Runway overrun Onur Air

Runway overrun after rejected take-off of the Onur Air MD-88, registration TC-ONP, at Groningen Airport Eelde on 17 June 2003

The Hague, 6 April 2006 (investigation number 2003071)

THE DUTCH SAFETY BOARD

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[1] Untill 1st February 2006.

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CONSIDERATION

Please find herewith the investigation report of the Dutch Safety Board into the accident with a MD-88 (Boeing McDonnel Douglas) of the Turkish charter company Onur Air at the Groningen Airport Eelde. On June 17th, 2003 the crew rejected the take-off at a late stage, as a result of which the aircraft overran the runway ending. The aircraft and part of the airport infrastructure sustained serious damage. 142 passengers and 7 crew members were on board of the aircraft. None of the occupants sustained any serious injuries as a result of the accident.

The investigation shows that the crew initially rejected the take-off when an acoustic alert signal was activated. This signal pertained to a warning for an incorrect setting of the trim of the longitudinal control system. When carrying out a check the crew did not find any peculiarities, although these were present. After this short interruption the take-off was resumed and this time, when the (repeating) sound alert signal went off, the signal was ignored. It is the Board's view that take-off should not have taken place with this signal. During the investigation a number of other operational flaws were also found, mainly pertaining to the load and the corresponding location of the centre of gravity of the aircraft and the manner these were dealt with operationally.

When the captain noticed that the control force required to rotate the aircraft was significantly higher than normal he decided to reject the take-off. At that moment the remaining runway length was too short to bring the aircraft to a complete stop before the runway end. After the aircraft overrun the runway end and collided with the approach lights and underground concrete structures of the approach lights system it came to a standstill in the soft soil, with serious damage as a result.

The evacuation took place shortly after the aircraft came to a stop. The most important findings regarding the evacuation are: the cabin crew did not give enough evacuation instructions and not all the available cabin exits were used. This hindered the evacuation. Furthermore, most of the passengers stated that the crew spoke English in an insufficiently clear manner.

The presence of underground electricity wells[1] in soft soil near the take-off and landing runway increases the risk of fire in the event of a collision. In this accident no fire occurred and this is why it did not lead to serious consequences for the passengers and crew. The evacuation after the accident was difficult.

According to the Board, with respect to safety, ignoring the (repeating) acoustic alert signal is very wrong and very serious indeed. Onur Air recognised this after having been granted access to this report and immediately took internal measures after the incident.

However, the Board wondered whether this was an incidental mistake or a structural safety shortcoming within the Onur Air organisation.
Given the issue described above -structural and/or incidental- the Dutch Safety Board investigated whether there were more accidents with Onur Air and whether similar accidents had occurred on any where else. In its report, the Board restricted itself to the ICAO database. The Board also used a recently published report from the French BEA (Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile / Bureau for Investigations and Analyses for civil aviation safety). This report concerns a fatal accident with a Boeing 727 in Benin (Africa) on December 25th, 2003.

Investigation of the ICAO database revealed that no other (published) accidents of Onur Air are known. However, 37 similar accidents are known to have occured since 1995 world-wide. Out of these, there were 30 cases in which, after a take-off was rejected, an aircraft overran the end of the runway. In most cases it was a take-off that was rejected after the so-called V1 take-off decision speed[2] had been passed (as was the case for the Onur Air accident). In many cases the aircraft performances had decreased by a higher actual aircraft weight and an incorrect position of the centre of gravity. In one instance a warning system was also ignored. In some of these cases, engines that were mounted below the wing(s) broke off, often resulting in fire.

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[1] In line with the start runway in question are concrete transformation wells containing equipment for lighting the runways.

[2] V1 is the speed the pilot uses as a reference for the decision to continue or break off take-off. In the latter case, the remaining runway length still allows stopping.

ESTABLISHING WEIGHT AND CENTRE OF GRAVITY

The investigation of the warning system and into the measurement of the centre of gravity showed that the same steering force problems could occur without activation of the warning system. The investigation also revealed that the most important contributing factor to the control forces being too high was the fact that the actual centre of gravity was located much more to the front of the aircraft than the crew had calculated.

It turns out this also plays a crucial role in a recently published report from the French BEA on the Boeing 727 that crashed with over 130 fatalities in Benin on December 25th, 2003. During the take-off the aircraft did not rotate adequately and it crashed in the sea after the runway end.[3] Comparable centre of gravity problems also arise during the investigation into a serious incident with a Boeing 737 of Transavia at Rotterdam Airport in 2003, which investigation is still pending.

The manufacturer of the MD-88 in question states that precise data are required in order to set the stabilizer adequately. This means that the procedures (calculation of the centre of gravity and loading of the aircraft) must be executed in a correct manner. If this is not the case, for instance due to human failure, the actual centre of gravity can deviate (possibly even significantly) from the centre of gravity as entered in the aircraft systems. Because this can not be established for many aircraft, a so-called 'self sensing system' seems necessary.

The current generation of aircraft are equipped with several systems that protect humans (the pilots) against failure, precisely because they are so paramount for safety. It is striking that this has not yet been solved for problems pertaining to the centre of gravity, because, in the Board's view, this is in the same league as for instance the (a) stall speed warning system[4], (b) ground proximity warning system (GPWS), [5] and (c) landing gear systems.[6]

The developments within the newest aircraft, such as the Boeing 777 and the Boeing 747-400, which are equipped with systems to measure the centre of gravity, indicate that the sector recognises the importance hereof. However, there is no obligation stemming from the governmental authorities to have such systems installed in new aircraft. As this obligation is lacking, many aircraft are not equipped with this safety equipment and therefore airlines and supervision authorities must pay extra attention to issues pertaining to load.

As a result of the accident with the Onur Air aircraft, the Board has looked into the governmental supervision regarding (foreign) charter airlines in order to establish to which extent possibilities for improvement exist, thereby decreasing the risk of accidents such as that of Onur Air.

GOVERNMENTAL SUPERVISION ON SAFETY

The basic principle of international civil aviation is that airlines are certified by the state where the aircraft is registered or by the state in which the airline is based. This certification (including the supervision on the safety) is accepted just like that by other countries. This principle was used for years and years within most countries of the world, including the European Union and therefore the Netherlands too.

As of 1996 there was a significant change in this situation. After a series of accidents, reaching an all-time low with the accident of a charter flight of a Turkish registered Boeing 757 headed for Frankfurt, which crashed into the Atlantic Ocean shortly after take-off, before the coast of the Dominican Republic on February 6th, 1996, during which all 189 occupants (mainly German tourists) were killed[7], an initiative was taken to inspect foreign (that is: *all*) airlines at European airports. This initiative is known as the SAFA-programme (Safety Assessment of Foreign Aircraft). Governmental authorities carry out SAFA-inspections. The results of these SAFA-inspections are stored in an international database and are managed by the Joint Aviation Authorities (JAA).

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[3] The BEA-report mentions as a direct cause: "*The difficulty that the crew encountered in performing the rotation with an overloaded aeroplane whose forward centre of gravity was unknown to them*".

[4] Warning system for a flying speed that is too low.

[6] Warning system for landing-gear that is not functioning well.

[7] The cause of the accident was a blocked pitot tube, due to which the captain's speed indication was unreliable. The causes mentioned by the investigation report are, among others, safety shortages concerning the aircraft maintenance, the way the flight was carried out, knowledge on aircraft systems and the lack of crew resource management.

Further on in this consideration we will elaborate on the JAA's role. The Dutch Safety Investigation Board requested the SAFA-inspection reports in question.

The accident with Onur Air at Eelde happened on June 17th, 2003. In Europe SAFA-inspections were carried out on at least 38 Onur Air flights from January 2002 up to the day of the accident. Most of these SAFA-inspections took place in France and Germany and one in the Netherlands. In the first half of 2003, before the date of the accident, no SAFA-inspections of Onur Air flights took place in the Netherlands. SAFA-inspections are not aimed at identifying structural underlying safety shortages, but provide an indication of items which require closer examination.

How is the safety in aviation organised?

How is it possible that, nonetheless, an accident takes place in which serious safety shortages are found such as those in this Onur Air flight? In order to explain this one must first explain how the safety management system is organized in aviation. On the one hand, the (certified) regulations for use and maintenance of the aircraft's manufacturer apply. On the other hand international aviation regulations aimed at flight safety apply.

The basic principle of international legislation is that every state keeps its sovereignty and is therefore responsible for its own supervision on aviation regulations and safety. International legislation has an influence on this. In the case of aviation operations between Turkey and the Netherlands international organisations and treaties partially determine the organisation of the safety supervision on such aviation operations.

International Civil Aviation Organisation ICAO

The international civil aviation organization (ICAO) is the most important organization, it came about after the Chicago convention of 1944 and is a United Nations agency. The ICAO has provided a minimum number of standards and recommended practices for the safety of international civil aviation. The Dutch Safety Board considers the fact that these are only the most basic requirements to be an inevitable consequence of the compromises reached between the (current) 188 ICAO-member states: the ICAO-rules must be considered as 'the international minimum safety level required starting from the principle of equal opportunities'.

Within the ICAO system, individual countries bear their own responsibility regarding their own aviation, but they do have to adhere to the ICAO's standards and recommendations. This implies that the standards have to be laid down in national legislation and regulations. If they deviate from the ICAO standards and/or recommendations, member states must report this to ICAO. There is no penalty policy linked to the compliance with the ICAO-rules at an international level. Based on the deviations that are reported airlines are able to decide whether they can/want to fly to a country whereas member states are able to check whether they wish to receive an airline from another member state.

In practice, it turns out that not every country complies with the ICAO standards, although no deviations have been filed. Eventually, for ICAO this led to starting a programme in 1996 subjecting the national governmental authorities that are responsible for legislation and regulations in civil aviation to an inspection (audit) ('top-down'). This is an audit with a follow-up. At the end of 2005, a new cycle (audit + follow-up) was started by ICAO amongst the member states. During this audit ICAO looks into the implementation of the ICAO standards by the government concerned.

European Civil Aviation Conference

Apart from the ICAO there are still other (regional) international organisations that deal with (safety) legislation. One of them is the intergovernmental (European) organization: the European Civil Aviation Conference (ECAC), founded in 1955.
When a number of western and eastern European countries founded the ECAC, this underlined the aviation interests for this region[8].

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[8] The ECAC consists of 42 member sates, including all 25 EU member states, www.ecac-ceac.org

This follows, among other matters, from the ECAC's objectives upon its formation:
"(…) *generally to review the development of intra-European air transport with the object of promoting the co-ordination, the better utilisation and the orderly development of such air transport* (…)".

The ECAC supports the ICAO's starting-points. The objectives of the current ECAC-organisation are:

- *Harmonisation of civil aviation legislation and practices among the member states;*
- *Promoting understanding concerning the aviation policy between member states and other parts of the world.*

An organisation that is linked to the ECAC is the JAA: the Joint Aviation Authorities (JAA), in which a number of European national governmental authorities that are responsible for legislation (including the supervision on safety) in civil aviation are joined[9]. Because differences in legislation between ECAC-member states continued to exist, a number of European countries came together in 1970, in the context of the ECAC-objectives, to make arrangements on joint certification rules for large civil aircraft and aircraft engines. Initially, these arrangements were necessary for the European aviation industry (including Airbus). Since 1987, the JAA's sphere of activities has expanded to developing and implementing common safety legislation and procedures. This co-operation aims at obtaining high and consistent safety standards and a 'level playing field' for competition within Europe. In this regard, the importance of harmonising the JAA legislation with the American legislation has been emphasised.

ECAC members are welcome to join the JAA. The ECAC-member states themselves are responsible for implementing the JAA-legislation in their national legislation. As is the case with the ICAO-rules, there is no penalty policy at international level linked to compliance to the JAA-rules.

When the JAA came about, the road was taken towards a more uniform legislation between the ECAC-member states. However, there was no tool to inspect whether the aircraft complied with the legislation. Partly as a consequence of a series of accidents, the ECAC member states started the SAFA-programme (Safety Assessment of Foreign Aircraft) in 1996. The SAFA-programme entails the following: at their airports, the ECAC-member states are entitled to inspect all aircraft of the other ECAC-member states and aircraft of non-ECAC member states. This ECAC 'bottom-up' inspection of aircraft is complementary to the ICAO-audits performed of governmental authorities that are responsible for the supervision on safety ('top-down').

The results of the ICAO-audits and the SAFA-inspections are stored in international databases and are accessible for the member states. Both for the ICAO-audits and for the SAFA-inspections the frame of reference consists of the ICAO's (minimum) requirements, also known as the ICAO standards. The Dutch Safety Board holds the view that it would be a good thing if the safety information that can be derived from the audits became available to the public. This should happen in such a way that it would not have a negative impact on the quality of the audits.

Civil Aviation Safety Organisation of the European Union

Because differences in implementation of the JAA-legislation between the ECAC-member states remained (JAA-legislation cannot be imposed on the ECAC-member states), the 25 ECAC-member states that are also member of the European Union, founded the European Aviation Agency (EASA), an agency of the European Union. As of the 28th of September 2003, EASA gradually started taking over tasks from the national airworthiness authorities. Moreover, JAA-rules are binding and the JAA will be abolished within a period of two to three years.

EU-member states must adopt the EASA-legislation unabridged, so that there can be no differences in legislation between the EU-member states. As not yet every ECAC-member state is a member of the EU and in order to uphold unity within the European continent, the JAA-as mentioned earlier-will continue to exist for a few years still.

Turkey is a full-fledged JAA member. It arose from investigations that a planned JAA-audit to assess the implementation status of the JAA legislation was postponed as a consequence of the banishment of Onur Air in 2005. This audit was carried out in November 2005.

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[9] There are 40 JAA-member states. The JAA-member states are all ECAC-member states. 25 JAA member states are also EU-member state, *www.jaa.nl.*

AIR TRANSPORT AGREEMENT

Before a foreign airline is allowed to fly to a Dutch airport a so-called 'air transport agreement' is drafted between the government from state of the operator and the Dutch government. In the case of Onur Air these are the Turkish Civil Aviation Authority (CAA) and the Dutch Directorate-General Transport and Aviation of the Ministry of Transport, Public Works and Water Management. In the agreement between Turkey and the Netherlands there is no section on safety. It is known that ECAC promotes using a safety section in the agreement since 1997.
In 1997, the Dutch government, when conducting talks with Turkey, suggested including a provision on safety. Turkey did recognise the necessity and the value hereof but was afraid the application thereof would be unilateral. To-date, there is no safety section in the treaty between the Netherlands and Turkey.
Since 2003 the Dutch government automatically includes a safety section in air transport agreements.

During the investigation into the Onur Air accident it came to light that the available information from ICAO audits and SAFA inspections is not studied prior to the (annual) renewal of the permission to fly to Dutch destinations.

SAFA-INSPECTIONS

Investigation revealed that the SAFA-inspections are limited in scope and nature. During a SAFA-inspection inspectors look at the aircraft and flight documents, there is a visual inspection of the general state of the aircraft and the state of the mandatory safety equipment in the cabin is checked. The SAFA-inspectors are not allowed to open any panels or hatches themselves and do not perform flight inspections. As SAFA-inspections are not very elaborate, they can only be indicative and do not replace adequate governmental supervision of the state of registry or the state of the operator.

The findings stemming from the SAFA-inspections are divided in three categories, depending on how serious they are. Category 3 findings are the most serious.
There is no penalty system linked to the SAFA-inspections at an international level.
Penalties can only be imposed through national legislation and rules.
In the Netherlands the following penalties can, among others, be imposed for category 3 findings:
- grounding the aircraft for 6 hours (article 11.2 part 3 Aviation Act);
- banning the aircraft or the airline (article 1.3 and 5.3 Aviation Act).

At the end of 2003 a report was issued from the Civil Aviation Authority, the Netherlands, which mentions the results of an investigation into the ground operations at airport Schiphol[10]. The reason for this report was that there had been an increasing number of signals of unsafe situations at the ground handling services during an earlier, global investigation in 2001. The Civil Aviation Authority, the Netherlands (IVW DL), the transport department (IVW DV) and the Labour inspectorate participated to the investigation in 2002-2003.

One of the results was that more attention had to be given to the loading of aircraft in general. Therefore, the Inspectorate carried out more inspections into the loading of aircraft. As a consequence thereof the number of SAFA-inspections at Dutch airports was increased. Among others, the so-called 'low cost holiday carriers' where the governmental supervision of the country of origin was considered insufficient, were looked at closely.

Because a uniform approach within the EU was lacking, the European Commission announced that the SAFA-programme would become embedded in EU-legislation. Moreover, in November 2005 the European Commission reached an agreement on uniform standards for drawing up a blacklist of airlines that have been banned by member states.

The EC also made proposals on extending EASA's competencies in the, among others, following areas:
- checking whether aircraft comply with essential EU-safety requirements;
- certification of aircraft that do not come from EU member states in the same manner as happens in the United States.

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[10] *Safety First, Nulmeting van grondafhandeling op de luchthaven Schiphol,* 12 November 2003, www.ivw.nl.

It appears that the method used in the United States[11], whereby the FAA only gives foreign airlines permission to fly to destinations within the United States after a certification, has been used for many years now. This method allows banning airlines that do not comply with the FAA safety requirements, including the ICAO requirements or those airlines of which the governmental supervision in the country of origin is not always sufficient. To-date no EU member states provides certification to airlines that come from non-EU member states.

OVERRUN AREA

Investigation revealed that at the Groningen airport, in the area after the end of the runway, the so-called 'overrun area', there are underground concrete structures (transformation wells) in soft soil. The Dutch Safety Board holds the view that such a combination (underground structures and soft soil) entails a great fire hazard for the occupants in the event of a collision (the aircraft fuel, the risk of ignition of sparks and the engines which are hot). As Onur Air's MD-88 is a type of aircraft of which the engines are not located under the wing, but are mounted on the rear side of the fuselage, reducing the risk of contact with the ground.

The Board is insufficiently aware whether the risk that has been established at the Groningen airport is characteristic for other (large) airports in the Netherlands. The Board therefore deems it desirable that this is investigated.

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[11] Federal Aviation Regulation Part 129: *foreign air carriers and foreign operators of U.S. registered aircraft engaged in common carriage.*

SUMMARY

As aviation has a worldwide nature, it remains complicated to build in enough safety guarantees by means of supervision. The Dutch Safety Board finds that, despite the limited inspection options in the country of destination, the SAFA-inspections can still provide serious findings (category 3).

The following statements can be made concerning the governmental supervision:

- The country where the aircraft is registered bears the main responsibility concerning supervision.
- When issuing and renewing air transport agreements, the Dutch government does not make enough use of the information it has at its disposal (ICAO-audits) on foreign governments who have the primary responsibility for the supervision of airlines abroad.
- Based on agreements that have been reached SAFA-inspections in the country of destination (not being the country of origin of the aircraft) are limited in scope and depth.
- There is no international penalty policy linked to the results of the ICAO-audits and SAFA-inspections.

In spite of all the ICAO and ECAC measures (respectively audits/follow-up and SAFA), various accidents, including the Onur Air accident of 2003, were not prevented. This confirms the board's suspicion that the structural safety shortage lies in the lack of sufficient supervision on safety, primarily by the company itself but also by the government. The aviation safety system is complex due to its worldwide nature. Therefore, the supervision by government remains paramount to safety in aviation. For this reason and because the Safety Board did not investigate the Turkish governmental supervision of Onur Air, nor the organization Onur Air in Turkey, the Board’s safety recommendations are mainly addresses to the competent Ministry of Transport, Public Works and Water management and Civil Aviation Authority of the Netherlands.

The Dutch Safety Board finds that the member states of ECAC or the EU have different policies when a member state finds that an airline has (structural) safety shortages. This can create uncertainty and confusion for the traveller (the citizen/civilian) on the safety level of the airline itself and can also lead to uncertainty and confusion for the airline itself. Therefore, a uniform approach within the member states is required.

All things considered the Board reaches the conclusion that the supervision of safety of aircraft in Europe needs to be stepped up The cautious steps the ECAC made in that direction in the past need to be continued more forcefully in EU-context. Therefore, the board felt positive about the measures the European Commission announced concerning uniform standards for assessing airlines that are put on a 'European' blacklist. The board also fully approves the proposals to extend EASA's competencies to verification of all aircraft to check whether they comply with European safety requirements, as well as certification of airlines that come from non EU member states.

It appears from the above that the EU is able to take necessary and effective measures. In the meantime it is important to check whether it is possible to extend the SAFA-inspections both in terms of quantity and in terms of quality and to make them applicable to all aircraft that fly to European airports. The latter can also prevent aircraft with flaws and/or structural safety shortages to continue flying if the supervising authority of the aircraft in question fails to notice this.

The Directorate-General Transport and Aviation and the Civil Aviation Authority could make more use of the available information on flaws in the foreign supervision (such as the findings of the ICAO-audits) and of the SAFA-inspections. This information can be the starting-point for safety clauses in air transport agreements between countries. Such a clause has a motivating effect for adequate foreign supervision.

RECOMMENDATIONS

INFRASTRUCTURE

- It is recommended to the Minister of Transport, Public Works and Water Management to investigate to which extent the requirements concerning the underground infrastructure in the direct vicinity of start and landing runways has to be stepped up to prevent serious damage to aircraft that overrun the runway.

MEASUREMENT OF WEIGHT AND CENTRE OF GRAVITY

- It is recommended to the Civil Aviation Authority, the Netherlands (IVW) to check in which way the risks of an incorrect load can be decreased in the short term by, among others, verifying how this aspect can be given more attention during inspections.
- It is recommended to the Civil Aviation Authority, the Netherlands (IVW) to develop certification requirements for aircraft from the civil aviation category, to provide weight and centre of gravity measurements to the crew of new aircraft and to investigate the possibility to provide these data with existing aircraft.

PERMISSION

- The recommendation is made to the Minister of Transport, Public Works and Water Management to review the system of permission for foreign operators so that:
  - All available safety information, such as for instance the results of ICAO audits, is used when assessing a request for permission.
  - Clear-cut agreements are made in the bilateral agreements concerning the guarantee of the flight safety as well as concerning the criteria that will be used when suspending the permission.

- The recommendation is made to the European Aviation Safety Authority (EASA) to stimulate attention being given on a European scale to the development of the method with which aviation authorities and airlines from non-EU countries can be assessed.

SUPERVISION

- The recommendation is made to the Minister of Transport, Public Works and Water Management to improve the supervision on foreign operators, in order to strengthen the governmental supervision on aviation, by:
- Making available the safety information present in the Netherlands regarding the airline in question and the supervising state to all the staff members involved in the supervision.
- To assess the SAFA-programme in the Netherlands and to suggest measures for improvement.

PROVISION OF INFORMATION

- The recommendation is made to the International Civil Aviation Organisation (ICAO) to verify in which way the results of the ICAO audits into the quality of the supervision in the member states can be made available to the public.
- The recommendation is made to the Minister of Transport, Public Works and Water Management to make its point of view on this issue known to the ICAO.

The chairman of the Board
prof. Pieter van Vollenhoven

General secretary
mrs. M. Visser

SYNOPSIS

During take-off at a speed of approximately 130 knots the captain, who was pilot flying, rejected the take-off above the decision speed because he experienced a heavy elevator control force at rotation. The stabilizer warning sounded during the entire take-off roll. The aircraft overran the runway end and came to a stop in the soft soil. During subsequent evacuation one cabin crew member and a few passengers sustained minor injuries. The aircraft sustained substantial damage. There was no fire.

LIST OF ABBREVIATIONS

AFM	aircraft flight manual
AIR	airworthiness of aircraft, an ECAC defined safety oversight area of expertise
AMM	aircraft maintenance manual
AND	aircraft nose down
ANU	aircraft nose up
AOC	air operator certificate
AOG	aircraft on ground
APU	auxiliary power unit
ART	auto reserve thrust
ASDA	accelerated stop distance
ATC	air traffic control
ATIS	automatic terminal information system
ATPL	airline transport pilot license
ATS	auto throttle system
˚C	degrees Celsius
CA	cabin attendant
CAA-NL	Dutch Civil Aviation Authority (in Dutch indicated as IVW-DL: Inspectie Verkeer en Waterstaat, divisie Luchtvaart)
CLMP	operational mode of the auto throttle system permitting manual throttle change without disengaging the system
CG	centre of gravity
CVR	cockpit voice recorder
deg	degrees (angle)
DGCA	Directorate General of Civil Aviation of Turkey
DOI	dry operating weight index
DOW	dry operating weight
DSB	Dutch Safety Board
ECAC	European Civil Aviation Conference
EASA	European Aviation Safety Agency
EU	European Union
EHGG	Groningen Airport Eelde (ICAO code)
EPR MAX	maximum engine pressure ratio
EPR NORM	normal engine pressure ratio
ESS	engine synchronization system
E&E compartment	electronic- and equipment compartment
FAA	Federal Aviation Administration
FD	flight director
FDR	flight data recorder
FL	flight level
FOD	foreign object damage
ft	feet
IATA	international air transport association
ICAO	international civil aviation organization
JAA	Joint Aviation Authorities
JAC	job card number
JAR-OPS 1	joint aviation requirements – operations part 1
KNMI	Koninklijk Nederlands Meteorologisch Instituut (Royal Dutch Meteorological Institute)
kV	kiloVolt
lbs	pounds (1 pound equals approximately 0.4545 kilogram)

m	meter
MAC	mean aerodynamic cord
MD-88	Boeing McDonnell Douglas MD-88
n.a.	not applicable
N1	fan rotor blade speed (%)
N2	core engine speed (%)
OHY	Onur Air (IATA code)
OM	operating manual
OPS	aircraft operations certification and supervision, an ECAC defined safety oversight area of expertise
ORG	civil aviation organization, an ECAC defined safety oversight area of expertise
PF	pilot flying
PNF	pilot not flying
QNH	barometric pressure at mean sea level according to standard atmosphere
RTOLW	regulated take-off length and weight
SAFA	safety assessment foreign aircraft
SARP	standards and recommended practices
SOI	safety oversight initiative
T.O.	normal thrust in take-off mode of the auto throttle system
TO-CG	centre of gravity during take-off
TODA	take-off distance available
T.O. FLX	derated thrust in take-off mode of the auto throttle system
UTC	coordinated universal time
USOAP	universal safety oversight audit program
V	Volt
V1	take-off decision speed
V_2	safe climb speed
$V_{\text{flaps up}}$	flaps up configuration speed
V_{mca}	minimum required speed for maintaining sufficient controllability
Vr	rotation speed
$V_{\text{slat retract}}$	slat retract configuration speed
VHF	very high frequency
W&B	weight and balance

1 FACTUAL INFORMATION

Place : Groningen Airport Eelde
Date and Time : 17 June 2003, 07:22 hours[2]
Aircraft : Boeing McDonnell Douglas MD 88
Operator : Onur Air
Flight Crew : 2, no injuries
Cabin Crew : 5, one minor injury
Passengers : 142, a few minor injuries
Type of Flight : holiday charter
Phase of Flight : take-off
Type of accident : runway overrun after rejected take off above V1
Runway condition : dry

1.1 HISTORY OF THE FLIGHT

Arrival at Groningen Airport Eelde
On 17 June 2003 at 06:21 an Onur Air Boeing McDonnel Douglas MD-88 registered as TC-ONP contacted Groningen Airport Eelde tower for landing on runway 05. The flight with number OHY 2263 originated from Dalaman (Turkey). On board were 7 crew members and 146 passengers. During the non-precision approach,[3] the aircraft was not properly lined up and too high for landing. A go-around was initiated at 6:28. The published missed approach procedure (i.e. climb 2,000 feet on track 053, contact ATC) was not followed. Instead, a left hand visual circuit was made at an altitude of 1,000 feet. ATC did not challenge this deviation from the standard procedure. The aircraft made an uneventful landing on runway 05 at 6:33.

At Groningen Airport Eelde 76 passengers disembarked. The 70 passengers with destination Maastricht-Aachen Airport remained on board. An additional 72 passengers with destination Dalaman boarded the aircraft making a total of 142[4] passengers on board.

Flight preparation
For the purpose of CG determination, the cabin is divided into two compartments. The load and trim sheet as prepared by the crew assumed 70 passengers in compartment #1 and 70 passengers in compartment #2. Seat allocation was not used for the passengers (free seating policy).

During the interviews with the Dutch Safety Board the captain and the first officer mentioned that with more than 80 passengers on board the free seating policy was standard. With less than 80 passengers on board, the passengers would have to be seated more in the centre of the aircraft. As 141 passengers were on board, it was mentioned by the cockpit crew that there would be no problem for the centre of gravity (CG) position. The purser stated that the aft part of the cabin had not been occupied by passengers. Her own position was in front of the cabin right behind the cockpit.

Sig, the ground handling agent at Eelde, did not have a contract with Onur Air to provide load sheet calculations. The handling agent presented to the crew the final passenger data: the number of males, females, children and infants and their respective assumed standard weights. These assumed standard weights differed from standard weights as used by Onur Air, see 1.6.4 *assumed passenger weights* in table 2. The handling agent also supplied the cargo weight and distribution figures.

During the turnaround at Groningen Airport Eelde the TC-ONP was refuelled with 2.630 liters (approximately 4,600 lbs) kerosene. According to the load and trim sheet the centre of gravity for take-off (TO-CG) was at 11.1% mean aerodynamic cord (MAC) and the take-off mass was 127,529 lbs. The first officer explained that he had checked the load sheet calculation, which had been made by the captain.

During flight preparation, the “Onur Air take-off performance chart with optimum flap setting for Groningen Airport Eelde runway 23” was used. This flaps setting was 24 degrees.

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[2] All times mentioned in this report are UTC (local time minus two hours).
[3] Published approach procedure for runway 05.
[4] 141 Plus one infant.

The flight phase

The first officer stated he performed a visual inspection of the aircraft (walk around). The wind information from the automatic terminal information system (ATIS) as recorded on the cockpit voice recorder (CVR) was 100 degrees with 5 knots and variable between 060 and 150 degrees. At 07:09 the start-up clearance for runway 05 as runway in use was received. On request of the flight crew runway 23 was approved for departure by ATC.

