U.S. Department
of Transportation
**Federal Aviation
Administration**

800 Independence Ave., SW.
Washington, DC 20591

FOIA Control No. 2001-007025WA

This is in response to your Freedom of Information Act (FOIA) request dated July 26 seeking a copy of the audit conducted by the International Civil Aviation Organization (ICAO) on Emirates Airlines and a copy of a letter prepared by Kim Miller, AFS-50, that was forwarded to the Department of Transportation (DOT) regarding the code share requested by Emirates Airlines.

In response to item 1 of your request, we are not prepared to release the contents of the detailed report for a safety audit completed by ICAO on the United Arab Emirates. Under the aegis of the International Aviation Safety Assessment (IASA) program, and related participation under the ICAO Universal Safety Oversight Audit Program, the Federal Aviation Administration (FAA) determines whether the Civil Aviation Authorities (CAA) of other countries are equipped, staffed, etc., to perform duties under the standards of ICAO that would then authorize air carriers of those countries to operate to the United Sates and to participate in code-sharing activities with U.S. air carriers. The success of these activities requires a great deal of cooperation and negotiation between the CAAs and FAA. If the particulars of the evaluations of those countries and their carriers were to be publicly disclosed, it would frustrate the candor and cooperation that is necessary to the success of this program and the negotiations that often ensue about corrective measures that need to be taken. Under Title 49 U.S.C. section 40115, we are authorized to withhold any information in which the disclosure would prejudice the formulation and presentation of the position of the United States in international negotiations. That statute qualifies under Exemption 3 of the FOIA 3 U.S.C. 552(b)(3) for withholding records specifically exempted from disclosure by another Federal statute.

In response to item 2 of your request, we have enclosed a copy of the January 30, 2001, memorandum from the FAA to the DOT regarding a proposed code-share between Emirates Airlines and Continental Airlines.

There are no fees associated with processing your request as the cost to process is less than $10.

The undersigned is responsible for this partial denial. You may request reconsideration of this determination by writing the Assistant Administrator for Region and Center Operations, Federal Aviation Administration, 800 Independence Avenue, SW., Washington, D.C. 20591. Your request for reconsideration must be made in writing within 30 days from the date of receipt of this letter and must include all information and arguments relied upon. Your letter must state that it is an appeal from the above-described partial denial of a request made under the FOIA and include your assigned FOIA control number. The envelope containing the appeal should be marked "FOIA."

Sincerely,

Louis C. Cusimano
Acting Director, Flight Standards Service

Enclosure

INFORMATION: Review of Continental Airlines Code-Share Application Involving Emirates Airlines

Director, Flight Standards Service

Director, Office of International Aviation, X-40

The Federal Aviation Administration (FAA) has completed a review of available information pertaining to the proposed codeshare services between Continental Airlines Inc. and Emirates Airlines, an air carrier of the United Arab Emirates (OST-2000-7495 & OST-2000-7490). This review was undertaken in follow-up response to your memorandum of June 13, 2000 requesting such information. The FAA's review established the following information that may be pertinent to whether the codeshare authority sought by Continental Airlines and Emirates Airlines should be conditioned, limited, or withheld for safety reasons.

Because of binding international agreements and law, the agency does not currently examine the compliance of individual foreign air carriers with internationally agreed-upon standards for safety. While FAA conducts "ramp" type inspections of foreign air carriers when they operate to the United States, we have not conducted any such inspections of Emirates Airlines because it currently has no operations to the U.S. Therefore, information that would be developed during such an inspection is not available to the FAA for use in this review.

The FAA also depends on the aeronautical authority of the State of the operator to certify and oversee the safety of its airlines in accordance with international standards and agreements. United Arab Emirate's compliance with minimum international standards for safety oversight has not been evaluated under the FAA's International Aviation Safety Assessment program. However, the UAE did provide the FAA a copy of the International Civil Aviation Organization (ICAO) detailed report of the safety oversight audit conducted in their country under the Universal Safety Oversight Audit Program. The information contained in the ICAO report and developed by the FAA during recent discussions with representatives of the UAE aeronautical authority do not support a finding that it oversees civil aviation safety in accordance with minimum international standards.

The FAA has not reviewed a report of an audit of Emirates Airlines conducted by Continental under its code-share audit program. Such a review in not necessary given the above-referenced information regarding the level of safety oversight being applied in the UAE.

Because the FAA cannot find that the aeronautical authority of the UAE oversees civil aviation safety in accordance with minimum international standards, the FAA recommends against the issuance of the code-share authority sought by Continental Airlines.

Original Signed By:
L. Nicholas Lacey

L. Nicholas Lacey

cc:AFS-1/50/50 K. Miller
File:
Word:A:\EMIRAT 1.DOC
AFS-50:KMiller:jk:267-3864:01/26/01

U.S. Department
of Transportation
**Federal Aviation
Administration**

Flight Standards Service

800 Independence Ave., SW.
Washington, DC 20591

FOIA Control No. 2002-1420

This is in response to your Freedom of Information Act (FOIA) request dated November 28, 2001, and your clarification letter of December 17, 2001, seeking a copy of the report of the review conducted by the Federal Aviation Administration (FAA) on the Civil Aviation Authority (CAA) of the United Arab Emirates, a copy of the detailed report of an audit conducted by the International Civil Aviation Organization (ICAO), and all relevant information to it that could not be released to Mr. Pepe, who had made a similar request on your behalf.

In response to your request, we are not prepared to release a copy of the report regarding the review conducted by the FAA on the CAA of the United Arab Emirates, a copy of the detailed report of an audit conducted by the ICAO, or other relevant information that was previously denied to Mr. Pepe.

Under the aegis of the International Aviation Safety Assessment (IASA) program, and related participation under the ICAO Universal Safety Oversight Audit Program, the FAA determines whether the CAA of other countries are equipped, staffed, etc., to perform duties under the standards of ICAO that would then authorize air carriers of those countries to operate to the United States and to participate in code-sharing activities with United States air carriers. The success of these activities requires a great deal of cooperation and negotiation between CAAs and the FAA. If the particulars of the evaluations of those countries and their carriers were to be publicly disclosed, it would frustrate the candor and cooperation that are necessary to the success of this program and the negotiations that often ensue about corrective measures that need to be taken. As you have discussed with the CAA of your own country of Belgium, each ICAO member State considers this information to be of a sensitive nature and does not make a public distribution of such material. Under Title 49 U.S.C. section 40115, we are authorized to withhold any information in which the disclosure would prejudice the formulation and presentation of the position of the United States in international negotiations. That statute qualifies under Exemption 3 of the FOIA 5 U.S.C. 522 (b) (3) for withholding records specifically exempted from disclosure by another Federal statute. Therefore, we are withholding 40 pages of records.

There is no fee for processing this request, as the cost to process is less than $10.

The undersigned is responsible for this denial. You may request reconsideration of this determination by writing the Assistant Administrator for Region and Center Operations, Federal Aviation Administration, 800 Independence Avenue, SW., Washington, D.C. 20591. Your request for reconsideration must be made in writing within 30 days from the date of receipt of this letter and must include all information and arguments relied upon. Your letter must state that it is an appeal from the above-described denial of a request made under the FOIA and include your assigned FOIA control number. The envelope containing the appeal should be marked "FOIA."

Sincerely,

James J. Ballough
Director, Flight Standards Service

ICAO Universal Safety Oversight Audit Programme

ICAO SUMMARY REPORT

OF THE

GENERAL CIVIL AVIATION AUTHORITY

OF THE

UNITED ARAB EMIRATES

REVISED DECEMBER 2000

(Abu Dhabi, 23 November to 1 December 1999)

INTERNATIONAL CIVIL AVIATION ORGANIZATION

Audit Summary Report on the Safety Oversight Audit Mission to the United Arab Emirates

(Abu Dhabi, 23 November to 1 December 1999)

1. BACKGROUND

1.1 The General Civil Aviation Authority (GCAA) of the United Arab Emirates was audited from 23 November to 1 December 1999 by an ICAO safety oversight audit team in accordance with the Memorandum of Understanding (MOU) agreed on 6 June 1999 between the United Arab Emirates and ICAO and included in Attachment A to the audit interim reports forwarded to the United Arab Emirates on 18 January and 12 April (Arabic version) 2000. The audit was carried out pursuant to Assembly Resolution A32-11, with the objective of ascertaining the safety oversight capability of the GCAA of the United Arab Emirates and to ensure that it is in conformity with ICAO Standards and Recommended Practices (SARPs), as contained in Annexes 1, 6 and 8 to the Chicago Convention and related provisions in other Annexes, guidance material and relevant safety-related practices in general use in the aviation industry as referred to in such material.

1.2 On 18 January 2000, the United Arab Emirates submitted an action plan addressing all the draft findings and recommendations which were made available to it at the end of the audit on 1 December 1999. Although the United Arab Emirates was requested to resubmit a modified action plan on the basis of the official audit interim report dated 12 April 2000, no other action plan reflecting the findings and recommendations as contained in the official audit interim report was received. Hence the Safety Oversight Audit (SOA) Section submitted the audit final report based on the action plan provided and a summary report was published and forwarded to all Contracting States in July 2000.

1.3 A modified action plan was submitted on 18 August 2000, as a result of which this revised summary report was prepared.

2. CIVIL AVIATION ACTIVITIES IN THE UNITED ARAB EMIRATES

At the time of the audit, the civil aviation activities in the United Arab Emirates included:

a)	number of technical staff employed by the organization at Headquarters	67
b)	number of regional offices	1
c)	number of technical staff employed at regional offices	6
d)	number of active pilot licences	1 237
e)	number of active flight crew licences other than pilot licences	7
f)	number of active licences other than flight crew licences	827
g)	number of commercial air transport operators	10

perform their duties and responsibilities. To carry out the necessary scheduled audits and surveillance as planned, the GCAA should consider increasing the number of its airworthiness staff.

3.2 **Primary aviation legislation and civil aviation regulations in the United Arab Emirates**

3.2.1 **Abstract of findings**

3.2.1.1 The primary aviation legislation of the United Arab Emirates is the *United Arab Emirates Ministry of Communications Civil Aviation Law* (hereinafter referred to as the *"Civil Aviation Law"* or *"CAL"*), which was approved by the Council of Ministers and the Federal National Council and ratified by the Supreme Council for the Federation on 10 June 1991. It was amended on 15 June 1996 by Federal Law No. 4, establishing the General Authority of Civil Aviation. The Civil Aviation Law makes provision for the air navigation regulations, defines the functions of the Civil Aviation Authority and the Director General and outlines his responsibilities to develop, issue and revise operating regulations and rules of the air navigation regulations.

