operational and occupational safety.

Among other things it was found and stated in the report by the CAA of the Netherlands that the requirements for training and education of personnel are not consistent. This increases the risks for occupational safety deficits.
High staff turnover rates are typical for the ground handling sector. This aspect, as well as a continuous demand for savings on personnel and ground handling material, increases the safety risks.
The report contains relevant recommendations regarding:

- improvement of (JAR-OPS) legislation and regulations for ground handling;
- establishing of requirements for safety critical occupations;
- assumed (used) weights for 'weight and balance'.

The Board did not investigate if these recommendations had been carried out.

1.20 ADDITIONAL INFORMATION

1.20.1 Other CG related occurrences

Two similar occurrences with Boeing 737-800's, which were investigated by the Bundesstelle für Flugunfalluntersuchung (BFU) and the Swedish Accident Investigation Board, were considered.

The BFU in Germany investigated an occurrence which happened at Dortmund Airport in Germany on November 29th 2002. In this occurrence the tail of a Boeing 737-800 touched the runway during the take-off where after the crew rejected the take-off.
Due to the rear CG position to be expected in view of the load and trim sheet, the ramp agent had informed the captain that 10 passengers had to be moved from the rear to the front. This transfer was documented on the load and trim sheet but in fact the passengers remained on the seats they had been assigned by the passage department. There was no instruction to the cabin crew by the ramp agent. With the transfer of the passengers into compartment A, the CG position would have been within the allowable range even with the deviations found (no spare wheel, no correction for the catering, deviating masses in the front and the rear cargo compartments and incorrect entry for the total passenger mass). With the transfer of the passengers not accomplished, the CG position during the take-off of the Boeing 737-800 was far beyond the allowable rear limit.

The Swedish Accident Investigation Board investigated an occurrence which happened with a Boeing 737-800 at Gothenburg/Landvetter Airport in Sweden on December 3rd 2003.
At the start, when the aircraft was approaching 80 knots and before V_1 had been reached, the F/O, who was the pilot flying, noted that the aircraft's nose was lifting spontaneously without him moving the control column. He reported this to the captain who took over the control and rejected the take-off. The pilots and airline personnel later discovered that the particulars in the load sheet concerning the distribution of passengers in the cabin did not tally with where the passengers were actually sitting.
The investigation noted shortcomings in the routines and computerized systems used for the production of load sheets. As a result the take-off was commenced with a CG position at more than ¼ aft of the certified CG span.

The Air Accidents Investigation Branch (AAIB) in the United Kingdom investigated a similar event which happened with an Airbus A320-214 at Kefallinia in Greece on October 27th 2002.
The captain rejected the take-off after the nose pitched up rapidly when the aircraft started its take-off roll. Investigation revealed that all the passengers were seated aft of row 13, which was significantly

[23] IVW-DL rapport *Safety First, Nulmeting van grondafhandeling op de luchthaven Schiphol*, www.ivw.nl.

different from the distribution shown on the load and trim sheet. This form indicated that the passengers had been spread evenly through the cabin.

The data base of the National Transportation Safety Board (NTSB) in the United States, which is primarily intended to reflect domestic events, was searched and did not contain any similar events.

The database of the Boeing company was searched and contained one event where a Boeing 737-800 tipped back and struck the tail shortly after the application of take-off thrust. An evaluation of the load sheet indicated that there was a significant error in the calculations and that the actual CG was likely in the range 36-38% MAC. The calculated CG was well aft of the certified limit for take-off under any thrust setting.

The database of ICAO was searched and contained four additional occurrences where an uncommanded pitch up movement took place after take-off thrust had been selected. In three cases a tail strike occurred. In all cases the movement was caused due to an exceedance of the aft limit of the CG for take-off. The aircraft involved were an Airbus A300-600, an Airbus A320, a Boeing 747-400 and a McDonnell Douglas MD-11.

1.20.2 Publication by CAA of the UK

In November 2000 the Civil Aviation Authority of the United Kingdom published FODCOM (Flight Operations Department Communication) 12/2000 because of an increasing number of aircraft loading occurences. This publication had as goal to remind operators, crew members and handling personnel of the requirements and responsibilities involved in the loading of aircraft.

1.20.3 Measures taken by Transavia airlines after the occurrence

Following the occurrence, short term and long term actions were taken by Transavia airlines, aimed at preventing flights being operated outside the CG envelope.

Short term actions (on January 13th 2003):

- Issuance of a Cockpit Bulletin General for crews in which they were told to pay attention to an equally spread distribution of passengers to conform to the applicable instructions in the BOM and the CSM;
- Issuance of a memorandum for crew members departing from Rotterdam on January 13th in which they were requested to pay extra attention to the inspection of the loading (by the ground handling agency) of the aircraft before the beginning of the flight;
- Issuance of a memorandum for cabin crew to draw their attention to the procedure that passengers should be equally spread throughout the cabin before the “cabin ok” sign is given to the cockpit crew;
- Message to all operational managers of Transavia airlines destination airports to pay attention to an equally spread distribution of passengers for all flights, in particular triangle flights, to conform to the applicable instructions in the ASM.

Long term actions:

- Cockpit crews have to complete the automatically generated load and trim sheet for every flight with actual load data and determine the CG position;
- All aircraft have been equipped with cabin section indicators (OA till OD) on the overhead stowage bins to indicate to the cabin crew the limits of each section;
- Introduction of the Passenger Distribution Card (PDC). The purser performs a headcount per cabin section, making use of the cabin section indicators, and hands this information over to the captain in the form of a PDC. The PDC was introduced on April 8th 2003;
- Re-introduction of the graphical depiction of the flight envelope on the load and trim sheet. In the past the cockpit crew members had to fill out a load and trim sheet, including the CG envelope graphics, by themselves. In 2000 the software program, that produces the computer generated load and trim sheet, was introduced whereby the graphical depiction of the flight envelope disappeared. As a result of the occurrence Transavia airlines re-introduced the graphical depiction of the CG envelope on the load and trim sheet, enabling cockpit crew members to quickly obtain a clear picture of the position of the CG. See appendix F;
- To emphasize on weight and balance related procedures during audits on stations.

1.21 USEFUL OR EFFECTIVE INVESTIGATION TECHNIQUES

Not applicable.

2 ANALYSIS

2.1 GENERAL

The day of the occurrence was the first day of a work cycle of the pilots. They had been off duty for several days. Both pilots stated they were well rested and fit for duty. They arrived at the crew centre ahead of the scheduled reporting time and there was no time pressure. CVR data revealed a relaxed atmosphere in the cockpit. It can be understood that the captain strove to depart on time. There were no indications that the cockpit crew was in a hurry.

Meteorological conditions were no factor during the occurrence.

When the crew started the take-off roll by selecting take-off thrust the nose pitched up. This motion was caused by the pitch up moment of the thrust together with the CG behind the aft limit for take-off.

The aircraft had a valid certificate of airworthiness and a valid maintenance release to service.

2.2 FLIGHT PREPARATION

The load and trim sheets of the Transavia flights are produced well in advance (in Amsterdam) and are based on planned load figures. The load and balance software program is based on the assumption that passengers are seated equally spread throughout the cabin. The actual seat assignment has to be done accordingly by the handling company. The actual loading could differ from the planning, therefore it is essential that the planned load figures are compared with the actual load figures to finalize the load and trim sheet. This has to be done by the cockpit crew shortly before taxi. The actual passenger count is provided by the handling company and is available after the passengers have boarded.

Before departure the captain verbally received the load figures from the Aviapartner load controller. Subsequently the cockpit crew adjusted the traffic load and the zero fuel weight on the load and trim sheet, as prescribed in the BOM. Because there was a difference of less than 1,000 kg, no new load and trim sheet was prepared.
Seat allocation was done by Aviapartner Passenger Services in such a way that passengers were assigned seats in the rear of the cabin to keep the seats in the front of the cabin empty to facilitate the boarding at the next station, Maastricht. This is contradictory to the instruction in the ASM, which prescribes that the seats shall be issued in such a way that an equally spread passenger distribution is obtained. Based on information from the purser it is concluded that the actual seating was according to the seat assignment as given by Aviapartner.
To prevent a situation where the passengers are not seated according to the distribution as assumed on the load and trim sheet, the purser has to verify that the passengers are seated equally throughout the cabin and report any discrepancies to the captain. In accordance with this instruction the purser informed the captain that the passengers were seated mainly in the aft part of the cabin. The captain looked into the cabin from his position in the cockpit and took no action. When seated in the left hand cockpit seat and looking backwards, most of the rows where no passengers were seated are visible. It is considered that the purser got the impression that the captain approved the situation. The first officer was not directly involved. In accordance with the applicable instruction in the BOM, the captain should consider the effect of a seating deviation on the CG position. However in this instruction no specific criteria are mentioned as how to accomplish this, except for the additional remark that it may be necessary to reseat passengers.
The observation from the purser (four passengers were seated in the first row and the remaining passengers from row thirteen and aft) indicated a significant deviation from the figures on the load and trim sheet. Apparently the cockpit crew did not realise the importance of this observation in relation to the CG position.