Engine start and taxi-out were uneventful. During taxi the flight was cleared for a domestic flight from Groningen Airport Eelde to Maastricht Aachen Airport as OHY 2264. The final destination was Dalaman (Turkey). At 07:18 the aircraft received take-off clearance for runway 23. Two flight crew members were in the cockpit. The captain was pilot flying (PF) in the left seat and the first officer was pilot not flying (PNF) in the right seat.

The captain stated that after the aircraft was lined up on runway 23 the take-off was initiated. After the throttles were advanced, the stabilizer warning sounded. The throttles were retarded and the aircraft stopped. The captain stated that the aircraft had moved five to six meters before it stopped. Eyewitnesses reported that 50 to 150 meters were used before the take-off run was resumed. One eyewitness estimated the used distance as 90 meters, approximately twice the length of the aircraft. Flight data recorder (FDR) data revealed that the aircraft entered the runway and initiated the take-off. After the aircraft stopped, the distance travelled was approximately 25 meters.

On the runway checks were performed. FDR data indicated a stabilizer position change from 6.8 to 7.2 degrees aircraft nose up (ANU). Thereafter the crew initiated a static engine spin-up. Again the stabilizer warning sounded. The crew released the brakes and started the take-off roll. From the CVR it is derived that during the entire take-off roll the warning sounded continuously.

When attempting to rotate the captain experienced a heavy elevator control force. The captain stated that he needed much more than normal back pressure on his control column to lift the nose. He felt ”it was impossible to make the take-off”, and as the nose did not rise he decided to reject the take-off. Post accident analysis revealed that the rejection was initiated at 128 knots.

Both pilots stated that during rejection brakes and reversed engine thrust had been applied, which is confirmed by the FDR readout. The aircraft overran the runway end with a speed of approximately 75 knots. During the deceleration in the soft soil, it hit the approach lighting system, including the concrete structures embedded in the ground. It came to a stop approximately 100 meters beyond the runway end. There was no fire. All occupants evacuated the aircraft safely. Some of them returned to the aircraft and re-entered it, to pick up their belongings. In addition, the pilots remained on board and only left the aircraft when instructed to do so by the fire brigade.

Crew interviews
During the interview, the captain stated that no technical anomalies were known before flight, and that the anti-skid system had been serviceable. He stated that the warning sounded again at a speed of 100 knots. About the same observations and actions were mentioned by the co-pilot, whereby he characterized the warning as a stabilizer motion warning. The co-pilot acknowledged that it is company policy to reject the take-off when a take-off configuration warning occurs. The captain stated that he considered the warning as false and therefore continued the take-off. The captain recalled that the calculated rotation speed (Vr) was 135 knots. According to the co-pilot, the captain initiated rotation at 120 knots.

1.2 INJURIES TO PERSONS

Injuries	Crew	Passengers	Others	Total
Fatal	0	0	0	0
Serious	0	0	0	0
Minor/None	7	142	0	149
Total	7	142	0	149

1.3 DAMAGE TO AIRCRAFT

The aircraft sustained substantial damage.

1.4 OTHER DAMAGE

Approach light system runway 05
Runway end lights runway 23

1.5 PERSONNEL INFORMATION

Flight crew

Captain : Turkish male, age 49
Date employed : 1 February 1996
Date upgraded to captain : 24 April 2003
License : ATPL, valid until 23 February 2004
Latest medical examination : Valid until 1 January 2004

Flying experience (hours)	: All types	MD 80/88
Total	7500	2096
Total within Onur Air	4960	2096
Last 90 days	196	196
Last 24 hours	4:30	4:30

First Officer : Turkish male, age 59
Date employed : 15 December 1997
License : ATPL, valid until 14 February 2004
Latest medical examination : Valid until 04 August 2003

Flying experience	: All types	MD 80/88/90
Total	11443	3428
Total within Onur Air	3428	3428
Last 90 days	152	152
Last 24 hours	4:30	4:30

Note: Cyprus Airways had previously employed the first officer from 1992 until 1997 where he acquired experience as captain on both the Boeing 727 and the Boeing MD-90.

Cabin crew

CA1 (Purser) : Turkish female, age 46
Crew station : Left forward door
License : Cabin attendant certificate, valid until 25 October 2003
Aircraft types: A321, A300 B4, A300 600, MD 88
Basic training : March 1999
Latest recurrent : November 2002

CA2 : Turkish female, age 28
Crew station : Aft door (Tail cone exit)
License : Cabin attendant certificate, valid until 10 October 2003
Aircraft types: A321, A300 B4, A300 600, MD 88
Basic training : March 2000
Latest recurrent : October 2002

CA3 : Turkish male, age 23
Crew station : Aft left service door
License : Cabin attendant certificate, valid until 17 December
2003 Aircraft types: A321, A300 B4, A300 600, MD 88
Basic training : January 2001
Latest recurrent : December 2002

CA4 : Turkish male, age 23
Crew station : Aft door (Tail cone exit)
License : Cabin attendant certificate, valid until 10 April 2004
Aircraft types: A321, A300 B4, A300 600, MD 88
Basic training : April 2002
Latest recurrent : March 2003

CA5 : Turkish male, age 22
Crew station : Right forward service door
License : Cabin attendant certificate, valid until 10 April 2004
Aircraft types: A321, A300 B4, A300 600, MD 88
Basic training : March 2003
Latest recurrent : Not applicable

1.6 AIRCRAFT INFORMATION

1.6.1 General

Registration : TC-ONP
Aircraft type : Boeing McDonnell Douglas MD-88
Manufacturer serial number : 53549
Year of construction : 1997
Certificate of Airworthiness : No. 1277, issued 3 June 1997, valid until 19
March 2004 issued by the General Directorate
of Civil Aviation of Turkey and valid until 19-03-2004.
Certificate of Registration : No. 1277, issued 3 June 1997 issued by the
General Directorate of Civil Aviation of Turkey,
no expire date.
Engines : 2
Manufacturer and type : Pratt and Whitney JT8D-219

The design of the Boeing MD-88 originates from the DC-9 of the former Douglas company. The DC-9 entered service in 1965 and accommodated approximately 70 passengers. Subsequent DC-9 types got stretched fuselages creating more passengers seats.

After the merger of the McDonnell and the Douglas companies the DC-9-80 (MD-80) family of airplanes was developed with larger wing span, stretched fuselages and larger engines compared to the DC-9 family. The airplane is a low-wing twin engine jet transport airplane with the horizontal stabilizer mounted on top of the vertical stabilizer (T-tail) and its two engines waist-mounted to the aft fuselage. Within the MD-80 family the sub-types differ in weight and range capabilities and have – except for one – the same length which provides 172 seats in a single class high-density configuration, although most MD-80's are configured for fewer seats . The long fuselage is typical for this type of aircraft. The MD-88 is equipped with advanced cockpit displays.

The TC-ONP was built in 1997 and since then operated by Onur Air. The passenger cabin is configured for 172 seats and, for weight and balance calculations, divided into two compartments.

1.6.2 Relevant thrust settings, speeds and flap settings

General
For air transport category aircraft it is standard procedure to determine thrust setting, speeds for take-off and initial climb and flap setting before departure.

On the TC-ONP the take-off thrust can be set either by moving the throttles forward by hand, or by use of the Auto Throttle System (ATS). The ATS automatically positions the throttles to maintain the required take-off engine thrust. The use of the ATS is recommended in the Onur Air operating manual (OM).

Thrust setting
In order to minimize the effect of *split engine thrust* the procedure requires to first set engines on a mid-thrust engine pressure ratio (EPR[5]) level of 1.4 EPR. Provided the pilot assures sufficient matching, subsequent engine accelerations starting from mid-thrust levels then result in less thrust differences between the two engines when ATS is selected on.

Another reason for different engine thrust may be if one air conditioning pack, which is fed by one engine, is on, whilst the other air conditioning pack fed by the other engine is off. More commonly, throttle levers usually are not exactly aligned when producing the same take-off thrust. For more detailed information please refer to appendix B, part B.

The throttle response was used to reconstruct the selected thrust. FDR data indicate that engines did not stabilize at 1.40 EPR, but both initially increased to a maximum of 2.12 EPR (left engine) and 2.16 EPR (right engine). ATS was engaged shortly afterwards. From FDR it was derived that at the time the engines stabilized the thrust values were 2.02 EPR for the left engine and 1.97 EPR for the right engine. The shallow EPR (and also N1) decrease is a common engine output response during the take-off as speed increases and engine inlet conditions change.

No take-off data card with an indication of calculated thrust was found after the accident. For more detailed information on thrust setting, see appendix B part B.

Take-off decision speed V1
The speed indicated as V1 is the speed which the pilot uses as a reference in deciding whether to continue or to reject the take-off when the crew discovers a malfunction. When the decision to stop is made at or below this speed, the aircraft must be able to stop within the remaining runway length available.

During the accident flight, the standard speed calls "eighty" and "one hundred" by the PNF can be heard. The V1 call is not heard on the CVR.

Rotation speed Vr
The rotation speed is that speed at which rotation to the lift-off attitude is initiated. In this respect, the stabilizer position is important to achieve sufficient controllability for a proper rotation. The moment of rotation and the rotation technique have a significant influence on take-off performance.

The PNF calls "Rotate" when Vr is reached to inform the PF he has to initiate rotation. No "rotate" call is heard on the CVR. After the "one hundred" call the first officer said "It is not reached yet", followed by the captain's remark "It is not rotating".

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[5] EPR: being the ratio between the pressure in the compressor and in the turbine of a gas turbine engine as parameter of engine thrust.

Climb speed V2
This speed is a safe climb speed with pre-dictated margin to stall speed and minimum required speed for maintaining sufficient controllability (V_{mca}[6]).

Take-off flap setting
On the MD-88 the flaps for take-off can be positioned anywhere from 0-13 degrees or from 15 to a maximum of 24 degrees.
The aircraft flight manual (AFM) does not mention a specific flap setting for take-off. For best take-off performance on a given runway an optimum flap setting is preferred. Performance speeds such as V1, Vr and V2 vary with the flap position for the take-off. Generally, these speeds decrease when flap setting is increased.
The actual flap position during take-off was 24 degrees.

In Appendices A and B more information about flap settings and take-off speeds can be found.

1.6.3 Take–off performance data

The take-off performance calculation used for this flight could not be found on board the aircraft. However, a speed booklet was found in the cockpit containing various speeds for take-off (V1, V2 and wing flap/slat configuration speeds), manoeuvring and landing in relation to the aircraft mass. The take-off speeds in this booklet refer to an 11 degrees flap setting only.

In the Onur Air operating manual under *Normal procedures 2.2.2.2*, it is prescribed that the flap setting for standard take-off is 11 degrees. Most operators use either flaps 11 or flaps 15 as standard take-off flap settings at airports with adequate runway length. An other take-off flap setting may become necessary due to performance requirements.
Onboard the TC-ONP a list with Onur Air airport destinations was found. This document was called “MD-88 RTOLW” (regulated take-off and landing weight, see appendix A) and was issued by the Onur Air performance office of the flight operations support centre on 04-04-2002. For each runway of every destination the applicable flap setting for take-off “OPT” (optimum flap) or “STD” (standard flap) is shown. For this particular flight from runway 23 at Groningen Airport Eelde the optimum flap position was 24 degrees.

The “ONUR Air take-off performance chart with optimum flaps setting” for Groningen Airport Eelde runway 23 was probably used. It is based on a balanced[7] take-off with optimum flap setting of 24 degrees. The validity of this table has not further been investigated. By using the head- or tailwind component and ambient temperature conditions together with the applicable take-off mass in this table, the required thrust setting, flap position and various performance speeds can be determined for take-off.

During the interview with the aviation police[8] the captain recalled that the rotation speed was (Vr) was 135 knots. The co-pilot mentioned that the speed at which rotation was initiated was 120 knots. During rotation the captain experienced heavy control forces. When asked, both pilots did not know why the aircraft did not rotate.

On request Onur Air provided performance data based on the existing conditions prior to the accident. In the Onur Air operating manual it is prescribed that V1, V2, Vflap up and Vslat retract are set with speed bugs on the speed indicators.

In table 1 the company calculated speeds are listed together with the speeds derived from the speed booklet, which was found displayed in the cockpit and the speed bugs settings on the airspeed indicators.

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[6] V_{mca}: minimum calibrated airspeed at which it is possible to recover without exceptional skills, alertness and strength and to maintain the aeroplane in straight flight at that speed either with zero yaw or with bank not in excess of 5 degrees after the critical engine has failed with the remaining engine on take-off thrust.
[7] Balanced take-off: condition in which V_1 is chosen such that the take-off distance for a dry runway with 35 feet over the runway threshold when having an engine failure at V_1 is equal to the accelerate-stop distance.
[8] The information as described under *Interviews* primarily reflects the interviews conducted by The Dutch Safety Board’s investigators at the day of the accident. During these interviews V_1 and V_r were discussed, but not reproduced by the crew. However, V_r was mentioned later during an interview with the Dutch Aviation police.

source	V_1	V_r	V_2	$V_{flaps\ up}$	$V_{slats\ retract}$	based on
Displayed speed booklet (with ONUR logo)	129	135	145	150	187	128,000 lbs, flaps 11 degrees
Airspeed indicator captain	128	not applicable	145	151	186	As found after accident
Airspeed indicator co-pilot	128	not applicable	145	149	188	As found after accident
Onur Air (post accident)	122	125	132	147	187	Crew data: flaps 24 degrees
The Dutch Safety Board (post accident)	123	128	137	152	193	130,000 lbs, flaps 24 degrees, 5 knots tailwind[9]

Table 1: performance speeds in knots.

With respect to the reconstruction of the accident take-off made at Groningen Airport Eelde for the investigation, see Appendix B part B.

1.6.4 Take-off mass, centre of gravity and stabilizer setting

Take-off mass

Investigation revealed different assumed values for passenger weights in various sources available to the pilots. The results of a questionnaire held amongst passenger of the accident flight have been added.

source		male	female	child	infant
		pounds (lbs)			
Operating Manual	ONUR Air	165	145	77	22
Binder documents	ONUR Air	185	185	185	- -
Ground handling agent	ONUR Air	175	145	77	22
W&B manual	Boeing	170	170	170	- -
Questionnaire	The Dutch Safety Board	192	157	31	- -

Table 2: assumed passenger weights (including hand luggage) by source in pounds.

In the load and trim sheet the values from the ground handling agent have been used. The male-female ratio was such that the average passenger weight was 158 pounds. The total passenger mass was determined to be 22,221 pounds by the pilots.

Post-accident investigation resulted in the averages as presented above. When these derived values are projected on all passengers onboard during the accident flight, a most probable passenger mass is estimated at 24,090 pounds, which equals approximately 171 pounds per passenger.

The take-off mass as derived from the load and trim sheet was 127,529 pounds. Investigation revealed a most probable take-off mass of approximately 130,000 pounds. For more detailed information see Appendix C part B.

The Load and Trim Sheet

The centre of gravity (CG) calculation is performed to assure that the CG is within limits and to adjust the proper position of the stabilizer trim for take-off to ascertain longitudinal control with acceptable control forces. To determine the centre of gravity during take-off (TO-CG) a load and trim sheet can be used by the crew.

Further, the take-off mass, combined with runway and weather data, is used to establish various speeds and engine thrust settings. The effects of the various parameters used in the load and trim sheet are explained in Appendix C part A.

Accident flight

Load and trim sheet information and investigation data were compared. On the load and trim sheet, the cabin is divided into two compartments. For the use of the graph in the load and trim sheet equal spread of passengers is required for each compartment, as indicated in the weight and balance manual.

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[9] By interpolation between 0 and -10 knots headwind (tailwind) the various performance speeds have been determined for a 5 knots tailwind condition, see RTOLW table in appendix A

TO-CG information on the load and trim sheet was compared with TO-CG data derived from The Safety Board's investigation:
An outdated dry operating weight index (DOI) document was used. The valid document was not found onboard the aircraft. On request, Onur Air forwarded the missing document that revealed a more forward TO-CG of the empty[10] aircraft. Take note of Appendix C part A for DOI background information.
There was 2,000 pounds more fuel in the centre tank and 1,700 pounds less fuel in the wing tanks, creating a more forward effect on the TO-CG than assumed on the load and trim sheet.
The passenger seating was not consistent with the load and trim sheet. Passengers were seated more forward than assumed.

For this flight passengers were free to choose their seat (free seating policy[11]). The Onur Air standard procedure requires that the captain instruct the cabin crew to re-seat passengers to create the actual seating distribution in compliance with the assumed distribution on the load- and trim sheet. There are no indications that this procedure was followed.

The forward- and aft certified TO-CG limits for a 130,000 lbs take-off mass shown in the graph on the load and trim sheet are approximately -0.5 % MAC and 30.4 % MAC.

TO-CG and stabilizer position
The valid dry operating weight index (DOI) and the fuel- and cargo mass values found after the accident as well as the results from the questionnaire (passenger locations) were used to calculate the most probable TO-CG position. Based on this information a comparison of the most probable TO-CG and the TO-CG as used by the crew and their corresponding stabilizer settings for a flaps 24 take-off with 141[12] passengers can be demonstrated:

	TO-CG [% MAC]	**TO-CG computer insert [% MAC]**	**Stabilizer position [degrees ANU]**
Crew	11.1 (calculated)	13.5 (found)	7.2
Dutch Safety Board	-2.2 – 1.3	System test ok	11.3 – 12.0

Table 3: take-off centre of gravity and stabilizer position

The stabilizer position for the TO-CG 11.1 % MAC and flaps 24 degrees as calculated by the crew was 8.0 degrees ANU instead of 7.2 degrees ANU, see also Appendix C part B. It is unclear how the TO-CG computer insert of 13.5 % MAC was brought about.

Control column force and ground roll distance
On request Boeing provided control column force and take-off ground roll data for different scenarios where applicable variations of stabilizer position and rotation speeds are considered.
With the post-accident determined take-off mass and TO-CG with the stabilizer set at 11.9 degrees ANU, a pull force of approximately 16 pounds would have been required for lift-off. The estimated ground roll distance[13] for this take-off with a rotation speed of 128 knots is 3,590 feet (1,095 meter).

For the actual take-off with the stabilizer set at 7.2 degrees ANU, the pull force produced by the pilot to realize the achieved 6 degrees elevator deflection was approximately 50 pounds. The estimated ground roll distance for this take-off with a rotation speed of 120 knots is 4,500 feet (1,373 meter).

Generally, control column forces can be changed by trimming the stabilizer. When the aircraft is manually controlled the stabilizer trim rate is one degree per three seconds.

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[10] Here the meaning of 'empty' is: no passengers, no luggage and no fuel onboard the aircraft.
[11] The Operating Manual of Onur Air states the following under chapter 8, operating procedures 8.1-40 : *"The load and trim sheet is prepared assuming a particular passenger seating distribution. If a seat allocation system is used in connection with the preparation of the load and trim sheet any possible errors in the CG position will be covered / compensated by the operational CG envelope – provided the passengers are seated as allocated. Free seating however might require a repositioning of passengers in the cabin. The Commander shall instruct the cabin crew to re-seat passengers so as to create the actual seating distribution in compliance with the assumed distribution on the load and trim sheet."*
[12] The infant onboard the aircraft is not included in the CG calculation.
[13] The take-off ground roll distances are approximate, not FAA approved and should be used for comparison with each other.

More information of the Boeing performance and column force study is found in appendix N.

1.6.5 Investigation of aircraft systems

The Longitudinal Control System

In the Boeing documentation the pitch control system is referred to as longitudinal control system. Pitch control is strongly affected by both the functioning of this control system and the stabilizer position in relation to the CG of the aircraft. For achieving sufficient down force by the stabilizer trim and elevator control surfaces necessary for rotation, the stabilizer position (change) is far more effective than elevator deflection.

Technical investigation of the longitudinal control system and related systems of the TC-ONP did not reveal malfunctions or relevant improper rigging. The flap bus cable[14] was found broken after the accident. The flap bus cable delivers an input to the elevator servo force limiter, which is in operation during autopilot engagement. Failure of the flap bus cable has no impact on column force.

For system description and investigation results, see Appendix D parts A and B.

The Take-off Configuration Warning System

A proper setting of flight controls is essential for a safe operation. Improper settings of flight controls during take-off may lead to higher critical airspeeds, unfavourable performance and degraded controllability.

On the MD-88 a number of system conditions with respect to the aircraft configuration are monitored during take-off: release of the parking brake, position of the speed brakes (spoilers), position of the slats and flaps and the position of the horizontal stabilizer. A warning horn and a “voice” mentioning the concerning system component will sound when a non-take-off configuration condition is detected.

The stabilizer warning system forms a part of the take-off configuration warning system. The system verifies whether the selected stabilizer position is appropriate in relation to the calculated TO-CG and flap setting to ensure longitudinal controllability. The pilots (should) adjust the stabilizer until the stabilizer trim indicator in the cockpit is opposite to the (middle of the) green band of the stabilizer position scale. With the trim position indicator outside the green band range the system generates a stabilizer warning.

One factor that defines the specific take-off condition is the TO-CG information that is calculated and then manually entered into the take-off condition computer via thumbwheels by the flight crew, along with the planned take-off flap setting. If the TO-CG calculation is in error, or if it is entered incorrectly, the stabilizer position will be calculated for the errant TO-CG that was entered, and thus can be an incorrect setting for the actual airplane CG. The take-off condition computer on this type of aircraft has no other means to determine the actual CG of the airplane.

Some airplanes like the Boeing 747-400 offer systems that automatically sense the weight and CG of the aircraft. With a self-sensing system on the airplane the crew must compare the sensed CG to the derived CG from the load and trim sheet and resolve any differences. After the stabilizer trim is manually set the crew has to make sure that it is in the green band.

The captain stated and the CVR recording confirmed that during the take-off a stabilizer warning sounded. After the accident DTSB investigators found the TO-CG input on the take-off condition computer set at approximately 13.5 % MAC (and flap input 24 degrees) , which positioned the green band opposite to the stabilizer trim position indicator.

Functional checks were carried out in order to verify proper functioning of the stabilizer warning system. Stabilizer configuration warning tests in accordance with the Aircraft Maintenance Manual (AMM) showed no anomalies in the system. Additional tests were performed to verify what TO-CG (thumbwheel) inputs on the take-off condition computer would generate a stabilizer warning. It was found that 13.5 % MAC input could not produce a warning. When 11.1 % MAC was inserted the stabilizer warning sounded.

The functioning of the stabilizer warning system, as part of the take-off configuration warning system, and more details of the functional stabilizer warning tests are explained in Appendix E parts A and B.

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[14] Flap bus cable: cable which connects all separate flaps to ensure flap symmetry during flap travel.

1.7 METEOROLOGICAL INFORMATION

Weather conditions in the Groningen Airport Eelde area between 06:00 and 08:00 UTC, provided by the Royal Dutch Meteorological Institute (KNMI).

General conditions
An easterly ground flow transports warm, dry stabile air to the area. The upper airflow is south westerly and humid.

Weather conditions
Wind:

ground	easterly	3-6 Knots
500 ft:	110 degrees	10-15
1500 ft:	130	10
3000 ft:	200	10
FL 050:	230	10
FL 100:	240	15

Temperature:

ground:	17 ºC
500 ft:	17
1500 ft:	16
3000 ft:	12
FL 050:	10
FL 100:	01

Visibility: more than 10 kilometers
Clouds: altocumulus and cirrus area's above FL 100
0º C level: above FL 100
Icing: none
Turbulence: none
Thermals: none

Actual station EHGG at 7:25 UTC:
Wind 100 degrees 6 Knots, visibility more than 10 kilometers,
temperature 16 ºC, dew point 13 ºC, QNH 1014

1.8 AIDS TO NAVIGATION

Not applicable.

1.9 COMMUNICATIONS AND RECORDINGS

A copy of the transcript of the communication between Groningen Airport Eelde tower and the TC-ONP is attached as Appendix F.

1.10 AIRPORT INFORMATION

Groningen Airport Eelde has two asphalt runways, 01/19 and 05/23. Runway 01/19 has a length of 1500 meters and is 45 meters wide. Runway 05/23 has a length of 1,800 meters and is 45 meters wide. Both runway surfaces consist of asphalt. Runway 23 was used for take-off. The take-off distance available (TODA) was 1,860 m, the accelerate stop distance available (ASDA) 1,800 m.

1.11 FLIGHT RECORDERS

1.11.1 Cockpit Voice Recorder

The transcript of the cockpit voice recorder can be found in Appendix G. Turkish conversations were translated into English.

From the CVR[15] and FDR recording it was determined that a stabilizer warning sounded when the power levers were advanced for the first take off attempt. Furthermore the CVR recording revealed that the crew mentioned “24 flaps”, “is CG correct”, ”that’s OK it is 11.1” and “everything is all right”. After advancing the power levers for the second time the stabilizer warning sounded again. On the CVR recording the calls “eighty” and “one hundred” can be heard. The co-pilot says ”it’s not reached yet”. No V1 call is heard on the recording. When the captain indicates “it’s not rotating” the co-pilot responds “let’s continue, sir”.

1.11.2 Flight Data Recorder

The FDR data plot is shown in Appendix H.
From the FDR it is determined that the attempt to rotate started at 120 knots during which the aircraft accelerated to a maximum speed of 133 knots during the ground roll. Forward take-off thrust is interrupted after brakes have been applied at approximately 127 knots.

Additional parameters derived from the FDR demonstrated that the actual flap setting was 24 degrees and the stabilizer trim setting was 7.2 degrees aircraft nose up during the take-off roll. From FDR it was derived that at the time the engines stabilize the thrust values were 2.02 EPR for the left engine and EPR 1.97 for the right engine. After rejection both thrust reversers and spoilers deployed.

1.12 DESCRIPTION OF DAMAGE

1.12.1 General

The aircraft damage found was of secondary origin as a result of overrunning the runway.
The damaged was caused by contact with the approach light system and by sinking of the landing gear in the soft soil. A limited general description of damage is given below.

1.12.2 Aircraft damage

The fuselage sustained most of the damage in the nose landing gear area as the nose landing gear broke off and bent back when it sank into the soft soil. Parts of the belly skin, a fillet fairing panel and nose landing gear and electronics & equipment (E&E) access doors, the bulkhead and various frames of the fuselage construction were destroyed or severely damaged as well as supports, beams et cetera. Particularly the E&E compartment area showed damage and deformation, including the racks for the electronics and equipment. In addition, the main battery installation was destroyed. During the first stage of repair heavy short circuitry was observed in the E&E compartment area. Further, two VHF antennas were destroyed and the right angle of attack transducer was damaged.

Both left and right main landing gear link assemblies and support bracket were broken during the event. Tires showed cuts, heavy abrasion and portions missing. Hydraulic brake flex lines were leaking with evidence of kinking.
Both left and right flap trailing edge assemblies were cracked due to contact with the ground. The flap bus cable bracket showed a nick at the base. The flap bus cable had a sheared fuse pin and was found broken.

Engines and APU

Both engines had mud on the spinner cone and foreign object contamination in the inlet area. The right engine inlet cowling and the lower access door had punctures. The auxiliary power unit (APU) had evidence of FOD ingestion.

1.13 MEDICAL AND PATHOLOGICAL INFORMATION

Not applicable.

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[15] Most of the conversation in the cockpit is in the Turkish language. The quotes from the CVR used in this paragraph have been translated into the English language.

1.14 FIRE

Not applicable.

1.15 SURVIVAL ASPECTS

1.15.1 Flight safety briefing and evacuation

All but three passengers were Dutch citizens. All passengers[16] confirmed that before the flight the cabin crew gave a safety briefing. The briefing was given in the Turkish and English languages. Most of the passengers stated that the briefing was difficult or impossible to understand. A number of them blamed the quality of the public address system; others stated that the English language was poorly pronounced. The passengers rated the onboard safety briefing cards from good to poor, some passengers indicated they did not look at the cards at all. Some passengers stated that the cabin crew did not check if the seat belts were properly donned. One passenger who was travelling with a two year old infant stated that she had not received a child restrain. She had fastened her seat belt around herself and the infant sitting on her lap. During the take-off two of the cabin crew members were seated in the forward galley, one at the left aft service door and two others next to the tail cone emergency exit.

Twenty-six passengers stated that they verbally received orders from the cabin crew after the take-off had been rejected and the aircraft came to a complete stop. Initially these orders were to remain seated, then followed by the instruction to leave the aircraft. At the time these instructions were given the CVR had already stopped recording. These 26 passengers were all seated near one of the cabin crew member stations. One passenger stated that there was a public address call from the cockpit immediately after the aircraft had come to a complete stop. However, this passenger also stated that the announcement was unreadable. According to the purser the public address system did not work after the aircraft had stopped and that the first officer had come out of the cockpit and ordered the evacuation.

Most of the passengers stated that no orders were given and that they either decided to evacuate the aircraft on their own accord or that they followed other passengers who started to evacuate the aircraft. Passengers stated that some of the cabin crew members were initially passive, only when asked by the passengers they opened the forward cabin doors. The purser stated that it was difficult to control the passengers. When the aircraft had come to a stop, passengers left their seats and came forward. She opened the door when the evacuation order was given by the first officer.

The three cabin attendants located in the aft part of the cabin stated that they did not receive any orders to start the evacuation. The cabin attendant located at the left aft service door stated he opened one of the left overwing exits and was unable to reach the right overwing exits because there were many passengers. As the right overwing exits were already opened by passengers he decided to remain in the aisle and direct the passengers to the exits. Both cabin attendants located at the aft emergency exit (tail cone) stated that they had difficulties reaching the overwing area due to the crowd. They decided not to use the aft emergency exit because there were no passengers in the most aft part of the aircraft. They both stated, they directed passengers to the overwing exits. All but one overwing exits were opened by passengers. More than 50 percent of the passengers stated that they did not see any cabin crew members during the evacuation at all.