3.2.1.2 A supplementary aviation legislation was promulgated in 1992 by the Civil Aviation Authority of the United Arab Emirates, referred to as the "Civil Aviation Regulations" or "CARs". The CARs are complete and comprehensive and address all aspects of safety in conformity with the provisions contained in Annexes 1, 6 and 8. Article 19 of the CAL further states that "the Chicago Convention and other protocols and agreements pertaining to civil aviation shall be considered complementary to the provisions of this law", thus strengthening the CARs. In addition to the CARs, the GCAA issues a civil aviation advisory publication (CAAP). The intent of this publication is to provide legally binding instructions, information and guidance to operators of UAE registered aircraft.

3.2.1.3 The primary aviation legislation and civil aviation regulations of the United Arab Emirates were found to be satisfactory and adequate to support civil aviation activities in the United Arab Emirates and no findings were made which required remedial action by the State.

3.3 **Civil aviation organization system in the United Arab Emirates**

3.3.1 **Abstract of findings**

3.3.1.1 The Flight Safety Department (FSD), within the GCAA, is responsible for personnel licensing, certification and supervision of commercial air transport operators, continuous airworthiness of aircraft and maintenance. The headquarters of the GCAA is located in Abu Dhabi and a regional office is established in Dubai. None of the other Emirates of the United Arab Emirates has a regional office. The GCAA uses the services of the ICAO Technical Cooperation Bureau (TCB) to provide expert advice to inspectors in aircraft operations and airworthiness of aircraft. Minimal training has been provided to the airworthiness inspectors and to some of the operations inspectors. The GCAA does not have dedicated licensing staff but has elected to task both airworthiness and operations staff with this responsibility.

3.3.1.2 Article 35 of the CAL gives inspectors the right of access to all civil aviation-related locations. However, access to some facilities was reported to be a particular problem at some airports in the United Arab Emirates. Also, not all GCAA inspectors have been provided with the appropriate credentials to enable them to access several airports and aviation facilities for inspection duties.

3.4.2 Corrective action plan proposed/implemented by the United Arab Emirates

3.4.2.1 *With respect to the need for amending the procedures established for the validation and issuance of national licences on the basis of foreign licences, the GCAA indicated that it would change its procedures to reflect the recommendation of ICAO by January 2000. It also indicated that the new procedures would be included in the next edition of its AIP which was scheduled to be published on 20 April 2000. In its revised action plan, dated 18 August 2000, the GCAA indicated that the AIP was amended per schedule and the new procedures are now contained in the AIP.*

3.4.2.2 *The GCAA indicated that civil aviation advisory publication (CAAP-4) was amended on 1 January 2000 to implement the recommendation by ICAO. In its revised action plan, dated 18 August 2000, the GCAA indicated that the AIP was amended per schedule and the new procedures now contained in the AIP make reference to CAAP documents and publication availability.*

3.5 Aircraft operations certification and supervision in the United Arab Emirates

3.5.1 Abstract of findings

3.5.1.1 The aircraft operations certification system in the United Arab Emirates is administered by the GCAA Aviation Safety and Standards Department (GCAA Flight Standards) headed by a Director. In addition to the Director of GCAA Flight Standards, the Department also has two operations inspectors. These inspectors and the Director undertake flight operations inspections duties. The GCAA was also benefiting from the services of three flight operations inspectors provided by ICAO's TCB.

3.5.1.2 The operations inspectors also undertake personnel licensing examinations and ground operations inspection duties including dangerous goods and cabin safety issues. All of the inspectors are qualified in their respective specialties and have been properly selected per established criteria. Their initial training records are documented and maintained in personnel file records. However, the GCAA has not established a formal recurrent training programme for its operations inspectors to ensure maintenance of proficiency.

3.5.1.3 The GCAA has developed a formal process for the certification of air operators, which both the applicant and GCAA must undergo to ensure that the applicant complies with all certification and operational requirements before an AOC is issued. The certification process provides for interaction between the applicant and the GCAA from initial inquiry to certificate issuance or denial. The process is designed to ensure that an applicant's programme, systems and intended methods of compliance are thoroughly reviewed, evaluated and tested. The process, once completed, provides reasonable assurance that the applicant's infrastructure (programmes, methods and systems) will result in continued compliance after certification.

3.5.1.4 Surveillance files and records indicated that *ad hoc* surveillance of certified operators was being carried out. However, no actual system for surveillance of certified operators had been developed.

3.5.1.5 During the audit, seven findings relating to aircraft operations certification and supervision in the United Arab Emirates were made and seven recommendations put forward to rectify them.

considered valid within the framework of the authority as a declaration of duties and responsibilities and for use as a prospectus for inspector training. The CARs provide inspectors with the authority and the right of access to aviation facilities as appropriate; however, the GCAA did not always provide the inspectors with the appropriate credentials to enable them to access airports and facilities for inspection duties. Since the United Arab Emirates is made up of seven separate Emirates, the GCAA airworthiness personnel have not been given access in the form of a permanent identity cards by each Airport Authority. Hence they could only gain access to the seven airports by prior appointment. The overall audit programme of the authority was behind schedule and some areas within the maintenance facilities have not been audited by the GCAA at all. Surveillance has mainly been concentrated on visits mainly to maintenance organisations. Apron or ramp audits are not being conducted.

3.6.1.2 Training is provided on a regular basis to the core airworthiness personnel including minimal *ad hoc* training to the airworthiness technical experts provided by TCB. Airworthiness inspectors are provided with procedures manuals and airworthiness notices. The Airworthiness Section was in the process of writing the *Airworthiness Policy and Procedures Manual* which will replace the existing *Airworthiness Procedures Manual* developed approximately eight years ago. The procedures completed to date were based on JAA material. The last two audits of an operator had not involved visits to the operator. The inspector had, prior to the audit, requested the operator to provide him with copies of their last internal audits of two areas identified by the GCAA and those were in turn recorded as GCAA audits of the operator.

3.6.1.3 One of the objectives of the GCAA is not to burden itself with unnecessary paperwork and manuals. To that end, it has outsourced its own copies of aircraft airworthiness documentation, i.e. maintenance manuals, IPCs, WDM, structural repair manuals, flight manuals, etc. It is assumed that manuals would always be available for the operators and maintenance organizations, should they be required. Such a system has been adopted to reduce the space in the library and the workload of amendments. Copies of ICAO documentation are available in a controlled library. The GCAA does receive some ADs but, again, the minimum paperwork concept has been applied. It is considered that operators should be responsible for compliance with ADs and the GCAA chose to have an active involvement only where emergency ADs were concerned.

3.6.1.4 No manufacturing industry has been established within the United Arab Emirates. However, the GCAA has issued a number of design approvals, to be renewed annually, to design organizations outside the United Arab Emirates. The approvals were predicated on the company holding an approval from its national airworthiness authority. Each company was visited by the GCAA once every one to two years. Although such approvals were being granted, the GCAA did not have the requisite expertise in that field to justify such an approval being issued.

3.6.1.5 During the audit, five findings relating to airworthiness of aircraft in the United Arab Emirates were made and five recommendations put forward to rectify them.

3.6.2 Corrective action plan proposed/implemented by the United Arab Emirates

3.6.2.1 *With respect to the recommendation on the need to strengthen the inspectorate staff specifically by recruiting qualified personnel with adequate experience in engineering in order to assess and properly conduct effective oversight of its approved design organizations, the GCAA indicated that it has strengthened its airworthiness staff to include expertise in avionics and to ensure full coverage of*

5. STATUS OF IMPLEMENTATION AND LIST OF DIFFERENCES FROM ICAO SARPS

Differences identified during the audit are found in Attachments A and B to this summary report and differences *vis-à-vis* Standards will be included in the relevant Annex Supplement in line with Article 17 of the MOU signed between the United Arab Emirates and ICAO.

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ATTACHMENT A

STATUS OF IMPLEMENTATION AND LIST OF DIFFERENCES FROM ICAO STANDARDS (ANNEX 1 — PERSONNEL LICENSING)

ICAO Standard reference	UAE's regulations reference	Differences between the national regulations of the United Arab Emirates and ICAO Standards
1.2 a)	Nil	UAE does not issue glider pilot, free balloon pilot or flight navigator licences.
1.2 b)	Nil	UAE does not issue flight operations officer or aeronautical station operator licences.
1.2.4.1		Until otherwise advised, UAE medical assessments differ from the provisions of Chapter 6.
1.2.5.2	CAR, Chapter II, 1.7	18 months for the holder of an air traffic controller licence under 40 years of age, 12 months over 40 years.
2.1.1.1	Nil	The UAE does not issue glider pilot or free balloon pilot licences.
2.1.3.1.1	Nil	The UAE has not established a class rating for helicopters.
2.3.1.3.1	CAR, Chapter II, 2.3.3.a	The applicant shall have completed not less than 50 hours of flight time as a pilot of aeroplanes.
2.3.1.3.2	CAR, Chapter II, 2.3.3.b	The applicant shall have completed in aeroplanes not less than 20 hours of solo flight time under the supervision of an authorized flight instructor, including 8 hours of solo cross country flight.
3.2	Nil	UAE does not issue flight navigator licences.
4.3.1.4	CAR, Chapter 5,	The applicant shall hold a current Class 2 Medical Assessment.
4.5	Nil	UAE does not issue flight operations officer or flight dispatcher licences.
4.6	Nil	UAE does not issue aeronautical station operator licences.
5.1.1		UAE licences do not show: 1. address of holder and 2. signature of holder.
5.1.3		UAE pilot licences are metallic gold colour of credit card size.