The load and trim sheet used by the crew did not reflect the actual situation. The incorrect distribution of the passengers over the cabin on departure caused the position of the CG to be situated well behind the aft take-off limit.

2.3 CENTRE OF GRAVITY AWARENESS

2.3.1 General

The balance of the airplane is of great importance for the safety of the flight. Consequently the position of the CG is a critical factor for the operation. This is reflected by the attention given to CG related issues in the relevant company documentation.

As there are no technical means available on the aircraft to warn the crew for differences between the calculated and the actual CG, it is essential that the procedures regarding weight and balance are clearly described, adequate, known and complied with.

2.3.2 Occurrence flight

Regarding the occurrence flight, it was found that:

- passengers were not seated according to the passenger distribution table;
- there was no adequate response from the cockpit crew to the report of the purser about the incorrect passenger distribution;
- the skidding of the nose gear during line up was not recognized (by the F/O) as an indication of a possible tail heavy condition;
- after the incident the cockpit crew initially did not understand that the occurrence was caused by the fact that almost all passengers were seated in the rear of the aircraft.

Based on these findings the Board is of the opinion that the cockpit crew was not aware of the significant effect of passenger distribution on the CG and, as a consequence, on the controllability of the aircraft.

2.3.3 Analysis of 23 flights

The Board investigated records of 23 similar three leg flights to determine whether the situation under investigation could be regarded as an isolated case or not. Those flights were all Transavia airlines multi leg flights that departed from Rotterdam during the chosen period[24]. It was investigated whether or not on these flights seats were assigned according to the passenger distribution table and if, in case of deviations, an ASR was filed. It was found that seat assignment according to the passenger distribution table did not take place for any of the investigated flights.

ASRs regarding the investigated flights were not found. Besides the fact it is compulsory to report significant passenger loading errors (by means of an ASR), there is another good reason to report them. That is if passengers are not equally spread throughout the cabin reseating has to take place shortly before departure. This is time consuming and distracting for cockpit and cabin crew and it could hamper the preparation for flight. So it is also in the interest of crew members to report this routine. From the absence of reports it is concluded that the investigated flights most likely departed with the assigned seating as given by Aviapartner[25].

There is no reason to assume that the situation was different during the months before these 23 flights took place. No flight reports regarding a loading error on a three leg flight and related to the 23 flights were received by Transavia airlines in the period from November 1st 2002 until the date of the occurrence.

From the foregoing it is concluded that a number of cockpit crew members were not aware of the significant effect of passenger distribution on the CG and, as a consequence, on the controllability of the aircraft.

The Board's view is that awareness by cockpit crew members as to the critical effect of passenger distribution was of a general nature because they were used to receiving a predetermined CG and did not process the load data in an active way.
Crews could operate with a CG deviating from the CG on the pre determined load and trim sheet without realizing the consequences of it. The airline did not detect this routine error and therefore could not inform crew members about the potential risk. That could be the reason that on the occurrence flight no adequate action was taken by the captain after the remark of the purser.

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[24] Period from December 15th 2002 till up to March 3rd 2003.
[25] transavia.com stated in a commentary on the second draft that absence of reports is no proof that no re-seating was undertaken. The Board considers the absence of reports as a deficiency of the quality system.

From statements made by Aviapartner employees it was learnt that it was common practice for the Passenger Services employees to assign seats unequally spread through the cabin for multi leg flights. Those employees were not familiar with the passenger distribution table in the ASM. Awareness by these employees about the possible consequences of unequal seat assignment could therefore not be expected.

2.4 WEIGHT AND BALANCE

The take-off weight, after processing the final figures, was 61,276 kg. This was well below the maximum take-off weight for this flight.

The baggage was loaded in the cargo compartments according to the Transavia airlines standard load distribution of 20% of the baggage in hold #2 and 80% in hold #3 for the Boeing 737-800 aircraft. The passenger seat assignment form, as provided by Aviapartner, showed that four passengers were seated on the first row and the other passengers were seated from row 13 and aft. The purser confirmed this.

According the load and trim sheet the forward limit of the take-off CG was 9% MAC, the aft limit was 29.2% MAC and the take-off CG was 24.8% MAC. The actual CG at take-off was 40.8% MAC. This was well behind the aft limit for take-off. In other words the aircraft was 'tail heavy'.

A consequence was that the cockpit crew made an incorrect input in the flight management computer, resulting in an incorrect stabilizer setting.

2.5 ORGANISATION AND MANAGEMENT

2.5.1 General

As discussed before, Transavia airlines had made the choice to separate the loading process from the preparation of the load and trim sheet. Therefore loading had to be done in accordance with the figures on the load and trim sheet to ensure that the load sheet reflected the actual situation. This could be accomplished by clear procedures for all personnel involved. Compliance to the rules had to be the subject of adequate supervision.

The Board is of the opinion that the separation of the actual loading process from the load and trim sheet preparation process encompasses a potential risk. When the actual situation is not according to the load and trim sheet, flight safety may be at risk. An unsafe situation can be prevented by installing an adequate defence. Transavia airlines' defence was the requirement for cabin and cockpit crew to verify the load situation and take appropriate action if required.

2.5.2 Procedures

Procedures have to be clearly prescribed in the applicable manuals. And it is important that all manuals are consistent with each other. The procedure regarding passenger distribution in the Handbook Cabin Personnel was different from the procedure in the CSM. This could lead to uncertainty by the responsible cabin crew member concerning which procedure was applicable.
The procedure in the BOM referring to the distribution of passengers did not give criteria on how to check if passengers were evenly distributed and how to correct deviations. The indication that reseating could be necessary is considered to be insufficient with the absence of instructions on how to accomplish this. Also the procedures in the CSM regarding passenger distribution were considered inadequate for the same reason. Also there were no visible markings in the cabin to identify the different cabin sections. Therefore the cabin crew was unable to determine whether the number of passengers per cabin section was as indicated on the computer generated load and trim sheet.
It is the opinion of the Board that procedures on passenger distribution were not adequate leaving crew members to use their own criteria regarding this matter.

The deficiencies in the procedures related to the distribution of passengers were brought to the attention of the responsible managers by means of an audit before the occurrence took place, but insufficient corrective actions took place. See 2.6, QUALITY AND SAFETY.

2.5.3 Aviapartner

Aviapartner has committed itself to act according to the ground handling agreement between Aviapartner and Transavia airlines. This agreement states that *the handling company acknowledges to have full understanding of the most recent version of the carrier's ASM […] and agrees to act accordingly.*

The ASM states that *the handling agent shall ensure (on behalf of Transavia) that all relevant ground operations personnel will be trained, examined, checked and kept proficient to the required standard. General familiarisation training about the content of the Transavia ASM shall be given to all relevant ground operations personnel.*

The ASM prescribes that the *seats shall be issued in such a way that an equally spread cabin distribution is obtained*.

The occurrence flight and the 23 analysed flights indicated that seat assignments according the passenger distribution table did not take place for any of those flights. The employees of Aviapartner did not comply with the applicable ASM procedure, regarding the issuance of passenger seats. Though Aviapartner provided an in-house Passenger Services training on 'basic check-in'. The concept of equally spread passenger distribution was not part of this training, as this was according to the station manager of Aviapartner a load control related subject.
The station manager was not familiar with the contents of the ASM nor with the equally spread concept, used by the airline.

Aviapartner load controllers are trained on the subject of weight and balance and qualified to issue load and trim sheets. However for Transavia airlines flights, no load and trim sheets were issued by Aviapartner as this was not a part of the ground handling agreement.
The load controller who passed the load figures to the cockpit crew was not informed by Aviapartner about the equally spread passengers concept. His responsibility was limited to baggage loading and to pass the load figures, including the total number of passengers, to the cockpit crew.

The Board concludes that as a result of the separation of the actual loading from the load and trim sheet preparation, and the limited role of the load controller none of the Aviapartner ground staff employees had a complete overview of the loading process.

The Board concludes that the Aviapartner organisation at Rotterdam was not familiar with the Transavia airlines loading procedure, no training was given on the ASM passenger distribution procedures and deviations from the required seating were not recognized.

2.5.4 Relation to ground handling organisation Aviapartner

Supervision by Transavia airlines
Transavia airlines decided not to perform a pre-assessment audit on Aviapartner at Rotterdam. Ground Service Inspectors of Transavia airlines visited Rotterdam and assessed the ground handling by Aviapartner in December 2002. The inspection covered the check in process, the boarding process and ramp handling. However it did not cover weight and balance related procedures. Transavia airlines remained unaware that it became routine to assign seats not according to the seat assignment procedure in the ASM for three leg flights.

A computer generated load and trim sheet, which is produced before the actual load figures are known, is uncommon in the industry. Transavia airlines however did not inform the handling company sufficiently about this method.

Since Aviapartner started operations at Rotterdam it planned the passenger distribution for three leg flights in consultation with the ground handling company at the next station. The investigation of the 23 three leg flights indicates that two other ground handling companies also did not act according to instructions, regarding seat assignments. The management of Transavia airlines did not become aware of those deviations.