The fire fighting brigade arrived approximately 3 minutes after the accident. Some fire fighters stated that the evacuation took place in an orderly fashion and that the cabin crew did a good job handling the evacuation. None of the passengers experienced any difficulties evacuating the aircraft. However, some of them thought that the evacuation took too much time. This was attributed to the fact that many passengers wanted to collect their hand luggage before leaving the aircraft. Another factor was that a queue had formed at the left forward exit as some of the elderly passengers were afraid to use the escape slide. Some passengers re-entered the aircraft after the evacuation to collect the hand luggage they had initially left behind. Onur air evacuation procedures specifically instruct the passengers to leave their hand luggage behind during an evacuation.

According to the fire brigade the cockpit crew remained on board of the aircraft during and after the evacuation. These crew members left the aircraft after the fire brigade instructed them to do so.

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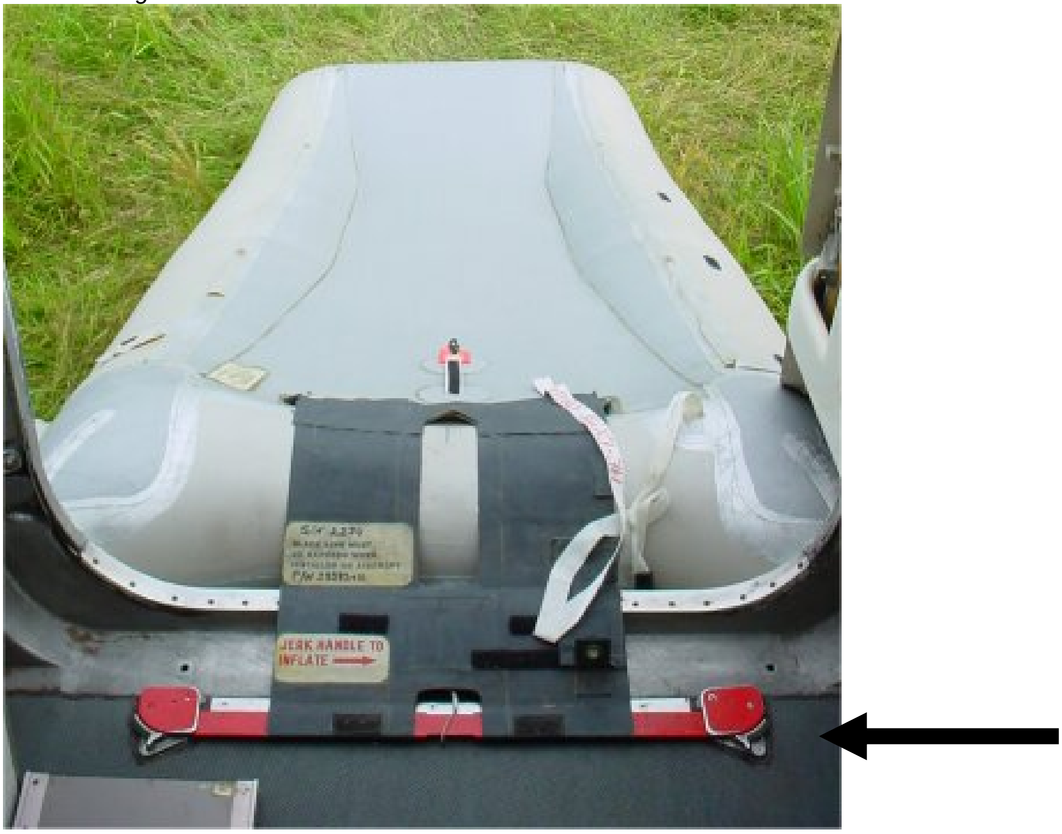
[16] All passengers refers to; all passengers who have reacted on the questionnaire.

1.15.2 Aircraft Exits

The left forward aircraft door was used during the evacuation. This door was fitted with an escape slide. The purser stated that she opened the door and activated the slide by pulling the inflation cord. The right forward aircraft door was not used during the evacuation. When a cabin crew member opened this door the slide fell out off its container and the package dropped on the ground next to the aircraft.

During the investigation it was noted that two different systems that hold the slide bar were used for the left and right forward aircraft doors. (See pictures below)

Slide bar right forward door



Slide bar left forward door

All four emergencies over wing exits were used. One of the over wing exits was opened by a cabin crew member, the other three were opened by passengers. According the instructions on the safety briefing card the hatches of these exits should be put aside inside the aircraft. During this evacuation the hatches were thrown outside. None of the passengers seated on the exit rows received a briefing regarding the operation of the emergency exits.

Neither the aft left service door was opened nor the emergency exit in the tail cone of the aircraft. After the accident these exits were checked. Both doors functioned normally. The functioning of the slides and the tail-cone dropping were not checked.

Passengers per exit

Left forward aircraft door	52
Right forward aircraft door	none
Left forward over-wing exit	4
Left aft over-wing exit	9
Right forward over-wing exit	33
Right aft over-wing exit	27 (+ 1 infant)
Left aft service door	not opened
Tail cone exit	not opened

From 16 passengers it is not known which exit they used during the evacuation.

1.15.3 Airport fire brigade

Groningen Airport Eelde is an ICAO[17] category 7 aerodrome[18]. At the time of the accident the fire and rescue capacity of the fire brigade were in accordance with the requirements for such a category aerodrome.

According to information received from Groningen Airport Eelde the fire brigade was informed about the accident by ATC immediately after the accident and arrived at the site with two fire trucks and seven fire fighters approximately three to four minutes after the alarm. In the Fire Fighting Regulation Civilian Aerodromes (Brandweerregeling Burgerluchtvaartterreinen) the maximum time to reach any runway end during optimal visibility- and terrain conditions is three minutes.

According to the evaluation report written by the airport authorities shortly after the accident, the terrain conditions where the aircraft had come to a stop were characterized as marshy and difficult to pass. This in combination with the fact that there was no fire, made the fire brigade decide to approach the aircraft using the available roads instead of approaching the aircraft directly across the terrain. The rules as laid down in the Fire Fighting Regulation Civilian Aerodromes state that when water-rich or marshy areas are to be found at or near the airport, the airport authorities will assure the fire fighting and rescue equipment is sufficient and adequate to cope with these terrain conditions.
The fire fighters assisted with the evacuation and cooled the brakes of the aircraft. From the ATC transcript it is derived that the flight crew checked whether ATC was aware of the accident, shortly after the accident happened.

Police units and fire fighting departments near the airport were alarmed according the airports emergency response plan. Some of the airport fire fighters later commented that there probable were too many vehicles and personnel near the crash site during the later stages of the evacuation.

1.15.4 Overrun area

The aircraft came to a stop in the area were the approach lights for the opposite runway are positioned. During the overrun several approach lights were hit. The approach lights are designed to minimize damage during a collision with an aircraft and operate on reduced voltage. The transformers that reduce the voltage from 2-5 kV to 40 Volt have been installed in embedded, heavy concrete structures.

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[17] ICAO: International Civil Aviation Organization, a specialised agency of the United Nations

[18] Levels of protection to be provided by an airport are nationally determined by the Dutch 'Brandweerregeling Burgerluchtvaartterreinen' (Fire fighting regulation civilian aerodromes). These regulations are based on the ICAO Annex 14 regulations. The category indicates the fire fighting capacity e.g. aircraft size which can be handled, number of fire fighting vehicles and amount of fire fighting agent.

At the day of the accident the soil in the overrun area was not strong enough to support the aircraft. During the overrun the main landing gear sank in the soft soil and damaged several of the approach light system embedded concrete structures and their contents. The centre and wing fuel tanks and engines did not encounter the concrete construction.

On some airports embedded concrete structures are used which have a concrete slope as part of the construction, to minimize damage to an aircraft during a collision. ICAO Annex 14 only addresses obstacles above ground which may endanger aircraft in the air.

1.16 TESTS AND RESEARCH

The DTSB requested Boeing to conduct a study that would contribute to a better reconstruction of the stick force experienced by the captain during the rotation attempt and to provide performance data to evaluate the actual flight versus other relevant scenarios. The National Transportation Safety Board (NTSB) of the United States of America assisted in the process of matching the investigation questions of DTSB to the available sources from the manufacturer to get the required answers. For more background information, see appendix N.

1.17 ORGANIZATIONAL AND MANAGEMENT INFORMATION

Areas with potential underlying causal factors within the Onur Air organization and management haven been identified with the Tripod analysis[19] method.

- Training for pilots, including CRM.
- Training for cabin crew, with emphasis on evacuation aspects.
- Quality Assurance, including availability of current documents and manuals,
- unambiguous information and the implementation of changed data and procedures.
- Supervision on the operation by the management to comply adequately with procedures and standards.
- Oversight by the Turkish authority to meet the required level of safety, i.e. by conducting appropriate audits and various inspections.

These potential factors have not been further investigated. However section 1.18.3 and Appendix I contain more information about the principle of oversight, audits, and inspections in aviation.

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[19] Tripod analysis: see chapter 1.19 for a description and purpose to apply this investigation method.

1.18 ADDITIONAL INFORMATION

1.18.1 Passenger questionnaire

In order to get a picture of the events that took place inside the cabin of the accident flight all of the 141 passengers of flight OHY2264 received a questionnaire containing some personal questions as well as a number of questions regarding various flight safety aspects and the evacuation. The questionnaire also contained questions regarding passenger seating and passenger weights, the results of these particular questions are used in section *1.6.3 Take-off mass, centre of gravity and stabilizer setting*. A copy of this questionnaire can be found in Appendix M. 128 Persons have responded to this questionnaire, five others were contacted by telephone and were asked the most relevant questions. The information of eight passengers could not be obtained.

1.18.2 Aircraft technical investigation

Appendix J demonstrates general background information concerning the performed technical investigation of the longitudinal flight control systems and determining the actual mass and balance during the take-off.

1.18.3 Oversight

The following paragraphs contain a general overview of the oversight issues concerning international flights. Information that is more detailed can be found in Appendix I.

General

The basic principle of international law is that every state is sovereign and therefore is responsible for its own aviation rulemaking and safety oversight. International agreements may have influence on the competence of a state. For scheduled international flights (including scheduled holiday charters) permission to land from the state of destination is needed.

In the case of air carrier operations between countries, several international bodies and agreements play a role in how the safety oversight of these operations is arranged. Among these are the international civil aviation organisation (ICAO) with its universal safety oversight audit program (USOAP), the European civil aviation conference (ECAC) and the joint aviation authorities (JAA) with its safety assessment of foreign aircraft (SAFA) program.

ICAO

This specialized agency of the United Nations sets the minimum standards and recommended practices (SARP's) for international civil aviation. Individual states are responsible for regulating their aviation industries but have to take into account the minimum standards established by ICAO of which they are the member states. States may file notifications of differences regarding their implementation of ICAO standards in their national regulations.
Personnel licensing, certificates of airworthiness, and other documents regarding the operations of an aircraft are issued by the state of registry and/or state of operator based on its own national law and should be in conformity with ICAO standards unless differences are filed.
The state where an aircraft is registered is responsible for the adherence of the aircraft to the ICAO minimum safety standards. The state of destination where an aircraft is visiting has limited possibilities for checking the safety of foreign aircrafts operating in its territory.

USOAP

ICAO has a universal, mandatory safety assessment program to determine the ability of all its member states to conform to the safety-related standards and recommended practices. The main conclusions of these assessments are made available to other contracting states.

ECAC, JAA, and SAFA System

The European civil aviation conference, with its associated body the joint aviation authorities, set up a program called the safety assessment of foreign aircraft to complement ICAO's safety oversight program. Part of this Safety Assessment of Foreign Aircraft (SAFA) program is the ramp inspections on foreign aircrafts, whether registered in ECAC or non ECAC states, which are landing in ECAC countries.

Air transport between Turkey and the Netherlands

In September 1971 an air transport agreement between Turkey and the Netherlands was signed. There is no article in the agreement dedicated to aviation safety. In a meeting in January 1997 between the contracting parties, the Netherlands proposed to incorporate an article on aviation

safety. The Turkish delegation warned against possible unilateral abuse of such a clause but promised to study the proposed text.
The Turkish delegation declared its readiness to adopt the proposed text if and when the Netherlands side would commit to replace it in the future if and when an ICAO standard safety clause might be available. In 2003 a commonly recommended text was accepted. The accepted text was not incorporated in the bilateral agreement.
With regard to an incorporation of the text it was therefore decided to wait until an agreement was reached in ICAO. The basis for such agreement has been constituted at the World Air Transport Conference in March 2003, which accepted a commonly recommended text. It is up to the individual states to incorporate that text in their respective bilateral air services agreements. The Turkish and Netherlands authorities have not included the clause at this moment but may do so at an appropriate moment.

Although the agreement is mainly on the subject of scheduled flights in the 1997 meeting non scheduled services were discussed as well.

Onur Air flights into the Netherlands
Onur Air started operating in the Netherlands in 1993. Based on the ICAO convention and the air transport agreement, every year Onur Air submits their flight schedule for approval to the inspector bilateral agreements based at the civil aviation inspectorate (IVW). This inspector does not have knowledge of the contents of the air transport agreement and the ICAO audits. The 2003 summer season flight schedule was submitted and approved.

SAFA Inspections

General
The ramp inspections use ICAO minimum safety standards as reference. During the inspections, mainly the aircraft documents and manuals, flight crew licenses, flight preparation, the apparent condition of the aircraft and the presence and condition of mandatory cabin safety equipment are checked. The technical inspection of the aircraft is limited to a general visual inspection; opening of inspection panels by an inspector is not permitted. There is no sanction system incorporated in SAFA, however the individual states conducting the inspection may impose sanctions based on their national regulations. The sanction systems vary from state to state.

SAFA Inspections in the Netherlands
The Netherlands have participated from the beginning of the program in 1996. SAFA inspections are performed by the civil aviation inspectorate (IVW) of CAA-NL.
The civil aviation inspectorate indicated that the inspectors do not have detailed knowledge of the various differences that are filed by the states of registry to the ICAO standards, which are used as a reference for the SAFA inspections.

Furthermore, information from the civil aviation inspectorate revealed that when an aircraft registered in a JAA member state is inspected, the applicable JAR is taken as a reference.
In the Netherlands, among others, the following sanctions are possible:
Departure permission of an aircraft can be denied for six hours. (article 11.2 part 3 Wet Luchtvaart)
Entry of an aircraft or airline can be denied. (article 1.3 and 5.3 Wet Luchtvaart)

SAFA inspections of Onur Air flights
From January 2002 until the date of the accident at least 38 Onur Air flights were inspected. Most inspections were performed in France and Germany, one in the Netherlands. During these inspections, no significant safety deficiencies were found on Onur Air. In the first half of 2003, before the accident date, no Onur Air aircrafts were inspected in the Netherlands.

European Union
In 2004 the European Union has issued a directive 2004/36/EC dated 21 April 2004 (the SAFA directive) on the safety of third (non EU) countries aircraft using EU airports. This Directive introduces a harmonized approach to the effective enforcement of international safety standards within the Community by harmonizing the rules and procedures for ramp inspections of third-country aircraft landing at airports located in EU states. The EU states shall bring into force the laws, regulations and administrative provisions necessary to comply with this Directive by 30 April 2006.

Implementation of the Directive in the Netherlands is expected at 30th of April 2006. With the implementation of the Directive, the sanction system also will be expanded. For example the denial of take off permission can be indefinitely instead of six hours.

In 2005 the European Commission has proposed a Regulation of the European Parliament and the Council on the information of air transport passengers on the identity of the operating carrier and on communication of safety information by Member states. The regulation entered into force 20 days after publication in the Official Journal on 27 December 2005. Because of this regulation the EU commission established a list of air carriers, which are subject to an operating ban within the Community. This list was first published in March 2006.

1.18.4 Other comparable events

General

ICAO was requested to provide a list of other instances with similarities of rotation problems caused by CG and stabilizer mis-trim conditions. Also the consequences of a runway overrun with respect to damage, hull integrity, fuel leakage and collisions with or damage by obstacles or terrain should be included as much as possible. ICAO returned a list of 37 occurrences of aircraft of 27.000 kg or more that crashed during take-off. In 30 cases the aircraft overran the runway after take-off was rejected because of various reasons. The occurrences are dated from 1995 and later.

The majority of the overrun events are rejected take-offs initiated at but mostly beyond V_1. In some cases this is not specified in the delivered information, in others the actual V_1 was considerably lower than assumed as the actual aircraft mass was (sometimes much) higher than assumed. Other cases indicated a too slow response by the crew. Reasons to abort vary from engine failures, blown tires during the ground roll until open cargo door warnings or (false) cargo fire warnings and other factors. Another group of rejected take-offs was due to longitudinal control problems which were revealed when rotation was attempted, see also under *Lack of rotating response*. In a number of cases wing mounted engines separated, frequently accompanied by post-accident fire. Overheated brakes usually occurred and in most cases caused flat tires, either by activated fuses (to prevent a burst tire) or by tire burst. In some cases overheated brakes led to smoke and/or a fire. The nose wheel at least sheared off or collapsed, and to some less extent the same applied for main landing gears depending on terrain conditions. In many cases performances for take-off and rejection degraded due to an overweight condition and different from assumed CG.

Take-off configuration warning

In one instance in Argentina (1999) the take-off configuration warning generated a flap warning indicating an improper flap configuration. The aural warning was disregarded and the take-off was continued resulting in a crash of the Boeing 737 with many fatalities and injuries.

Lack of rotating response

From some accidents in the ICAO database more relevant specific information was available. These have been taken out to make a better comparison with the Onur Air accident possible.

During the take-off at Johannesburg, South Africa, of a cargo flight the pilot of the Ilyushin IL-18 (4 engines turboprop) experienced a high elevator stick force at rotation speed and the aircraft failed to further accelerate. The take-off was aborted and the aircraft overran the runway, whereby the nose wheel struck a threshold light and the left main landing gear collapsed when it hit a concrete plinth. The left engine separated and a fire started. The CG had exceeded the forward limit and the aircraft was overloaded by 5,000 kg.

During a take-off in Ecuador the crew of the Tupolev TU-154 experienced that the aircraft did not rotate at rotation speed. Take-off was continued for another 10 seconds before rejection as the crew attempted to solve the problem. Signs of continuous braking on the last 800 meters on the runway were found. No control system malfunctions were identified. The final point of the taxi checklist - selecting switches for the hydraulic valves of the control system – was forgotten, probably because of previous technical problems during engines start and pre-departure delay. The last engine to be started was lighted during taxi. The runway overrun killed 80 persons and 15 people were seriously wounded.

During the take-off at Bratislava, Slovakia, the Boeing 707 did not respond to pitch control input. Trimming the stabilizer did not prove to be successful. Take-off was aborted and the aircraft overran the runway. The main landing gear sank into the soil, the nose gear collapsed and both inner engines were damaged.

During the take-off at Detroit, Michigan, USA, the captain of an Airbus A320 experienced that the nose up effect became more prominent as airspeed increased before the rotation speed was reached. As he was focussed outside the airplane he missed the V1 call of the first officer. As he felt the airplane was going to be uncontrollable and going to stall he aborted the take-off which ended with a runway overrun. Except a relation between pilot's input and a typical fly-by-wire system response, an improper stabilizer setting was not identified and thus not corrected during the taxi check list. The captain stated that he was not trained to perform high-speed aborted take-offs. The slide of one of the doors detached from the airplane when the door was opened, caused by an improper chamfer on the telescopic girt bar which attaches the slide to the airplane structure.

During take-off at Pekanbaru, Indonesia, the pilot of the Boeing 737 felt at the time that he rotated that the aircraft would not fly and he aborted the take-off. The aircraft overran the runway with 240 meters outside the airport terrain.

1.19 USEFUL OR EFFECTIVE INVESTIGATION TECHNIQUES

Tripod Beta analysis.
The Tripod theory has been developed in order to explain and control human failures. Approximately 70% of the human failures are explained by the context people work or act in. Within this context latent failures of the organization, in this case the operator Onur Air, exist. These latent failures are categorized in basis risk factors.

Tripod Beta is an investigation tool for accident analysis based upon the Tripod theory. Among other things this method was used to identify what happened, how it happened and why it happened.

2 ANALYSIS

2.2 MISSED APPROACH

The approach to Groningen Airport Eelde runway 05 was discontinued as the aircraft was not properly lined up for the runway and too high to perform a safe landing. It is not clear why the applicable missed approach procedure was not followed, nor why the deviation that resulted in flying over the Eelde built up area at 1,000 ft, was not challenged by air traffic control. However, no relation could be established between this event and the mishap that occurred during the following departure from Eelde.

2.3 GENERAL NOTE

All crew members were properly licensed. Various take-off related performance data, load and trim figures, relevant speed values, stabilizer setting and weather information, were reviewed and established by the cockpit crew in order to enable a safe take-off. The take-off data used by the cockpit crew were compared with the figures that had been collected and recalculated by the investigating board. Some significant deviations and ambiguities were found.

2.4 LOAD AND TRIM

2.4.1 Take-off mass

The average passenger masses used by the ground-handling agent Sig (male 175 pounds, female 145 pounds, child 77 pounds) in preparing the load and trim sheet were lower than the actual average males and females masses as specified in the questionnaire results. Based on findings from the questionnaire, the average passenger mass for this flight was estimated to be 171 pounds. Post flight investigation revealed four different sources with as many different weight values which could be used to establish passenger mass. It could not be found if there was an agreement between Onur Air and the handling agent on the weights that should be used to determine the estimated passenger mass in the load and trim sheet. The standard assigned passenger mass(es) should be unambiguously laid down in the operating manual, and be used as a reference for other publications. If the prescribed 185 pounds for each passenger as indicated in the document found in the binder called “uçak idari dosyasi (reg: TC-ONP)” from ONUR Air had been used, the crew would have determined an approximate 3,800 pounds higher passenger mass.

The difference between the post flight calculated most probable take-off mass (130,000 pounds) and the used take-off mass (127,529 pounds) on the load and trim sheet was predominantly caused by the 2,000 pounds higher actual passenger mass. Additionally, the actual fuel- and luggage mass was not according the load and trim sheet which accounted for approximately 500 pounds of the higher take-off mass.
The take-off mass in the load and trim sheet was exceeded with approximately 2,500 pounds, which equals 2 % of its take-off mass.

2.4.2 Centre of gravity

In 1.6.4 and Appendix C part B the indexes of passenger and cargo masses together with fuel distribution and dry operating weight index (DOI) have been established in order to determine the actual centre of gravity during take-off (TO-CG). A comparison between the most probable TO-CG and the TO-CG used by the crew has been made.

The revision 18 DOI table was not on board. The DOI from revision 17, which was used by the crew to calculate the TO-CG, was not representing the actual situation. The actual DOI resulted in a more forward actual TO-CG than established by the crew.
In addition, during refueling the fuel was not distributed according to the load and trim sheet. This deviation was accepted or not noted by the crew, and resulted in a more forward actual TO-CG.

Based on Onur Air procedures it could be established that free seating was allowed on this flight. In the load and trim sheet the pilots assumed 70 passengers in both compartment 1 and 2. However, the questionnaire shows 80 to 87 passengers were seated in compartment 1 and 54 to 61 passengers in compartment 2. To comply with the load and trim sheet repositioning of the passengers was essential. This meant 70 passengers in each compartment for this flight.

When using the graphical method to determine the passenger index the average arm for each compartment is considered constant. When a compartment is not full, the average arm usually does not correspond with the centroïd of that passenger compartment. This emphasizes the importance of reseating also when an unequal distribution per compartment is evident and the graphical method is applied to derive TO-CG.
However, no reseating was carried out. This resulted in an actual TO-CG more forward than the calculation on the load and trim sheet indicated.

The suggestion by the cockpit crew that a number of 141 passengers “could not lead to problems with the CG” was contradictory to the findings. The Safety Board’s calculations showed that with this number of passenger the TO-CG could move outside the CG envelope (see CG-table in Appendix C part B and Appendix K). Actually, the most probable TO-CG position was found to be just outside of the forward TO-CG limit.

It was explained by the pilots that normally free seating was applied with more than 80 passengers on board. It seems that this 80 passenger’s limit was used as a company procedure to apply free seating. However, the origin of this rule remained unclear.
The statements of the pilots might also indicate a misunderstanding about the necessity to equally spread passengers with more than 80 passengers on board. It is unclear whether “equally spread” meant to the crew an equal number of passengers in each compartment (in this case 70 passengers), or an equal distribution over the individual compartment.

The graph of the load and trim sheet, which is used to determine the passenger index, assumes a passenger weight of 170 pounds. This coincided with the determined most probable average passenger weight of 171 pounds and represented the actual situation.
However, in those situations where the assumed average passenger weight which is used to determine the total passenger mass significantly differs, a correction is required when using the graphical method for CG determination. No notes, warnings or procedures were found either in the load and trim sheet or in the OM to correct for the use of assumed passenger weights other than 170 pounds when the graph is used for CG determination.

In conclusion it seems that deviations in DOI, fuel distribution and in particular the passengers’ distribution contributed to a more forward TO-CG than determined in the load and trim sheet. In figures this means that the TO-CG was within the -2.2% to 1.3% MAC range and most likely -0.7 % MAC (Appendix C part B). This is just outside the forward limit of the TO-CG
(-0.5 % MAC) and 11.8 % MAC more forward than the TO-CG determined by the crew. This 11.8 % MAC difference equals approximately 38 % of the approved MAC-scale when the aircraft mass is 130,000 pounds.

2.5 TAKE-OFF

2.5.1 Take-off runway

The main runway in use was runway 05. The crew requested to depart from runway 23, most probably to shorten the taxi- and flight time to Maastricht - Aachen Airport Beek.
ATIS/ATC wind was 100 degrees with 6 knots. The choice to depart from runway 23 resulted in an approximate 4 knots tailwind condition. It is not clear whether or not the crew took the tailwind component into account during performance calculation. The tailwind condition had a negative effect on the take-off performance because it increased the take-off distance. A 10 knots maximum tailwind component during take off is allowed according the Onur Air operating manual (OM).

2.5.2 Take-off thrust

From the FDR it could be derived that the auto throttle system (ATS) was used as recommended in the OM. However, the standard procedure to engage the ATS was not followed. Instead of stabilizing the engines at 1.40 EPR first and then switch the ATS on, the throttles were manually advanced beyond the position required for the take-off thrust. Consequently, the engines immediately accelerated to 2.12 EPR (left engine) and 2.16 EPR (right engine) and overshot the required thrust of 2.01 EPR.

When the ATS has been engaged both throttles stop as soon as one of the engines has reached the target EPR. With this system feature it would have been expected that the left engine would reach the target EPR first (closer to target EPR when ATS was switched on) and that the right engine would remain at a higher EPR level. Because the right engine eventually settled at a lower level it is concluded that the right throttle was rather abruptly manually retracted after the overshoot.

By analyzing the engine thrust responses it is believed that the left engine thrust setting approximately was 2.02 EPR. The right engine thrust had decelerated to 1.97 EPR. Considering the required thrust and the point where the set thrust is not that accurately determined, it is believed that the target EPR most likely was 2.01 EPR as prescribed. Considering the performance requirements in the RTOLW table and applicable check list it is assumed that both air conditioning packs were off.

The magnitude of the split engine thrust normally is too large to be solely explained by throttle stagger and (acceptable) engine trimming tolerances. These possible effects might have been aggravated, because the ATS engagement (and thus further engine acceleration to take-off power) was not started from a stabilized 1.40 EPR mid-thrust level for each engine as required.
It is concluded that the total thrust was lower than required, because a thrust correction for the right engine was omitted. Overall, the applied lower thrust resulted in an increased accelerate stop[20] distance.

2.5.3 Stabilizer warning

When the thrust levers were advanced to select take-off thrust the take-off configuration warning system generated a stabilizer warning. This warning indicated a mismatch between the take off condition computer readout and the stabilizer position indicator. After the aircraft stopped on the CVR is heard “24 flaps”, and “Is CG correct?” “That’s OK, it is 11.1”. Based on this information it seems that only the inserts of the take-off condition computer were checked and a small stabilizer position adjustment was made.

Most likely the crew had inserted the determined TO-CG of 11.1 % MAC and the flap setting of 24 degrees in the take-off condition computer which should have resulted in a stabilizer position of 8.0 degrees ANU. However, the FDR readout showed that the initial stabilizer position before take-off was 6.8 ANU. This difference activated the stabilizer warning. If the crew had made a proper evaluation and had identified the source of the warning, they would have reset the stabilizer to 8.0 degrees ANU. Because only a stabilizer trim position change to 7.2 ANU was performed a mismatch still existed. By further eliminating the mismatch between take-off condition computer output and stabilizer trim position the warning would have ceased. Instead, the crew resumed the take-off and the stabilizer warning reappeared and continued to sound during the entire take-off roll until the throttles were retarded to reject.
The crew should have rejected the take off at the moment the warning re-appeared. Negligence of this warning is an infringement of a generally accepted operating standard.
The stabilizer warning system and stabilizer motion warning system did not reveal malfunctions during functional tests carried out in accordance with the aircraft maintenance manual, see Appendix D part B.

It is concluded that the CG thumbwheel setting most likely was 11.1% during the take-off as mentioned on the CVR. The 13.5% setting that was found during the investigation must have been altered after the accident. The safety board did not find any evidence that the stabilizer *motion* warning sounded during take-off as stated by the first officer. The stabilizer position change before the actual take-off run was too little to activate the motion warning system, see Appendix D *Horizontal Stabilizer*. It is believed that the first officer has confused this with the stabilizer warning.

The stabilizer warning system of the MD-88 – like the vast majority of transport category airplanes - does not protect against stabilizer settings which are not in conformity with the actual TO-CG. When an erroneous TO-CG is inserted (TO-CG input error) in the take-off condition computer, the required stabilizer position is incorrect as well (stabilizer position output error).

Some airplanes offer systems that automatically sense the weight and CG of the aircraft. With a self-sensing system on the airplane the crew is able to compare the sensed CG with the derived CG from the load and trim sheet. By resolving any differences control problems during rotation can be avoided when the stabilizer position is in the green band and checked against the actual TO-CG.

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[20] accelerate stop distance: distance required from a standing start to reach the point when the most critical engine suddenly fails and then come to a complete stop.