STATUS OF IMPLEMENTATION AND LIST OF DIFFERENCES FROM ICAO STANDARDS
(ANNEX 6 — OPERATION OF AIRCRAFT)
(PART I — International Commercial Air Transport — Aeroplanes)

ICAO Standard reference	UAE's regulations reference	Differences between the national regulations of the United Arab Emirates and ICAO Standards
Annex 6, Parts I and III, Appendix 2	OPS 4.404	The requirements related to the contents of the operations manual given in CAR, Chapters 2 and 3 do not meet all the requirements as indicated in Annex 6, Parts I and III, Appendix 2.
3.6	OPS 4.408	There is no requirement in the regulations for operators to establish an accident prevention and flight safety programme.
4.2.6.2	OPS 4.411	The regulations do not require that an operator specify the method by which it is intended to determine minimum flight altitudes for operations conducted over routes for which minimum flight altitudes have not been established by the State flown over or the responsible State. This method must be included in the operations manual and correspond to the requirements of Annex 2.
4.3.5.4	OPS 4.423	The regulations do not require that two-way communications be maintained by the aeroplane's inter-communication system or other suitable means between the ground crew supervising the refuelling and the qualified personnel on board the aeroplane, when refuelling is taking place while passengers are embarking, on-board or disembarking.
6.3.11	OPS 4.433	The regulations do not require that operators establish procedures for operational check and evaluations of recordings from the flight data and cockpit voice recorder systems to ensure the continued serviceability of the recorders.
6.2	OPS 4.434	The regulations do not require that all flight crew members required on flight deck duty communicate through boom or throat microphones below the transition level/altitude.
13.2	OPS 4.453	The regulations do not require that there be onboard a checklist of the procedures to be followed in searching for a bomb in case of suspected sabotage.
13.3	OPS 4.454	The regulations do not require operators to establish a training programme to enable the crew members to act in the most appropriate manner to minimize the consequences of acts of unlawful interference.

ATTACHMENT B

STATUS OF IMPLEMENTATION AND LIST OF DIFFERENCES FROM ICAO RECOMMENDED PRACTICES

(ANNEX 1 — PERSONNEL LICENSING)

Note: — The Chicago Convention requires that a Contracting State files differences existing between its regulations and ICAO Annex Standards. However, due to the specific mandate given to ICAO for the implementation of the ICAO universal safety oversight audit programme, it is necessary to include differences existing between the National Regulations and ICAO Annex Recommendations, including definitions to encourage implementation and for inclusion in the summary report. Differences with Annex Recommended Practices will not be included in the Supplement to the relevant Annex if they should remain unimplemented by the time the final report is published.

ICAO RPs reference	UAE CARs reference	Differences between the national regulations of the United Arab Emirates and ICAO Recommended Practices
1.2.4.4.2	Nil	No provisions.
2.1.3.1.1	Nil	There were no class rating for helicopters certificated for single operations.
2.6.1.5.2	Nil	No provisions.
2.10.1.5.2	Nil	No provisions.
6.3.2.23.1	Nil	No provisions.
6.4.2.22.1	Nil	No provisions.

— END —

South African Civil Aviation Authority

SERIOUS INCIDENT

Aircraft registration:	**A6-ERN**
Type of aircraft:	**Airbus A340-300**
Date of accident:	**9 April 2004**
Location:	**Johannesburg International Aerodrome**

CA18/3/2/0330

SOUTH AFRICAN CIVIL AVIATION AUTHORITY

SERIOUS INCIDENT REPORT – EXECUTIVE SUMMARY

Aircraft Registration	**A6-ERN**	**Date of Incident**	9 April 2004		**Time of Incident**	1731Z	
Type of Aircraft	AIRBUS A340-300		**Type of Operation**		Scheduled Flight	International	
Pilot-in-command Licence Type		Airline Transport	**Age**	41	**Licence Valid**	Yes	
Pilot-in-command Flying Experience		Total Flying Hours	13387		Hours on Type	8:46	

Last point of departure	Johannesburg International Aerodrome, South Africa
Next point of intended landing	Dubai, United Arabic Emirates.

Location of the incident site with reference to easily defined geographical points (GPS readings if possible)

In the overrun area of Runway 21R at Johannesburg International Aerodrome (S26°08.783' E028°14.067').

Meteorological Information	Surface wind: 270° at 6 knots, Temperature: 19°C, CAVOK				
Number of people on board	2 + 12 + 260	**No. of people injured**	Nil	**No. of people killed**	Nil

Synopsis

The aircraft was on a scheduled international flight from Johannesburg International Aerodrome to Dubai International Aerodrome. The captain was the pilot flying and it was his first take-off in the actual type of aircraft. Both pilots had completed the Cross Crew Qualifications training, which qualified them to take part in Mixed Fleet Flying.

The captain received a "tip" during recent recurrent training sessions to move the Side Stick Order Indicator to the 9° position on the Primary Flight Display during rotation for take-off to attain the prescribed 2/3 backward side stick movement needed to rotate the aircraft for take-off. During the take-off he did not only move the side stick backwards to obtain this position, but also attempted to maintain it at that position. This caused the aircraft to pitch down again and not to transit to flight in the planned distance. It was only when the aircraft reached the end of the runway and the tyres impacted with the runway-end lights that sufficient side stick backward input was given and full thrust was selected that the aircraft transitioned to flight.

Several main wheel tyres and the flap drive system were damaged by tyre debris. The aircraft had to dump fuel and returned for a landing.

The aircraft was correctly maintained and it was the return leg of its first revenue flight in the service of the operator. As far as it could be determined, the aircraft performed in accordance with the published take-off performance data.

Probable Cause

During the take-off roll the captain applied an improper rotation technique by referencing the Side Stick Order Indicator to the 9° position on the Primary Flight Display. This caused the aircraft to de-rotate and not to lift-off as expected. When the aircraft over-ran the end of the runway with the associated noise, the aircraft was rotated further and became airborne with the application of Take-Off/Go-Around thrust.

The training and mindset of the pilots could be considered as a significant contributory factor to this incident. They were "programmed" by tailstrike avoidance information, aircraft difference information and certain expectances to perform the way they did.

A further contributing factor to the cause of this incident could be considered as the differences in take-off performance of the different Airbus aircraft of the operator's fleet.

A further contributing factor to the cause of this incident was that this was both flight crew members second flight in the actual aircraft of this variant of the Airbus A340 (Captain's first flight as pilot flying).

SERIOUS INCIDENT REPORT

Name of Owner	: Boeing Aircraft Holding Company
Name of Operator	: Emirates
Manufacturer	: Airbus Industries
Model	: A340-313
Nationality	: United Arabic Emirates
Registration Marks	: A6-ERN
Place	: In the overrun area of Runway 21R at Johannesburg International Aerodrome.
Date	: 9 April 2004
Time	: 1731Z

All times given in this report are Co-ordinated Universal Time (UTC) and will be denoted by (Z). South African Standard Time is UTC plus 2 hours.

Purpose of the Investigation :

*In terms of Regulation 12.03.1 of the Civil Aviation Regulations (1997) this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and **not to establish legal liability**.*

Disclaimer:

This report is given without prejudice to the rights of the CAA, which are reserved.

1. FACTUAL INFORMATION

1.1 History of Flight

1.1.1 Previous Flight

The day before the event, the crew had operated from Dubai to Johannesburg in an Airbus A340-300 and on that occasion the First Officer was the pilot flying (PF). That flight had been the first occasion either pilot had actually operated, or been in, the Airbus A340-300 apart from their flight simulator experience. The crew were licensed to participate in Mixed Fleet Flying (MFF), but had previously only operated the Airbus A340-500 and the Airbus A330-200. On the take-off from Dubai, both crew members noticed that, whilst the aircraft performed adequately, the Airbus A340-300 seemed to have visibly less performance than other Airbus types they were familiar with.

1.1.2 Pre-Flight Conditions and Preparations for Incident Flight

During an interview, both pilots reported that they were adequately rested and were fit for duty. The local time in Johannesburg was two hours earlier than that in Dubai. The evening departure was at a time of day when their alertness levels may have been expected to be relatively high. The departure was in darkness and in fine weather conditions. The crew stated that they arrived at the aerodrome with plenty of time to prepare for the flight which was on schedule. At that time they were advised of a minor discrepancy, that the data pertaining to the aircraft (A6-ERN) was not contained in the Departure Control System (DCS) at Johannesburg. However, the crew was informed that data for a similar aircraft (A6-ERM) was in the DCS data-base and that the Dry Operating Weights and Indices (DOW&I) were identical for both aircraft. It was intended to issue a computer generated load sheet for A6-ERM and to make a handwritten correction of the aircraft registration. For the return flight to Dubai the Captain was to be the Pilot Flying (PF). The crew completed normal pre-departure checks, during which the First Officer completed an external inspection of the aircraft. He observed that, unusually, the nose wheel oleo was fully compressed. He drew this to the attention of the engineer and was informed this was because the forward hold was fully loaded with cargo and the rear hold was not as yet. The Captain carried out the pre-departure briefing. Since this was the first time he had operated the Airbus A340-300 as PF he gave a thorough briefing, during which he made mention of tail strike awareness emphasizing that he would particularly concentrate on not over-rotating, as the Airbus A340-300 was vulnerable to a tail strike. Also, that Johannesburg was a high altitude airport, where the aircraft response would be more sluggish than at sea level. He said he went on to mention that, owing to the relatively low power of the Airbus A340-300, they should expect to use a longer take-off run than they would have been used to, had they been flying an Airbus A330-200.

The crew was advised of the final zero fuel weight of 173.7 tons, which with a take-off fuel of 58.7 tons, gave a take-off weight of 232.4 tons. The take-off performance was manually calculated, independently, by both crew, with reference to the Regulated Take-off Weight (RTOW) runway performance charts, and this gave a V_1 of 144 knots, a V_r of 152 knots and a V_2 of 157 knots, with a Flex (reduced thrust) temperature of 35°C. The flap setting for take-off was determined as 1+F. This data was entered into the Flight Management Guidance and Envelope Computer (FMGEC), take-off performance page and cross checked.

The load sheet was duly received and relevant data was also entered into the FMGEC, once again with appropriate cross checks, as defined in the aircraft Standard Operating Procedures. In addition, since they had been advised of the problems relating to the DCS at Johannesburg, the First Officer cross-checked the Johannesburg DOW and DOI against the load sheet that had been generated ex Dubai. That load sheet, generated by the operator's Mercator Airport Control System DCS, did contain the DOW and DOI data for A6-ERN. He satisfied himself that basic weight and balance of A6-ERN was indeed the same as A6-ERM. The load sheet advised that there were 14 crew and 260 passengers on board and that the aircraft weight was as expected, including a payload of 38.8 tons. In addition, the Zero Fuel Weight (ZFW) Mean Aerodynamic Chord (MAC) was 28.3% and the Take-off Weight (TOW) MAC was 27.5%, giving a stabilizer take-off trim setting of 4.9° nose up.