Transavia airlines did not alert Aviapartner about the uncommon practice and inherent risks to produce the load and trim sheet before the actual load figures are known, nor did it adequately supervise the passenger loading related activities by Aviapartner.

Training of ground handling staff
According to the ground handling agreement, it was an Aviapartner task to provide adequate training regarding the ASM to the Passenger Services employees. Based on this contract Transavia airlines assumed that Aviapartner trained its own ground handling personnel. Therefore Transavia airlines did not provide training to the ground handling employees of Aviapartner.
However, training on the contents of the ASM was not given by Aviapartner. Most Passenger Services employees had learned their activities 'on the job' with their former employer Servisair but apparently did not have sufficient knowledge of the contents of the ASM. Two Passenger Services employees stated they had never seen the passenger distribution table in the ASM.

In the BOM is written that the post holder Ground Operations shall *ensure that ground handling departments are staffed by trained personnel who have a thorough understanding of their responsibilities within the organisation*. Regarding the knowledge level of the ground handling personnel, Transavia airlines had certain expectations, because Aviapartner signed the ground handling agreement and thereby committed itself to *ensure (on behalf of Transavia) that all relevant ground operations personnel would be trained, examined, checked and kept proficient to the required standard.* However, the ground handling agreement on its own does not assure that those obligations are fulfilled. Adequate inspections and audits were not performed by the airline.
Therefore it is concluded that the post holder Ground Operations did not comply with the requirement mentioned above.
The Board concludes that Transavia airlines did not assure that Aviapartner was staffed by trained personnel who had a thorough understanding of their tasks and responsibilities.

2.6 QUALITY AND SAFETY

2.6.1 Occurrence reporting system
An effective quality and safety system is dependant upon input from within the organisation. With reference to safety, Transavia airlines cockpit and cabin crew members were required to report significant (passenger) loading errors by means of an ASR, directly forwarded to the Safety & Quality Assurance department. If an occurrence was not related to safety, reporting should be done by means of a trip report (for cockpit crew) or a flight report (for cabin crew). It is noted that an accurate explanation as to how to assess a passenger loading error as significant or not, is not incorporated in the BOM and CSM.

Dispatch records of flights are another source of data for the quality and safety system. Transavia airlines did not use this data source as an input for safety analyses. The analysis of the examined 23 three leg flights, which included all Transavia airlines multi leg flights that departed from Amsterdam and Rotterdam (which made an intermediate stop at Maastricht) during the chose period, indicated that departures with an irregular passenger distribution most likely took place repeatedly. Because these deviations did not generate problems, the occurrences and the possible safety implications were not noticed and not reported to the company. No input was made in the safety system by an ASR and the organisation remained unaware of this.

In response to the above mentioned finding Transavia airlines searched for trip and flight reports for all flights regarding incorrect passenger distribution and found a total of six trip reports by cockpit crew and remarks in 35 flight reports by cabin crew in the period November 1st 2002 till up to March 31st 2003. To put this finding in the correct perspective it must be considered that in the mentioned period 7.880 flights took place.
The higher number of reports by cabin crew can be explained by the way passenger seating is incorporated in the routinely made flight report. It can be marked in a box and explained by a note on the back. Additionally it is considered that cabin crew members are dealing directly with passenger loading irregularities by virtue of their presence in the cabin. It could not be established if cockpit crew members were informed in all reported cases. Three occurrences were reported by both a trip report and a flight report. From the remarks in the flight reports it is learned that during the investigated period irregular seat assignments were occasionally recognized by the cabin crew and that reseating was reported in many of those cases.
No ASRs were found related to passenger loading errors in the examined period. It is remarkable that the reported occurrences were only mentioned in trip- and flight reports and thus not regarded as safety related. The management of the airline could not explain the absence of ASRs regarding passenger loading errors. It is concluded that the passenger loading errors were not considered as significant deviations and therefore not recognized as a safety issue by the crews. The lack of definite criteria on how to quantify loading errors could be a contributing factor.

Trip and flight reports are not put into the Transavia airlines quality and safety system and the incorporated data are consequently not used for safety analysis. It is also noted that the departments that handled the information from trip and flight reports did not recognise the potential safety problem. Even after the occurrence had taken place no appropriate action was taken on the trip and flight reports. Line managers involved did not forward the trip and flight reports, which were used to report deviations from the required passenger distribution, to the Safety & Quality Assurance department[26].

It is concluded that the management of the departments who received and handled the trip and flight reports with flight safety related information did not take appropriate corrective action to solve this structural problem. The Safety & Quality Assurance department did not receive the reports, neither was the lack of forwarding these reports observed by audits performed by the Safety & Quality Assurance department.

The Board is concerned that the management of Transavia airlines did not become aware of the seat distribution problem because the occurrence reporting system did not provide the necessary information to detect deviations from the passenger loading procedures. This was caused by crew members not reporting the deviations or using incorrect forms to report them and by the management of Transavia airlines not taking corrective action and by the audit system not detecting these shortcomings.

2.6.2 Response to audit results

Another important input for the quality and safety system is provided by audits. The results from an internal audit that took place on September 4th 2001 were considered by the Board. During that audit several findings related to mass and balance were generated, of which the following two are relevant to the occurrence.

Finding FO-06-040901-01 states: *It is not shown in the CSM towards which criteria the purser can verify if the passengers are evenly distributed as required in the BOM. It is also not clear if verification should be done per cabin section. […] In the CSM the principles of mass and balance are not clearly described with respect to the tasks and responsibilities of cabin crew and the communication about this subject to the cockpit crew.*

Finding FO-06-040901-02 states*:[…] It is not shown that the cockpit crew is able to check the assumption that the passengers are equally spread per cabin section and how to act in case of deviations.*

Two corrective actions, regarding both findings, were introduced two months before the occurrence. They contained the introduction of the load and trim sheet project and the equal distribution of passengers as an additional condition for the 'cabin ok' message.

Although the proposed actions did not contain criteria on how cockpit and cabin crew could verify the equally spread passenger distribution and how to act in case of deviations, both findings were declared closed by the auditor. At the date of the closure of the CARs, the status of the implementation of the proposed actions was not well defined. As a consequence crews still had insufficient guidance on how they should reseat passengers.

The Board considers the appropriateness and effectiveness of the corrective actions insufficient. The problem was not adequately acknowledged and the follow up was not thoroughly analysed, before closing the CARs.

2.6.3 Measures taken by Transavia airlines after the occurrence

Following the occurrence, Transavia airlines established short term and long term actions to prevent similar occurrences. The short term actions mainly had the goal to remind all persons, involved in the passenger loading process of Transavia airlines flights, of the importance of the equal distribution of passengers.

The investigation of the 23 multi leg flights revealed that within the period of almost three months after the date of the occurrence unequal seat assignments still took place. This is confirmed by 26 (out

[26] transavia.com stated in a commentary on the second draft report that the number of reports regarding incorrect passenger distribution was very small in relation to a number of different (non safety related) categories. Therefore it is understandable that the employees who processed the flight reports did not see a reason to inform the line managers. As a consequence the line managers did not inform the Safety & Quality Assurance department.

of the 35) flight reports, written by cabin crew members, and five (out of the six) trip reports, written by cockpit crew members, after the occurrence took place.

The effectiveness of the long term actions has not been investigated by the Board.

The Board concludes that the short term measures, which were taken by Transavia airlines after the occurrence, were inadequate to prevent an unequal seat assignment. The airline still did not have control over seat assignments performed by ground handling companies.

2.7 SUPERVISION BY THE CAA OF THE NETHERLANDS

On the subject of weight and balance regarding three leg flights within the Transavia airlines operation it is found that daily routine differed significantly from the written procedures (regarding the passenger distribution table) as approved by the CAA of the Netherlands.

The audits and inspection flights which were performed by the CAA in the year 2002 (before the occurrence happened) did not reveal similar cases, nor were observations reported that can be directly related to the occurrence.
After the occurrence the CAA declared that their audits and/or inspections would include a focus on weight and balance related procedures.

The Board concludes that the system of audits and inspection flights of the CAA did not uncover the risks involved in the Transavia airlines loading process.

2.8 OTHER CG RELATED OCCURRENCES

Search in databases of other Safety Boards and international organizations revealed that similar occurrences of uncommanded pitch up movements on the ground had occurred. In three cases the aft limit of the CG for take-off was exceeded. The cause was that the distribution of the passengers in the cabin deviated from the load and trim sheet used by the cockpit crew. In another case a significant error in the CG calculation itself was made.
There was diversity in the types of aircraft which were involved.