2.5.4 Stabilizer setting

Contrary to the TO-CG 11.1% MAC as determined by the crew, The Safety Board found that the most probable TO-CG was -0.7% MAC. By using this most probable TO-CG of -0.7 % and a flap setting of 24 degrees it was found that the required stabilizer trim position should have been 11.9 degrees ANU. In fact the stabilizer position during take-off was 7.2 degrees ANU. This deviation highly affected the ability to rotate, see section *2.4.7 Elevator control forces*.

It is concluded that the stabilizer position error was primarily the result of a difference between the assumed loading according to the load and trim sheet and the actual loading. If the stabilizer had been readjusted to 8 degrees ANU to eliminate the stabilizer warning this would still have resulted in a 3.9 degrees difference with the required 11.9 degrees ANU. The actual stabilizer position of 7.2 degrees aggravated the stabilizer position error condition.

2.5.5 Flaps

Flap position

The Onur Air performance MD-88 RTOLW table prescribed an optimum flap setting for take-off from runway 23 at Groningen Airport Eelde. FDR data show that the actual flap setting during take-off was 24 degrees, which was in accordance with the prescribed Onur Air procedure. Flap position has a direct effect on take-off speeds. With a flap 24 take-off the reference speeds are lower than with a flap 11 take-off.

Flap bus cable

Metallurgical investigation confirmed that the pin sheared off and that no pre-existing anomalies were found. It is mentioned, however, that the shearing action smeared the surface. It is concluded that the shear pin failed when the extended flaps were damaged as they hit the ground, resulting in too high tension on the cable and consequently shearing off the pin.

However, flap bus cable integrity does not affect column force and the cables between control columns and control tabs were not obstructed by the autopilot servo torque limiter.

2.5.6 Speeds

The speed bug settings on the airspeed indicators of both the captain and the first officer corresponded with the speeds as shown in the speed booklet for a flap 11 degrees (standard) take-off. This speed booklet was placed on the pedestal against the instrument panel.

In the interview with the Dutch aviation police the captain mentioned Vr as 135 knots. This suggests that the speeds from the speed bug card for 11 degrees standard take-off were set. This setting was not in accordance with the actual 24 degrees flap position.

Post flight data analysis revealed that the captain attempted to rotate at approximately 120 knots. This was well below the assumed rotation speed (Vr) of 135 knots and below the assumed decision speed (V_1) of 128 knots which was indicated by the V1 bug. Consequently V1 had not yet been called by the first officer.

The (post accident) calculated V1 and Vr for the actual flap setting 24 degrees, take-off mass and tailwind condition are respectively 123 knots and 128 knots. It is concluded that rotation was initiated below Vr. An attempt to rotate below the prescribed rotation speed increases the take-off distance due to increased drag as well as increasing the control column force necessary to rotate the airplane.

2.5.7 Elevator control force

In his attempt to rotate the captain experienced a lack of response from the aircraft following his control input even after he applied more than usual force. This caused the controls to feel heavy which can be explained by (a combination of):

- The functioning of the variable load-feel system. The variable load-feel system generates a similar load feel under different CG conditions. The system reference is the stabilizer setting which is related to the CG. Normally, with a correct stabilizer position this leads to a similar pull force on any take-off. In this case, with the stabilizer set at the faulty value of 7.2 degrees ANU - where it should be 11.9 degrees ANU - , the system generated a much heavier than usual feel.

- The stabilizer position error. As a result the applied elevator deflection was insufficient to obtain the required down force to enable rotation. Consequently, a higher elevator deflection was required resulting in a higher pull force.
- The attempt to rotate at an under-speed. This reduced the aerodynamic down force capability of the stabilizer and the effectiveness of the elevator deflection. Consequently, a higher elevator deflection was required resulting in a higher pull force. The early rotation attempt increased the ground roll distance.

When the stabilizer is set in accordance with the actual CG and the rotation is initiated at the correct rotation speed, the elevator deflection varies from approximately 2 till 4 degrees. This requires approximately 16 pounds pull force.
The captain experienced the normal amount of control movement to be insufficient and applied more input. FDR analyses demonstrated that the elevator deflection during the attempt to rotate reached approximately 6 degrees. The force the captain had to maintain was approximately 50 pounds, roughly three times more than he was used to.
Flight recorder data revealed that the nose wheel actually did lift off for a short period.

Based on the CG calculation by the cockpit crew the stabilizer would have been set at 8.0 degrees ANU during the flight preparation or after the first stabilizer warning. The Boeing study (See Appendix N) demonstrates that with this stabilizer position it would have shortened the ground roll distance. Furthermore, it would have been less distracting because of the absence of the stabilizer warning. It still would have required a 50 pounds pull force to achieve a 6 degrees elevator deflection, even with a rotation speed of 135 knots. At least 6 degrees elevator deflection was needed – where normally 2- 4 degrees will do - to compensate for the stabilizer mis-trim condition.

Normally, for a three degrees per second pitch rate, the rotation lasts approximately 4 – 6 seconds. Achieving a three degree per second pitch rate, while maintaining 6 degrees elevator deflection with 50 pounds pull force, is hard and very uncommon. Consequently, the rotation interval likely would have been longer in time and distance. Normally, during flight conditions control column forces are trimmed away, but this is unusual for rotation as being a dynamic condition. Besides, taking into account the amount of mis-trim and a stabilizer trim rate of 1 degree per 3 seconds there is too little time on the short runway to accomplish a significantly reduced column force. The safety board considers that a last instant trim change would probably have had no effect because the rate of change was too low to effectively correct the situation.

As there were no indications that system deficiencies had influenced the aircraft stopping performance, the related systems were not investigated in detail.
No causal longitudinal system deficiencies have been identified which could have contributed to the heavy elevator control force which the captain experienced.
It is concluded that the aircraft was in an airworthy condition prior to the accident.

2.5.8 Rejected take-off

The take-off concept with its various check speeds is mainly based on the assumption that a take-off can be continued safely after V_1. Though if a pitch control problem is at hand, this will most probably remain unnoticed until at rotation. When the inability to rotate becomes evident rejection of the take-off may lead to a runway overrun.

From FDR readout it is derived that the pilot stopped his attempt to rotate at approximately 127 knots, which was 4 knots past the post flight calculated V1 (123 knots). Before losing momentum the aircraft accelerated to a maximum speed of approximately 132 knots.

Considering the unusual high pull force the captain experienced, in combination with the absence of significant rotation, it is reasonable that in this situation he thought that “he could not make the take-off”. The relatively short remaining runway, because of the unfavorable performance conditions, and the continuously sounding stabilizer warning probably intensified his feeling. It is questionable that continuation of the take-off would have turned out to be successful. Considering the circumstances rejecting the take-off might have been the less bad choice.

2.5.9 Factors affecting the remaining stop distance

The first take-off was discontinued at an early stage. It was found that after the aircraft stopped the distance travelled was approximately 25 meters.
It may be concluded that it slightly reduced the remaining stop distance on the second attempt to take-off. The observations of eyewitnesses were considered to be less accurate for this purpose.

Although the reference speeds used by the crew were not correct for the actual situation, this had no effect on the stop distance. Rotation was initiated below rotation speed, which increased drag during the remainder of the acceleration phase and consequently reduced the remaining stop distance. Due to the small pitch change the effect was limited.

The aircraft mass was higher than assumed. This caused a longer distance/time for acceleration and subsequently for deceleration. For this reason the mass difference had a negative effect on the performance and reduced the remaining stop distance.
The omission of adjusting the thrust on the right engine resulted in a further degradation of the take-off performance. Take-off was performed with an estimated 4 knots tailwind component, which increased the take-off distance and reduced the remaining stop distance.

It is concluded that the multiple deviations from standard operational requirements added to the inability to stop before the runway end.

2.5.10 Consequences

The take off is considered to be a critical flight manoeuvre. It should be planned and executed carefully. Therefore it is essential that the pilot knows exactly the aircraft mass, the CG and its related stabilizer setting. Considering operational conditions reference speeds should be established in a prudent manner. It is necessary that instructions on how to achieve these figures are laid down unambiguously and taken into account by any person involved. By acting in this manner incorporated safety margins will remain present and a successful take off can be achieved.

The difference between the assumed loading according to the load and trim sheet and the actual loading led to an incorrect TO-CG, and consequently to an out of trim stabilizer condition during take-off. The required safety level was further undermined by additional deviations from the required accuracy level. When considering each contributing factor separately, its effect on the performance and available stop distance was modest. However, in combination the outcome proved to be significant. In the opinion of the board this has led to the rejected take-off and the overrun of the runway end. In addition it might be said that unfavorable deviations usually remain unnoticed until the moment the take-off is rejected.

2.6 SURVIVAL ASPECTS

The accident was survivable because the deceleration forces remained within human tolerance, there was no post crash fire and there was no substantial deformation of the passenger cabin.
The fact that seatbelts were not checked and that no child restraint was provided for the child could have had serious consequences if the deceleration forces would have been higher.

2.6.1 Overrun area

Because the overrun area was soft the aircraft sank in the soil and decelerated heavily. Several of the embedded heavy concrete constructions were badly damaged by the main landing gear. Because the MD-88 has no wing mounted engines they did not contact the concrete structures or dug themselves into the ground. Wing mounted engines have a higher risk for damage to the engines and the pylon area when the landing gear sinks into to the soft soil. Under some circumstances the engines might even break off. Consequently, chances that leaking fuel is ignited by hot engine parts are realistic. It was fortunate that the parts of the runway light system did not penetrate the fuel tanks. Also sparks from damaged electrical wiring, either from the aircraft or from the runway approach lights system can ignite the leaking fuel.

Although ICAO only has set standards for obstacles above on or on the overrun area surface, measures should also be taken if below the surface of the overrun area, heavy constructions are present. These measures should be aimed at preventing and/or minimizing the risk of aircraft damage by these constructions during an overrun.

The cover of the concrete construction should be strong enough to support the aircraft that use the airport. When there is a risk that parts of an aircraft penetrate the surface, the concrete construction should be designed in such a way that a collision does not result in serious damage to the aircraft.

It is concluded that the combination of soft soil and embedded heavy concrete constructions increased the risk of a post-accident fire.

2.6.2 Evacuation

Although all cabin crew members rated their command of the English language as good, a number of passengers rated the English as spoken by the cabin crew as poor and difficult to understand. It is uncertain to which extent this has influenced the emergency evacuation. Emergency instructions should always be clear

The passengers rated the onboard safety briefing cards from good to poor equally. The briefing cards meet the standards as agreed upon by the IATA member airlines. It is known that passengers often omit to look at the safety briefing cards.

Most of the passengers stated that they did not see any cabin crew members in the aircraft during the evacuation. All of the cabin attendants stated however that they remained onboard and assisted and directed the passengers through the emergency exits. The fact that their crowd control actions, such as telling passengers which door to use, urging them to expedite the aircrafts egress and instructing them to leave their hand luggage behind, was not optimal, has most certainly prolonged the duration of the evacuation. Once egressed passengers should not remain within the close proximity of the aircraft and should not return.

Only the left forward entry door and the four over wing exits were used for evacuation. The right forward slide could not be used when it dropped from its container. This most likely was caused because it had not been properly attached to the aircraft floor. The fact that the slide bar connecting system, which was used for the right service door, differs from the other doors may have contributed to the incorrect attachment of the slide bar.
The tail cone exit and left aft service door functioned normally during post accident checks. Although the cabin attendants the aft part of the aircraft did not deem it necessary to use the tail cone exit and the left aft service door, it is concluded that by not using all available exits, the evacuation was hampered.

It is not exactly clear how much time the emergency evacuation took, but the 90 second limit as required during the aircraft certification test was not met.

2.6.3 Emergency response

During the emergency response the commander of the fire brigade expected possible difficulties with the terrain conditions. Although he did not choose to approach the aircraft directly, the fire brigade reached the aircraft within three minutes. Regulations require the fire brigade to reach the runway end within three minutes. The aircraft came to a stop in the terrain beyond the runway end and therefore it can be said that the fire brigade responded in a timely fashion.

Both the ICAO annex 14 and the “Brandweerregeling Burgerluchtvaartterreinen” state that the airport authorities are responsible to equip the fire fighting force in such a fashion that they should be able to cope with the prevailing terrain conditions. It is unknown and has not been investigated whether or not the terrain conditions would have been adequate to support the fire brigade vehicles.

2.7 ORGANIZATIONAL AND MANAGEMENT FACTORS

During preparation the crew calculated an incorrect aircraft mass, did not spread the passengers sufficiently to comply with the predicted data in the load and trim sheet resulting in a faulty TO-CG. In addition, the stabilizer was set inaccurately. The quality of flight preparation contributes significantly to the safe execution of the flight. In this case however inaccuracies during preparation led to certain preconditions that hampered a safe operation.

Looking at the nature of the mentioned discrepancies one might consider them as a violation of regulations. It could not be established if these violations were the result of habitual behavior or not. However it can be concluded that some rules were laid down ambiguously or not clear to the pilots and staff involved. The company should have corrected that through adequate supervision on the operation. If we take also into consideration other deviations from the standard prescribed operation such as the thrust management on take off and the failure to manage the stabilizer warning the board comes to the belief that there was no adequate supervision on the operation by the management of Onur Air.

This feeling is intensified by some other observations. It is found that the company procedure to amend aircraft documentation failed. An outdated document was used as reference to establish the DOI.

It appeared that for this flight the standard passenger weights that were used by the ground handling agent to determine the passenger mass in the load and trim sheet were too low. The prescribed 185 pounds for each passenger as indicated in a document found on board was not used and probably not known to the handling agent. This should be agreed upon at forehand and is the responsibility of Onur Air.

Though anti-float tabs (see appendix D part B) were not directly relevant to the inability of the aircraft to rotate, their adjustments nevertheless did not meet the requirements and would have affected the effectiveness of the elevator deflection unfavorably when a stabilizer position of 10 degrees ANU ore more would have been set.

During tripod analysis potential areas to investigate management factors, which could have contributed to the accident, have been identified, included training. However, these have not further been investigated.

2.8 HUMAN FACTORS

Company instructions did not clearly specify all required information for flight preparation. As a result the cockpit crew was not sufficiently equipped to do their job. However, this does not dismiss them from their responsibility for a careful planning and a safe execution of the flight. In some areas however the performance of the crew was not at the required level. These areas were distribution of the passengers, configuration/thrust relation, stabilizer setting, reference speeds, failure management and adherence to standard operating procedures.
A more in depth look at cockpit crew performance during take-off identifies some human related operational factors. After the first alert of the stabilizer warning system the crew discontinued the take-off. A quick check of the data input into the take-off condition computer was done. Inadequate corrective action was taken and when the throttles were advanced for the second time the stabilizer warning sounded again. At that moment the take-off should have been aborted and the crew should have collected information on the nature of the warning to solve it.

Nonetheless the take-off was continued. On the CVR it could be heard that the first officer encouraged the captain to continue the take-off whilst the captain was still coping with the stabilizer warning. The first officer says, “Everything is all right”. “Why is this warning given?” was recorded. This expresses uncertainty about the situation. When asked during the interview, the captain stated that he considered the warning as false. On the other hand the first officer declared it was company policy to reject the take-off when a stabilizer warning occurs. Although the captain regarded the warning as false he should not have resumed the take-off. Besides that the first officer should have prevented him from doing so in accordance with his statement after the accident. At this stage the crew acted unsafe. Continuation of the take-off with an active stabilizer warning is considered as an infringement of a generally accepted operating standard. The demonstrated ease with which this was done is considered to be remarkable.

When the captain felt his attempt to rotate counteracted by the heavy force on his control column he concluded, in his own words that “he could not make the take-off” and consequently rejected the take-off. In that stage of the flight there was no possibility for the first officer to correct the situation if he intended to do so at all. The decision to reject the take-off after rotation was not according operating standards but the captain felt he had no other opportunity left.

However, all deviations from standard operational procedures which attributed to the outcome of this event are considered by The Safety Board as a consequence of inconsistencies in preparation, bending the rules and non-adherence to procedures. This emphasizes the need to operate within the framework of clearly defined rules and regulations. Every deviation should be corrected as soon as possible because the resulting negative effect on the safety of the operation can accumulate without additional warning.
In that respect the presence of a self sensing CG system can be very valuable as a last defense to avoid an errant TO-CG input by the crew for setting the stabilizer for take-off.

2.9 CREW RESOURCE MANAGEMENT

When a certain warning is given it is standard practice that the reason for the warning is identified and correct action is taken. In this case however at the time the stabilizer warning reappeared a mutual understanding between captain and co-pilot developed as to continue the take-off. This should have been prevented by one of the crew and not encouraged. The opportunity to correct the stabilizer setting and consequently take away the stress of a sounding alert during take-off was needlessly missed.

In spite of his uncertainty the captain continued the take-off with the stabilizer warning still active. A possible explanation could be that he, only MD-88 captain since two months, felt encouraged to continue with the approval of the first officer who was 10 years older and significantly more experienced on the MD-88. This suggests that a negative authority gradient between the captain and first officer existed.

The stabilizer misplacement of 0,8 degrees as such, the part that caused the warning, did not result in the apparent inability to rotate. However, it is considered that the continuous sound of the stabilizer alert during the take-off roll increased the captain's existent feeling of discomfort. In addition his visual interpretation of the remaining runway length might have prompted the captain to rotate well before his reference rotation speed. The first officer replied on the situation with "it is not reached yet ", which might be seen as a reference to the rotation speed and a reflection of his consideration that the attempt to rotate came too early. The intention of this remark is clear after the accident but if the captain understood the meaning of it can be regarded as doubtful. It could mean that the decision speed had not been reached but it could likewise mean that the rotation speed was not reached yet. Even it is possible that the captain did not hear the remark because it was masked by the stabilizer warning sound.

When the captain indicates, "it's not rotating" the co-pilot responded with "let's continue, sir". It must be said that there is no standard call for a condition like this but in the opinion of the board this call did not contribute to remedy the situation even when considering that the co-pilot was not aware of the developing control problem.

Certain general requirements regarding desired behavior are commonly accepted as standard practice to function in a multi-pilot crew. These standards are developed to enable pilots to work in close cooperation and communicate effectively with each other. Many aspects of human interaction have been identified and proved to be important tools in optimizing the working relation. It is referred to as crew resource management (CRM) and should be trained to operate in a safe way.

It is felt by The Safety Board that the crew did not demonstrate sufficient understanding of the standard practice of CRM. It has not been investigated whether Onur Air has instituted formal initial and recurrent CRM training. Anyway, based on the facts of the accident it must be considered as desirable to revive the CRM training program within the company.

2.10 OVERSIGHT

General

Based on the ICAO treaty, every state is responsible for the oversight of aircraft registered in that state. A state that is receiving foreign aircraft has only limited possibilities to review the safety of a visiting aircraft and mainly has to rely on the state of registry.

The possibility for states to file differences to ICAO's standards causes irregularities in the implementation of these standards from state to state. It is important for the country of destination to obtain information about the level of compliance of the state of registry with ICAO standards, including the differences filed. Additional information on the implementation of the standards can be obtained through ICAO audit reports.

Permission for Onur Air to operate in the Netherlands

The ICAO audit reports on the status of Turkey's safety oversight were, like other ICAO Audit reports, available to the Dutch authorities. However, this information was not used by DGTL nor was it passed on to the Inspector Bilateral Agreements at the civil aviation inspectorate. DGTL as well as the inspectorate also state that approval of schedules does not take safety into consideration for the yearly approval for the winter- and summer flight schedules. Although the approval is based on a bilateral air transport agreement with Turkey, the Inspector Bilateral Agreements does not have knowledge of the contents of the agreement.

It is concluded that approval of the schedules has been granted without taking into account the ICAO audit results regarding the state of registry and/or the state of operator.

Furthermore, a bilateral air transport agreement can always be reviewed and amended to incorporate new clauses deemed necessary, such as a clause regarding safety issues. In 1997 DGTL proposed to incorporate such a clause in the existing (since 1971) air transport agreement with Turkey. It is unclear how much effort DGTL has put in to achieving the desired result but the clause was never formally incorporated into the bilateral air transport agreement with Turkey.

SAFA inspections
SAFA inspections use ICAO safety standards as a reference.

The limited general technical scope of the SAFA inspection of the aircraft means that many shortcomings cannot easily be detected: A ramp inspection cannot guarantee the airworthiness of a particular aircraft.

The fact that the aircrafts papers are issued according to the ICAO standards cannot guarantee that the papers are issued based on the correct procedures. For instance, a certificate of airworthiness can be issued by the authority of the state of registry without checking if the aircraft is actually maintained according to the manufacturer's procedures.

Deficiencies found during the investigation like weight and balance miscalculations, incorrect DOI document, non-compliance with load and trim sheet conditions and non adherence to standard operation procedures are hard to detect during SAFA inspections due to the limited scope of these inspections. Therefore it can be concluded that it is questionable whether a SAFA inspection performed before this flight could have prevented the Onur Air accident.

After the accident and, according to the inspectorate, based on the results of the investigation of the ground handling companies, the inspectorate focused their attention on Turkish charters operators. As a result of this, the number of findings increased.

Summary
For international flights, the aviation system depends mainly on the oversight of the state of Registry of the visiting aircraft. Therefore it is very important that all relevant safety information related to the state of Registry is used and shared within the ministry of transport before permission to enter is granted.

ICAO audits asses the implementation level of standards and recommended practices in a contracting state from the top down. The Safety Board acknowledges the fact that ICAO audits are beneficial if states implement change, as proposed by audits. However the fact that there are no enforcements or sanctions, changes proposed may be implemented gradually.

Although both ICAO audits and SAFA inspections try to achieve a common adherence level to safety, the tools to enforce set standards and minimum requirements are left to the state of registration and/or the state of destination themselves.

The different policies of ECAC/JAA/EU Member states in treating an operator found having safety deficiencies by another Member states create uncertainty and confusion regarding the safety level of an operator on the general public. This results in operators being banned in one state and not in the other. A uniformed approach and treatment among Member states is needed.

At this time there are no rules or systems in place to ensure that foreign operators operating in The Netherlands meet an equivalent safety level as intended for Dutch operators. The bilateral air transport agreements between The Netherlands and another state should therefore include the necessary safety provisions.

3 CONCLUSIONS

FINDINGS

- All crew members were properly licensed.
- No relation could be established between the missed approach and the mishap that occurred during the following departure from Groningen Airport Eelde.
- The standard assigned passenger weight(s) to be used in the load and trim sheet were not unambiguously laid down in the operating manual.
- The actual passenger mass was approximately 2,000 pounds more than accounted for.
- The calculated take-off mass in the load and trim sheet was exceeded by approximately 2,500 pounds, which equals 2 % of its actual weight.
- The DOI used to calculate the TO-CG was not representing the actual situation.
- The actual DOI resulted in a more forward actual TO-CG than assumed.
- The fuel was not distributed according to the load and trim sheet and resulted in a more forward actual TO-CG than assumed.
- Free seating was allowed on this flight. However, as prescribed, reseating was required to comply with the load and trim sheet distribution and an equal distribution per compartment.
- No reseating was carried out. This resulted in a more forward TO-CG than the calculation on the load and trim sheet indicated.
- The suggestion by the cockpit crew that a number of 141 passengers “could not lead to problems with the CG” was contradictory to the findings.
- Deviations in DOI, fuel distribution and in particular the passenger distribution contributed to a more forward TO-CG than assumed in the load and trim sheet.
- The most probable TO-CG was found to be just outside of the certified forward TO-CG limit.
- The tailwind condition increased the take-off distance.
- The deviation of the required take-off thrust increased the take-off distance.
- The TO-CG insert in the take-off condition computer most likely was 11.1% MAC at take-off. The computer output prescribed a stabilizer position of 8 degrees ANU.
- The stabilizer position was set at 6.8 degrees ANU. This is not in accordance with the take-off condition computer output. On selecting take-off thrust this generated a stabilizer warning.
- The crew did not make a proper evaluation and did not identify the source of the warning.
- The crew adjusted the stabilizer to 7.2 degrees ANU that did not eliminate the mismatch between the output of the computer and the actual stabilizer setting. As a result the stabilizer warning remained present.
- At the second time the warning sounded, the take-off should have been rejected and the crew should have determined the nature of the warning.
- The stabilizer warning sounded during the entire take-off roll until the thrust levers were retarded for rejection of the take-off.
- The most probable actual TO-CG was –0.7%. The corresponding stabilizer position for take-off is 11.9 degrees ANU.

- During post accident testing the stabilizer warning system and stabilizer motion warning system did not reveal any malfunction.
- The stabilizer was not set in agreement with the actual TO-CG. This deviation highly affected the ability to rotate.
- The TO-CG insert in the take-off condition computer found after the accident was 13.5 % MAC. Nothing could be found which explained this alteration.
- The stabilizer position error was primarily the result of the difference between assumed loading according to the load and trim sheet and the actual loading. This was aggravated by a mismatch between the assumed required stabilizer position and the actual stabilizer position.
- The stabilizer portion of the take-off configuration warning system requires a correct input in the take-off condition computer.
- The MD-88, like most transport category aircraft, has no self-sensing weight and balance system to detect the actual TO-CG.
- The 24 degrees flap setting during take-off was in accordance with the prescribed procedure.
- The speed bugs setting was not in accordance with the required setting for a 24 degrees flap take-off.
- Rotation was initiated below the take-off decision speed (V_1) and consequently below rotation speed (V_r).
- The early rotation attempt reduced the aerodynamic capability of the elevator and stabilizer.
- As a result of an incorrect stabilizer position the load feel system generated a counterforce that was higher than required.
- As a result of incorrect stabilizer position the applied elevator deflection was inadequate. Consequently, the captain applied more pulling force on the control column than normal.
- The normal force required for rotation is approximately 16 pounds. Post flight analyses found the force needed to continue the take-off and rotate the aircraft for lift off as to be 50 pounds.
- Take-off was rejected beyond post flight calculated decision speed V1.
- It is questionable that continuation of the take-off would have turned out to be successful.
- Considering the circumstances rejecting the take-off might have been the least-bad choice.
- The take-off concept does not take into account (pitch) control problems after the decision speed has been passed.
- No causal system deficiencies could be identified which could have contributed to the heavy elevator control force the captain experienced. It is concluded that the aircraft was in an airworthy condition prior to the accident.
- No indications existed that system deficiencies could have influenced the aircraft stopping performance
- Multiple deviations from standard operational requirements had a negative effect on the stop distance. Those added to the inability to stop before the runway end.
- Company instructions did not clearly specify all information required for flight preparation.
- The continuation of the take-off with an active (sounding) stabilizer warning is considered to be remarkable as it is a violation of standard operating procedures.

- The required safety level for this flight was undermined by additional deviations in the operation from the required accuracy level.

- The crew did not demonstrate sufficient understanding of the standard practice of CRM.

- The combination of soft soil and embedded heavy concrete constructions increased the risk of a post-accident fire.

- The English language as spoken by the cabin crew was rated by a number of passengers as poor and difficult to understand.

- During the evacuation passengers were not sufficiently instructed on how to leave the aircraft. This prolonged the evacuation.

- Once evacuated, passengers remained within the close proximity of the aircraft and some were allowed to return on board.

- Not all available exits were used during the evacuation. This hampered the evacuation.

- The fire brigade responded in a timely fashion.

- The state of registry and/or the state of the operator is responsible for the oversight on the operation of aircraft and airworthiness of aircraft registered in that state.

- The state of destination has limited possibilities for checking the level of safety of foreign aircraft operating in its territory.

- ICAO performs safety audits on member states. The audit reports are available to all member states.

- There is no sanction system in place to enforce improvements proposed in the ICAO audit reports.

- No safety clause was incorporated in the air transport agreement between Turkey and The Netherlands.

- Dutch approval of the scheduled flights is granted without taking safety issues into account.

- JAA has no legal power and no system is in place to force member states to implement JARs before a mutual agreed date.

- For SAFA inspections the ICAO requirements are used as a reference. For aircraft from full JAA member states the (higher) JAR-OPS level is used as a reference.

- The SAFA inspections of aircraft are limited to a general visual inspection and document inspection. It cannot guarantee the airworthiness of a particular aircraft and the quality of operation. The Netherlands highly depends on adequate supervision by the state of the operator and/or state of registry.

- Due to the limited scope, it is questionable that a SAFA inspection performed before the accident flight would have prevented this accident.

CAUSES

Probable cause(s)

- The crew resumed the take off and continued whilst the take off configuration warning, as a result of the still incorrect stabilizer setting, reappeared.
- The actual center of gravity during take-off (TO-CG) was far more forward than assumed by the crew. As a consequence the horizontal stabilizer was not set at the required position for take-off.
- The far more forward TO-CG - contributed to an abnormal heavy elevator control force at rotation and made the pilot to reject the take-off beyond decision speed. This resulted in a runway overrun.

Contributing factors

- By design the aircraft configuration warning system does not protect against an incorrect TO-CG insert.
- The aircraft was not equipped with a weight and balance measuring system.
- Deviations of operational factors accumulated into an unfavorable aircraft performance condition during take-off.
- Cockpit crew showed significant deficits.

4 RECOMMENDATIONS

INFRASTRUCTURE

- It is recommended to the Minister of Transport, Public Works and Water Management to investigate to which extent the requirements concerning the underground infrastructure in the direct vicinity of start and landing runways has to be stepped up to prevent serious damage to aircraft that overrun the runway.

MEASUREMENT OF WEIGHT AND CENTRE OF GRAVITY

- It is recommended to the Civil Aviation Authority, the Netherlands (IVW) to check in which way the risks of an incorrect load can be decreased in the short term by, among others, verifying how this aspect can be given more attention during inspections.
- It is recommended to the Civil Aviation Authority, the Netherlands (IVW) to develop certification requirements for aircraft from the civil aviation category, to provide weight and centre of gravity measurements to the crew of new aircraft and to investigate the possibility to provide these data with existing aircraft.

PERMISSION

- The recommendation is made to the Minister of Transport, Public Works and Water Management to review the system of permission for foreign operators so that:
  - All available safety information, such as for instance the results of ICAO audits, is used when assessing a request for permission.
  - Clear-cut agreements are made in the bilateral agreements concerning the guarantee of the flight safety as well as concerning the criteria that will be used when suspending the permission.