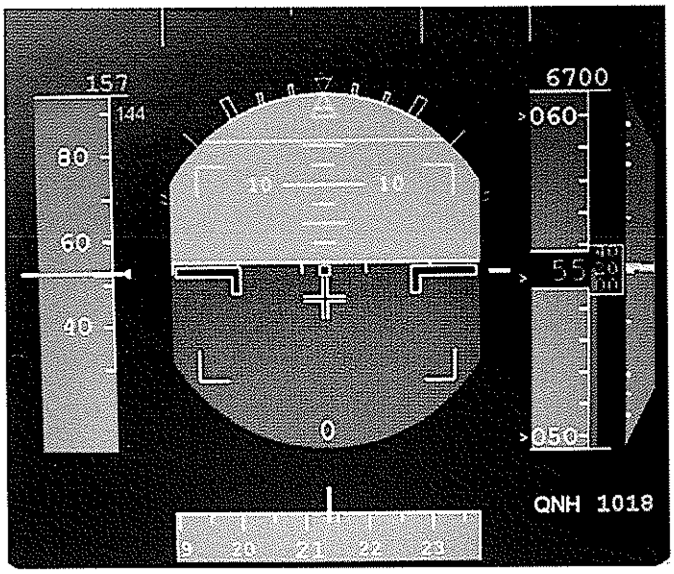
The first officer called and obtained the Air Traffic Control (ATC) clearance for the flight to Dubai from Johannesburg Clearance on 121.7 MHz at 1710Z. They were cleared for the Witbank 2B Standard Instrument Departure (SID) to a flight level of 330 off Runway 21R. After further pre-departure planning and checks, the aircraft was pushed back, one minute behind schedule, at 1716Z.

1.1.3 The Departure

After starting all the engines the flaps were set to 1+F and the stabiliser trim was set to 4.9° nose up. Shortly before releasing the ground engineer, the First Officer asked again about the nose oleo extension. The engineer advised that it was acceptable and that it was now about 3/4 of an inch. Ground Control cleared the aircraft to taxi to Runway 21Right, the planned departure runway, which has a total length of 4418 metres. With all checks completed, including selecting the Air Conditioning Packs to OFF, for increased engine performance, the aircraft was cleared to line up and later take-off at 1729Z using the full length of Runway 21R and, with a slight cross wind from the right of 280° at 5 knots, the take-off run commenced.

1.1.4 The Take-off

After a normal application of the reduced, flexible, thrust all required calls were made and the aircraft behavior was entirely normal. With the power set, both crew stated that they considered the aircraft acceleration to be slow, in comparison to the other types which they flew (Airbus A330-200 and Airbus A340-500), but that this matched their expectations, in light of their experience the previous day and the Captain's earlier briefing.



The Captain maintained the aircraft on the centreline as it accelerated, with the First Officer monitoring airspeed, the engine instruments and the centreline tracking, etc. During the initial ground run the PF applied a forward stick control input as described in the Flight Crew Operating Manual to counter the nose up effect of setting engine takeoff thrust to about 80 knots. At 75 knots the Side Stick Order Indicator (SSOI) started moving back to the centre position as the PF centralized the sidestick. As the aircraft approached 144 knots the First Officer called "V_1" and this was reiterated by the auto call-out. At 152 knots the First Officer called "rotate". The Captain stated that, at this point he went fully onto instruments, to ensure the rotation was as accurate as possible. His understanding of the new technique was to achieve 2/3 back stick, by bringing the stick rearward at a measured rate, over three seconds. This he achieved by cross-referring to the SSOI and finally placing the SSOI at +9° on the Primary Flight Display (PFD) pitch scale, to initiate rotation and to maintain this, to get the aircraft airborne. Thereafter to follow the flight director Speed Reference System (SRS) pitch command.

Recorded data shows that, in initiating the rotation, the Captain applied rearward side-stick such that the SSOI, displayed on the PFD indicated +9° and that, after approximately 4 seconds the aircraft nose started to move upwards at a normal rate. When asked to explain this method of initiating the take-off, the Captain said that he was using this technique, having been made aware of it in his refresher training that he had completed in March. During a lesson to standardize rotation techniques across all Airbus Fly-by-Wire (FBW) types operated by Emirates, and to avoid a tail strike, he had been taught that the positive selection of 2/3 back stick was a requirement. The stick position could be more accurately obtained by placing the SSOI to 9° nose up on the PFD and that this would transition the aircraft to flight correctly.

He had subsequently used this method, successfully, during recurrent Airbus A340-300 simulator training (including heavy weight take-offs), and on line operations of the Airbus A330-200. He had not had the opportunity to fly the Airbus A340-500 since that time and had, of course, not operated the Airbus A340-300.

The Digital Flight Data Recorder (DFDR) data then shows that, over the next 3 seconds and simultaneously with the pitch up, there was a progressive relaxation of the rearward stick input, which had the effect of keeping the SSOI in its original position on the PFD but also decreased the nose up pitch demand. Over the next two seconds, the aircraft pitch attitude stopped increasing with a maximum achieved value of +5.6° and, after a further 4 seconds, the pitch attitude had decreased to +3.5°. With the aircraft main wheels still on the ground, the SSOI remained displayed on the PFD and the Captain continued to control the SSOI at 9° nose up on the PFD, failing to realize that, to do so, he had moved the stick forward from the original 2/3 back position, thereby lowering the nose and keeping the aircraft on the ground. Keep in mind that the moment the aircraft start to rotate and the nose rise, the horizon indication on the PFD start to sink lower on the PFD display. With the PF attempting to keep the SSOI at a 9° relative to the horizon effectively caused him to relax back-pressure on the stick and thus lowers the aircraft's nose.

At the same time, the First Officer stated that, having called "rotate", he transferred his gaze outside, to ensure that the aircraft rotated correctly and continued to track the centreline. He also stated that the rotation seemed to take an excessively long *time.* In his estimate it took 6 to 7 seconds before the nose lifted. He could see the runway end lights approaching and could also see the brightly lit apron area on his right hand side. He saw the nose rise but then noticed the nose drop slightly. He assumed that the Captain had detected an excessive pitch up rate and was correcting to avoid a tail strike and he looked inside at his instruments, to confirm this. What he recalled seeing did not alert him to an abnormal situation, since he was expecting the take-off roll to be longer than he had previously experienced. He stated that he saw the SSOI at 9° and the pitch attitude still appeared low enough to avoid a tail strike. He further stated that from this point on he could not see the end of the runway but he felt that the aircraft was about to transition to flight. The next thing that either pilot recalled was that they felt a heavy 'juddering' vibration and noise. Whilst they believed the aircraft was approaching the very end of the runway they thought they were on a rough area of paved surface. Simultaneously the First Officer called "TOGA" (meaning 'apply full thrust'), which the Captain selected, though he did not recall hearing the call by the First Officer. 2 Seconds after leaving the end of the runway, the aircraft became airborne, the noise and vibration ceased and, with a positive climb indication, the landing gear was selected up. The aircraft had travelled off the end of the runway onto a flat grassy area and had impacted 25 runway approach lights. The lights, mounted on small concrete plinths were approximately 20cm high. The rear wheels of both main landing gear bogies were still on the ground and impacted the edges of several plinths, plus the lights. This immediately caused some, or all, of the tyres on wheels 5, 6, 7 & 8 to burst, throwing tread debris against various parts of the aircraft and damaging some fairings and the flap drive mechanism.

During an interview with the cabin crew, all the cabin crew members observed that the aircraft took longer than what they are used to, to leave the ground and they all heard unusual sounds at approximately the time when the aircraft became airborne. The cabin crew members seated in the area above the wing centre section at doors 3L and 3R related to the investigator that they specifically heard loud "bang" sounds and vibration, just before the aircraft became airborne.

From the ATC recordings of the microphones in the control tower one could determine that the ground controller saw the aircraft overrun the runway. He was very disturbed and made several comments to the tower controller. During one of these comments he said "He didn't rotate at all, he just went into this black and then he went." They came to the conclusion that the aircraft must have impacted with some of the runway end lights and started the process of calling the emergency services to inspect the lights and the area for any signs of damage. The approach lights damaged were facing south and were not illuminated because the active runway at that time was Runway 21R.

1.1.5 After Take-off

The initial climb out and thrust reduction was normal, but as the aircraft was accelerated and flaps were retracted, an Electronic Centralized Aircraft Monitoring (ECAM) caution annunciated for FLAPS LOCKED. The crew presumed that this had arisen, as a result of the rumbling they had felt on lift off, causing a vibration which caused the flap asymmetry protection system to activate. However, as a precaution they requested ATC to inspect the runway for any signs of damage, or debris. ATC subsequently responded that there was none. In light of this information and in the absence of other warnings, plus no ECAM system for displaying tyre pressure being installed, the crew assumed that the landing gear and tyres were unaffected. The captain contacted the engineering section in Dubai and they requested that the pilots should attempt to move the flaps, but this attempt proved that the flaps were locked although the slats did move. Since the flaps were now immovable and not fully retracted, continued flight to Dubai was not a viable option. A decision was made to return, in the hope that the flap problem could be resolved quickly, to allow the flight to continue to Dubai, without undue delay. ATC were informed and the aircraft was flown to a designated area for fuel dumping down to maximum landing weight. The fuel dumping procedure commenced shortly after the pilots made sure that this was their only option and they had completed the necessary calculations. The Passengers, Cabin Crew, Dubai Maintenance Control Centre (MCC), Network Control, ATC and South African Airways (SAA) ground handling were all kept fully informed.

The passengers were informed that there was a problem with the flaps and, on hearing this, a pilot from the operator seated close to the wing on the left-hand side passed a message to the Captain, stating that he was available to help, if required and that he felt that the incident was probably more serious than just having jammed flaps. This message was passed on by the Purser and acknowledged by the Captain. The pilot/passenger attempted to look at the wings, but felt that to do so, on his own initiative was going to alarm some of the passengers, so he decided against it.