3 CONCLUSIONS

3.1 FINDINGS

1. The operating crew was current and licensed to conduct the flight.
2. The aircraft had a valid certificate of airworthiness and a valid maintenance release to service.
3. Meteorological conditions were not a factor in the occurrence.
4. Time pressure is not considered to be a factor in the occurrence.
5. When the crew started the take-off roll by selecting take-off thrust the nose pitched up.
6. The pitch up movement of the nose was caused by application of thrust together with the CG behind the aft limit for take-off.
7. Seat assignment was not according to the passenger distribution table.
8. The passenger distribution was not according the load and trim sheet and the passenger distribution table.
9. The separation of the loading process from the load and trim sheet preparation process is a potential safety risk.
10. The purser reported the unequal distribution of passengers to the captain.
11. The captain did not take action after the report of unequal passenger distribution from the purser.
12. The term ‘equally spread’ was not accurately defined in the BOM and the CSM.
13. No tool was available to accurately assess passenger seating distribution per cabin section (as presented on the computer generated load and trim sheet).
14. Crew members had to execute BOM and CSM procedures on passenger distribution verification using their own criteria.
15. The actual centre of gravity at take-off was 40.8% MAC and exceeded the aft limit for take-off of 29.2% MAC, as indicated on the load and trim sheet.
16. The corrective actions by Transavia airlines to internal audit results, related to mass and balance, were insufficient and did not prevent the occurrence.
17. A number of cockpit crew members of Transavia airlines did not adhere to the reporting procedures regarding passenger loading errors.
18. The management of the departments who received and handled the trip and flight reports with flight safety related information did not take appropriate corrective action to solve this structural problem.
19. The trip- and flight reports which were used to report deviations from the required passenger distribution were not received by the Safety & Quality Assurance department and consequently not used for safety analysis.
20. The occurrence reporting system of Transavia airlines did not provide the management with information to detect and correct deviations from the passenger loading procedures.
21. Transavia airlines did not alert Aviapartner about the uncommon practice and inherent risks to produce the load and trim sheet before the actual load figures are known.
22. Unequal seat assignment took place frequently.

23. Aviapartner did not provide training to its Passenger Services employees on the use of the passenger distribution table in the ASM.

24. None of the Aviapartner ground staff employees had a complete overview of the loading process.

25. Aviapartner did not act in accordance with the ground handling agreement.

26. The management of Transavia airlines did not adequately supervise the passenger loading related activities by Aviapartner.

27. Transavia airlines did not assure that Aviapartner was staffed by trained personnel who had a thorough understanding of their tasks and responsibilities.

28. Investigation of 23 dispatch records of multi leg flights indicated that seat assignment according to the passenger distribution table did not take place for any of the reviewed flights.

29. The cockpit crew concerned was not aware of the significant effect of passenger distribution on the CG and, as a consequence, on the controllability of the aircraft.

30. A number of Transavia airlines cockpit crew members were not aware of the significant effect of passenger distribution on the CG and, as a consequence, on the controllability of the aircraft.

31. Transavia airlines provided six trip reports and 35 flight reports about passenger distribution occurrences. The crews did not regard these occurrences as significant deviations and therefore not as a safety threat.

32. The short term measures taken by Transavia airlines after the occurrence did not prevent unequal seat assignments to re-occur.

33. Audits by the CAA did not uncover the risks involved in the Transavia airlines loading process.

34. Inspections by the CAA did not find deficiencies related to the weight and balance process as used by Transavia airlines.

3.2 CAUSE AND CONTRIBUTING FACTORS

Probable cause
Attempted take-off with the centre of gravity well behind the applicable aft limit.

Contributing factors

Transavia airlines
Flight operations:
- Lack of action by the cockpit crew members involved. The passenger distribution was recognized by the purser as deviating from standard. Her subsequent report to the cockpit crew did not result in any corrective action, despite the responsibility of the captain to take all reasonable steps to ensure that the aircraft weight and balance is within limit;
- Lack of awareness from the cockpit crew concerned regarding the significant effect of passenger distribution on the centre of gravity of the aircraft.

Quality system:
- Inadequate response to audit results, related to mass and balance. No evaluation of the effectiveness of the corrective actions;
- Inadequate occurrence reporting of passenger loading errors;
- Inadequate follow-up of the occurrence reports regarding passenger loading errors;
- Insufficient supervision over the seat assignments by ground handling companies;
- No assurance that Aviapartner was familiar with the ASM and was staffed by trained personnel who had sufficient knowledge of their responsibilities.

Aviapartner

- No training was given on the use of the passenger distribution table in the ASM to it Passenger Services employees;
- Seat assignment was not according the passenger distribution table in the ASM.

4 RECOMMENDATIONS

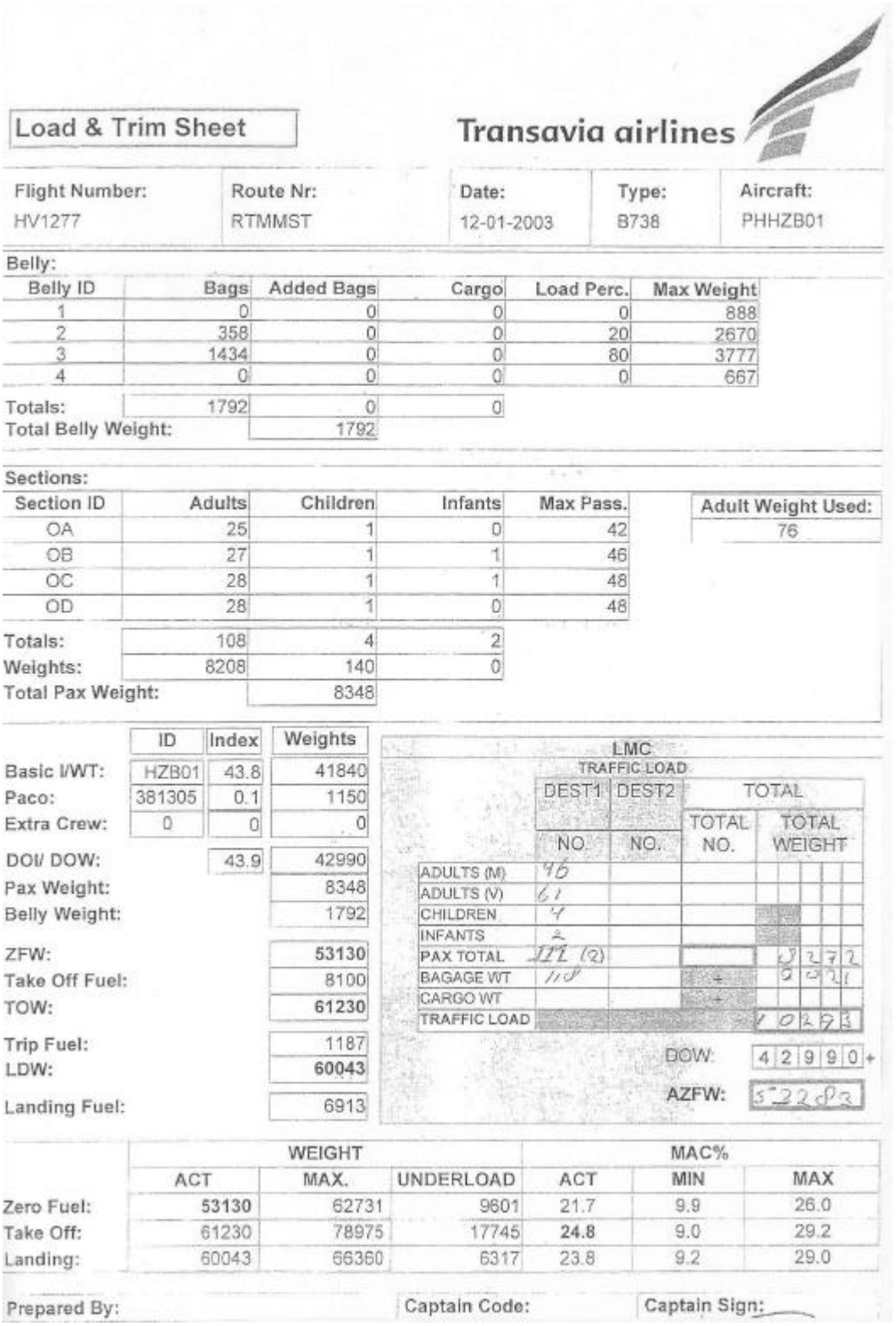
transavia.com is recommended to:
- Enhance its pilot's awareness about the effect of passenger distribution on the centre of gravity of Boeing 737-800 aircraft, and
- Evaluate its quality system, in particular regarding the:
  - supervision on contracted ground handling companies;
  - results of audits, and the effectiveness of associated corrective actions;
  - procedures about reporting safety-related occurrences.

Aviapartner is recommended to:
- Improve its quality system as such that shortcomings regarding the dispatch of passengers become visible.

The Minister of Transport, Public Works and Water Management is recommended to:
- Orchestrate the draft of quality and safety regulations for ground handling companies by the European Aviation Safety Agency (EASA).

The governmental bodies towards which a recommendation has been issued must take a stance regarding the follow-up of this recommendation within 6 months of publication of this report to the minister concerned. Non-governmental bodies or individuals towards whom a recommendation has been issued must take a stance regarding the follow-up of this recommendation within a year of publication of this report to the minister concerned. A copy of this reaction must simultaneously be sent to the Chairman of the Dutch Safety Board and to the Minister of the Interior and Kingdom Affairs of the Netherlands.