- The recommendation is made to the European Aviation Safety Authority (EASA) to stimulate attention being given on a European scale to the development of the method with which aviation authorities and airlines from non-EU countries can be assessed.

SUPERVISION

- The recommendation is made to the Minister of Transport, Public Works and Water Management to improve the supervision on foreign operators, in order to strengthen the governmental supervision on aviation, by:
- Making available the safety information present in the Netherlands regarding the airline in question and the supervising state to all the staff members involved in the supervision.
- To assess the SAFA-programme in the Netherlands and to suggest measures for improvement.

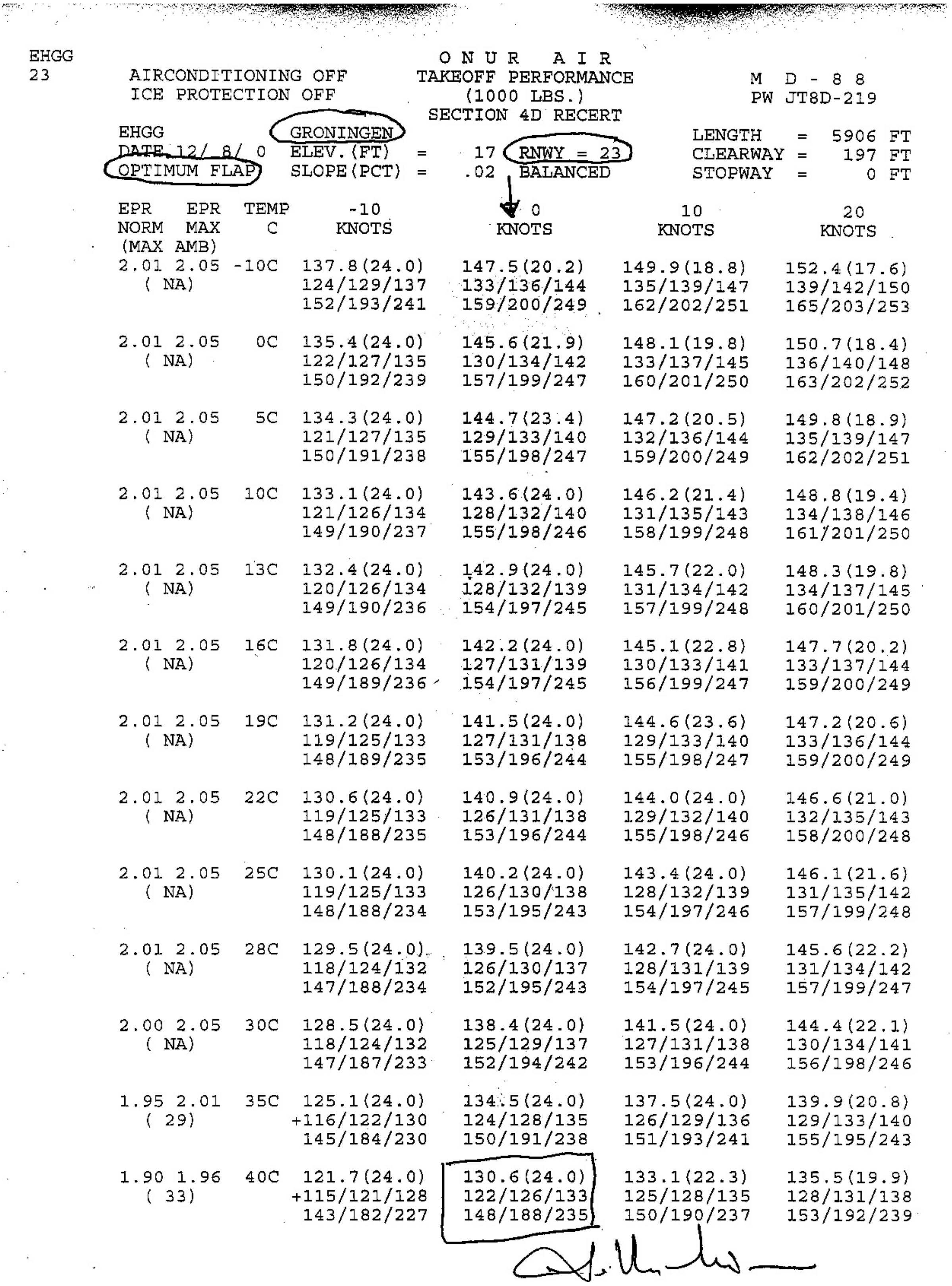
PROVISION OF INFORMATION

- The recommendation is made to the International Civil Aviation Organisation (ICAO) to verify in which way the results of the ICAO audits into the quality of the supervision in the member states can be made available to the public.
- The recommendation is made to the Minister of Transport, Public Works and Water Management to make its point of view on this issue known to the ICAO.

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 which 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

RTOLW table runway 23 (page 1 and 2)



```
EHGG                                  O N U R   A I R
23      AIRCONDITIONING OFF        TAKEOFF PERFORMANCE            M  D - 8 8
        ICE PROTECTION OFF            (1000 LBS.)                 PW JT8D-219
                                    SECTION 4D RECERT
      EHGG              GRONINGEN                            LENGTH    =  5906 FT
      DATE 12/ 8/ 0     ELEV.(FT)   =    17  RNWY = 23       CLEARWAY =    197 FT
      OPTIMUM FLAP      SLOPE(PCT)  =   .02  BALANCED        STOPWAY  =      0 FT

      EPR   EPR  TEMP       -10             0              10              20
      NORM  MAX   C        KNOTS          KNOTS           KNOTS           KNOTS
      (MAX AMB)
      2.01 2.05 -10C  137.8(24.0)    147.5(20.2)    149.9(18.8)    152.4(17.6)
        ( NA)         124/129/137    133/136/144    135/139/147    139/142/150
                      152/193/241    159/200/249    162/202/251    165/203/253

      2.01 2.05   0C  135.4(24.0)    145.6(21.9)    148.1(19.8)    150.7(18.4)
        ( NA)         122/127/135    130/134/142    133/137/145    136/140/148
                      150/192/239    157/199/247    160/201/250    163/202/252

      2.01 2.05   5C  134.3(24.0)    144.7(23.4)    147.2(20.5)    149.8(18.9)
        ( NA)         121/127/135    129/133/140    132/136/144    135/139/147
                      150/191/238    155/198/247    159/200/249    162/202/251

      2.01 2.05  10C  133.1(24.0)    143.6(24.0)    146.2(21.4)    148.8(19.4)
        ( NA)         121/126/134    128/132/140    131/135/143    134/138/146
                      149/190/237    155/198/246    158/199/248    161/201/250

      2.01 2.05  13C  132.4(24.0)    142.9(24.0)    145.7(22.0)    148.3(19.8)
        ( NA)         120/126/134    128/132/139    131/134/142    134/137/145
                      149/190/236    154/197/245    157/199/248    160/201/250

      2.01 2.05  16C  131.8(24.0)    142.2(24.0)    145.1(22.8)    147.7(20.2)
        ( NA)         120/126/134    127/131/139    130/133/141    133/137/144
                      149/189/236    154/197/245    156/199/247    159/200/249

      2.01 2.05  19C  131.2(24.0)    141.5(24.0)    144.6(23.6)    147.2(20.6)
        ( NA)         119/125/133    127/131/138    129/133/140    133/136/144
                      148/189/235    153/196/244    155/198/247    159/200/249

      2.01 2.05  22C  130.6(24.0)    140.9(24.0)    144.0(24.0)    146.6(21.0)
        ( NA)         119/125/133    126/131/138    129/132/140    132/135/143
                      148/188/235    153/196/244    155/198/246    158/200/248

      2.01 2.05  25C  130.1(24.0)    140.2(24.0)    143.4(24.0)    146.1(21.6)
        ( NA)         119/125/133    126/130/138    128/132/139    131/135/142
                      148/188/234    153/195/243    154/197/246    157/199/248

      2.01 2.05  28C  129.5(24.0)    139.5(24.0)    142.7(24.0)    145.6(22.2)
        ( NA)         118/124/132    126/130/137    128/131/139    131/134/142
                      147/188/234    152/195/243    154/197/245    157/199/247

      2.00 2.05  30C  128.5(24.0)    138.4(24.0)    141.5(24.0)    144.4(22.1)
        ( NA)         118/124/132    125/129/137    127/131/138    130/134/141
                      147/187/233    152/194/242    153/196/244    156/198/246

      1.95 2.01  35C  125.1(24.0)    134.5(24.0)    137.5(24.0)    139.9(20.8)
        ( 29)        +116/122/130    124/128/135    126/129/136    129/133/140
                      145/184/230    150/191/238    151/193/241    155/195/243

      1.90 1.96  40C  121.7(24.0)    130.6(24.0)    133.1(22.3)    135.5(19.9)
        ( 33)        +115/121/128    122/126/133    125/128/135    128/131/138
                      143/182/227    148/188/235    150/190/237    153/192/239
```

127.529 → interpolate 122/125/132
147/187/232

Flap degree
(24.0)

```
EPR   EPR   TEMP     -10                0               10               20
NORM  MAX    C      KNOTS             KNOTS            KNOTS            KNOTS
(MAX AMB)
1.85 1.92   45C  118.4(24.0)      126.9(24.0)      128.9(21.0)      131.2(19.2)
  ( 38)         +114/119/126      121/124/131      124/127/134      127/130/137
                 141/179/223      146/186/231      149/187/233      152/189/235

1.81 1.88   50C  115.1(24.0)      123.0(21.8)      125.1(19.8)      127.1(18.5)
  ( 42)         +113/118/125      120/124/130      123/126/133      126/129/136
                 140/177/220      145/183/228      148/184/230      151/186/231

1.81 1.88   50C                   120.0(24.0)      125.0(19.8)      125.0(19.8)
  ( 42)                           117/121/127      123/126/133      123/126/133
                                  142/181/225      148/184/230      148/184/230

1.81 1.88   50C                                    120.0(24.0)      120.0(24.0)
  ( 42)                                            118/121/127      118/121/127
                                                   142/181/225      142/181/225

     FINAL SEGMENT CLIMB SPEED APPROXIMATELY = V SLAT RETRACT + 20 KIAS
     QNH CORRECTIONS - ADD/SUBTRACT     0/  50 LBS/.01 IN.HG ABOVE/BELOW 29.92
         +    = CHECK MINIMUM SPEEDS IF ACTUAL TEMP COLDER THAN SHOWN
     EPRS DETERMINED AT A PRESS ALT EQUAL TO RUNWAY ELEV. IF ALTIMETER SETTING
     BELOW 29.72 OR ABOVE 30.10 CHECK EPR SETTING CHART AT CORRECT PRESS ALT
     MAX AMB = MAXIMUM AMBIENT TEMPERATURE AT WHICH REDUCED THRUST TAKEOFF ALL
                                  *** LIMITATIONS ***
      0    = WT LESS THAN  80.0  BE = BRAKE ENERGY  TS = TIRE SPEED  AC = APPR
      0** = OUTSIDE AFM RANGE    EE = ENVIR.ENVELP  SS = SECOND SEG  FS = FINAL
      *(LETTER) = OBSTACLE       MC = MIN.CONT.SPD  ST = STRUCT.WT
      FP = WT LIMITED BY FLT PATH ACCEL HT
EHGG
23
END OF INPUT AIRPORT DATA CARDS
Stop - Program terminated.
```

— 2 -

APPENDIX B part A
Aircraft Performances

Take-off Performance

General
Aircraft performances are included in airworthiness requirements. Together with associated operational rules, they are intended to ensure a satisfactory operational safety level in civil aviation. Performances apply for every phase of flight, being take-off, climb, cruise through descent and landing. For this investigation the take-off performances are discussed as only the take-off and rejected take-off conditions were applicable. Within this phase of flight take-off parameters for airborne conditions (particularly flap retraction speeds) are excluded as the aircraft did not lift off but came to a stop.

An engine failure during the take-off run is a common reason to abort the take-off, for it immediately affects the aircraft take-off performance. However, for multi-engine aircraft the continuing of the take-off with partial loss of engine power should be considered. Aborted take-offs may sometimes be more hazardous than continuing take-off with limited engine power when the remaining runway is too short for deceleration to a stop. This poses an overrun accident risk for crew and passengers. At a certain point (and beyond) during the acceleration phase this risk applies for almost all take-offs made by commercial jet aircraft.
Consequently, concepts of critical engine failure speed have been developed to provide better information for pilots operating multi-engine aircraft to better decide whether to abort the take-off, or not. Besides this take-off decision speed (V1) the rotation speed (Vr) and a safe pre-dictated climb speed (V2) are determined for each flight to assure safe performances and margins with terrain or obstacles.

The take-off decision speed V1
It is noted that the development of the take-off decision speed V1 is primarily related to an engine failure during take-off. Other reasons to abort the take-off occur at least as frequently as engine failures. In all cases V1 is used as take-off decision speed, being the speed reached at a certain point after which the take-off should be continued as it generally is safer.

This speed is normally determined by using the balanced take-off method. It is reached at that point where the acceleration-stop distance is equal to the take-off distance while having an engine failure during acceleration at V_1. In case of continuing the take-off the aircraft is capable of passing the runway end at 35 feet height with a safe climb speed, called V2.

Dependent on the type of aircraft engine thrust reversers may be used when installed to aid in deceleration during a rejected take-off. Generally, the effect of engine thrust reversers is not accounted for in the performance calculations.

The rotation speed Vr
The rotation speed is that speed at which rotation to the lift-off attitude is initiated. The take-off mass of the aircraft is dominating for establishing the value of this parameter and shall not be less than V1.

Timing and rotation technique affect V2 and height above the runway threshold. When the rotation is too late and/or too little the aircraft will pass low over the runway threshold with a speed higher than V2. When the rotation is started too early and/or too much the total effect of drag will increase during the remainder of the take-off run affecting the acceleration unfavourably. As a result the aircraft will pass low over the threshold and with the speed possibly still below V2. In this respect a correctly adjusted stabilizer position is important to achieve sufficient controllability for a proper rotation technique.
In case rotation is initiated before the pre-determined V1, it will be reached at a point farther on the runway than it should. In fact, the V1 decreases. Now the risk of rejecting beyond the lower V1 is increased.

The climb speed V2
This speed is a safe climb speed with pre-dictated margin to stall speed or minimum required speed for maintaining sufficient controllability (V_{mca}) with the most critical engine failed and a maximum roll angle of 5 degrees. Climb requirements have been fulfilled.

Appendix B part B

TC-ONP take-off performance at Groningen Airport Eelde

Reconstruction of the take-off performance for runway 23

Speeds
Except for speed bugs set on the airspeed indicators and a speed booklet, which was found displayed in the cockpit, no pre-flight performance related data were found. The values found are shown in table x together with other sources for comparison. In the Onur Air OM it is prescribed that V1, V2, Vflap up and Vslat retract are set with speed marks. Vr usually is a memory item for the crew and not to be set on the airspeed indicator.

source	V_1	V_r	V_2	$V_{flaps\ up}$	$V_{slats\ retract}$	**based on**
Displayed speed booklet	129	135	145	150	187	128,000 lbs, flaps 11 degrees
Airspeed indicator captain	128	not applicable	145	151	186	As found after accident
Airspeed indicator co-pilot	128	not applicable	145	149	188	As found after accident
Onur Air (post accident)	122	125	132	147	187	Crew data: flaps 24 degrees
The Dutch Safety Board (post accident)	123	128	137	152	193	130,000 lbs, flaps 24 degrees, 5 knots tailwind[21]

Table 1: used speeds and sources for the investigation

Data available to crew
To establish performance requirements for take-off the available take-off mass was 127,529 lbs as prepared by the crew in the load and trim sheet. The prevailing weather conditions were 1014 hectopascal for the QNH and wind from 100/110 degrees with 6 knots. The ambient temperature was 16 degrees Celsius. For determining the applicable performance speeds and thrust settings the RTOLW table was to be used, see Appendix A.

Onur Air flight safety department
On request of the DTSB ONUR Air received the crew data to provide a post accident performance calculation to aid in the investigation. The flight safety department returned a copy of the RTOWL table in which the speeds as indicated above were shown. The “assumed temperature method” to derate engine thrust was applied for a zero knots headwind condition. By assuming the average temperature of 42.5 Celsius (interpolation between 40 and 45 degrees Celsius) an optimum take-off flap setting of 24 degrees was determined for 128,750 lbs maximum take-off mass.

Engine thrust
In the OM of Onur Air, under normal procedures 2.2.2.1 Limitations, the operator states that a flex take-off thrust (derated take-off thrust) should only be used with flaps 11 degrees.

When no derating is applied the EPR NORM is 2.01 and EPR MAX 2.05 based on the prevailing ambient temperature of 16 degrees during the take-off. The maximum allowed take-off mass is 142.200 lbs for zero knots headwind and 137,000 lbs for 5 knots tailwind.

Onur Air did not indicate the EPR thrust setting in its post accident calculation.

Reconstructing the engine thrust setting
On the TC-ONP the take-off thrust can be set either by moving the throttles forward by hand, or by the use of the auto throttle system (ATS). By controlling the set EPR the ATS function automatically positions the throttles to maintain airspeed or engine thrust, dependant from the selected operational mode(s). The T.O and T.O. FLX modes are only available when the flight director (FD) is engaged for speed control functions.

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[21] By interpolation between 0 and -10 knots headwind (tailwind) the various performance speeds have been determined for a 5 knots tailwind condition, see RTOLW table in appendix A.

Auto throttle system
The take-off thrust can automatically be set by selecting an EPR limit thrust mode on the thrust rating panel and engaging the ATS. To set normal thrust the take-off (T.O.) mode is used in which the system uses the ambient temperature to select the EPR limit. The auto reserve thrust (ART) function [22] is selected to produce extra thrust of the remaining engine when the other engine fails.

For a derated take-off the pilots have to insert the assumed temperature for the take-off flex thrust mode (T.O. FLX) to establish a derated EPR thrust limit. In this mode the ART function of the ATS needs to be switched off, which assures that EPR MAX for the assumed temperature is automatically set by the system. Appendix A reflects the relation between the temperatures and thrust settings (EPR NORM and EPR MAX). Another option is to select an EPR thrust limit manually by rotating the manual EPR set knob on the engine control and indicating panel to the desired EPR thrust limit value. The use of the ATS is recommended in the Onur Air operating manual.

During a normal take-off the PF advances the throttles till both engines are stabilized at approximately 1.40 EPR. Then the PF calls for “auto throttle on” to be carried out by the PNF. The auto throttle function is engaged by moving the switch from the OFF to the AUTO THROT position on the flight guidance control panel. According to the flight crew operating manual and the Onur OM the PNF verifies the maximum thrust for take-off and whether the CLMP[23] mode becomes active, which occurs when 60 knots calibrated airspeed is exceeded. Now, the amount of thrust of each engine as set by the ATS may be adapted manually when required. Incorrect thrust levels, including significant differences in engine thrust, should be trimmed away by the PNF.

The auto throttle switch is solenoid held. Besides when it is switched off manually, it will automatically disengage when the flight guidance system (FGS) detects malfunctions, the auto throttle disconnect button on either throttle is pushed or when electrical power, which holds the solenoid of the switch, is lost. When reverse thrust is actuated the switch will be disengaged.
Post accident investigation revealed that the auto throttle switch was found in the OFF position and the FD switches were in the FD position (engaged).

Split engine thrust
Individual engines on the same aircraft may spin up with different acceleration rates. In order to minimize this effect in the final take-off thrust the procedure to engage the ATS requires to first set engines on a mid-thrust EPR level (1.4 EPR). Provided the pilot assures sufficient matching, subsequent engine accelerations starting from mid-thrust levels then result in less thrust differences when ATS is selected on.

It is mentioned that the engine synchronization system (ESS), which synchronizes the two engine EPR values, is not active as soon as the ATS gets into the CLMP mode. The functioning of the ESS is resumed as soon as the climb mode for thrust setting is selected.

When the ATS is in operation, it drives both throttle levers simultaneously but not separately. As soon as one of the engines reaches the set EPR value, both throttle levers stop to move. This may result in unequal EPR values between both engines. Differences in throttle cable tension or little anomalies in engine system conditions (pressure leaks in the EPR sensing system, bleed air, fuel manifold, or gas path damage to one of the engines) may explain the different thrust of the engines when both throttle levers are in the same position. Hence, throttle levers are not aligned when producing the same take-off thrust. This stagger should not exceed 1½ throttle lever knob.

After engine overhaul or fuel control replacement engines have to be trimmed within the margin of + 0.015 till – 0.0 EPR as indicated in the AMM. Consequently, the maximum EPR difference between both engines as an acceptable maintenance tolerance as indicated in the AMM is 0.015 EPR.

Another reason for different engine thrust may be if one air conditioning packs which is fed by one engine is on, whilst the other air conditioning pack fed by the other engine is off. The air conditioning pack switches normally are in the AUTO position when on the ground. In the “Before take-off check list” they remain in the position AUTO or have to be changed to OFF. Consequently, a different EPR indication between two engines may be possible when one air conditioning pack is not switched off. When both are switched off it will not affect the difference, but it will affect both thrust levels.

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[22] ART function, see note under 1.6.2., thrust setting.
[23] CLMP: mode of the auto throttle system in which the throttles automatically remain stationary during acceleration beyond 60 knots by removing the electrical power from the servo motor which drives the throttles. This mode permits manual positioning of the throttles without disengaging the auto throttle system.

According to the RTOLW (see appendix A) both air conditioning packs should have been off for the take-off made from EHGG. After the accident the checklist for a crash landing was found displayed in the cockpit, in which it is prescribed for the air conditioning supply switches to be set in the OFF position. The position of the air conditioning supply during the take-off and the stagger of the throttles, if any, could not be determined

Throttle responses
FDR information demonstrates that the take-off mode (TO) had been selected and was followed by the clamp (CLMP) mode. The general trend throughout the take-off run reveals that both engines stabilize as N2 and fuel flow remain on a constant level. The shallow EPR (and also N1) decrease is a common engine output response during the take-off as ground speed increases and inlet conditions change. EPR (and N1) slightly decrease as a result of re-balancing the energy between the N1 and N2 spools.

The throttle response was used to reconstruct the selected thrust. FDR data indicate that engines did not stabilize at 1.40 EPR, but both initially increased to a maximum of 2.12 EPR (left engine) and 2.16 EPR (right engine). ATS was engaged shortly afterwards when EPR TO mode was recorded. Only the left throttle position was registered. From the right throttle no valid position data could be obtained.

The take-off thrust was essentially set by 70 knots. From FDR it was derived that at that time values were 2.02 EPR for the left engine and EPR 1.97 for the right engine. After rejection both engine thrust reversers deploy and that reverse thrust is applied

Flap position
From the Onur Air operating manual it can be derived that for MD-88 operations a standard flap setting of 11 degrees is used. In addition Onur Air indicates that any other flap settings between 0 – 24 degrees may become necessary due to performance requirements. From the FAA approved AFM it can be derived that for the best take-off performance on a given runway an optimum flap setting is preferred. No standard flap setting is mentioned in the AFM.

Generally, operators may incorporate own standards in their operational procedures to enhance less workload and to make daily operation easier as long as they do not impair safety and contradict to existing procedures or requirements. The incorporated standard of 11 degrees take-off flap setting was not further investigated. The positions of the flaps were 24 degrees during take-off as shown on FDR data in Appendix H.

Spoilers position
During the rejection the spoilers deployed, see Appendix H for FDR data.

Stabilizer trim position
FDR revealed that the stabilizer position was 9.1 ANU during landing. During the turn around the stabilizer position was changed to 6.8 ANU. Just before the engine thrust setting is increased for take-off, a change of the stabilizer position was recorded to 7.2 ANU. This value remained during the rest of the take-off run.

A separate post-accident measurement of the stabilizer position was carried out. The stabilizer leading edge position was measured with respect to a rivet position used for reference. This “rivet method” was translated by Boeing into approximately 7.0 degrees ANU.

APPENDIX C part A

Load and trim sheet

In the load and trim sheet the mass of the aircraft, different masses of the passengers, cargo (luggage), fuel and are listed. This overview serves to provide information to the crew with respect to mass limits. Except that any maximum mass – specifically for take-off and landing – should not be exceeded, it is essential to keep the resulting mass distribution, expressed as CG, within a forward and aft limit as well. The CG calculation is performed to assure that among other things the TO-CG position is within the flight envelope for take-off. This TO-CG is essential for adjusting the stabilizer trim to ascertain longitudinal control with acceptable control forces.

To determine the TO-CG a load and trim sheet can be used by the crew as it is a quick method, see appendix K. The parameters which affect the CG position are shortly explained below.

DOW/DOI
The dry operating weight (DOW) is the aircraft mass excluding the passengers and cargo (payload) mass, the useable fuel mass and ballast fuel mass. It includes the crew and their luggage and the standard operational but variable items like cabin and lavatory supplies and galley loads (foods, drinks et cetera). The corresponding CG position of the DOW is expressed as the dry operating index (DOI) and is the starting point for establishing the CG.

The flight operations department of Onur Air composed a table for the MD-88 fleet, listing the DOW and DOI for each company MD-88 with options for crew numbers and inbound or outbound flight.

Cargo
For every cargo compartment the different effects on the CG position are expressed by the various cargo indexes (500 pounds mark lines) as shown by the graphical method. Cargo stowed in compartments A, B, and C contribute to a more forward CG. Cargo stowed in compartment D has a more rearward effect.

Fuel
Except for low quantities, the effect of fuel in the main wing tanks is that it alters the CG rearward. Fuel present in de center tank has a forward effect on the CG-position. The fuel in the aft auxiliary tank creates a rearward effect on the CG. The forward auxiliary tank was not installed on the TC-ONP. The resulting fuel index indicates the total fuel mass effect on CG.

Passengers

Mass
The passengers are divided in numbers of males, females, children and infants. The assumed passenger weights usually include hand luggage and they may vary per consulted document, manual or ground handling agent.
The actual average passenger weight may be different for each group of males, females and children. For the actual average weight of all passengers the male-female ratio and their hand luggage, which is included, are significant.

Center of gravity
When it comes to the determination of CG, no distinction in weight between males, females and children is made for the graph. The assumed passenger weight is 170 pounds as constant value for each passenger, as prescribed in the W&B manual.
The passenger indexes in the graph demonstrate that the forward effect on the CG of compartment 1 is significantly more than the rearward effect of compartment 2. For each compartment it is assumed that the resulting moment (assumed passenger mass times average arm) of all passengers in a compartment varies linearly with the number of passengers seated in that compartment. This is only achieved when passengers are equally spread within each compartment. Equal spread of passengers itself is not an absolute necessity for flight nor for a correct CG-calculation. However, it is the valid condition which should be complied with when using the graph. The use of the graph usually prevails, for it is quicker than totalizing the resulting moment[24].

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[24] When no equal spread is applied, the calculation method as demonstrated in the Weight and Balance manual should be used. This would mean that the resulting moment per every seat row should be determined for an accurate CG-calculation.

Appendix C part B

Actual load and trim calculation

The load and trim sheet which had been used by the crew for the accident flight was indicated as "MD-88 version: 172". Down the page an additional mark was found with "OHY" as an abbreviation for ONUR Air. The load and trim sheet is demonstrated in Appendix K.

Dry Operating Weight and Index
The DOWDOI in the load and trim sheet originated from a document called "MD-88 DOW/DOI table" revision 17 found present in a binder called (uçak idari dosyasi (reg: TC-ONP)) on board the aircraft. It was issued by the Onur Air flight operations support center performance office. It appeared that revision 18 had been in effect, but was not to be found on board.

Onur stated: "Revision 17 included 3,000 pounds standard ballast fuel. This was done for the stations where (...) computers are not able to handle ballast fuel index correction automatically. After one and a half months trial, we decided that revision 17 might create confusion due to the fact that the crew were supposed to arrange DOW accordingly by adding ballast fuel amount in to DOW as we instructed. We issued revision 18 which does not include any index incorporated with ballast fuel. DOI/DOW calculation for revision 17 and revision 18 is identical. The only difference is a positive 350 index which is equivalent to 3,000 pounds ballast fuel in revision 17. We inform our flight crew for the actual DOW/DOI of the aircraft by issuing the latest tables as hard copy revisions."

In the OM another DOW/DOI table was found. Onur Air explained that DOW/DOI values in the OM are generic basic information and do not reflect customized catering or crew combinations options.

Document	**location**	**issued**	**DOW [lbs]**	**DOI**
Ops Manual page 6.2-1 revision 12	Onboard	22-01-02	84,897	6036
MD-88 DOW/DOI table revision 17	Onboard, in binder	15-04-03	85,340	6280
MD-88 DOW/DOI table revision 18	Not onboard	29-05-03	85,340	5930

Table 2: DOW/DOI by source.

Cargo Mass and Distribution
Except a toolbox in cargo compartment A both cargo compartments A and B were empty. Cargo compartment C contained the luggage of the passengers which boarded the aircraft at Groningen Airport Eelde with destination Dalaman. It had been weighed by the ground handling agent when the passengers had checked. According to a ground handling employee which actually unloaded and loaded the cargo at Groningen Airport, cargo compartment D contained the luggage for the passengers who boarded the aircraft in Dalaman (Turkey) with destination Maastricht-Aachen (The Netherlands).

After the accident each piece of luggage was separately weighed and it was recorded in what cargo compartment it had been stowed. The results were compared to the values as written down in the load and trim sheet.

	Compartment C	**Compartment D**
According to load and trim sheet	2,597 lbs	2,871 lbs
The Safety Board's investigation	2,719 lbs	2,915 lbs
Difference	+122 lbs	+ 44 lbs

Table 3: loading cargo compartments

Fuel mass and distribution

Fuel tanks configuration
The Boeing McDonnell Douglas MD-88 is designed with one main fuel tank in each wing, a centre wing tank and two auxiliary fuel tanks. The aft auxiliary fuel tank is stationed aft of the centre wing tank. The forward auxiliary tank is positioned in front of the centre wing tank.