1.1.6 Preparation for Landing

ATC now advised the crew that a second inspection had revealed damage to two runway end lights and that the aircraft may have traveled about 150 meters across the grass, at the end of the runway, before becoming airborne. There was however, no sign of any other damage, or debris. During the planning for the approach and landing, even with the report of the second runway inspection, one could hear on the CVR that the pilots was still not comfortable that the aircraft did not suffer tyre damage. During this time the crew received an Aircraft Communication Addressing and Reporting System (ACARS) message from Dubai enquiring how they feel about performing a 'Fly Past' but this was discounted. The crew had planned a non-standard configuration (Flaps Locked) for the approach and calculated that, at maximum landing weight a significant safety margin existed, in terms of landing distance required, for any runway at Johannesburg. During the captain's communications with the Senior Manager Network Control (SMNC) in Dubai he was informed that they were to land on Runway 21R. This perplexed the crew, who though aware it was a longer runway than 21L, also realized that they would be required to perform a non-precision approach, rather than an ILS, so this idea was disregarded. They requested the use of Runway 21L and the ATC cleared them accordingly. The pilots obtained the latest aerodrome information from the Aerodrome Flight Information Service (AFIS) and completed the approach checklist. The crew was then informed that the wind had changed, which meant that a Northerly landing was preferable and they can plan for a landing on Runway 03R, which suited the crew well.

With fuel dumping completed the aircraft was radar vectored for a long final approach to Runway 03R. While the crew was briefing for the landing the ATC now advised that a third inspection of the threshold of 03L had revealed some tyre debris in the area of the broken lights. As a result of this information, it became clear that the aircraft would not be able to taxi to the gate, the cabin crew, passengers and ATC were now briefed that the aircraft would stop on the runway, to allow an inspection of the landing gear, prior to taxiing to the parking stand. ATC then further extended the approach to allow other traffic to land, since both runways could then become unusable (03L with damaged approach lighting and 03R with possible Foreign Object Damage (FOD) from tyres, after the aircraft landed). With other traffic on the ground the aircraft was configured for landing and the approach to runway 03R commenced, with a landing reference speed (V_{REF}) of 148 knots, at a landing weight of 189.5 tons, a calculated landing distance required of approximately 1400 metres, with a runway length of 3400 metres. Low auto brake was selected. As a precaution, and in case any undetected tyre damage existed, the crew requested emergency services on standby for their return.

1.1.7 The Landing

The touchdown was smooth, but high levels of vibration and noise was immediately apparent and full reverse thrust was applied, with normal spoilers. The vibration was of such magnitude that several covers on the emergency exit lights in the cabin detached and fell to the floor, plus several other lighting units became dislodged. The aircraft decelerated, but at approximately 70 knots normal braking appeared to have failed. The first officer made a comment about number eight brake and, after he had also attempted using his brake pedals he suggested using the parking brake to stop the aircraft. The Captain did not approve of this suggestion. The aircraft was still moving at 70 knots and showing no signs of stopping, began to veer towards the left-hand side of the runway. To regain some braking, the Captain instructed the First Officer to select the anti-skid/nose wheel steering switch to OFF, thereby allowing accumulator pressure to power the brakes. This also allowed some degree of lateral control to return, using differential brakes, thereby keeping the aircraft on the runway.

With the upwind end of runway 03R rapidly approaching, full braking, without antiskid, was successfully applied. As the aircraft slowed down the crew observed shards of rubber and dust being blown forwards past the windscreen and cancelled the reverse thrust. The aircraft came to a halt approximately 250 meters from the end of the runway. The cabin crew was alerted to prepare for an evacuation. The fire services were in immediate attendance and seven of the main gear tyres were reported as damaged and deflated with several of the wheels also substantially damaged. There was no sign of fire and it was decided to revert to normal cabin operations to await stairs and buses for disembarking the passengers. The passengers were disembarked via the stairs and returned to the aerodrome building.

1.2 Injuries to Persons

Injuries	Pilots	Crew	Pass.	Other
Fatal	-	-	-	-
Serious	-	-	-	-
Minor	-	-	-	-
None	2	12	260	-

1.3 Damage to Aircraft

1.3.1 The aircraft's tyres suffered damage during the overrun when the wheels impacted the runway end lights and light plinths. The tyre debris impacted the lower fuselage in the area of the main and centre landing gears. A flap drive shaft directly above the right-hand main landing gear was sheared and a piece of tread penetrated a panel directly above the left main landing gear, leaving a hole, approximately 10cm by 15cm in the upper surface of the left wing. Both flaps and other portions of the fuselage were damaged. The pressure hull of the aircraft was not penetrated, but debris left a large hole in the rear left wing-to-body fairing. There was extensive secondary damage of various components, plus dents and rub marks over the whole of the rear fuselage.

1.4 Other Damage

1.4.1 Twenty five runway end lights were damaged when the aircraft's wheels contacted them during the overrun of the runway surface. Some of the concrete plinths for the runway end lights suffered compressive damage when the main wheel of the aircraft over-ran them.

1.5 Personnel Information

1.5.1 Mixed Fleet Flying

Mixed Fleet Flying is defined as: *the operation of a base aircraft and one or more variants of the same type, common type, related type, or a different type by one or more flight crew members, between training or checking events (Airbus, Mixed Fleet Flying, A330-A340: Issue 2-AI/ST-S June 2000).*

In pursuit of a policy of MFF, Airbus have divided the fly-by-wire (FBW) 'family' of aircraft into three type *groups* – Airbus A318/319/320/321 narrow body, Airbus A330-200/300 wide-body twin engine and Airbus A340-200/300/500/600 wide-body four engine type. Certification has been achieved for 'same type rating' within each of the 3 groups, requiring only a familiarization or 'differences' course to pass from one *variant* to another. The MFF way of operating was certified by both the Joint Aviation Authorities (JAA) and the Federal Aviation Administration (FAA). A joint group from the JAA, FAA and Transport Canada (TCCA) evaluated the differences between the Airbus A340-600 and the Airbus A340-500 and came to the conclusion:

Differences between A340-200/300 and A340-600 were assessed during first phase completed early March 2002 and the three Authorities recommended that the same pilot type rating (single license endorsement) is applied to the A340-600 as to the A340-200/300.

Furthermore they concluded:

The Authorities determined that only "B" level differences (candidate aircraft are functionally similar) existed between the Airbus A340-600 and Airbus A340-500. Ground courseware on Computer Based Training (CBT)/Video/Transparencies is adequate to cover differences when transitioning from Airbus A340-600 to the Airbus A340-500.

As a consequence the three Authorities recommended that the same pilot type rating (single license endorsement) is applied to the Airbus A340-500, as to the Airbus A340-200/300.

According to the ***manufacturer*** of the aircraft, the concept of giving birth to a true aircraft family with a very high level of commonality emerged at the same time and resulted in an industrial strategic choice having tremendous consequences on the aircraft design and operation.

Furthermore the ***manufacturer*** of the aircraft states that this strategic industrial choice had three objectives:

- A **high level of commonality to raise the overall safety of the flight.**
  The behavior of the crew on any aircraft of the family is similar in terms of aircraft and system handling: thus the skills and flight experience piled up on the former aircraft applies to the new one.

- A **high level of commonality to optimize the training.**
  A pilot trained on one of the aircraft of the family can safely control the flight path and handle the systems of any other aircraft of the family without the need for special additional skills or lengthy training.
  Thus, the transition training needs to address the essential differences, whereas, in case of Mixed Fleet Flying, the recurrent training can be optimally shared between two aircraft types, and credit is given for take-off and landings done on one aircraft to remain current on the other one.

- A **high level of commonality to allow a safe Mixed Fleet Flying (MMF).**
  The MFF is most beneficial for Airlines operations and economics, but it is also beneficial for the pilots themselves: it is challenging for them while improving their personal and family life. Professionally, it gives them a far wider operational experience by facing various ATC environments as well as operational problems.

  MFF enhances their skills and experience, keeping them more in the loop while reducing complacency.

This strategic industrial choice has had tremendous repercussions on the aircraft and cockpit design. It has dictated the implementation of:

- The Fly by Wire system with high level control laws providing similar handling characteristics within and outside the normal envelope of all the aircraft of the family
- The cockpit layout similar in terms of hardware and ergonomics throughout the family
- Integrated automated systems (AFS) and Display units with similar data and parameters, providing the same operational philosophy and similar procedures.

The General Civil Aviation Authority (GCAA) of the United Arab Emirates (UAE) captured the MFF principle in their Civil Aviation Regulations. Their regulations relating to the MFF principle were similar to the JAR-OPS principles. Furthermore the GCAA of the UAE approved the Cross Crew Qualification (CCQ) course from the Airbus A330-200 to the Airbus A340-500 of the operator, after the Airbus JAA/FAA approved course and the CCQ/MFF principle was assessed for adequacy and it's limitations. The GCAA thus accepted the MFF and CCQ principles and the operator's training courses and training manuals were submitted and approved accordingly.

1.5.2 Cross Crew Qualification

To transition from one type *group* to another, (different type is formally assigned to two or more aircraft that have different type certificates for which simulator training are mandatory, eg. A330/A340) requires a CCQ course. Subject to regulatory constraints pilots may then operate a mixed fleet of the aircraft for which they are qualified.

The CCQ course is founded on the philosophy that the pilot is already qualified on the base aircraft (in this case the Airbus A330), and it focuses only upon differences between the types. Take-off rotation technique is described in the same terms for all types and is not, therefore, a topic in the Airbus CCQ course footprint.

The operator's requirement for pilots to be eligible for both CCQ and MFF is defined in the Flight Operations Manual (FOM) chapter 3, page 13. In summary, pilots are required to have operated on the Airbus A330 at the operator, in their respective role (Captain or First Officer), for at least 12 months. In addition there is an assessment of suitability by Fleet Management. These requirements have been approved by the GCAA on the basis of JAR-OPS 1 and JAR FCL 1.

The Airbus A330-200 to A340-300 CCQ consists of: one day of computer based training (CBT) on aircraft technical differences; one 4 hour simulator session to familiarize with 4-engine characteristics; one 4 hour simulator 'skills test'; three sectors of Initial Operating Experience (IOE) flying the aircraft. The operator has added some additional exercises in the simulator sessions specific to John F Kennedy (New York), US PRM and high take-off weight operations, a 2 hour Zero Flight Time (ZFT) simulator session, an Safety and Emergency Procedures (SEP) Computer Based Training (CBT) session, a half-day aircraft performance exercise using a self-study questionnaire and a 2 hour Minimum Navigation Performance Specification (MNPS) lecture (the only face-to-face lecture of the course). Other than a half-day Airbus A340-300/A340-500 familiarization CBT to qualify the pilot for the Airbus A340-500 variant, there is no additional simulator or line training required.