APPENDIX A: LOAD AND TRIM SHEET, AS PREPARED FOR FLIGHT HV1277 ON JANUARY 12TH 2003



Load & Trim Sheet

Transavia airlines

Flight Number:	Route Nr:	Date:	Type:	Aircraft:
HV1277	RTMMST	12-01-2003	B738	PHHZB01

Belly:

Belly ID	Bags	Added Bags	Cargo	Load Perc.	Max Weight
1	0	0	0	0	888
2	358	0	0	20	2670
3	1434	0	0	80	3777
4	0	0	0	0	667
Totals:	1792	0	0		
Total Belly Weight:		1792			

Sections:

Section ID	Adults	Children	Infants	Max Pass.
OA	25	1	0	42
OB	27	1	1	46
OC	28	1	1	48
OD	28	1	0	48
Totals:	108	4	2	
Weights:	8208	140	0	
Total Pax Weight:		8348		

Adult Weight Used:
76

	ID	Index	Weights
Basic I/WT:	HZB01	43.8	41840
Paco:	381305	0.1	1150
Extra Crew:	0	0	0
DOI/ DOW:		43.9	42990
Pax Weight:			8348
Belly Weight:			1792
ZFW:			53130
Take Off Fuel:			8100
TOW:			61230
Trip Fuel:			1187
LDW:			60043
Landing Fuel:			6913

LMC

TRAFFIC LOAD

	DEST1 NO.	DEST2 NO.	TOTAL NO.	TOTAL WEIGHT
ADULTS (M)	96			
ADULTS (V)	61			
CHILDREN	4			
INFANTS	2			
PAX TOTAL	163 (2)			12792
BAGAGE WT	n/s		+	0 0 7 1
CARGO WT			+	
TRAFFIC LOAD				12863

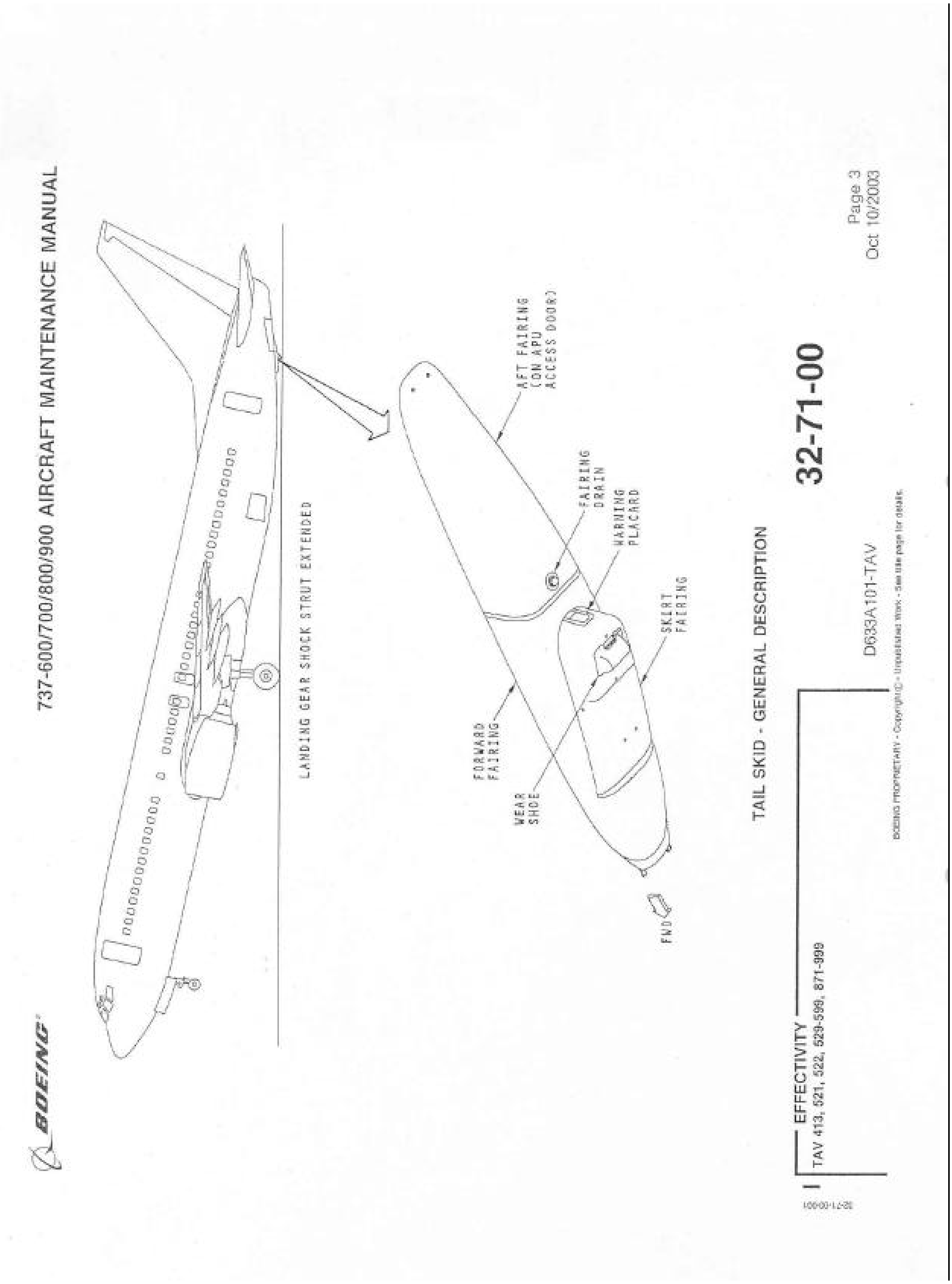
DOW: 42990+

AZFW: 55853

	WEIGHT			MAC%		
	ACT	MAX.	UNDERLOAD	ACT	MIN	MAX
Zero Fuel:	53130	62731	9601	21.7	9.9	26.0
Take Off:	61230	78975	17745	24.8	9.0	29.2
Landing:	60043	66360	6317	23.8	9.2	29.0

Prepared By: Captain Code: Captain Sign:

APPENDIX B: TAIL SKID, BOEING 737-800



APPENDIX C: ACTUAL PASSENGER DISTRIBUTION OF FLIGHT HV1277

Section: **Row number:**

OA:

	A	B	C	D	E	F
1			M	F	M	F
2						
3						
4						
5						
6						
7						

OB:

8						
9						
10						
11						
12						
13	M	F	M	F	A	A
14				F	M	F
15		M	F	F	M	

OC:

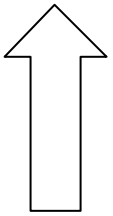
16	M	F	F	M	M	F
17	M	F	M	F	F	A
18	M	F	F	F	M	F
19	C	F	M	M	F	
20	M	M	F	F	M	F
21	C	F	M	M	M	F
22	M	F	M	F	F	C
23	M	F	F	M	F	

OD:

24	M	F	M	F	F	F
25	F	M	M	F	F	F
26	M	F	F	M	F	C
27	M	F	M	F	M	F
28	F	F	F	F	M	F
29	M	F	M	F	M	M
30	F	F	M	F	M	F
31	M	F	M	F	M	F

M = male, F = female
C = child, A = adult (sex unknown)

front side
of the aircraft



APPENDIX D: PASSENGER DISTRIBUTION TABLE, BOEING 737-800, AIRPORT SERVICE MANUAL

Transavia airlines

EDP-SYSTEM SEMI-PERMANENT DATA	AIRCRAFT DATA	C Sheet 5
ALL	AIRCRAFT TYPE BOEING 737-800	CARRIER TRA

8.2.2 Passenger distribution

The passengers shall be distributed according the table below in order to obtain an equally spread distribution.

total no. of pax	OA	OB	OC	OD
8	2	2	2	2
19	4	5	5	5
30	7	7	8	8
39	9	10	10	10
49	11	12	13	13
58	13	15	15	15
69	16	17	18	18
80	18	20	21	21
90	21	23	23	23
100	23	25	26	26
111	25	28	29	29
123	28	31	32	32
133	30	33	35	35
143	33	36	37	37
153	35	38	40	40
164	37	41	43	43
174	40	44	45	45
184	41	46	48	48