The fuel system of the TC-ONP was configured with only the aft auxiliary fuel tank installed. Fuel in this tank may be used as ballast and should then be considered as unusable and not transferable. The mass and CG effect of ballast fuel must be included in the operating zero fuel mass.

	Center wing	**Both main tanks**	**Aft auxiliary**	**Resulting index**
Load / trim sheet	5,000 lbs	10,000 lbs	0 lbs	- 22
The Safety Board's investigation	7,000 lbs	8,300 lbs	100 lbs	-134
Difference	+2,000 lbs	-1,700 lbs	+100 lbs	-112

Table 4: Fuel mass and distribution

In the load and trim sheet the take-off fuel is indicated as 14,500 pounds for mass calculation. For CG position calculation 15,000 pounds take-off fuel is used, as indicated in the table above. In another Onur Air document indicated as "load sheet info", the take-off fuel accounted for is 15,000 pounds. Taxi fuel is not mentioned in this document.

In the load and trim sheet the take-off fuel is indicated as 14,500 pounds. With respect to CG the total fuel load accounted for is 15,000 lbs. The Safety Board's investigation showed 15,300 lbs fuel on board after the event. A small amount (not more than 100 pounds) of fuel in the aft auxiliary tank was not included.

Passengers mass and distribution

Different passenger masses by various sources
Investigation revealed different assumed values for passenger weights in various sources available to the pilots. The results of a questionnaire held amongst passenger of the accident flight have been added.

source		**male**	**female**	**child**	**infant**
		pounds (lbs)			
Operating Manual	ONUR Air	165	145	77	22
Binder documents	ONUR Air	185	185	185	- -
Ground handling agent	ONUR Air	175	145	77	22
W&B manual	Boeing	170	170	170	- -
Questionnaire	The Dutch Safety Board	192	157	31	- -

Table 5: assumed passenger weights (including hand luggage) by source in pounds

In the load and trim sheet the values from the ground handling agent have been used. The male-female ratio was such that the average passenger weight was 158 pounds (infant not included). The total passenger mass was determined to be 22,221 ponds by the pilots.

Post-accident investigation resulted in the averages of the passengers which responded to The Safety Board's questionnaire as presented above.[25] When these derived values are projected on all passengers onboard during the accident flight, a most probable passenger mass is estimated at 24,090 lbs which equals approximately 171 pounds per passenger (infant not included). For detailed information concerning male-female compilation of the passengers and questionnaire responses, please refer to Appendices L and M.

Passenger distribution
Passenger compartment 1 is defined to start from row 1 up to row 18 and includes seats A and B. According to the graph in the load and trim seat 70 passengers (counting passenger index steps) were assumed to be seated in this compartment. Then 17 seats would remain unoccupied.

Passenger compartment 2 is defined to start from row 18 and includes seats C, D and E. According to the graph 70 passengers were assumed to be seated in this compartment as well. Then 15 seats would remain unoccupied. The effect on the CG by the two children and one infant is undetermined in the graph, but their effect is little and can be neglected.

It can be found that 80 to 87 passengers were seated in compartment 1 and that 54 to 61 passengers and 1 infant were seated in compartment 2. Eight males had not responded to the

---

[25] This passenger data could not be verified by the DTSB. It is known that the actual passenger weights may be higher as people tend to indicate a lower body weight than it actually is.

questionnaire. As it is unknown where they were seated four males are assumed to be seated in compartment 1 and 4 males to be seated in compartment 2. Hence, the most probable number of passengers was 84 in compartment 1 and 58 passenger and 1 infant in compartment 2.
For detailed seating analysis of the questionnaire please notice Appendix L.

Determination of the CG
In the next table different CG values are demonstrated by changing the CG-determination method, replacing the assumed passenger masses by most probable passenger masses, and by varying the passenger distribution. The separate effects can be noticed in the CG outcome, see table 6 below.

Passenger mass lbs	**Passenger mass distribution**	**Graphical method % MAC**	**Calculation method % MAC**	**Stabilizer setting Deg.**
Assumed mass 170	141 passengers most forward seating (31 empty seats in compartment #2)	1,7	-2.9	11.1 / 12.0*.
Assumed mass 170	141 passengers most aft seating (31 empty seats in compartment #1)	14.3	17.3	7.1 / 6.1
M 192 F 157 s C 31	141 passengers most forward seating, mass and M/F distribution according the questionnaire results (31 empty seats in compartment #2)	n.a.	-4.8	n.a. / 12.0*
M 192 F 157 C 31	141 passengers most aft seating, mass and M/F distribution according the questionnaire results (7 empty seats in compartment#1 and 24 empty seats in compartment #2)	n.a.	11.4	n.a. / 8.0
Average mass 171	141 passengers most forward seating, mass according the questionnaire results (31 empty seats in compartment #2)	1.7	n.a.	11.1 / n.a
Average mass 171	141 passengers most aft seating, mass according the questionnaire results (7 empty seats in compartment#1 and 24 empty seats in compartment #2)	14.3	n.a.	7.1 / n.a.
M 192 F 157 C 31	141 passengers, seat number and mass according the questionnaire results (7 out of 8 male passengers who did not react on the questionnaire in compartment #1 and 1 in compartment #2, 31 empty seats in compartment #2)	n.a.	-2.2	n.a. / 12.0*
M 192 F 157 C 31	141 passengers, seat number and mass according the questionnaire results (all of the 8 male passengers who did not react on the questionnaire in compartment #2, 7 empty seats in compartment #1 and 24 empty seats in compartment #2)	n.a.	1.3	n.a. / 11.3
M 192 F 157 C 31	141 passengers, seat number and mass according the questionnaire results (the 8 male passengers who did not react on the questionnaire are equally spread between compartment #1 and #2, 3 empty seats in compartment #1 and 27 empty seats in compartment #2)	n.a.	-0.7	n.a. / 11.9

Operational limits: -2.8% min – 33.4% max.

Note: For the calculation the weight per seat-row is multiplied by the corresponding arm based on the data provided in the weight and balance manual.

Note: the value with a star (*) is not the indicated value in the AFM in the Stabilizer – CG graph as the stabilizer positions beyond 12 degrees ANU are not shown in the graph. The maximum stabilizer position is 12.2 degrees ANU.
Analysis: Based on the collected loading data, the questionnaire results and the assumption that the 8 male passengers who did not respond were equally spread over compartment #1 and #2. Hence the most likely centre of gravity during the take-off is estimated to be -0.72%.

Stabilizer Trim Calculation and Setting

The assumed CG by the crew and the different CG value found in the take-off condition computer after the accident have been listed in the next table. Additionally, post accident CG values found by the Safety Board have been plot in a graph in the AFM to derive the corresponding stabilizer trim positions. The graph elaborates the same relation between the take-off condition computer inserts and the take-off condition computer readout, which represents the required stabilizer trim position. The acquired results have been added in the table for comparison.

Take-off cond comp		**stabilizer trim**		
CG insert	Flap insert	calculated	position	Remark
11.1	24	8.0	7.2	CG assumed by crew
13.5	24	7.3	7.2	CG insert as found
-2.2	24	12.0[26]	n.a	DSB: actual CG forward limit
1.3	24	11.3	n.a	DSB: actual CG aft limit
-0.7	24	11.9	n.a	DSB: most probable CG

Table 7: stabilizer trim positions for different CG's

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[26] This value is the ultimate value in the graph. Higher values are not plot.

Appendix D part A

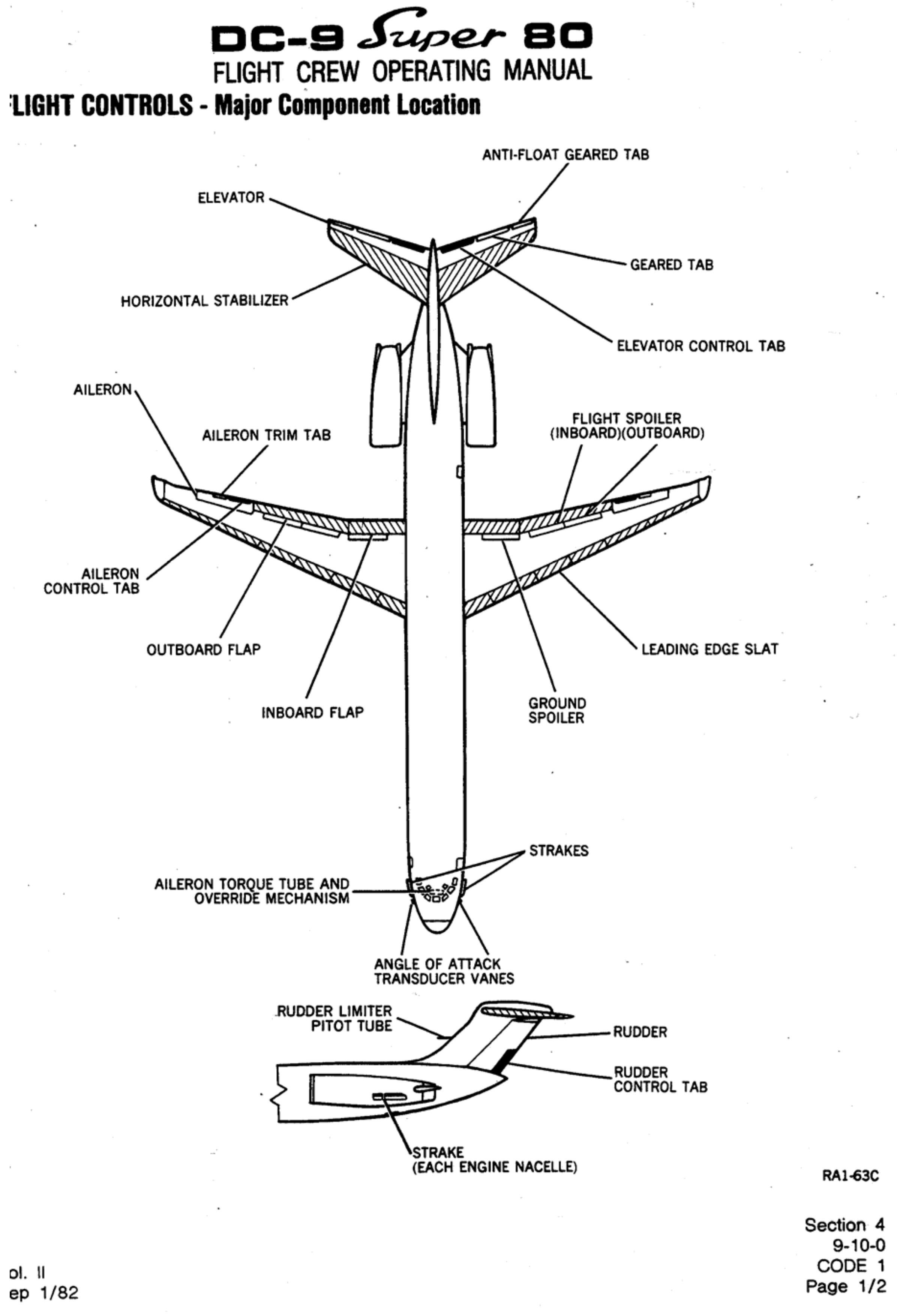
Description longitudinal control system
The Longitudinal Control System

Elevators and control tabs
The longitudinal control system primarily consists of a pair of separate elevators attached to the horizontal stabilizer. The elevator control is a primary flight control. For initial longitudinal control a pilot control column input will result in an elevator deflection. This is achieved by an aerodynamic boost system for each elevator that is operated by a single control tab. The mechanical system positions the control tab and consequently this induces an aerodynamic force which will move the elevator in the opposite direction.

Each control tab is directly driven by an independent two-way cable system from the corresponding control column (one system for the captain and one for the co-pilot) in the cockpit. The left and right elevator surfaces are not interconnected, but only linked to their own separate driving system. Both control columns are interconnected enabling both left and right system to work in unison. An illustration of the longitudinal control surfaces is shown in figure 1 (next page).

Geared tabs and anti-float tabs
When the elevator moves, the geared tab moves in opposite direction (same direction as the control tab) to aid in changing and maintaining the elevator position. The geared tab is hinged to the elevator surface and is mechanically connected by a couple of rods to the horizontal stabilizer. This construction creates that geared tab deflection will vary with elevator position.
The anti-float tab is to prevent down-float of the elevator when the horizontal stabilizer position is more than 10 degrees ANU. Its movement is programmed to stabilizer position: the more the stabilizer is set in a position beyond 10 degrees ANU trim (maximum is 12.2 degrees ANU), the greater the anti-float tab down deflection will be.

Variable load-feel system
Aerodynamic load feel forces are supplemented by a variable load feel system. The variable load-feel mechanism is connected by cables to the longitudinal trim system. Control column force will vary with stabilizer position and will decrease with forward center of gravity (CG) conditions when the stabilizer is set accordingly. The variable load-feel mechanism in conjunction with the load-feel and centering spring mechanism provides a simulated feel for the longitudinal control system and returns the control column to neutral when it is released by the pilot.



DC-9 Super 80
FLIGHT CREW OPERATING MANUAL

LIGHT CONTROLS - Major Component Location

ol. II
ep 1/82

Section 4
9-10-0
CODE 1
Page 1/2

Figure 1: flight crew operating manual 9-10-0 page 1/2.

Dampers and hydraulic boost cylinders
A viscous damper is installed in the leading edge of each elevator and attached to the elevator itself and the stabilizer. Hydraulic boost cylinders and an elevator power control follow up mechanism are also connected to elevators and control tabs.

Horizontal Stabilizer
The horizontal stabilizer is a secondary flight control and is located at the top of the vertical stabilizer (vertical fin) on the Boeing McDonnell Douglas MD-88. It is hinged forward of the rear spar in such a way that the leading edge can be moved up and down to provide longitudinal trim.

Stabilizer movement is achieved by driving a jackscrew by either a primary electric motor or an alternate electric motor. The trim rate is one degree ANU or AND position change per three seconds. Primary trim is either electrically controlled by dual switches on each control wheel, or mechanically controlled by dual handles on the pedestal in the cockpit. In both cases the primary electric motor is driven. Alternate stabilizer operation is provided by two alternate long trim switch levers on the pedestal by which the alternate electric motor is controlled. During auto-flight the alternate motor is also used by the autopilot commands for trim. The alternate trim rate is approximately one degree per 10 seconds.

Figure 2: pedestal take-off condition computer.

The stabilizer take-off setting is determined by entering the calculated CG value from the load and trim sheet and the required flap setting in the pedestal mounted take-off condition (mechanical) computer. The stabilizer calculated numeric outcome will appear in the take-off condition long trim window. The crew have to set the horizontal stabilizer by running the stabilizer till the take-off position indicator matches the long trim window numeric outcome, see also the picture left.

The take-off position indicator is driven by a trim indicating system follow up cable, which is mechanically connected to the stabilizer. This system also drives a sensing device which provides an audible signal in the flight compartment for approximately each 0.5 degrees stabilizer movement. Though it is called a warning in the AMM, it actually serves more as an annunciation as it usually confirms advertent stabilizer movement. However, in case of unintended or inadvertent movement the warning sounds as well. In this light it may be considered as a warning.

A vocal warning will sound when a specific rate of stabilizer movement is exceeded during autopilot operation. This warning for a so called runaway stabilizer trim condition will not be further discussed as during a take-off the autopilot normally is not engaged.

The autopilot elevator servo torque limiter and flap bus cable
The autopilot elevator torque limiter is designed to limit the autopilot’s elevator authority mechanically. It is attached to the longitudinal cable system between the control columns and the elevator surfaces. During autopilot engagement the cables are jammed in by a slip clutch which is driven by a servo actuator for elevator deflection.

During take-off the autopilot was not engaged and then the slip clutch was free. However the cables still run over the drum through the drum and clutch housing. Hence, in order to verify free elevator operation during autopilot disengagement the autopilot elevator torque limiter was also inspected. No anomalies were found.

When a flap is jammed or obstructed during flap extension or retraction, flap travel is interrupted to prevent flap asymmetry. On the MD-88 this realized by the flap bus cable which interconnects all flaps in a cable loop. The flap bus cable has an input to the servo torque limiter which is in operation during autopilot engagement only. Failure of the flap bus cable has no impact on the column force.

Appendix D part B

Functional checks

Functional checks indexed as Onur 2185-100 t/m 113 Job Card numbers (JAC) had been performed in accordance with existing functional checks as published in the AMM. The list shows an overview of the tested and examined topics.

Index (JAC)	AMM Test
100	Elevator load feel/centering mechanism
101	Excessive friction check of the Elevator control system
102	Elevator and tabs travel checks
103	Elevator power control valve and linkage
104	Elevator power control valve follow up mechanism
105	Rigging of the flap bus cable (not accomplished)
106	Take-off Warning system test
107	Trim contactors and manual override
108	Manual override control and brake switch control
109	Primary longitudinal trim brake switch
110	Horizontal Stabilizer Motion Warning Sensor
111	Horizontal Stabilizer Position Indicator Module
112	Elevator and tab clearances
113	Horizontal Stab Warning Take-off Warning Switch

General
In general terms the testing covered to check free and correct elevator input without excessive force and obstructions and with full elevator control authority (deflection). All relevant rigging of (sub)systems, stabilizer indicator readouts and positions, take-off condition computer readouts and flight control surfaces were checked for proper adjustments and movements.

Only the rigging of the flap bus cable could not be further established, because the shear pin of the cable bus was found broken after the accident.

Longitudinal control system obstructions
The functional tests did not reveal excessive friction in the system and the control columns could be moved full back and forward. However, the right elevator was slightly out of limits for one test, though it should be mentioned that the wind conditions were not optimal for this test.

Longitudinal control system adjustments
It was found that the adjustments of the variable load and feel system were in accordance with the requirements. Overall, the measured column forces were just within limits.

Most of the elevator and tabs deflections or position measurements (travel checks) were satisfactory. However, the right elevator position was slightly out of limits for one particular test. Specifically both anti-float tabs did not meet the requirements for deflection when the stabilizer is trimmed for 10 degrees ANU position or more.

The concerned functional checks for the entire stabilizer trim system did not reveal any anomalies which could explain the heavy elevator control forces as experienced by the pilots. The stabilizer motion warning horn sounded when required.

Pulling control column with 40 pounds

During the functional checks performed at Groningen Airport Eelde on November 13 and 14, it was required for the “Check Elevator Control System for Excessive Friction” test to pull the control column with 40 pounds (AMM, page 603, item B11).

This was accomplished by putting two feet against the instrument panel by one person. In order to facilitate this, a second person assisted to keep the column in that position for a short moment.

Appendix E part A

Stabilizer Warning System in more detail

The stabilizer warning system is a part of the take-off configuration warning system. The functioning of the stabilizer warning system is explained below.

Stabilizer warning
The significant component for triggering the stabilizer warning is the horizontal stabilizer green band switch mounted in the take-off condition computer.
By rotating the CG and the flap thumbwheels (See figure 2 Appendix D) the assumed TO-CG and required flap setting for take-off are selected. This drives a rotating scale showing the numeric outcome in the long trim readout window and also a green arrow pointing to the stabilizer position indicator scale. The numeric outcome in the window and the value shown by the green pointer (i.e. the green arrow head with the white arrow in the middle) correspond. See also figure 2 in Appendix D part A.

Now the mechanical switch verifies whether the actual stabilizer position matches the readout of the take-off condition computer. If not, the next step for the pilot is to run the stabilizer that much that its position is in accordance with the calculated value derived from the take-off condition computer. In practise the pilot will run the stabilizer till the stabilizer long trim position indicator, which is mechanically connected to the stabilizer, matches the middle of the green pointer.

To avoid that the system is over-sensitive for small off-set conditions, and hence generating warnings easily, a certain margin is acceptable within the system between required (calculated) and actual stabilizer position. This margin equals the width of the green arrow head and it represents the range – the green band - in which the switch remains in the open position. As long as the stabilizer trim indicator remains within the green band no stabilizer warning is generated.

When the long trim indicator is not aligned with the horizontal stabilizer green band, the switch is in a closed position allowing an electrical signal to the central aural warning unit as soon as the throttles are set for take-off. In this unit the input signal from the horizontal green band switch is processed into a warning horn and a “stabilizer” voice sound output signal to the speakers in the cockpit. The pilots are now warned that a mismatch between calculated and actual stabilizer position exists.

One factor that defines the specific take-off condition is the TO-CG information that is calculated – by the dispatcher or the flight crew - and then manually entered into the take-off condition computer via thumbwheels by the flight crew, along with the planned take-off flap setting. If the TO-CG calculation is in error, or if it is entered incorrectly, the stabilizer position will be calculated for the errant TO-CG that was entered, and thus can be an incorrect setting for the actual airplane CG. The take-off condition computer on this type of aircraft has no other means to determine the actual CG of the airplane.

Appendix E part B

Stabilizer warning conditions

Additional functional checks

General
The additional checks were the first time accomplished in presence of Onur Air technicians and the Quality Assurance manager when they participated in the technical investigation. More comprehensive checks were repeated in presence of the Onur Air Flight Safety manager and MD-88 chief pilot.

Following the functional checks, which had been performed in accordance with the AMM (see appendix D part B), additional functional tests were carried out to verify specific CG inputs and stabilizer warning system responses for comparison with other investigation data. The setting of the flap-thumbwheel on the take-off condition computer was found at 24 degrees. For all tests this insert was maintained.

Specific take-off condition computer CG inserts
The first TO-CG inserts on the take-off condition computer which was significant to the investigation was 11.1% MAC, for this was the assumed CG in the load and trim sheet and mentioned on the CVR.

The second TO-CG insert which was significant to the investigation was 13.5 % MAC, for this value was found by the Safety Board after the accident. With this value inserted the take-off condition computer readout and stabilizer trim position indicator matched approximately in the middle of the green band. On CVR, however, a stabilizer warning was heard.

The third TO-CG insert which was significant to the investigation was 14.0 % MAC, for this value would result into a take-off condition computer readout of 7.2 degrees ANU according to the AFM. During take-off the actual stabilizer position was 7.2 degrees ANU according to FDR data.

Steps taken
Step (1): the applicable CG and flap setting combinations were put in the take-off condition computer. The stabilizer was run till the actual stabilizer position matched the long trim readout (calculated stabilizer position) of the take-off condition computer. It was observed whether or not a stabilizer warning was triggered.

Step (2): based upon the settings as described in step (1) the stabilizer was run in both ANU and AND till the warning came on, indicating the green band limits.

Step (3): considering the actual stabilizer position (7.2 degrees, see FDR) and flap position (24 degrees, see FDR), it was verified at which settings of the CG-thumbwheel on the take-off condition computer a stabilizer warning was heard. The results are shown in the following table:

		Step 1	**Step 2**	**Step 2**
CG insert	Flap insert	Computer readout	Green band limits	Green band limits
11.1	24	8.0/ no warning	9.5 – 6.9*[27]	9.5 – 7.2**[28]
13.5	24	7.3/ no warning	8.8 – 6.4*	8.8 – 6.6**
14.0	24	7.1/ no warning	8.5 – 6.2*	8.7 – 6.3**

Table 1

			Step 3
Stabilizer position	Flaps insert	CG variable insert	Stabilizer warning
7.2	24	11.1	Yes
7.2	24	Transit up	Yes
7.2	24	12.4	No
7.2	24	Transit down	No
7.2	24	11.5	yes

Table 2

---

[27] : * results from 13 and 14 November 2003 with Onur technicians and Quality Assurance manager.
[28] : ** results from 26 November with Flight Safety manager and MD-88 chief pilot.

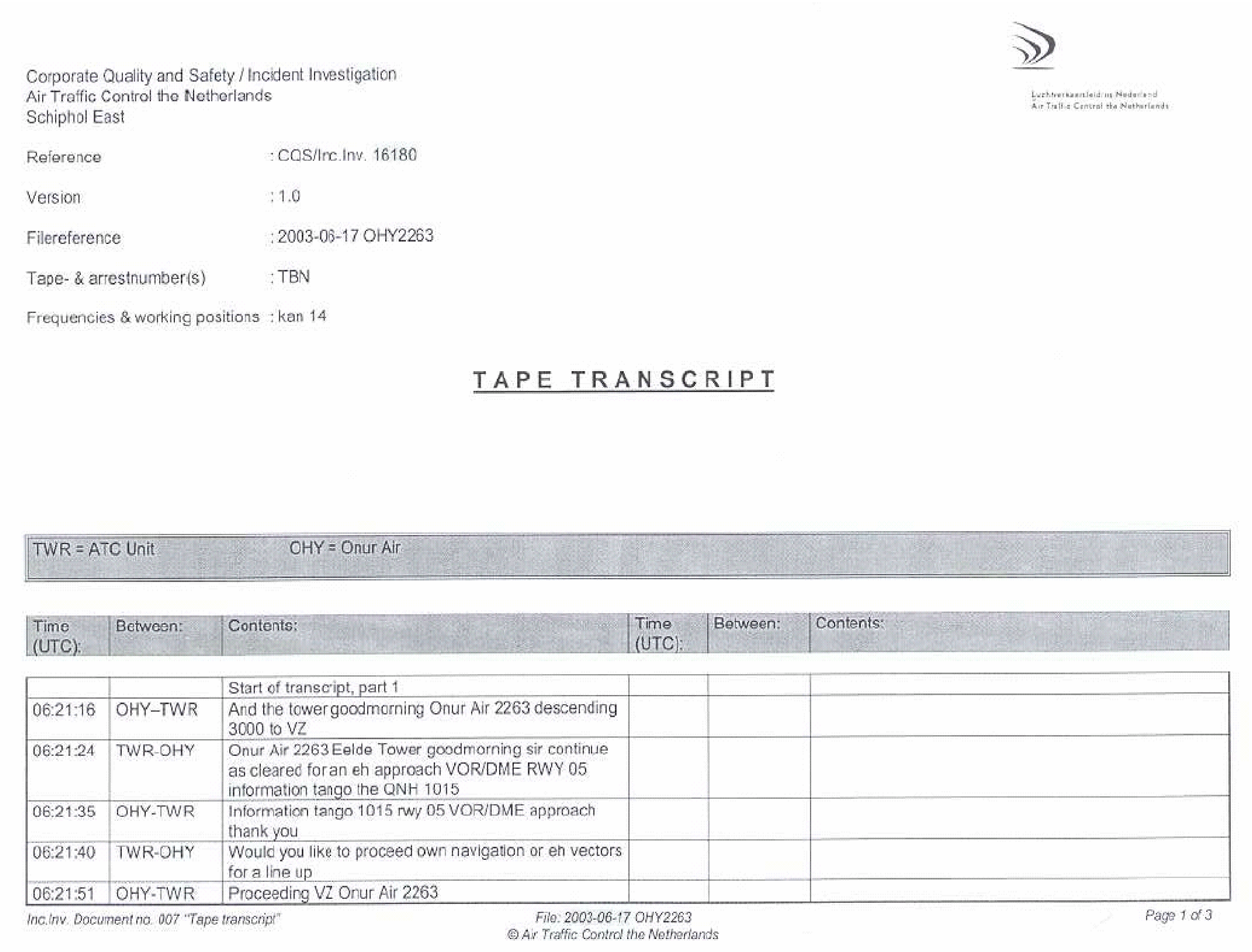
Note with step 3
At CG-values of 11.1 and lower (flaps insert 24) a stabilizer warning was maintained. When the CG-thumbwheel was slowly rotated the warning stopped at 12.4 setting and remained silent at higher CG-settings as long as the green band range indicator (green arrow) moved along the stabilizer position indicator. When the CG-thumbwheel was slowly rotated back it remained silent when passing the 12.4 setting. The warning started again when a CG-setting of 11.5 was reached. At settings less than 11.5 the warning remained.

Activating and de-activating the stabilizer warning on this side of the green band range by varying the CG-thumbwheel position was not consistent and the moment of switching was dependant from the direction of rotating the CG-thumbwheel.

Regardless the direction of rotation, with the stabilizer positioned at 7.2 degrees ANU the stabilizer warning was active at CG-setting 11.1. No warning could be reproduced at a CG-setting of 13.5 degrees.