Operator Initial Operating Experience (IOE) has been conducted on short sectors around the UAE, or in some cases in Toulouse using an Air Canada Airbus A340-500, with the third sector constituting a 'line check'. Both pilots involved in this incident had successfully and correctly completed the required training for CCQ and MFF.

According to the operator's FOM chapter 3 page 8: **Recency Requirements,** for the Pilot-in-Command the operator shall not assign a pilot to act as pilot-in-command of an aircraft unless: .... *(d) within the preceding 90 days that pilot has made, on the same type of aircraft, at least three take-offs and landings.* However under **MFF Currency, A330/A340** the requirement change to: *Within 90 days: 3 Take-offs and Landings in either type, provided there is at least one segment conducted in each type.*

The above recency requirement is in particular attractive for the operational requirements of the particular operator, but also for operators in general who is approved to operate under the MFF principle. As long-haul aircraft become a reality with extended flight times, the flights will have to be operated with four flight crew-members to satisfy flight duty requirements. This will have the negative effect that only one flight crew member out of four will be able to act as PF during the take-off and one crew member will be able to act as PF during the landing. It will thus become more and more difficult to satisfy the recency requirements without applying the MFF principle. With MFF the pilot can be scheduled for a number of short haul flights between the long haul flights and in such a way satisfy the recency requirements under the MFF provision. With the increased number of take-offs and landings it also increase the pilot's proficiency and therefore safety.

1.5.3 Recurrent Training

As with all types, pilots are required to undergo recurrent ground school and simulator training (including Pilot Proficiency Check), every 6 months. Under the rules of MFF, the type alternates each 6 months (A330/340). The Airbus A340 Project Group developed the ground school course 'footprint' for the first recurrent phase. During early simulator sessions at the operator a senior instructor from the manufacturer observed inconsistency in rotation rates. Subsequent to this the Project Group included a module on take-off rotation technique in the recurrent ground school course for all Airbus FBW types. The ground school instructors, for delivery in recurrent sessions, then developed this into modular lectures.

The Captain had undergone this phase of recurrent training in March 2004, and it was established that the ground school instructor referred to the use of the SSOI as a guide to the required side stick deflection, during this training. However, the instructor stated that he only passed this on as a 'tip' to judging 2/3 back stick at the initiation of rotation and did not state that the SSOI should be a reference for the rotation maneuver itself. Use of the SSOI was not referred to in the standard lesson plan, or in the Power Point presentation. Other pilots attending the training with the Captain did not recall this being discussed.

The First Officer had not undergone the recurrent phase of training since completing the CCQ course.

1.5.4 Airbus A340 Introduction into Service with the Operator

To oversee the flight operational and pilot training aspects of the Airbus A340 introduction, the A340 Project Group was established under the Project Manager A340. Included in the Group's tasks was the development of standard operating procedures and of the pilot training syllabus, in liaison with the aircraft manufacturer and EK Flight Training. The syllabus was intended to constitute a CCQ course to the Airbus A340-300 for pilots already qualified on the Airbus A330-200, and then a 'familiarization' course for the Airbus A340-500. In order to achieve type qualification prior to entry to service, members of the Project Group underwent simulator and flight training on the Airbus A340-300 at a large operator in Europe. This included line training on trans-Atlantic flights on the European operator's network.

1.5.5 Pilot-in-Command Experience and MFF training

The **captain** provided the following information on his pilot questionnaire:

Nationality		Canadian			
Licence No	UAE 1492	Gender	Male	Age	41
Licence valid		Yes	Type Endorsed	Yes	
Ratings		Instrument			
Medical Expiry Date		31 July 2004			
Restrictions		None			
Previous Accidents		Unknown			

Flying Experience:

Total Hours	13387
Total Past 90 Days	196.6
Total on Type Past 90 Days	77.8
Total on Airbus A330-200	3192
Total on Airbus A340-500	69:06
Total on Airbus A340-300	8:46

Please note the Flying Experience above do not include simulator flying experience.

The captain was notified to attend the CCQ course on 4 October 2003. He started off on the CCQ course on 27 October 2003 and completed the ground schooling requirements on 1 November 2003. According to the captain's CCQ training file he passed the ground school with excellent marks.

On 29 October 2003 he completed a Flight Simulator session and on the average his performance was scored "5" on a five point scale. The final assessment was "Good Progress" (the highest assessment score). A second simulator session followed on 30 October 2003 with a total flight time of 4 Hours. The comments indicated a "Generally good" session, with "Flying and Procedural accuracy needs improvement". The overall assessment of the session was "4" on a five point scale with the debrief comments as: *Normal Procedures from A330 basic aircraft need work. Flying acceptable. Most other work to a good standard.*

A third simulator session followed on 31 October 2003 with an hour flight time. The exercises flown during this session were more complex than the previous sessions and the captain scored on the average "4" on a five point scale. The captain scored a "5" for a Night – Cross wind: 50% - Go Around (A340 CCQ: 100% x/wind – Contaminated Runway (Braking action – Medium)) exercise. All the simulator sessions were flown with different Designated Check Airmen (DCA).

The first line training session was carried out on 3 November 2003. During this flight the captain flew an Airbus A340-500 for two sectors with a total flying time of 1:59 hours. The report indicated "good progress" with a comment "Demonstrated good use of new SOPS & 345 T/O & LDG techniques". The line check was flown on 5 November 2003 and it comprised of a sector of a flight, which totalled 1:50 hours on an Airbus A340-500. The report indicated a Line Check assessment of "very good". After this flight consolidation flights were performed on 6 November 2003. The captain flew four short sectors of approximately half an hour, each which totalled to 2:04 hours with an Airbus A340-500. The four sectors were flown as a consolidation in lieu of the 50 hours required for the MFF qualification between the Airbus A330-200 and the Airbus A340's. A waiver from the UAE GCAA (no. 25/2003) gave the pilots the opportunity to fly four sectors instead of 50 hours consolidation. After these requirements were met the captain started flying the Airbus A340-500 aircraft according to the MFF provisions as a captain.

On 16 March 2004 the captain was scheduled for recurrent training. He completed 4 hours of simulator training on the Airbus A340-300 simulator during this training session. The finding was:

> *The TRE, whose name and signature appears below, certifies that the candidate, whose name and signature appears above is* ***competent*** *as required by the current GCAA Civil Aviation Regulations.*

After the above mentioned recurrent training the captain flew two flights on the Airbus A340-500, but did not execute a take-off on any of these flights. He also flew four Airbus A330-200 flights and was PF executing the take-off on two of these flights (FOQA-data was available for these flights and will be discussed later in the report). The next flight that he acted as PF executing the take-off was the incident flight.

Although the captain has completed 69 hours flying the Airbus A340-500, it was, besides the simulator training, the first time that he was acting as PF on the Airbus

A340-300. At no occasion during his training, had the captain performed a flight in the Airbus A340-300 with an instructor or a line captain. The 8:46 hours he logged on the A340-300 was as PNF the previous day on the leg from Dubai to Johannesburg. He was one of the initial group of pilots that was trained on the Airbus A340's, thus he was already scheduled for recurrent training and had completed it as discussed above.

1.5.6 First officer Experience and MFF training

The **first officer** provided the following information on his first officer questionnaire:

Nationality		Irish			
Licence No	UAE 8437	Gender	Male	Age	34
Licence valid		Yes	Type Endorsed	Yes	
Ratings		Instrument.			
Medical Expiry Date		15 September 2006			
Restrictions		None			
Previous Accidents		Unknown			

Flying Experience :

Total Hours	6385
Total Past 90 Days	148.8
Total on Type Past 90 Days	104
Total on Airbus A330-200	1002
Total on Airbus A340-500	109
Total on Airbus A340-300	8:46

Please note the Flying Experience above do not include simulator flying experience.

The first officer was notified to attend the CCQ course on 29 December 2003. He started the CCQ course on 12 January 2004 and completed the ground schooling requirements on 16 January 2004. According to the first officer's CCQ training file he passed the ground school with excellent marks.

On 13 January 2004 he completed a Flight Simulator session and his performance was scored "5" in all aspects on a five point scale. The final assessment was "Good Progress" (the highest assessment score). A second simulator session followed on 14 January 2004 with a total flight time of 4 Hours. The comments indicated a "A very good PPC/IR all items completed to a very good EK standard". The overall assessment of the session was "5" on a five point scale with the debrief comments as: *Candidate achieved a very good overall standard. Very good technical knowledge.*

A third simulator session followed on 15 January 2004 with a four hour flight time. The exercises flown during this session were more complex than the previous sessions and the first officer scored on the average "4" on a five point scale. The first officer scored a "5" for a Night – Cross wind: 50% - Go Around (A340 CCQ: 100% x/wind – Contaminated Runway (Braking action – Medium)) exercise. The first officer also flew with different Designated Check Airmen (DCA) during each of the simulator sessions.

The first line training session was carried out on 22 January 2004. During this flight the first officer flew an Airbus A340-500 for two sectors with a total flying time of 2 hours. The report indicated "good progress" with a comment "All major A345 aspects covered/demonstrated. Good rotation & landing technique. Well flown raw data ILS". The line check was flown on 22 January 2004 and it comprised of a sector of a flight which totalled 2:20 hours on an Airbus A340-500. The report indicated a Line Check assessment of "very good". After this flight consolidation flights were performed between 26 January 2004 and 21 February 2004. The first officer flew seven sectors totalling 51:13 hours with Airbus A340-500 aircraft. Fifty hours of consolidation flying was required for the MFF qualification between the Airbus A330-200 and the Airbus A340's. After these requirements were met the first officer started flying the Airbus A340-500 aircraft according to the MFF provisions as a first officer.

The first officer was not due for recurrent training by the time of the incident.

The first officer acted as Pilot Flying on the sector from Dubai to Johannesburg the previous day. Although he has completed 104 hours flying the Airbus A340-500, it was, besides the simulator training, his first time that he was acting as PF on the Airbus A340-300. The flight time was 8:46 hours and that was the only time he had accumulated flying the actual aircraft.

1.5.7 Medical Report

Both pilots underwent a medical examination some time after the event, which revealed no latent medical conditions that may have affected their performance.

1.5.8 Cabin Crew

The captain de-briefed the cabin crew members after the incident before they left the aircraft. The investigators interviewed the cabin crew after the incident. According to the information gathered during this interview it was apparent that they conducted themselves in a professional manner with no safety concerns identified relating to the executing of their duties.