8.3 Cabin Crew Seats

N/A

8.4 Galleys

N/A

8.5 Pantry Weight/Pantry Code

N/A

8.6 Crew Distribution/Crew Code

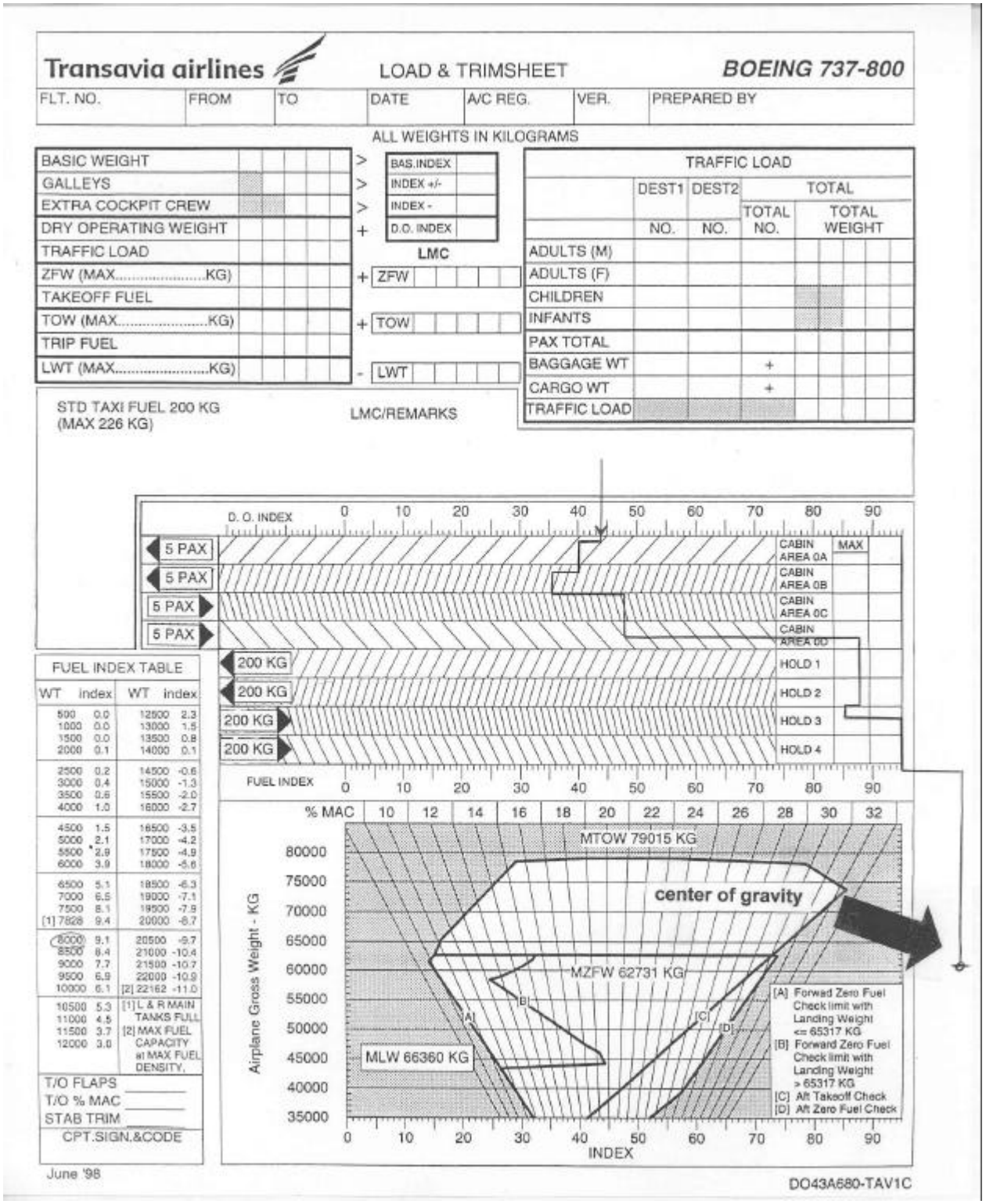
N/A

APPENDIX E: RELEVANT PARAGRAPHS JAR-OPS 1

JAR-OPS 1.605 describes the requirements for the operator with regard to the mass and balance of the aircraft. JAR-OPS 1.610 Loading, mass and balance states: "*An operator shall specify in the operations manual, the principles and methods involved in the loading and in the mass and balance system that meet the requirements of JAR-OPS 1.605. This system must cover all types of intended operations.*"

JAR-OPS 1.625 Mass and balance documentation states: "*An operator shall establish mass and balance documentation prior to each flight specifying the load and its distribution. The mass and balance documentation must enable the commander to determine that the load and its distribution is such that the mass and balance limits of the aircraft are not exceeded. The person preparing the mass and balance documentation must be named on the document. The person supervising the loading of the aircraft must confirm by signature that the load and its distribution are in accordance with the mass and balance documentation. This document must be acceptable to the commander, his acceptance being indicated by countersignature or equivalent. An operator must specify procedures for last minute changes (LMC) to load. Subject to the approval of the authority, an operator may use an alternative to the procedures required above.*"

APPENDIX F: LOAD AND TRIM SHEET WITH GRAPHICAL DEPICTION AS INTRODUCED AFTER THE OCCURRENCE



The arrow in the graphical depiction indicates that the actual CG at take-off was situated outside the envelope.

APPENDIX G: DISPATCH RECORDS OF GROUND HANDLING COMPANY AT MAASTRICHT

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
Flight number	Departure	Date	total	OA	OB	OC	OD	OA	OB	OC	OD	MAC take-off	Aft MAC take-off limit
(#)			(pax #)	(pax #)	(pax #)	(pax #)	(pax #)	(%)	(%)	(%)	(%)	(%)	(%)
1	EHRD	15.12.2002	59	6	31	0	22	-57	106	-100	46	24.0	27.2
2	EHAM	16.12.2002	147	37	43	21	46	8	16	-44	21	22.4	29.7
3	EHRD	22.12.2002	87	39	6	42	0	95	-73	90	-100	13.0	28.1
4	EHAM	23.12.2002	149	42	46	13	48	-23	24	-66	23	20.8	30.1
5	EHRD	29.12.2002	58	10	0	21	27	-23	-100	40	80	30.8	27.2
6	EHAM	30.12.2002	40	14	4	0	22	-40	-60	-100	120	24.6	26.8
7	EHRD	5.1.2003	122	20	42	12	48	-26	35	-62	50	27.9	29
8	EHAM	6.1.2003	145	32	31	34	48	-3	-13	-10	-26	27.9	30.1
➔➔ 9	EHRD	12.1.2003	111	4	13	46	48	-84	-53	58	65	**40.8**	29.4
10	EHAM	13.1.2003	131	32	37	27	35	10	12	-20	0	22.5	29.3
11	EHRD	19.1.2003	100	21	32	17	30	-8	28	-34	15	23.8	28.6
12	EHAM	20.1.2003	159	41	46	26	46	17	15	-38	9	21.9	30.1
13	EHRD	26.1.2003	101	16	37	18	30	-30	42	-30	15	24.4	28.4
14	EHAM	27.1.2003	156	38	22	48	48	5	-43	17	-20	27.7	30.2
15	EHRD	2.2.2003	92	23	24	22	23	4	0	4	0	23.4	29
16	EHAM	3.2.2003	135	25	42	34	34	-19	23	-3	-3	24.7	29.5
17	EHRD	9.2.2003	100	18	24	22	36	-21	-4	-15	38	28.2	28.6
18	EHAM	10.2.2003	147	42	28	48	29	23	-24	26	-24	21.2	30.2
19	EHRD	16.2.2003	84	12	15	28	29	-36	-28	27	31	29.1	28
20	EHAM	17.2.2003	126	26	32	32	36	-10	0	-3	12	27.6	30.7
21	EHRD	23.2.2003	96	16	26	24	30	-27	8	-4	20	29.0	30.2
22	EHAM	24.2.2003	148	6	46	48	48	-83	24	26	26	34.8	29.4
23	EHRD	2.3.2003	66	6	30	12	18	-60	87	-29	0	24.4	27.8
24	EHAM	3.3.2003	76	15	35	16	10	-11	84	-20	-50	22.8	31

Table 10: Figures regarding the 23 analysed flights

The table above shows the following information, regarding three leg flights with an intermediate stop at Maastricht, in the numbered columns:

1. Flight number. The flight marked with ➔➔ (number 9) is the incident flight under investigation;
2. The departure aerodrome;
3. The date of flight;
4. The total number of passengers that had been assigned a seat;
5. The absolute number of passengers that had been assigned a seat in cabin section A;
6. The absolute number of passengers that had been assigned a seat in cabin section B;
7. The absolute number of passengers that had been assigned a seat in cabin section C;

8. The absolute number of passengers that had been assigned a seat in cabin section D;
9. The deviation (in %) from the figures in the passenger distribution table for cabin section A;
10. The deviation (in %) from the figures in the passenger distribution table for cabin section B;
11. The deviation (in %) from the figures in the passenger distribution table for cabin section C;
12. The deviation (in %) from the figures in the passenger distribution table for cabin section D;
13. The MAC value (in %) for take-off. For the determination of this value, the airlines' load and trim sheet program and the following figures were used: the basic weight and the basic index of the aircraft involved, a standard load distribution (20/80), the planned transit baggage, the take-off fuel, a catering index of 0.1, a passenger weight of 84 kg and a passenger distribution according to the seat assignments.
14. The aft MAC limit (in %) for take-off. This value was read out of the graphical part of the load and trim sheet.

Note:

- For flights 1, 2, 3, 4, 5, 6, 17, 19 and 23 the fuel figures were based on other flights with a same routing, because no fuel data was available anymore for those flights.
- For flights 2, 14 and 19 the transit baggage weights were bases on other flights, because no data was available anymore for those flights.