APPENDIX F

Transcript ATC



Corporate Quality and Safety / Incident Investigation
Air Traffic Control the Netherlands
Schiphol East

Luchtverkeersleiding Nederland
Air Traffic Control the Netherlands

Reference : CQS/Inc.Inv. 16180

Version : 1.0

Filereference : 2003-06-17 OHY2263

Tape- & arrestnumber(s) : TBN

Frequencies & working positions : kan 14

TAPE TRANSCRIPT

TWR = ATC Unit OHY = Onur Air

Time (UTC):	Between:	Contents:	Time (UTC):	Between:	Contents:
		Start of transcript, part 1			
06:21:16	OHY–TWR	And the tower goodmorning Onur Air 2263 descending 3000 to VZ			
06:21:24	TWR-OHY	Onur Air 2263 Eelde Tower goodmorning sir continue as cleared for an eh approach VOR/DME RWY 05 information tango the QNH 1015			
06:21:35	OHY-TWR	Information tango 1015 rwy 05 VOR/DME approach thank you			
06:21:40	TWR-OHY	Would you like to proceed own navigation or eh vectors for a line up			
06:21:51	OHY-TWR	Proceeding VZ Onur Air 2263			

Inc.Inv. Document no. 007 "Tape transcript"

File: 2003-06-17 OHY2263
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Page 1 of 3

TWR = ATC Unit OHY = Onur Air

Time (UTC):	Between:	Contents:	Time (UTC):	Between:	Contents:
06:23:45	TWR-OHY	Onur Air 2263 continue descent to altitude 2000 feet and cleared straight in approach 05 report established you are number 1			
06:23:54	OHY-TWR	Roger descending 2000 cleared approach VOR/DME rwy 05 and call you established Onur Air			
06:26:41	OHY-TWR	Onur Air 2263 established rwy 05			
06:26:45	TWR-OHY	Onur Air 2263 roger and cleared to land 05 the wind 100/6 knots			
06:26:52	OHY-TWR	Roger copied cleared to land 05 Onur Air			
06:28:35	OHY-TWR	Onur Air 2263 we are now 1000 feet and left turn to established 05 request			
06:28:43	TWR-OHY	Ja dat is approved report established again or would you like vectors			
06:28:47	OHY-TWR	Thank you			
06:29:05	TWR-OHY	Onur Air 2263 would you like vectors or do it yourself			
06:29:10	OHY-TWR	Say again			
06:29:10	TWR-OHY	Would you like to have radar vectors or do it yourself			
06:29:14	OHY-TWR	Jah visual approach we need visual approach left turn uh and established rwy 05			
06:29:19	TWR-OHY	Oké number 1 05			
06:29:21	OHY-TWR	Thank you			
06:31:01	TWR-OHY	Onur Air 2263 is cleared to land 05 the wind 120/04			
06:31:08	OHY-TWR	Cleared to land 05 thank you			
06:33:20	TWR-OHY	2263 over to ground bye bye			
06:33:23	OHY-TWR	Bye thank you			

TWR = ATC Unit OHY = Onur Air

Time (UTC):	Between:	Contents:	Time (UTC):	Between:	Contents:
		Part 2			
07:18:02	OHY-TWR	And tower goodmorning Onur 2264			
07:18:07	TWR-OHY	Onur air 2264 Eelde tower goodday line up 23			
07:18:10	OHY–TWR	Line up 23 2264			
07:18:30	TWR-OHY	Onur air 2264 is cleared for take-off 23 the wind 110 6 kts initially climb 60.			
07:18:35	OHY–TWR	Initially climb 60 cleared for take-off 23, wind copied sir, 2364			
07:20:20	TWR-OHY	(unreadable)			Sounds like "abort 26"
07:22:23	OHY–TWR	Tower 2264			
07:22:25	TWR-OHY	Onur air 2264 Eelde tower go ahead			
07:22:28	OHY–TWR	Did you see (unreadable)?			Sounds like "our"
07:22:33	TWR-OHY	Ja fire brigade is on his eh way			
07:22:36	OHY-TWR	Oké			
		End of transcript			

APPENDIX G

Transcript CVR

Most of the conversations between the two pilots and the remarks they made were in the Turkish language. In this transcript these remarks and conversations are translated into English.

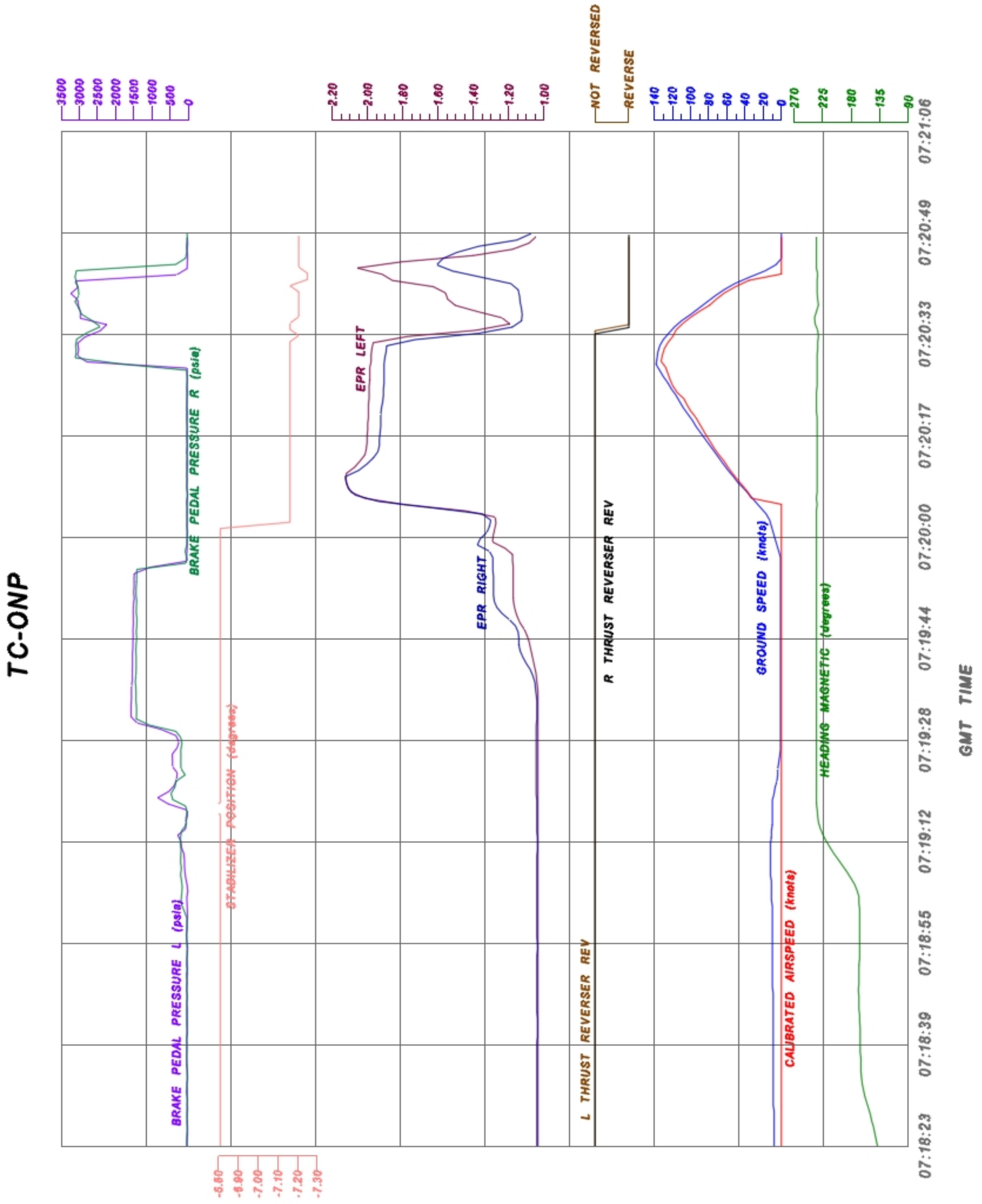
Tower-time	CVR-time		
7:18:30	28.05	TWR	Onur air 2264 is cleared for take-off, wind 110/6 knots initially climb 60
7:18:35	28.10	FO	Initially climb 60 cleared for take-off wind copied sir 2264
	28.12	FO	Flap slat re-check
	28.13	CAPT.	Yes re-check
	28.14	FO	24-24
	28.17	FO	Cabin call given
	28.19	FO	Radar
	28.20	CAPT.	Off
	28.20	FO	Ignition
	28.21	CAPT.	Bravo
	28.21	FO	Landing lights
	28.22	CAPT.	On
	28.23	FO	TCAS On
	28.24	CAPT.	Yes
	28.28	FO	FMS Runway update will you do
	28.29	CAPT.	No
	28.37	FO	Yes, checklist completed, have a nice flight sir
	28.43	CAPT.	We are cleared
	28.44	FO	Yes sir
	28.46	CAPT.	Understand
		(Start take-off roll, horn and stabilizer warning are activated and stop when the throttles are retarded.)	
	28.51	FO	This is 24 what's yours

	28.54	CAPT.	24 Flaps
	28.55	FO	He (Yes)
	28.56	CAPT.	Maybe it's not matched, but…
	29.07	FO	Ok Ok 24 Lets add the power now
	29.20	FO	Is CG Correct
	29.22	CAPT.	That's ok it is 11.1
	29.23	FO	Ok
	29.23	FO	Everything is all right
	29.24	CAPT.	He (Yes)
	29.27	FO	Lets add power again what will we see
		(Horn and stabilizer warning triggers again)	
	29.28	CAPT.	What's going on? (Allah Allah)
	29.32	FO	Lets go lets go sir
		(Warning continues)	
	29.38	CAPT.	Auto throttle on
		Some other traffic's conversation	
	29.44	FO	Speed is alive
	29.46	FO	Why is this warning given?
	29.47	CAPT.	80
	29.47	FO	Check
	29.50	FO	100
	29.56	FO	It's not reached yet
	29.57	CAPT.	It's not rotating
	29.58	FO	Lets continue sir
	29.59	CAPT.	Continue, continue
	30.00	CAPT.	It's not coming up

		(warning stops as power levers are pulled back for rejecting take-off)	
		CAPT.	It's not coming up
		CAPT.	It's not coming up
		CAPT.	It's not coming up
		CAPT.	The nose did not come up
	30.09	CAPT.	Engines
	30.11	CAPT.	The nose did not come up
	30.12	CAPT.	The nose did not come up
	30.13	CAPT.	The nose did not come up
	30.17	CAPT.	***** (curse)
7:22:23		OHY	Tower 2264
7:22:25		TWR	Onur air 2264 Eelde Tower go ahead
7:22:28		OHY	Did you see (unreadable)?
7:22:33		TWR	Ja fire brigade is on his eh way
7:22:36		OHY	Oke

APPENDIX H

FDR data plot



APPENDIX I

Oversight

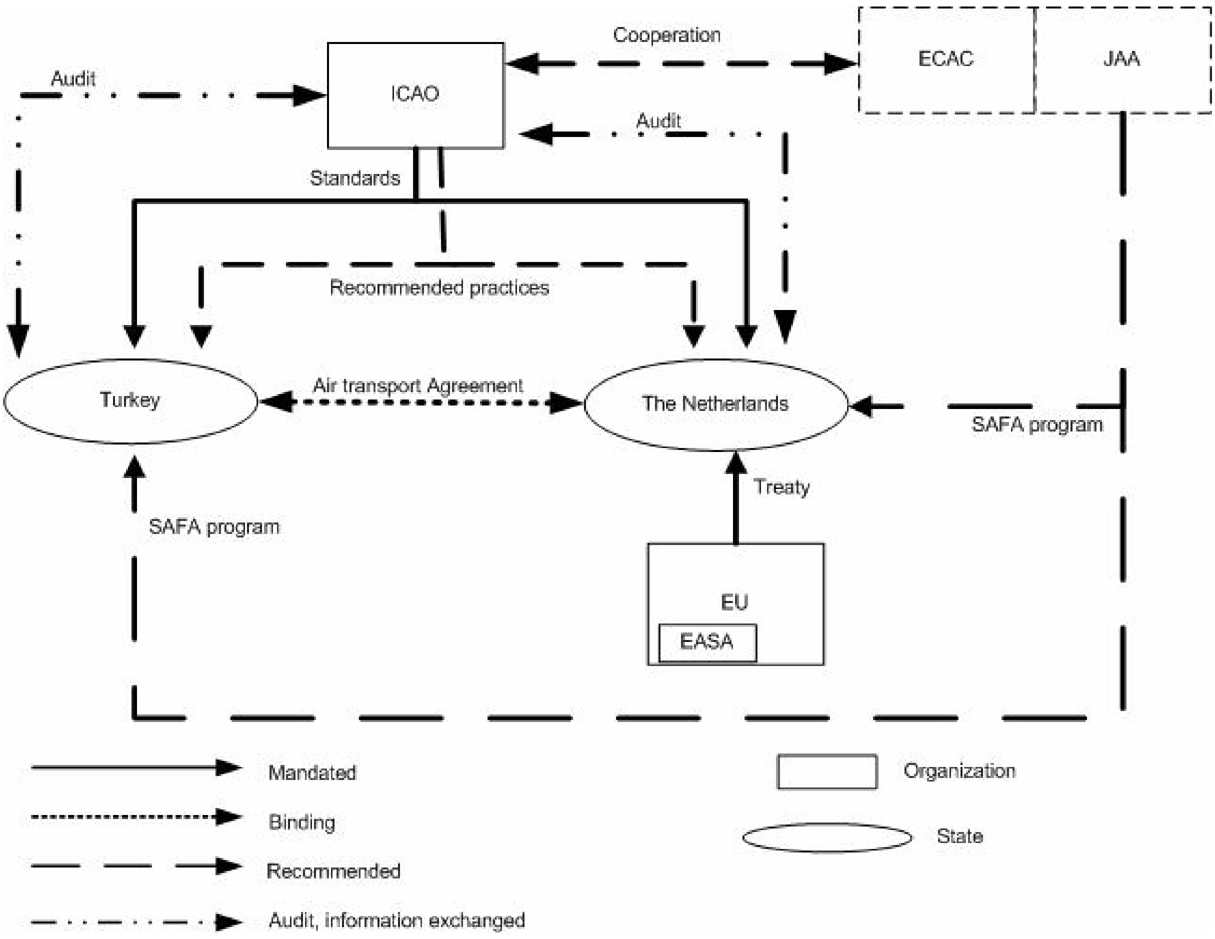
Introduction

It is the basic principle of international law that every state is sovereign. Consequently, every state has the right and responsibility to create its own aviation regulation and to conduct safety oversight accordingly in addition to the international minimum standards that they have agreed upon. International agreements may have influence on the competence of a state.

In the case of air carrier operations between Turkey and the Netherlands the following international bodies and agreements play a role in how the oversight of this operation is arranged.

- ICAO – International Civil Aviation Organization
- ECAC – European Civil Aviation Conference
- JAA – Joint Aviation Authorities
- EU – European Union
- EASA – European Aviation Safety Agency
- SAFA – Safety Assessment of Foreign Aircraft

The following diagram shows the states of Turkey and the Netherlands in relation to these international organizations.



Different international agreements relevant to passenger flights between Turkey and the Netherlands are discussed below.

Multilateral international agreements

Chicago Convention 1944
A convention on international civil aviation was organized in Chicago in 1944. The main purpose was the development of international civil aviation in a safe and orderly manner. The Chicago Convention codifies rules, principles, and arrangements on international civil aviation. Turkey and the Netherlands are contracting states parties to the Convention.

Principally, the performance of scheduled international commercial air services must be concluded in bilateral air transport agreements between states. Bilateral agreements exchange commercial traffic rights: the rights to take on and discharge passengers, cargo, and mail; and exchange permission to enter into the airspace above and to land in the territory of the states.

Non-scheduled flights across and into the territories of contracting states are regulated in article 5 of the Convention. With this article, contracting states agree to multilaterally exchange of commercial traffic rights agreed upon non-scheduled international air services, or sometimes called international charter air services. This means, this exchange of rights for non-scheduled does not need to be concluded in bilateral air agreements.

However, at the same time, the article also says that the taking or discharging passengers, cargo or mail are permitted, subject to the right of the state where the aircraft goes into to impose regulations, conditions or limitations as it may consider desirable. This has been interpreted in practice by states that they can require prior permission for the performance of all non-scheduled international air services. This kind of permission is sometimes given in bilateral air agreements, together with an exchange of rights for scheduled international air services. Sometimes it is given in bilateral air agreements specifically on international charter flights, or simply in unilateral governmental permits.

It should be noted that Chicago Convention 1944 does not provide any definition for scheduled air services nor non-scheduled flights. In practice, some states interpreted holiday charter flights as scheduled air services due to the nature that this kind of charter flights are always regular.

The same convention created the international civil aviation organization (ICAO). ICAO, a specialized agency of the United Nations, sets the minimum standards and recommended practices (SARPs) for international civil aviation. The uniform application of standards is recognized as necessary for the safety or regularity of international air navigation. ICAO standards should be incorporated into national legislations. Article 38 states that when it is impracticable for a state to comply with a particular standard, immediate notification to ICAO is mandatory, filing the difference.

Individual states are responsible for regulating their aviation industries but have to take into account the minimum standards established by ICAO that they have agreed upon. The state of registry, where an aircraft is registered, is responsible for the adherence of the aircraft to the ICAO minimum safety level, taking into account the differences to SARPs filed by states. The state of destination has limited possibilities for checking the safety of foreign aircraft.

In 1996, ICAO began a voluntary program of assessments of national aviation authorities, subsequently evolving into the universal safety oversight audit program (USOAP). USOAP has been implemented on a universal, transparent and mandatory basis from 1998 onwards. The ability of all ICAO contracting states to conform to the safety-related standards and recommended practices (SARPs) of the organization is assessed, and the main conclusions are made available to other contracting states.

In 2001 ICAO started a new audit cycle, through which a validation is made of the implementation by contracting states of their corrective action plans to address the findings and recommendations developed as a result of the initial audits

European Civil Aviation Conference (ECAC)
In 1955 the European civil aviation conference was formed. ECAC is an intergovernmental organization and has 42 member states. Both Turkey and the Netherlands are ECAC members. The objective of ECAC is *to promote the continued development of a safe, efficient and sustainable European air transport system.*

ECAC works in the close liaison with ICAO and uses the services of the ICAO Secretariat. ECAC seeks to:

- harmonize civil aviation policies and practices amongst its member states
- promote understanding on policy matters between its member states and other parts of the world.

The Safety Oversight Issues program
An activity of ECAC is the Safety Oversight Initiative (SOI) which started in 2001. An expert group is reviewing the ICAO audit results of ECAC and non ECAC states. The ICAO assessment reports of the states of registry of visiting aircraft are studied. The experts analyze the findings in all areas of expertise (primary aviation legislation, organization of CAA and oversight, operations, airworthiness and personnel licensing). The three classes of findings are: minor, significant and major.

The purpose of the analysis is to develop an adequate information basis, enabling to take view of non-ECAC states and identify whether further action would be necessary. The group has two tasks:

Allocate each finding to one of eight defined critical elements.
Decide on a rating for each of five defined safety oversight functions / area's of expertise, based upon the class of the findings.
Examples of the five area's are civil aviation organization (ORG), aircraft operations certification and supervision (OPS) and airworthiness of aircraft (AIR).

Based on the findings a rating from I to III is assigned. I indicates that the state is capable to ensure effective implementation, II means the capability is affected by significant findings and III indicates the state is not capable to ensure effective implementation of SARPs.

The output of the SOI process is a rating of the capability of a state to ensure
effective implementation of the SARPs.

At this moment the reports of 80 non ECAC states are analyzed and the reports of 16 ECAC states are analyzed. At the beginning of 2005 ICAO started with a new cycle of audits, using the comprehensive systems approach. Only reports on non ECAC states are available to this moment.

The Safety Assessment of Foreign Aircraft program
In 1996 ECAC launched the Safety Assessment of Foreign Aircraft (SAFA) program, complementary to the ICAO safety audits. The SAFA program is based on a bottom-up approach, taking as its starting point on-the-spot ramp inspections of aircraft landing in ECAC states using ICAO minimum safety level as a reference, and progressing through further steps to the involvement of states of registry or states of operator when circumstances so require.

The linkage between the USOAP and SAFA was framed through a memorandum of understanding between ICAO and ECAC, signed in November 1997. The European Community participates actively in the SAFA program through membership in the SAFA Steering Committee and of funding made available. The references for these inspections are contained in the safety-related standards of ICAO Annexes 1, 6 and 8

The principle of the program is that in each ECAC state, foreign aircraft (ECAC or non-ECAC) can be subject to a ramp inspection.

Participation is on a voluntary basis. In the year 2004 thirty one ECAC member states performed SAFA inspections.

SAFA inspections
During the ramp inspections the ICAO minimum safety level is used as a reference. Mainly the aircraft documents and manuals, flight crew licenses, flight preparation, the apparent condition of the aircraft and the presence and condition of mandatory cabin safety equipment are checked. The technical inspection of the aircraft is limited to a general visual inspection. Opening of inspection panels by an inspector is not permitted. If necessary, the inspector can request the maintenance personnel to open panels and doors. There is no sanction system incorporated in SAFA. The regulatory framework of the state conducting the inspection is the only basis for a possible sanction on the subjects of the program.

Inspections are carried out following a procedure common to all ECAC member states and are the subject of reports, which also follow a common format. In the case of significant irregularities, the operator and the appropriate aviation authority are contacted in order to arrive at corrective measures to be taken not only with regard to the aircraft inspected but also with regard to other aircrafts which could be concerned, or with regard to other aspects, such as operational practices and crew qualification, in the case of an irregularity which is of a generic nature.

The findings found during the inspections will then be defined into three categories: minor (cat.1), significant (cat. 2), and major (cat.3). Depending on the category of finding, a class of action is determined.

Category 1 findings result in a class of action 1: notification to the captain. In case of category 2 findings, it results additionally to the notification in a class of action 2: a letter will be sent to the AOC holder and the state of registry.

When a category 3 finding is discovered, there will be four possible actions on top of the previous two: a restrictive action on the operation of the aircraft (3a), a *corrective action is required before flight can be authorised* (3b) or *aircraft grounded* (3c). In case of a class of action 3d, entry permission repercussions will be imposed.

All data from the reports, as well as supplementary information (for example a list of actions undertaken and finalized following an inspection) are centralized in a computerized database, set up by the Joint Aviation Authorities, an Associated Body of ECAC, and are accessible by ECAC states. The information on the database is reviewed by the JAA on a regular basis to identify any areas of concern. ECAC is working on harmonized implementation of SAFA throughout ECAC.

Furthermore a proposal is made by JAA to incorporate the results of the *Safety Oversight Initiative* in the SAFA program by providing guidance on which inspection items should be focused on.

ECAC states on its website that SAFA inspections are limited to on-the-spot general visual assessments and cannot substitute for proper regulatory oversight. Ramp inspections serve as pointers, but they cannot guarantee the airworthiness of a particular aircraft.

Sanction system
There is no sanction system incorporated in SAFA. The regulatory framework of the state conducting the inspection is the only basis for a possible sanction.

In the Netherlands the following sanctions are possible:

- In case of a class of action “3 c” (“aircraft grounded”) departure permission of an aircraft can be denied for six hours. (art. 11.2 part 3 Wet Luchtvaart).
- In case of a class of action “3 d” finding (“entry permission repercussions”) entry of an aircraft or airline can be denied. (art. 1.3 and 5.3 Wet Luchtvaart)

In case of banning of an aircraft or airline by one of the participating states, a warning is sent to all ECAC members. It is the decision of each member state how to react on the actions of another state.

Joint Aviation Authorities
The Joint Aviation Authorities (JAA) is an associated body of ECAC, representing the civil aviation regulatory authorities of a number of European states who have agreed to co-operate in developing and implementing common safety regulatory standards and procedures, the joint aviation regulations, or JARs. This co-operation is intended to provide high and consistent standards of safety and a "level playing-field" for competition in Europe. Much emphasis is also placed on harmonizing the JAA regulations with those of the USA.

JAA started in 1970 as the Joint Airworthiness Authorities. Originally its objectives were only to produce common certification codes for large airplanes and for engines. Since 1987, its work has been extended to operations, maintenance, licensing and certification/design standards for all classes of aircraft. With the adoption of the Regulation (EC) No 1592/2002 by the European Parliament and the Council of the European Union (EU) and the subsequent set up of the European Aviation Safety Agency (EASA), a new regulatory framework was created in European aviation. Non EU states keep their responsibility in all fields.

JAA membership is open to ECAC members. At present, the JAA has 33 full members and 7 candidate members.

JAA has no legal power and no system is in place to force member states to implement JARs before a mutual agreed date.

Implementation of JAR-OPS 1 in national legislation
The implementation of Jar's by JAA States are routinely assessed during Standardization visits. The Netherlands has implemented JAR-OPS 1 in the national legislation in 1998 and was audited by the JAA in 2002.

According to the JAA on the day of the Onur Air accident JAR-OPS 1 was not incorporated in the Turkish legislation. The JAR-OPS 1 inspection (OPST) of Turkey has been postponed on request of the Turkish authorities until May 2005, but was delayed again. With regard to Turkey a JAR-OPS 1 Standardization visit (OPST) took place in November 2005.

European Union
In 2004 the European Union has issued a directive 2004/36/EC dated 21 April 2004 (the SAFA directive) on the safety of third countries aircraft using EU airports. This Directive introduces a harmonized approach to the effective enforcement of international safety standards within the Community by harmonizing the rules and procedures for ramp inspections of third-country aircraft landing at airports located in EU states. The EU states shall bring into force the laws, regulations and administrative provisions necessary to comply with this Directive by 30 April 2006.

The EC now is working on a revision of the Directive to create common procedures at the European level. The revision could also introduce an early warning system when important safety issues have to be addressed by the member states.

Implementation of the directive in the Netherlands is expected at 30 April 2006. With the implementation of the Directive, the sanction system also will be improved. For example the denial of take off permission can be indefinitely instead of six hours.

In 2005 the European Commission has proposed a Regulation of the European Parliament and the Council on the information of air transport passengers on the identity of the operating carrier and on communication of safety information by Member states. The regulation entered into force 20 days after publication in the Official Journal on 27 December 2005. Because of this regulation the EU commission established a list of air carriers, which are subject to an operating ban within the Community. This list was first published in March 2006.

European Aviation Safety Agency
In 2003 the European Aviation Safety Agency (EASA), an agency of EU, was founded. On 28 September 2003, the agency took over the responsibility for the certification and continued airworthiness of products designed or operated by persons under the regulatory oversight of EU Member states.

Third country aircraft operating within the EU are subject to the member states supervision. EASA is expected to extend its area of responsibility to the regulation of pilot licensing, air operations and third country aircraft by 2006/2007

Bilateral air transport agreement
In September 1971, an air transport agreement between Turkey and the Netherlands was signed. Article 4 of the agreement states that each of the contracting parties has the right to revoke or suspend the exercise of the rights based on the agreement in the case of failure of an airline of the other contracting party to comply with the laws or regulations of the contracting party granting these rights. There is no article in the agreement dedicated to aviation safety.

Although the agreement is mainly on the subject of scheduled flights, non scheduled services were discussed as well. The Netherlands' delegation underlined the attractiveness of the regional airports and invited the airlines of Turkey to make more use of these airports.

JAA, ECAC, EU and Eurocontrol

ECAC (42)

Eurocontrol (35)

Azerbaijan
Republic of Georgia

Armenia *
Iceland

Albania *
Bosnia & Herzegovina *
Bulgaria
Croatia
Former Yugoslav Republic of Macedonia *
Republic of Moldova *
Monaco
Norway
Romania
Serbia & Montenegro*
Switzerland
Turkey
Ukraine *

Estonia
Latvia
Lithuania

Austria
Belgium
Cyprus
Czech Rep
Denmark
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Luxembourg
Malta
Netherlands
Poland
Portugal
Slovak Rep
Slovenia
Spain
Sweden
UK

JAA (40)

EU (25)

* = Candidate Members

December 2005

APPENDIX J

Aircraft technical investigation

Reason of the technical investigation

The captain had mentioned when the throttles were advanced for the first time that they got a warning and stopped. Settings were checked. A second take-off was started and when take-off progressed the warning returned at high speed. When asked the warning was considered as false. Additionally, the first officer consistently called the warning a stabilizer motion warning in his statement.

The captain had stated that as pilot flying he experienced heavy elevator control force during rotation. He needed so much back pressure on his control column that he believed that he would not be able to lift off the aircraft from the ground. The captain emphasised it was “impossible to make the take-off”. Hence, he rejected the take-off beyond V1. When asked, both pilots could not explain why the aircraft did not rotate.

Longitudinal control performances are strongly affected by the CG and the correspondent stabilizer trim position, and the technical state of the longitudinal control system. For the investigation it was considered as necessary to examine the aircraft load and aircraft longitudinal control (related) systems

Mass and balance investigation

Cargo
The day after the event had occurred every single piece of luggage was weighted separately and recorded per cargo compartment in which it had been stowed.

Measuring the fuel quantity
After the accident no fuel leakages were found. Because no electrical power was available the fuel quantity indicators in the cockpit and on the re-fuelling panel could not be used. A few months later, when the repair works had started, the aircraft was put on jacks and was positioned in a wings level and 0.5 degrees aircraft nose down attitude. This attitude enabled the Safety Board to apply valid fuel sticks measurement as one method.

Later the aircraft was de-fuelled and the fuel distribution was registered per fuel tank as a second method. Except some remaining fuel in both main wing tanks all fuel was taken out. The amount of remaining fuel was determined with the support from Boeing. Both methods showed consistent values
In the final stage of repair the aircraft was refuelled. The cockpit fuel quantity indicators were crosschecked with the fuel truck quantity indicator. It was established that both cockpit and refuelling panel indicator readouts were very consistent with the transferred fuel quantity data from the fuel truck quantity indicator.

Passengers
Within a few weeks after the accident all passengers had received a letter with a questionnaire form from the Safety Board. They were asked to feed back to their best knowledge their seat number, their personal body weight and hand luggage weight they carried. Not all passengers replied. With respect to weight information from 64 females, 47 males and 2 children an individual weight was reported

All information was used to establish take-off mass and TO-CG and to compare with load sheet information.