As far as could be determined all the cabin crew members were appropriately qualified to execute their duties.

1.6 Aircraft Information

1.6.1 Aircraft Introduction into Service with Operator

The aircraft was one of a group of aircraft, which were taken out of service with another operator and put into storage. Towards the end of 2003 the owner made eight of the Airbus A340-300 aircraft available to the operator. These aircraft needed to be reinstated and modified to the operator's requirements. Part of this process was carried out on the incident aircraft at Hamburg in Germany. The aircraft was then flown to Dubai on 9 February 2004. Between this time and 8 April 2004 further maintenance and modification work was carried out at the operator's maintenance facilities. Several defects were also attended to during the time the work was carried out. On 8 April 2004 a local flight was carried out and several defects were entered in the Aircraft Technical Log (mainly avionics defects). The next day on 9 April 2004 the aircraft entered into scheduled revenue service with the operator on a flight from Dubai to Johannesburg. This was the first flight of the aircraft in the service of the operator, but it was also the first flight for the flight crew to fly the Airbus A340-300 aircraft variant.

1.6.2 The A340 Project Group was tasked with the planning of the introduction process of the Airbus A340's. The original planning started with the introduction of the Airbus A340-500's, but when the Airbus A340-300's became available the project group had to expand the planning to include the additional aircraft. They kept the flying crews up-to-date with information letters. One such letter (Introduction to the A340-300) dated 9 March 2004 informed the relevant flying crews about progress of the maintenance work and modification status of the aircraft and the operating procedures applicable to the Airbus A340-300 fleet when they are introduced. Some of the significant points covered in this letter which relate to this incident are:

- ...... These A343's are fitted with the CFM56-5C4 engine, which enjoys a higher thrust rating than the 5C2. However, compared to our A332 and A345 it has the **lowest thrust to weight ratio**.

- The rotation is expected to be the most critical aspect of A343 operation. The aircraft has a lower thrust to weight ratio compared to the A332 and A345 but does not enjoy the same flight control law protections embodied in the A345. During the CCQ, the use of correct rotation technique is emphasised. This is also being re-emphasised in A330 and A340 recurrent training. The message here is:
  "Use the correct rotation technique – know your pitch target – Avoid Tailstrike"

- In the **Conclusion**: MFF can be conducted without any erosion in safety as long as the differences and limitations are understood and Standard Operating Procedures respected. **Avoid that tailstrike**

1.6.3 The next update of the newsletter dealing with the Airbus A340-300 introduction into service was issued on 17 March 2004. Besides all the general information about the modification status of the Airbus A340-300 due to enter service at the operator there was a specific section dealing with **TAKE-OFF** and with **ROTATION TECHNIQUE & AWARENESS OF GROUND CLEARANCE GEOMETRY**. It was as follows:

Avoiding tailstrike during the rotation is a critical aspect of A343 operation. Two A340-300 CFM 5C4 engines produce less thrust than one A330 RR772B, although the A343 has a 42T higher MTOW than the A332.

Hot, high, optimised performance operations at Johannesburg require particular attention. Crew can expect that with the large $V_1 - V_R$ split, associated with 4-engine takeoff performance rotation may occur further down the runway than would be expected with equivalent two engine operations.

"Use the correct rotation technique – know your pitch target – Avoid Tailstrike"

The letter end with: *Happy and Safe Flying and Remember –* ***Avoid that Tailstrike.***

1.6.4 A further update on the Airbus A340-300 introduction into service was dated 9 April 2004 (the day of the incident and was probably not available to the pilots on the incident flight). The update contains information about the status of the different aircraft and the last part under the heading **Rotation Technique and Performance – Reminder** was as follows:

Avoiding tailstrike during the rotation is a critical aspect of A343 operation. Hot, high, optimised performance operations at Johannesburg require particular attention. Use the correct rotation technique, know your pitch target and ***avoid that tailstrike.***

1.6.5 Maintenance of Aircraft

The following technical/maintenance information about the aircraft was available to the investigator-in-charge:

Airframe:

Type	A340-313	
Manufacturer	Airbus Industries.	
Serial Number	0166	
Year of Manufacture	1997	
Total Airframe Hours (At time of Incident)	21 800.36	
Total Airframe Cycles (At time of Incident)	3996	
Last Phase Check (Date & Hours)	9 February 2004	21783
Hours since Last Phase Check	17.36	
C of A (Issue Date)	9 February 2004	
C of R (Issue Date) (Present owner)	9 February 2004	
Operating Categories	Transport (Passenger)	

Engines:

No. 1

Type	CFM 56-5C4
Serial no.	741628
Hours since New	20576.54
Cycles since New	3845

No. 2

Type	CFM 56-5C4
Serial no.	567211
Hours since New	17812.23
Cycles since New	3345

No. 3

Type	CFM 56-5C4
Serial no.	741461
Hours since New	18318.54
Cycles since New	3588

No. 4

Type	CFM 56-5C4
Serial no.	741506
Hours since New	19939.37
Cycles since New	3639

As far as it could be determined, the aircraft was maintained according to the manufacturer's requirements and the approved maintenance schedules.

1.6.6 There were only three entries in the defect column of the Aircraft Technical Log after the flight from Dubai to Johannesburg on the morning of 9 April 2004. These entries related to ECAM faults indicated on the *APU aft fuel pump* and fuel pump 4. Action taken entered in both the fuel pumps cases was "*operation normal on ground*". The other defect was related to the nose wheel steering that the crew had to report back about it's operation and the report was satisfactory with small amount of trim needed.

1.6.7 **Aircraft Design Features**

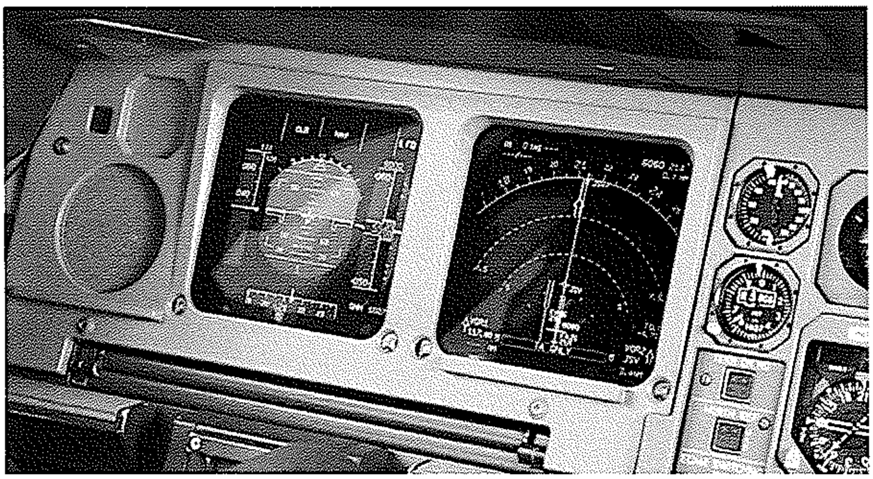
At this point some details will be provided for the understanding of the reader, about the Aircraft Design and operation and some of the systems that could have contributed to the events leading to the incident. In the **PRE-COURSE BRIEFING FOR PILOT TRAINEES** the information brochure discuss the **DESIGN OBJECTIVES** of the aircraft and significant points in this discussion is as follows:

Airbus has set new standards in fuel-efficiency, performance, manufacturing quality, durability, ease of maintenance, environmental friendliness and comfort. While advanced aerodynamics could achieve some of these objectives, the brilliant speed and accuracy of the computer was harnessed wherever possible. Exact performance matching of power plants with airframe was critical for the A340 in order to avoid carrying extra weight generated by engines, which provide excess thrust. (The twins have different design objectives, and considerable excess thrust to cover loss of 50% thrust following an engine failure).

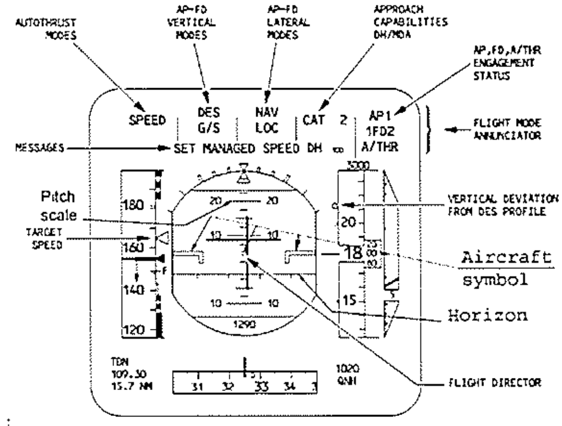
The aircraft was designed with the fly-by-wire technology and the above-mentioned course briefing state:

The designers of Airbus fly-by-wire aircraft have taken the use of computers a step further by internetting the computers and systems. Deliberately different manufacturers, different hardware and different software formats have been employed in order to eliminate potential for "common faults".

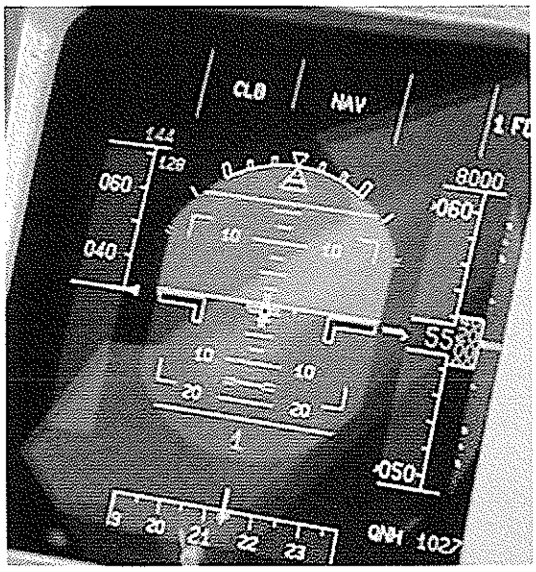
The side-stick (that replaces the conventional control column and yoke) provides no direct mechanical connection between the side-stick and the control surfaces. The means of transmission from side-stick to computers to control surfaces is via shielded low impedance electric cables. There is no mechanical inter-connection between the two side-sticks either, each side-stick provides electronic input signals to the flight computers. In the event of an incapacitated pilot freezing on his side-stick there is a take-over button fitted which provides the other pilot to take control. In the event of both pilots making inputs, the result will be the algebraic sum of both the inputs.