APPENDIX H: CORRECTIVE ACTION REPORTS

Corrective Action Report

Transavia airlines
Safety & Quality Assurance

Audit finding

To be completed by S&QA-department

CAR number:	FO-06-040901-01
Finding:	It is not shown in the CSM B 1.1.1-4 towards which criteria the purser can verify if the passengers are evenly distributed as required in the BOM 8.1.8-4. It is also not clear if verification should be done per cabin section. The role of the purser is not clear in the BOM statement: .....the number of passengers actually must correspond with the final figures..... (appendix 1 to JAR OPS 1.605(d)(1)) In the CSM the principles of mass and balance is not clearly described with respect to the tasks and responsibilities of cabin crew and the communication about this subject to the cockpit crew. (JAR OPS 1.610) It is not shown in the CSM how the cabin crew should act in case of extreme passenger weight situations. (JAR OPS 1.620 (b))
Reference to applicable requirements:	appendix 1 to JAR OPS 1.605(d)(1) JAR OPS 1.610 JAR OPS 1.620 (b)
Level:	2
Initial reply before:	31-10-2001
Final compliance date:	31-03-2002
Date: Name / signature auditor:	041001

Proposed Corrective action

To be competed by responsible auditee

Corrective action proposal:	Applicable CSM procedure will be revised to address the weight & balance issue/extreme passengers issue.
Final compliance date:	December 1, 2001
Name / function responsible auditee:	
Date / Signature auditee:	23 October 2001.

Reply to Corrective action proposal

To be completed by S&QA-department

Comment on proposal:	Accepted for the time. Closure of the CAR can be done pending the answer of CAR –02 of this audit. In this CAR the pilots way of checking the assumption of equally spread must be described. By telcom between HSC and WST also the role of the organization responsible for check-in has been discussed. In this case also the ASM should be revised. It should be noted that the relation between cockpit – cabin – groundhandling must be clear before closing CAR –01 and –02.
Comment on final compliance date:	No objection

Corrective Action Report

Transavia airlines
Safety & Quality Assurance

Date / signature auditor:	291001

Follow up report

To be completed by responsible auditee

Corrective action implementation status:	CSM wijziging heeft plaatsgevonden m.b.t. "weight & balance and extreme passenger" issue. Conformatie aan cockpit aangaande de gelijkmatige verdeling over de cabine wordt opgenomen in het cabin OK statement (middels revisie om BOM en CSM). VTZ zal Ground Services voorzien van informatie die moet borgen dat al in het check-in proces de gelijke verdeling wordt bewerkstelligd. Middels het ASM wordt deze instructie dan aan de afhandelaar gecommuniceerd. Ter info: 1. Een project genaamd LTS is opgestart om o.a. de integriteit van de W&B bereking te verbeteren. Ook zal in dit project de layout van het W&B sheet worden gewijzigd (verbeterd). 2. Transavia maakt gebruik van een operationele W&B enveloppe welke meer restrictiever is dan de AFM enveloppe. De operationele enveloppe borgt dat o.a. gear/flap retraction, inflight movements en pax deviations per cabin section, binnen de AFM enveloppe blijven.
Date / signature auditee:	28-06-02

Closure of Corrective action report

To be completed by S&QA-department

Comment on corrective action implemented:	Akkoord met voorstel. Na telcom met HSC overeen gekomen om CSM/BOM aanpassing op kort termijn via TI (gele pagina) te introduceren. Na implementatie LTS project zal dit onderwerp wederom aan de orde komen teneinde te verifieren of verbetering juiste effect heeft opgeleverd. Betrokkenheid van VTZ bij update van ASM mbt W&B en andere vlieg-operationele issues is noodzakelijk. **Deze CAR is gesloten.**
Date / signature auditor:	280602

Corrective Action Report

Transavia airlines
Safety & Quality Assurance

Audit finding

To be completed by S&QA-department

CAR number:	FO-06-040901-02
Finding:	It is not demonstrated that the number of passengers actually must correspond with the final figures of the actual distribution per cabin section. (BOM 8.2.2-3 and appendix 1 to JAR OPS 1.605(d)(1))). It is not shown that the cockpit crew is able to check the assumption that the passengers are equally spread per cabin section and how to act in case of deviations. (JAR OPS 1.610)
Reference to applicable requirements:	appendix 1 to JAR OPS 1.605(d)(1) JAR OPS 1.610
Level:	2
Initial reply before:	31-10-2001
Final compliance date:	31-03-2002
Date: Name / signature auditor:	041001

Proposed Corrective action

To be competed by responsible auditee

Corrective action proposal:	The weight & balance process will be evaluated. After this evaluation, applicable documentation will be revised.
Final compliance date:	April 1, 2001
Name / function responsible auditee:	
Date / Signature auditee:	November 5, 2001

Reply to Corrective action proposal

To be completed by S&QA-department

Comment on proposal:	No objection, keep S&QA informed about progress. Verification of suggestions and/or 'brainstorming' before implementation of proposals is advised.
Comment on final compliance date:	Agreed
Date / signature auditor:	051101

Corrective Action Report

Transavia airlines
Safety & Quality Assurance

Follow up report

To be completed by responsible auditee

Corrective action implementation status:	In het CSM is een note toevoegd aangaande equally distribution of passengers (zie ook FO-06-01). Voor een correcte conformatie naar cockpit crew wordt het CSM B1.1, page 8. als volgt aangepast: Conditions for cabin ok: - Safety equipment:....checked - Passengers: equally spread distribution corrected number on board - Slides... - Etc
Date / signature auditee:	June 19, 2002

Closure of Corrective action report

To be completed by S&QA-department

Comment on corrective action implemented:	Akkoord met voorstel. Zie ook antwoord op CAR -01 van deze audit. Spoedige revisie op CSM/BOM is gewenst. **Deze CAR is gesloten.**
Date / signature auditor:	280602

APPENDIX I: JUSTIFICATION OF INVESTIGATION

Investigators employed by the former Dutch Transport Safety Board (DTSB) which, on the 1st of February 2005 merged into the Dutch Safety Board (DSB), conducted the investigation. The investigation was carried out in conformity with the European and ICAO Annex 13 directives[27] that apply to aircraft accident and incident investigations. The Board is responsible for the investigation and formulates the recommendations that follow from the results of the investigation.

The serious incident with PH-HZB, Transavia airlines Boeing 737-800, was reported to the picket investigator on January 12th 2003. The same day, two investigators of the DTSB started the investigation on Rotterdam Airport. In collaboration with the Aviation Police, these investigators, among other things, counted and weighed the luggage in the cargo holds.

Shortly after the incident, the National Transportation Safety Board (NTSB), was informed about the occurrence. On behalf of the state in which the aircraft was designed and manufactured the NTSB assigned an accredited representative. Eventually, the NTSB's contribution to the investigation limited itself to a database-search.

Two employees of Transavia airlines' Safety & Quality Assurance department and a member of the Accident Investigation Group (AIG) of the Dutch Airline Pilots Association (ALPA) were added to the Safety Board's investigation team.

The investigation team conducted interviews with the captain, the first officer and the purser (of the flight concerned), employees of Transavia airlines, employees of the ground handling company Aviapartner, inspectors of the Dutch Civil Aviation Authority (CAA) and pilots flying on the Boeing 737-800.

The results of the investigation by the Aviation Police, on behalf of the Public Prosecution, were handed over to the investigation team of the DTSB.

Air Traffic Control the Netherlands delivered information about the available radio communication. The Royal Dutch Meteorological Institute (KNMI) provided the investigation team information about the weather conditions of the day of the occurrence.

Tripod Beta was used for analytical purposes. See Appendix J.

Based on the available information regarding facts and (underlying) factors of the incident the aviation committee of the DSB completed the draft report. Subsequently, the draft report was sent in May 2005 for review and comment to the captain, the first officer, and the purser of the flight concerned, the director Operations of transavia.com, the director of Aviapartner, the Dutch Civil Aviation Authority, the Dutch Aviation Directorate-General, the NTSB and the Boeing Company.

The comments on the draft report resulted in a number of meetings with the director Safety & Quality Assurance of transavia.com, Aviapartner's station manager at Rotterdam airport and a member of the AIG of the Dutch ALPA. The project manager and a senior investigator represented the DSB during these meetings. The comments and meetings resulted in a redraft of the report. In July 2006 this new version of the report was sent again to the parties involved for review and comment. Relevant comments on the second draft report were incorporated in the final report.

Finally, the Safety Board formulated four recommendations to prevent similar occurrences in the future.

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[27] Directive 94/56/EG of the Council of the European Union of November 21st 1994 '*concerning determination of the principles for the investigation of accidents and occurrences in civil aviation'* and the *International Standards and Recommended Practices of Annex 13 'Aircraft Accident and Incident Investigation'* of the International Civil Aviation Organization (ICAO).