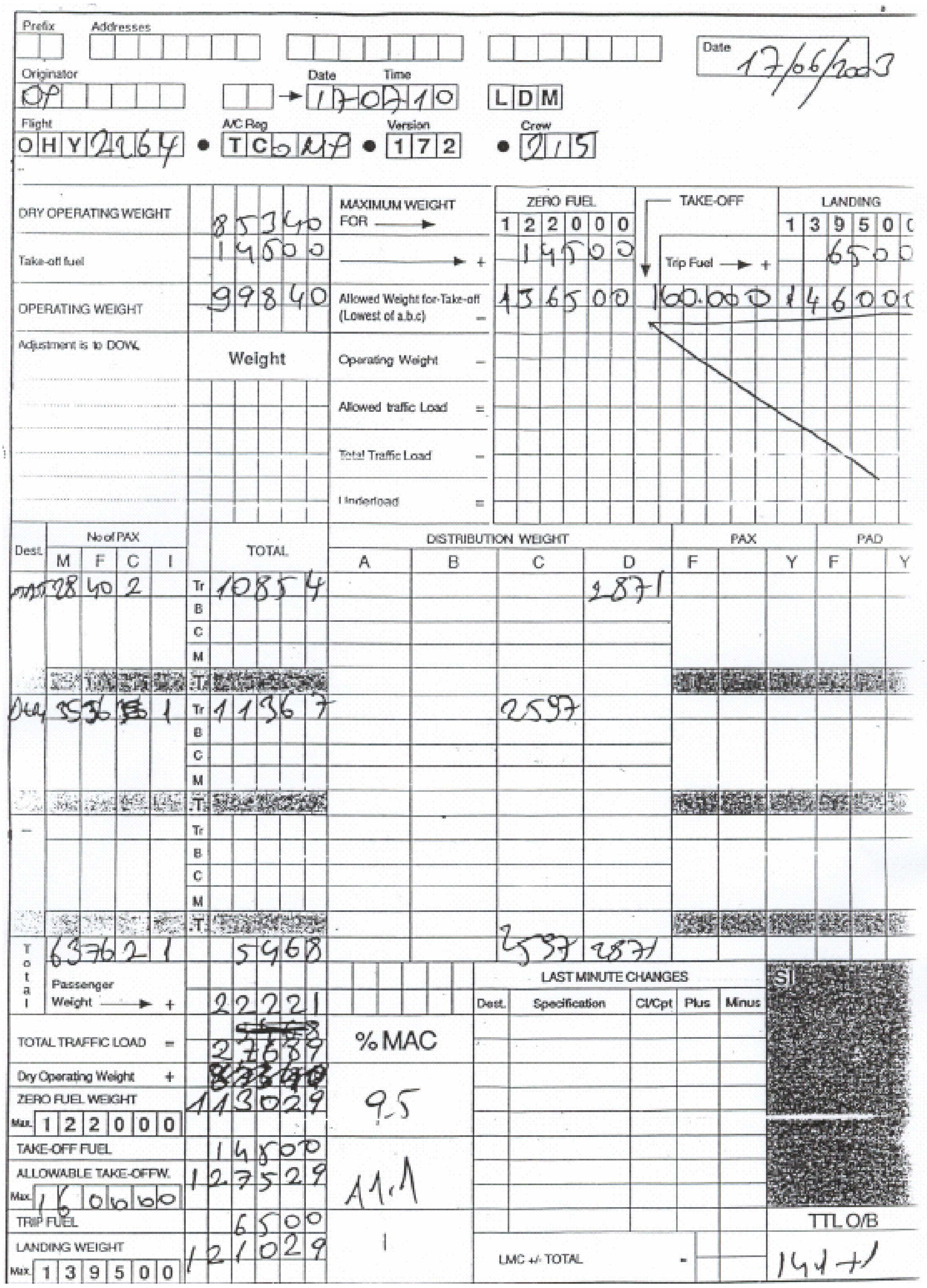
Investigation of longitudinal flight controls systems
To carry out the required functional checks properly, the serviceability of the electrical system and to some less extent a part of the hydraulic system was crucial. For reasons of safety and to avoid more damage to the aircraft it became obvious that the damage (particularly that of the electrical system) should be repaired first.

It was not before several months after the accident had occurred when the process of repair had resulted into a sufficient level of serviceability of the aircraft systems required for the investigation. Under the supervision of the Safety Board and assisted by a qualified maintenance supervisor the functional checks were accomplished. The works were performed in close co-operation with Onur Air representatives and qualified engineers. It is specifically mentioned that an excellent support by the AOG Incident Repair Maintenance Services team of Boeing contributed to an efficient progress of the field investigation.

The investigation primarily focussed on the technical state, the adjustments and the rigging of the longitudinal control (related) systems as they may disturb proper longitudinal operation. Further, a part of the take-off configuration warning system and the stabilizer motion warning system were included. Existing functional system checks in accordance with the AMM were leading.

Appendix K

Load and Trim Sheet made by the crew



Prefix
Addresses

Date 17/06/2003

Originator OP
Date Time → 17-07 10
LDM

Flight OHY2264 • A/C Reg TC ONP • Version 172 • Crew 2/5

DRY OPERATING WEIGHT	85340	MAXIMUM WEIGHT FOR →	ZERO FUEL 122000	TAKE-OFF		LANDING 13950	
Take-off fuel	14500	→ +	14500		Trip Fuel → +	6500	
OPERATING WEIGHT	99840	Allowed Weight for Take-off (Lowest of a.b.c) −	136500	160.000		14600	
Adjustment is to DOW	Weight	Operating Weight −					
		Allowed trafic Load =					
		Total Traffic Load −					
		Underload =					

Dest.	No of PAX M	F	C	I		TOTAL	DISTRIBUTION WEIGHT A	B	C	D	PAX F		Y	PAD F		Y
[illegible]	28	40	2		Tr	10854				2871						
					B											
					C											
					M											
					T											
Dus	35	36	[illegible]	1	Tr	11367			2597							
					B											
					C											
					M											
					T											
–					Tr											
					B											
					C											
					M											
					T											
Total	63	76	2	1		5468			2597	2871						

Passenger Weight → +	22221		
TOTAL TRAFFIC LOAD =	~~[illegible]~~ 27689	% MAC	
Dry Operating Weight +	85340		
ZERO FUEL WEIGHT Max. 122000	113029	9.5	
TAKE-OFF FUEL	14500		
ALLOWABLE TAKE-OFF W. Max. 160000	127529	11.1	
TRIP FUEL	6500		
LANDING WEIGHT Max. 139500	121029	1	

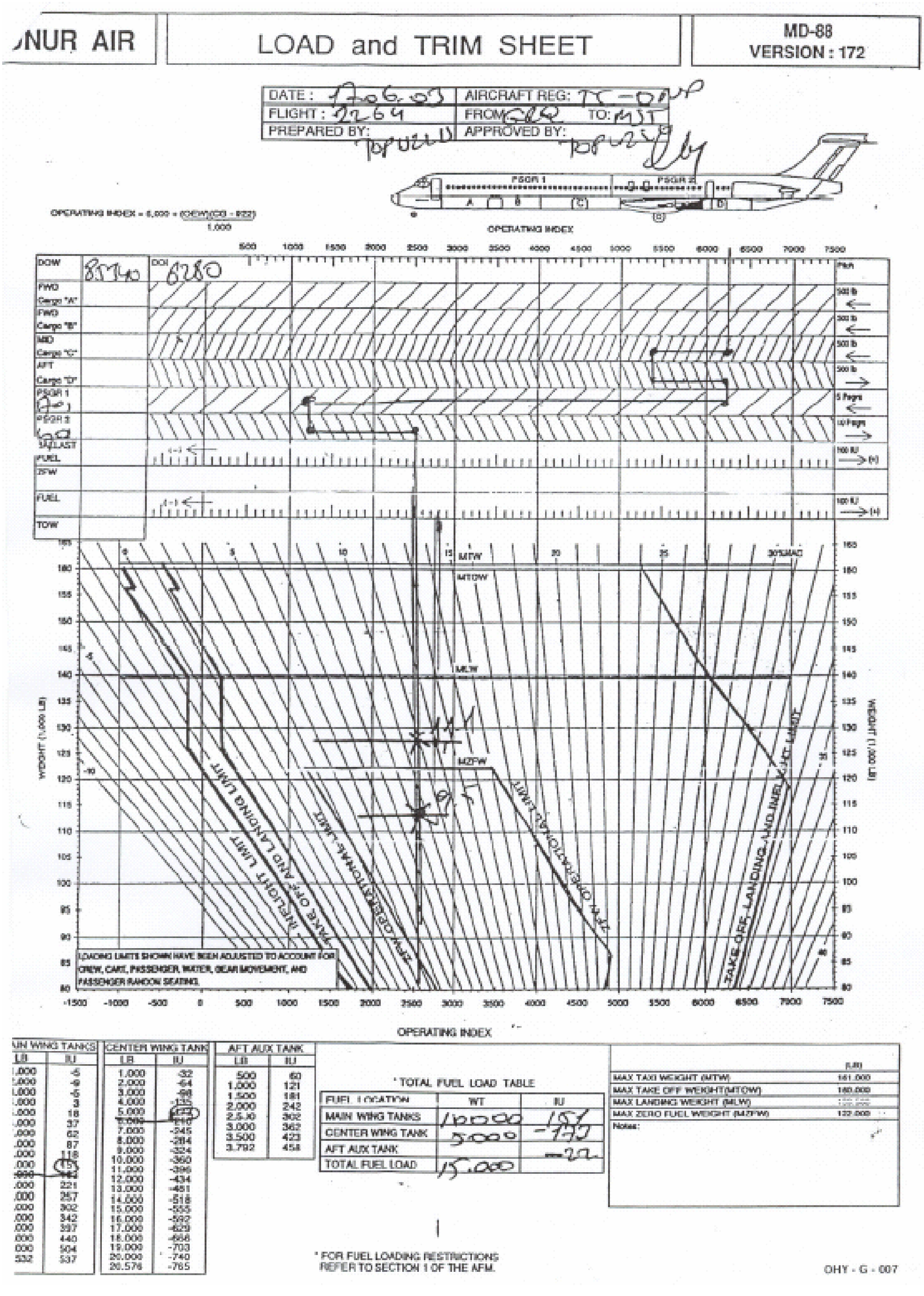
LAST MINUTE CHANGES

Dest.	Specification	Cl/Cpt	Plus	Minus

LMC +/- TOTAL -

SI [redacted]

TTL O/B 144+1



ONUR AIR

LOAD and TRIM SHEET

MD-88
VERSION : 172

DATE : 17.06.03 | AIRCRAFT REG: TC-ONP
FLIGHT : 2264 | FROM: GZP TO: MJT
PREPARED BY: TOPUZLU | APPROVED BY: TOPUZLU

OPERATING INDEX = 6,000 + (OEW)(CG - 822) / 1,000

DOW 88740 DOI 6280

LOADING LIMITS SHOWN HAVE BEEN ADJUSTED TO ACCOUNT FOR CREW, CART, PASSENGER, WATER, GEAR MOVEMENT, AND PASSENGER RANDOM SEATING.

MAIN WING TANKS		CENTER WING TANK		AFT AUX TANK	
LB	IU	LB	IU	LB	IU
,000	-5	1.000	-32	500	60
,000	-9	2.000	-64	1.000	121
,000	-5	3.000	-98	1.500	181
.000	3	4.000	-135	2.000	242
.000	18	5.000	-172	2.500	302
.000	37	~~6.000~~	-210	3.000	362
.000	62	7.000	-245	3.500	423
.000	87	8.000	-284	3.792	458
.000	118	9.000	-324		
.000	151	10.000	-360		
~~.000~~	[illegible]	11.000	-396		
.000	221	12.000	-434		
.000	257	13.000	-481		
.000	302	14.000	-518		
.000	342	15.000	-555		
.000	397	16.000	-592		
.000	440	17.000	-629		
.000	504	18.000	-666		
.000	537	19.000	-703		
532		20.000	-740		
		20.576	-765		

* TOTAL FUEL LOAD TABLE

FUEL LOCATION	WT	IU
MAIN WING TANKS	10000	151
CENTER WING TANK	5000	-172
AFT AUX TANK		-22
TOTAL FUEL LOAD	15.000	

	(LB)
MAX TAXI WEIGHT (MTW)	161.000
MAX TAKE OFF WEIGHT(MTOW)	160.000
MAX LANDING WEIGHT (MLW)	[illegible]
MAX ZERO FUEL WEIGHT (MZFW)	122.000

Notes:

* FOR FUEL LOADING RESTRICTIONS REFER TO SECTION 1 OF THE AFM.

OHY - G - 007

Appendix L

Factual information passenger weights & distribution

From the questionnaire which was sent to the passengers the following data was derived.

The total number of passengers was 141 plus one baby. 128 Persons have responded to the questionnaire, five others were contacted by telephone and were asked the most relevant questions. The information of eight passengers could not be obtained.

64 of the female passenger have given their body weight. The average weight of these passengers was 157 pounds (including hand luggage). 47 Of the male passengers have given their body weight. The average weight of these passengers was 192 pounds (including hand luggage). The weight of two children was also reported. The average weight of these children was 31 pounds (including hand luggage).

Onur Air
Onur Air uses the following passenger weights for the aircraft performance calculations:
Man : 175 pounds
Woman : 145 pounds
Child : 77 pounds
(All above mentioned weights include hand luggage.)

In the load sheet for this particular flight it was assumed that there was an equal passengers spread between passenger compartments 1 & 2.

All of the 133 passengers from whom we received information have given an indication which seat they occupied during the accident flight. 57 Passengers stated they occupied seats which were also indicated by other passengers, nevertheless the indications are accurate enough to place the passengers in either cabin-compartment one or two. 128 Of these passengers have also indicated which exit they used during the emergency evacuation of the aircraft.

Of these 133 passengers 80 were seated in cabin-compartment #1 en 53 and one infant were seated in cabin-compartment #2.
Cabin-compartment #1: rows 1 through 17 + row 18 seats A & B.
Cabin-compartment #2: rows 19 through 36 + row 18 seats C, D & E

	A	B	C	D	E
1				FM	M
2	FF	MM	M	FF	M
3	F	M	FF	FF	F
4	M	F	M		F
5	M	F		FF	M
6	M	F		M	F
7	F		F	M	F
8	MF	MF	FF	F	M
9		F		F	F
10		M	F	M	F
11	F	F	F	F	M
12			F	F	M
13	FM	MF	M		
14			F	F	F
15	FM	MF	M	C	F
16				M	F
17			M	C	F
18	M		------------	------------	------------
18	------------	------------			
19	M	F		M	F
20	FMF				
21	FF	MMF		M	F
22	F		M	MMM	FMF
23	F	M			
24	F	M			
25					
26	FFF	MMM			
27					
28				M	F
29	M	F			
30			FF		
31			FFM	FFF	M
32					
33				F	M
34				M	F
35	M	F	M		
36					F+I

F = female
M = male
C = child
I = infant
--------- = Separation between cabin-compartment #1 & #2

The cabin occupation as shown here is based on the seat occupation as indicated by the passengers.

Appendix M

Passenger questionaire (in Dutch only)

Naam en voornamen:………………………………………………………………………………………

Alle vragen hebben betrekking op de vlucht van Groningen Airport Eelde naar Maastricht, met als eindbestemming Dalaman, vluchtnummer OHY2264 op 17 juni 2003.

1. Bij deze vragenlijst is een tekening van een MD-88, waarmee de vlucht werd uitgevoerd, toegevoegd. Op deze tekening zijn de stoelrijnummers, de stoelletteraanduidingen als ook de beschikbare deuren en nooduitgangen aangegeven.
   Wilt u op deze tekening het volgende aankruisen:
   * uw stoel
   * de door u gebruikte deur of nooduitgang.
   Indien u niet zeker weet op welke stoel u heeft gezeten, verzoek ik u deze bij benadering aan te geven.

2. Is er bij de aanvang van de vlucht in het vliegtuig informatie gegeven over de veiligheidsprocedures?
   ☐ ja, op video
   ☐ ja, via een geluidsopname
   ☐ ja, via een demonstratie door een steward(ess)
   ☐ nee, er is geen informatie gegeven
   ☐ weet niet

3. Indien er sprake was van informatie betreffende de veiligheidsprocedures, in welke talen werd deze informatie verstrekt?
   (meerdere antwoorden mogelijk)
   ☐ Nederlands
   ☐ Engels
   ☐ Turks
   ☐ Anders, nl:…………………………………………………………………………………..

4. Wat is uw oordeel over de informatie met betrekking tot de veiligheidsprocedures?
   ☐ uitstekend
   ☐ goed
   ☐ voldoende
   ☐ onvoldoende
   ☐ slecht
   ☐ weet niet
   Toelichting:……
   …………………………………………………………………

5. Wat is uw oordeel over de veiligheidsinformatiekaarten, beschikbaar in de stoelzakken voor u?
   ☐ uitstekend
   ☐ goed
   ☐ voldoende
   ☐ onvoldoende
   ☐ slecht
   ☐ weet niet
   Toelichting:……
   …………………………………………………………

6. Waren er één of meerdere steward(esse)s aanboord die Nederlands spraken?
   ☐ Ja
   ☐ nee
   ☐ weet niet

7. Heeft u, nadat het vliegtuig tot stilstand was gekomen, opdracht gekregen om;
☐ te blijven zitten
☐ het vliegtuig te verlaten
☐ anders, namelijk:……………………………………………………………………
☐ weet niet

8. Zo ja, wie heeft u deze opdracht gegeven?
☐ Piloot
☐ steward(esse)s
☐ medepassagiers
☐ weet niet

9. In welke taal gebeurde dit?
(meerdere antwoorden mogelijk)
☐ Nederlands
☐ Engels
☐ Turks
☐ anders, namelijk:……………………………………………………………………
Toelichting:………
…………………………………………

10. Heeft u deze opdracht direct opgevolgd?
☐ Ja
☐ nee
☐ weet niet
Toelichting:………
…………………………………………

11. Heeft u problemen ondervonden bij het openen van uw veiligheidsriem en / of het verlaten van uw stoel?
ق ja ق nee ق weet niet
Toelichting:………
…………………………………………

12. Bent u door de steward(esse)s naar een uitgang verwezen.
☐ Ja
☐ nee
☐ weet niet

13. Zo ja, welke uitgang was dit (zie aanduiding op de tekening) en kunt u toelichten op welke wijze dit is gebeurd?
………
………

14. Is er paniek uitgebroken?
☐ Ja
☐ nee
☐ weet niet

15. Wie zijn er in paniek geraakt?
(meerdere antwoorden mogelijk)
☐ enkele passagiers
☐ veel passagiers
☐ Steward(esse)s
☐ pilo(o)t(en)

16. Zo ja, waar bleek dat volgens u uit?
………
………

17. Zo ja, kunt u beschrijven wat u toen heeft gedaan?
………
………

18. Hoe verliep in het algemeen de communicatie tussen de steward(esse)s en de passagiers tijdens de evacuatie
☐ uitstekend
☐ goed
☐ voldoende
☐ onvoldoende
☐ slecht
☐ geen mening
Toelichting:………
……………………………………………

19. Wie heeft de door u gebruikte deur of nooduitgang geopend?
☐ één van de steward(esse)s heeft de deur geopend
☐ ik heb de deur zelf geopend
☐ één van de medepassagiers heeft de deur geopend
☐ weet niet

20. Heeft u problemen ondervonden bij het verlaten van het vliegtuig?
☐ Ja
☐ nee
☐ weet niet
Toelichting:………
……………………………………………

21. Hoe lang duurde het vanaf het moment dat het vliegtuig tot stilstand kwam tot dat u zich op veilige afstand van het vliegtuig bevond
………. minuten.
Toelichting: ……
…………………………………………………………………………………………….....

22. Bent u bij het verlaten van het vliegtuig door iemand geholpen?
☐ ja, door een steward(ess)
☐ ja, door een bekende medepassagier
☐ ja, door een onbekende medepassagier
☐ nee, ik ben niet geholpen
☐ weet niet

23. Heeft u bij het verlaten van het vliegtuig uw handbagage meegenomen?
(Deze vraag heeft betrekking op de eerste maal dat u het vliegtuig verliet, de nood-evacuatie)
☐ ja
☐ gedeeltelijk
☐ nee
☐ weet niet

24. Wat is uw oordeel over de totale hulpverlening en opvang direct na het incident?
☐ Uitstekend
☐ Goed
☐ Voldoende
☐ Onvoldoende
☐ Slecht
☐ geen mening
Toelichting:………
……………………………………………

25. Bent u bij het incident, op welke manier dan ook gewond geraakt?
☐ Ja
☐ Nee
☐ weet niet

26. Kunt u beschrijven wat die verwondingen zijn?
……
……
……………………………………………………………………………………………………

27. Kunt u beschrijven hoe deze verwondingen zijn ontstaan?
....
....
....

Tenslotte

28. Met hoeveel personen (inclusief u zelf) maakte u deze reis?
………. personen, inclusief mezelf.

29. Waren er in uw gezelschap ook kinderen aanwezig?
☐ Ja, ……………(aantal)
☐ Nee, er waren in mijn gezelschap gaan kinderen

30. Hoeveel vliegreizen heeft u in de laatste 24 maanden gemaakt?
…………vliegreizen

31. Wat is uw geslacht en leeftijd?
☐ Man ……………jaar
☐ vrouw ……………jaar

32. Wat is uw gewicht en wat was het gewicht van uw hand bagage op deze vlucht?
Mijn gewicht: circa……………….. kilogram
Gewicht handbagage: circa……….. kilogram

33 Heeft u tijdens de evacuatie foto of video opnamen gemaakt?
☐ Ja, foto / video
☐ Nee

Heeft u verder nog opmerkingen / suggesties met betrekking tot het incident?

Appendix M

Results

General
The total number of passengers was 141 plus one baby. 128 Persons have responded to the questionnaire, five others were contacted by telephone and were asked the most relevant questions. The information of eight passengers could not be obtained.

Location of the passengers and used emergency exits
All of the 133 passengers from whom we received information have given an indication which seat they occupied during the accident flight. 57 Passengers stated they occupied seats which were also indicated by other passengers, nevertheless the indications are accurate enough to place the passengers in either cabin-compartment one or two. 128 Of these passengers have also indicated which exit they used during the emergency evacuation of the aircraft.
Of these 133 passengers 80 were seated in cabin-compartment #1 en 53 and one infant were seated in cabin-compartment #2.

Passengers per exit

Left forward aircraft door	52
Right forward aircraft door	none
Left forward over-wing exit	4
Left aft over-wing exit	9
Right forward over-wing exit	33
Right aft over-wing exit	27 (+ 1 infant)
Left aft service door	not opened
Tail cone exit	not opened

Of 16 passengers it is not known which exit they used during the evacuation.

Safety briefing
Almost all passengers indicated that the safety briefing was given in the form of a demonstration by the cabin crew members. The briefing was given in the Turkish and English language.

The passengers rated the briefing as:		
	Excellent	0%
	Good	4%
	Fair	34%
	Insufficient	20%
	Poor	40%
	No comment	2%

Many of the passengers indicated the briefing was difficult to- or could not be understood, either due to the poorly pronounced English or due to the poor quality of the public address system.

The safety briefing cards were generally rated from fair to good although 25% of the passengers indicated they had not looked at the briefing cards.

Evacuation
65% Of the passengers stated that no orders were given after the aircraft had come to a stop and that they had evacuated the aircraft on their own initiative.

10% of the passengers stated that they had not received any orders from the crew and that they had evacuated when urged to do so by their fellow passengers.

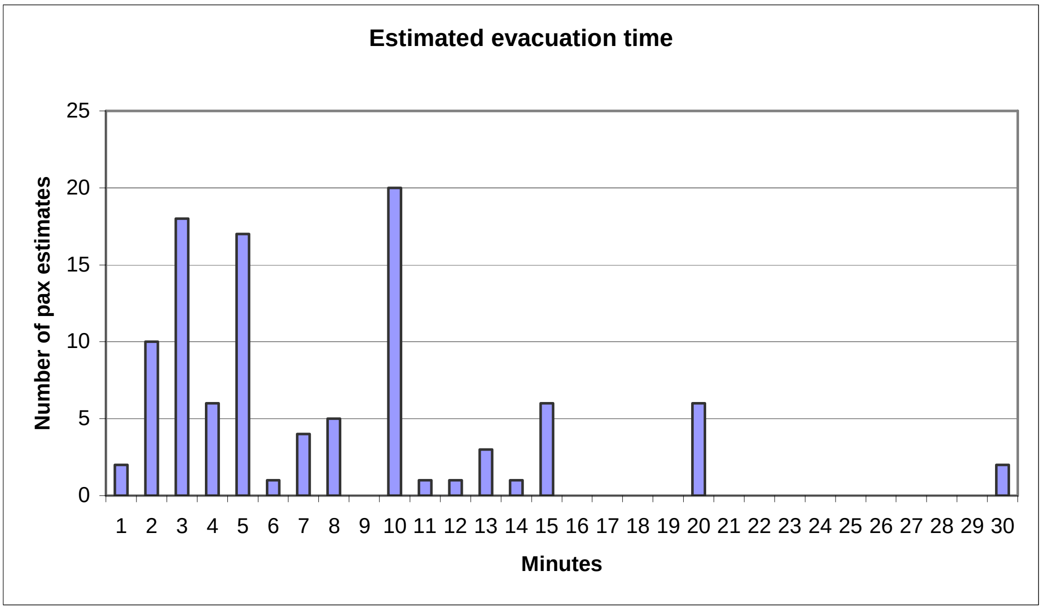
25% Of the passengers stated that the cabin crew had either instructed them to remain seated followed by the instruction to leave the aircraft or to evacuated the aircraft immediately. It must be noted that most of these passengers were seated near a cabin attendant's station.

Approximately half of the passengers stated that there was some panic. This panic was caused by the fact that some of the passengers thought the evacuation took too much time and in other cases passengers thought of the possibility of fire.

During the evacuation most of the passengers took their hand luggage with them, or re-entered the aircraft shortly after the evacuation to retrieve their hand luggage.

Almost all of the passengers had complaints regarding the presence of the cabin crew during the evacuation, they often also complained about the lack of communication during the evacuation.

The passengers were asked how much time passed from the time the aircraft came to a complete stop until the moment they had evacuated the aircraft and were located at a safe distance from the aircraft. Time estimates given by the passengers ranged from 1 to 30 minutes, some of the passengers indicated that they assisted others to get off the aircraft before they left themselves.



Passenger weights
64 Of the female passenger have given their body weight. The average weight of these passengers was 71.3 kg which equals 157 pounds (including hand luggage).

47 Of the male passengers have given their body weight. The average weight of these passengers was 87.3 kg which equals 192 pounds (including hand luggage).

The weight of two children was also reported. The average weight of these children was 14 kg which equals 31 pounds (including hand luggage).

Appendix N

Boeing study
Control column forces & Performances

Background
The DTSB requested Boeing to conduct a study that would contribute to a better reconstruction of the stick force experienced by the captain during the rotation attempt and to provide performance data to evaluate the actual flight versus other relevant scenarios. The National Transportation Safety Board (NTSB) of the United States of America assisted in the process of matching the investigation questions of DTSB to the available sources from the manufacturer to get the required answers.

Study
An MD-80 desktop computer simulation was updated to accurately reflect control column forces. The model was verified against flight test data from the flying quality report (FQR). These data are not officially FAA approved, but the FAA is aware of it and agrees with the document as such. It is mentioned that mis-trim characteristics were used as static data derived from free flight conditions in which angle of attack and speed are allowed to vary. Based on this mis-trim data initial stick forces were estimated to be within the 30 – 40 pounds range. However, the rotation is a dynamic event and during the take-off roll the angle of attack is constrained and the airflow over the tail is therefore significantly different than expected with mis-trim data. After the simulator results had been reviewed it was clear that the stabilizer gross mis-trim (approximately 5 degrees) significantly increased the stick force and that the 30-40 pounds range was not enough to rotate the aircraft in a timely matter.

A math pilot was used to drive the control column for the take-off rotation with a goal of normal 3 degrees per second pitch rate where possible. The point of departure was a 6 degrees elevator deflection in accordance with the elevator deflection during the accident flight. In addition a 10 degrees elevator deflection and the elevator deflection corresponding with full control tab input would be considered. It appeared that 10 degrees elevator deflection in combination with approximately 5 degrees stabilizer mis-trim (as it was the case in the accident flight) was prohibitive, for the cases 1-3 were far outside the normal envelope. As a consequence the cases for 10 degrees elevator deflection were not included in the results. Cases 1-3 represent the column force required to generate approximately 6 degrees elevator deflection during the rotation.

The take-off ground roll distances give an understanding of relative effects, but should not be reflected as to be matched against certified data. The ground roll distances are significantly increased by the stabilizer gross mis-trim condition. The distances are not FAA approved, are approximate and should be used for comparison with each other.

The prevailing conditions for the study were an aircraft take-off gross weight of approximately 130,000 lbs, the CG of -0.7% MAC and the flaps extended in the 24 degrees position. For simulation cases 01, 02 and 03 the applied thrust levels were 2.02 EPR (left engine) and 1.97 EPR (right engine). For case 04 both engines were supposed to produce 2.01 EPR. The results are demonstrated in the table below.

Case	Stabilizer	Vr (knots)	Column force (lbs)	Take-off ground roll (feet)
01	7.2 deg	120	˜ 50	4,500
02	7.2 deg	135	˜ 50	4,400
03	8.0 deg	135	˜ 50	4,190
04	11.9 deg	128	16	3,590

Table: column force and take-off ground roll distances

Control column force
On request of the DTSB Boeing provided stick force and take-off ground roll data for a number of cases in which applicable variations of stabilizer position and rotation speeds are considered. On the MD-80 aircraft family the stick force the pilot feels when pushing or pulling the column is delivered by the artificial load and feel system and the aerodynamic load on the control tab (normal friction in the systems is not considered).

The force produced by the load and feel system depends upon the applied column input: the more column displacement, the higher the force. Given a certain column displacement, the required force varies with the stabilizer position, for it affects the spring tension in the load and feel system.

Aerodynamic load depends upon the control tab deflection and airspeed: higher airspeed and more deflection require more column force.

Boeing’s study indicates that when the stabilizer would have been set at 11.9 degrees ANU (stabilizer position in accordance with most probable CG of the accident flight), a stick force of approximately 16 pounds would have been required to produce a normal elevator deflection of approximately 2 till 4 degrees. It is then assumed that the take-off would have been performed “according to the book” and with Vr = 128 knots. The required ground roll distance is roughly estimated at 3,590 feet.

FDR data show that the elevator deflection approximately was 6 degrees during the actual rotation attempt of the pilot. Given the prevailing conditions Boeing’s study also demonstrates that the produced stick force by the pilot to realize 6 degrees deflection must have been approximately 50 pounds. This stick force is also required for a 6 degrees elevator deflection when the stabilizer would have been set at 8.0 degrees ANU (stabilizer position in accordance with CG of 11.1 % MAC as assumed by the crew) and/or when the rotation would have been initiated at 135 knots (rotation speed as indicated in the speed booklet).

Further study results show that when full elevator control tab is applied it requires approximately 60 pounds stick force resulting into 7 till 8 degrees elevator deflection as it is subject to hinge moment limitations. Higher applied column forces would drive the elevator directly. The hinge moments become so high that a 10 degrees elevator deflection would require 400 pounds control column force.

Ground roll distance

For 7.2 degrees stabilizer position ANU and provided a pilot is able to apply approximately 50 pounds control force, rough estimates indicate a required ground roll distance of approximately 4,500 feet when rotation is initiated at 120 knots and 4,400 feet when initiated at 135 knots. For 8.0 degrees stabilizer position and starting rotation at 135 knots the approximate ground roll distance is 4,190 feet.