APPENDIX J: TRIPOD ANALYSIS

Tripod analysis

This study used Tripod-Beta as an accident analysis tool. Tripod Beta is based on Tripod theory which has been developed to explain and control human error in incidents and accidents. Tripod theory is based on two assumptions: (1) to a large degree, accidents are the direct result of human error, and (2) human errors are shaped and provoked by upstream workplace and organisational factors. Stated differently, according to Tripod theory humans err because the work setting or working conditions invite them to do so.

The Tripod Beta accident analysis tool assists researchers in answering the following questions.

- *What happened?*
  Tripod Beta accident analyses starts by the identification of the Top Event (unwanted final event such as a tail strike) and the unwanted events that preceded the final unwanted event. An unwanted event in Tripod Beta is the direct result of a "hazard" (e.g. centre of gravity behind the aft limit) which harms or alters a "target" (e.g. safety of the flight). Accordingly, in the subsequent step of Tripod Beta analyses, for each unwanted event the corresponding hazards and targets are identified. The event and corresponding hazard and target constitute a HET-trio.

- *How did this happen?*
  In order to prevent the "hazard" from harming the "target", organisations bring about barriers that control the hazard or defend the target. For instance, the barrier that may control the hazard "*centre of gravity behind the aft limit*" from harming or altering the target "*safety of the flight*" is "*reseating the passengers equally over the aircraft*". According to Tripod Beta, accidents will occur only when all barriers fail (i.e., failed barrier) or are not in place (i.e., missing barrier). Accordingly, in the next step of Tripod Beta accident analysis, for each HET-trio the missing and/or failing barriers are identified.

- *Why did this happen?*
  According to Tripod Beta, barriers fall short because of an active failure or immediate cause. Active failures or immediate causes are technical or human errors as a result of which the barrier, as implemented by the organization, falls short. In the present case, for instance, the barrier "*reseating passenger*" failed because the captain did not take appropriate action after the purser reported an unequal passenger distribution. In the next step of Tripod Beta accident analysis these active failures are identified and scrutinized. Subsequently, the preconditions that may explain the occurrence of the active failure (e.g. "*the captain's lack of awareness about the harmful effect of an equal passenger distribution*.") are identified in Tripod Beta. Finally, the structural shortcomings or latent failures at the organisational level (e.g. "*Inadequate response to audit results*") that are responsible for the preconditions are identified and examined.

Figure 1 depicts the results of the Tripod analyses in a simplified diagram. More specifically, the sequence of events and corresponding hazards and targets (HET-trio's) that, eventually, resulted in the top event (i.e., tail strike) is presented. Furthermore, figure 1 indicates for each HET-trio (1) which barrier could have prevented the unwanted event and (2) which active failure formed the immediate cause for the barrier to fail. Inspection of figure 1 reveals that:

- Aviapartner did not assign the seats to the passengers in accordance with the passenger distribution table in ASM. As a result, passengers seated themselves in the rear of the cabin;
- Consequently, the aircraft's centre of gravity was situated behind the applicable aft limit. This deviation was not rectified by reseating the passengers;
- Because of this, the aircraft pitched nose-up just after take-off thrust had been selected. Subsequently, this movement stopped when the aft fuselage and the tailskid assembly contacted the runway (i.e., tail strike during take-off).

For both barriers, the present report describes how and why these "controls" failed. In this respect, and in agreement with Tripod Beta, the report distinguishes between preconditions and latent failures at the organisational level. To uphold the readability of the diagram the preconditions and latent failures are not included in figure 1, but are presented separately in table 11.

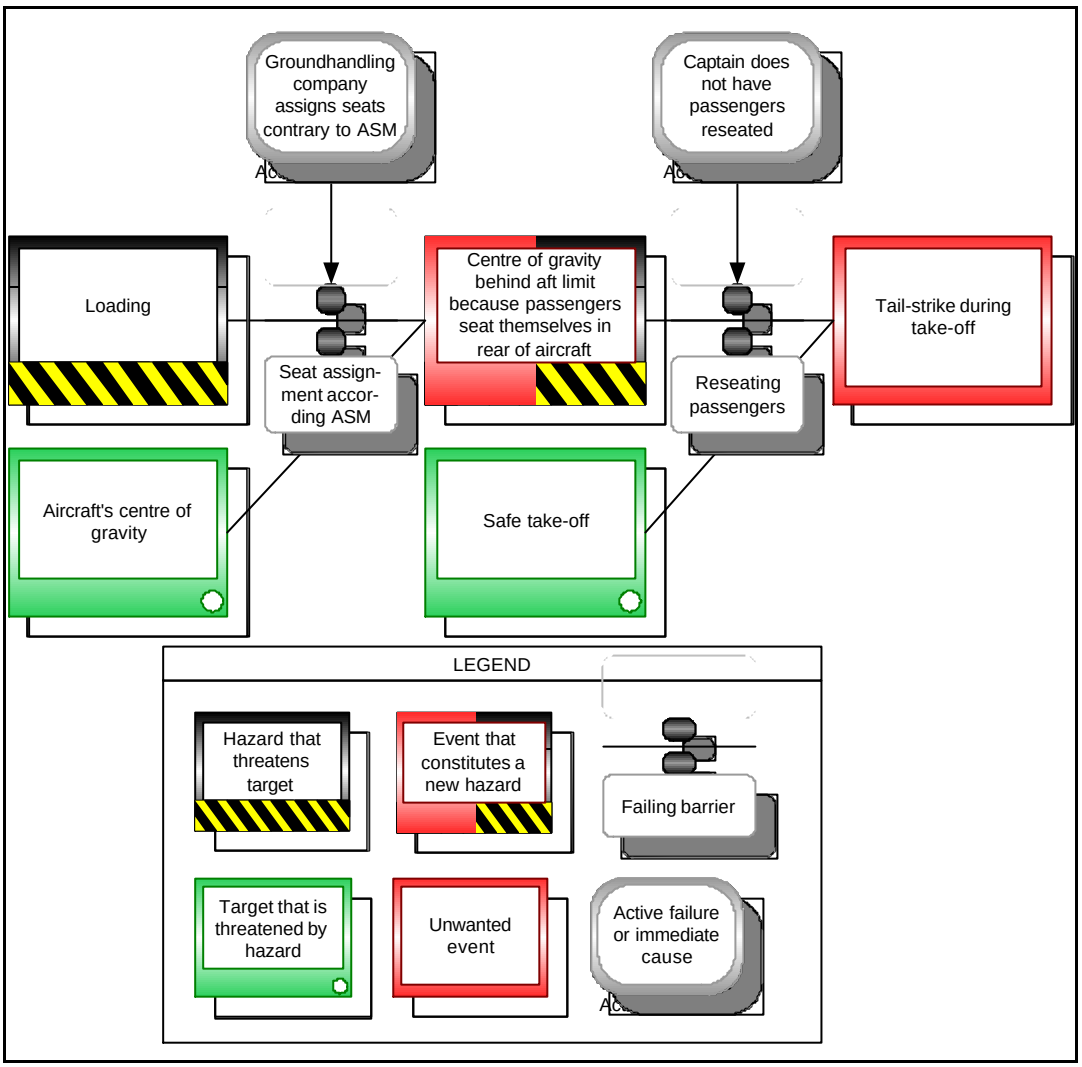

Figure 1: Simplified diagram of the Tripod analysis of the "Tail strike" of the Boeing 737-800 during take-off at Rotterdam airport on January 12th 2003

Barrier	Active failure	Precondition	Latent failure	Responsible party
• Seat assignment in accordance with ASM	• Contrary to ASM, Aviapartner assigns seats unequally to passengers.	• Aviapartner's staff was unfamiliar with ASM	• Transavia Airlines' quality system with respect to seat assignment is inadequate. This is indicated by: - Insufficient supervision over the seat assignments by ground handling companies; - No assurance that Aviapartner was familiar with ASM and was staffed by trained personnel who had sufficient knowledge of their responsibilities.	• Transavia Airlines
			• Aviapartner did not give sufficient training to its Passenger Service employees on the use of the passenger distribution table in the ASM.	• Aviapartner
			• The absence of a legal basis for the certification of ground handling companies.	• CAA
		• The loading process took place separately from the load and trim sheet preparation.	• The Dutch Safety Board did not investigate latent failures at the organisational level that may have preceded this precondition.	• Transavia Airlines
• Reseating passengers	• The captain did not have the passengers reseated.	• The cockpit crew's lack of awareness about the harmful effect of an equal passenger distribution.	• Transavia Airlines' quality system with respect to passenger distribution fell short at a number of issues. This is indicated by: - Inadequate response to results from audits related to mass and balance issues. No evaluation of the effectiveness of the corrective actions; - Inadequate occurrence reporting of passenger loading errors; - Inadequate follow-up of the occurrence reports regarding passenger loading errors.	• Transavia Airlines
		• Inadequate procedures, tools and definitions in BOM and CSM about passenger distribution.	• The Dutch Safety Board did not investigate latent failures at the organisational level that may have preceded this precondition.	• Transavia Airlines

Table 11: Overview of failing barriers and corresponding preconditions and latent failures