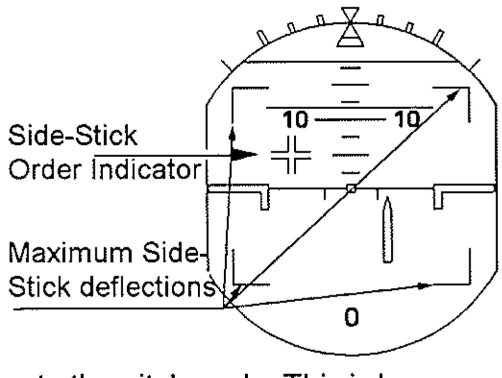
1.6.8 The aircraft's cockpit instrumentation was of the "glass cockpit" type lay-out (refer to photograph above). The Primary Flight Display (PFD) is the display panel on the left-hand side in the photograph. This display provides the pilot with mainly attitude information during operation of the aircraft. The basic layout of the Primary Flight Display is as indicated on the schematic to the right-hand side.



1.6.9 Due to the lack of mechanical inter-connection between the two side-sticks, the manufacturer incorporated a Side-Stick Indication display on the PFD's of both pilots. The Flight Crew Operations Manual (FCOM) (1.27.40) describes the Side-Stick Indications on the PFD, as "On ground, after first engine start, side stick position indications appear white on both PFD's. The indication disappears when the aircraft passes from "ground" to "flight" mode.



The schematic (to the right) shows the Side Stick Order Indicator (SSOI) as a small double-line cross ╬ representing the *combined* left and right side stick position, with the 'corners' of the maximum deflection envelope at the extremes of available travel, approximately 16° in pitch and approximately 20° in roll (FCOM 3.04.27). However, the 16° of travel does not correspond to 16° on the pitch scale of the attitude indicator on the PFD. The SSOI, "...permits the PNF to check that the PF is making an appropriate control input during takeoff roll" (FCOM 3.04.27). The SSOI ╬ disappears, once the aircraft attains the "flight mode", through the main landing gear air/ground switching. Any given rearward deflection of the side-stick will cause a relative upward displacement of the SSOI on the PFD. Whilst the aircraft is level on the ground, this will equate to a specific number of degrees above the horizon on the pitch scale of the attitude indicator. However, as soon as the aircraft pitch attitude changes (during rotation for example), the displacement of the SSOI, though constant in relation to the travel limit marks and the side-stick, will appear to increase in magnitude in relation to the pitch scale. This is because the horizon line and the pitch scale have moved down the PFD, while the SSOI remains referenced to the fixed travel limit marks.



In summary, the pitch scale of the attitude indicator of the PFD is not a quantitative indication of side-stick movement and has no constant relationship to side-stick deflection and SSOI displacement.

1.6.10 **Thrust Settings for Take-off**

On several occasions (FCTM 07-07 P4, Introduction letter of 9 March 2004, Flight Crew Instruction (FCI 2004/022) of 17 March 2004) there was reference to the lower thrust-to-weight ratio of the Airbus A340-300 in relation to the other aircraft operated by the operator. The following table relate the Airbus group of aircraft of the operator to each other with respect to mass-to-thrust ratio (the assumption during the calculation was an aircraft loaded to Maximum T/O Mass and the engines at Maximum Thrust Setting):

Aircraft	Airbus A340-300	Airbus A340-500	Airbus A330-200
Engines	CFM56-5C4	RR Trent 500	RR Trent 700 – RB211
Total Max. Thrust	4 x 34 000lbs = 136 000 lbs	4 x 54 500 lbs = 218 000 lbs	2 x 71 000 lbs = 142 000 lbs
Max T/O mass	275 000kg = (606 265 lbs)	372 000 kg = (820 120 lbs)	230 000 kg = (507 058 lbs)
Mass-to-Thrust ratio	4.457	3.762	3.571

NOTE: The table was compiled and the calculations were carried out in such a way that contrary to the usual reflection of thrust-to-weight ratio the mass-to-thrust ratio was calculated in order that the ratios could be reflected as full numbers and not as decimal numbers. This makes it easier to relate the numbers to each other.

The Airbus A340-300 is the aircraft variant with the highest mass-to-thrust ratio of the Airbus group of aircraft operated by the operator. Furthermore due to the manner in which aircraft take-off performance is certified, 4-engine aircraft generally demonstrate more 'sedate' performance than similar 2-engine aircraft during take-off and initial climb (with all engines operating). In several of the documents (A340-300 Introduction into Service Letters and FCTM 02-01 Page 6) pilots were warned about the "*pronounced gap evident between V_1 and V_r and V_2 will be significantly higher than the A330 at higher weights*".

1.6.11 Although the above was calculated with the different variants of the aircraft at Maximum Take-off Mass and the engines at Maximum Thrust Output, under normal operating conditions the engines are operated at de-rated power settings when a take-off below the Maximum Take-off Mass is performed. During the incident take-off the thrust of the engines were set according to the Flexible Takeoff Thrust settings determined by the Regulated Take-Off Weights (RTOW) Charts of the operator. The Flight Crew Operating Manual (2.2.20) describe a **Flexible Takeoff** as:

In many cases the aircraft takes off with a weight lower than the maximum permissible takeoff weight. When this happens, it can meet the required performance (runway, second segment, obstacle, ...) with a decreased thrust that is adapted to the weight: this is called FLEXIBLE TAKEOFF and the thrust is called FLEXIBLE TAKEOFF THRUST.

Furthermore the FCOM describe the Use of flexible Takeoff as:

The pilot can use flexible takeoff when the actual takeoff weight is lower than the maximum permissible takeoff weight for the actual temperature. The maximum permissible takeoff weight decrease when temperature increases, so it is possible to assume a temperature at which the actual takeoff weight would be the limiting one. This temperature is called FLEXIBLE TEMPERATURE or assumed temperature and is entered in the FADEC via the MCDU PERF TO page in order to get the adapted thrust.

1.6.12 In essence the pilots need to obtain the take-off gross mass of the aircraft after it is loaded, the surface wind conditions, barometric pressure and the ambient temperature and using the RTOW-chart for the specific aerodrome and runway they determine the flexible temperature, flap setting and take-off speeds. This information is entered into the FMGEC and the FADEC's of the engines are set to these values. When the pilots set the thrust levers to the flexible thrust position (gate) for the take-off, the FADEC's of the engines would set the thrust output of the engines at the flexible take-off thrust condition. The engines would produce the required amount of thrust for the aircraft to attain the runway limitations, the second segment climb limitations and if applicable the obstacle clearance limitations. In the event that the thrust levers were moved to the TOGA thrust position (gate) at any time during the take-off, the flexible temperature entered in the FMGEC is disregarded and the FADEC's of the engines revert to a setting for maximum thrust output of the engines taking into consideration the ambient temperature and other atmospheric conditions.

1.6.13 In the case of this incident, the performance data package presented in the RTOW chart was correct, and was correctly interpreted by the crew. The take-off flexible thrust and take-off speeds of V_1, V_R and V_2 were appropriate to the reported prevailing conditions. The recorded data indicated that engine acceleration and aircraft acceleration were normal. The take-off run was commenced from the correct point to take advantage of the full runway length. Interpreting the DFDR-data, V_1 was reached with adequate runway remaining for the aircraft to stop or to continue the take-off (with one engine out) and accelerate to V_2. The aircraft configuration and engine bleed configuration were both correct.

1.6.14 **Take-off Rotation Techniques**

References to take-off rotation technique appear in several different documents, which do not precisely accord with each other. The recommended 'family' rotation technique includes reference to use of 2/3 back stick and, although it was not approved by Airbus, one major airline had taken to teaching use of the SSOI to measure this deflection.

Whilst this was not formally recognized by Airbus, and although it has never been referred to in operator documentation, use of the SSOI was demonstrated by some Airbus instructors during operator pilot Initial Operational Experience (IOE) training in Toulouse. Furthermore, members of the Project Group were aware that Airbus was working on a training video on this subject, and had seen a prototype version. Realising that reference to the SSOI was becoming widely known, the Project Group intended to document its use as a means of 'calibrating' arm movement, and included this in a proposed amendment to the Flight Crew Training Manual (FCTM). However, in the knowledge that Airbus was reviewing their position on training in the use of the SSOI, it was decided to keep the amendment on hold until the manufacturer made their position clear.

During the operator's instructor training IOE in Toulouse it became apparent that most pilots were experiencing difficulty with the take-off, as a result of the architecture of the Airbus A340-500 elevator control system. This was encouraging 'pilot induced oscillations' (PIO) as a result of delay in the onset of the rotation and additional stick movements, as pilots "chased" the correct pitch attitude. As a result, it was emphasized that this could be avoided, by close attention to the instruments and to ensuring that an initial 2/3 back stick was selected and maintained.

Tail strike and rotation technique remained significant concerns within the Airbus A340 fleet and the first refresher phase was designed to address these. Discussion of use of the SSOI by Training/Standards/Project Group led to an understanding amongst Flight Crew Training Instructors that they may refer to the technique during the ground school phase.

1.6.15 **References for Take-off Rotation** -

FCOM 3.03.12 states, "At VR, initiate rotation with a positive side stick input to achieve a continuous rotation of about 3% towards a pitch attitude of 12.5°. After lift off, follow the SRS pitch command bar." *(This was probably a typographical error and the probable intent was to state, "3°/second...")*

FCOM 3.04.27 states, "Rotation is conventional. As the A340 has a large inertia, it is important to initiate the rotation with a positive backward stick input (typically 2/3 backstick). The rotation rate produced by a given sidestick input takes time to build up; once it has developed, it remains relatively constant for a given sidestick position. Rapid variations in stick position cause discomfort. The pilot continues the rotation to a typical all-engine attitude of about 12.5°. As the attitude changes and stabilises, the control laws change to those for the flight mode in pitch, allowing the sidestick to return to the neutral position to maintain 1g at the chosen attitude. Pitch trim can begin to work at 50 feet."

FCOM Bulletin 06/3 Avoiding Tail strikes at Take-off repeats the previous paragraph and provides some analysis of the tail strike hazard, whilst introducing a "maximum" rotation rate of 4°/second.

The FCTM was a document authored within the operator and section 07-07 page 4 states, "The 3°/sec rotation rate described in the SOP enables the aircraft to achieve take-off distance schedules specified under test conditions. Rotation rates under operational conditions may vary to ensure adequate tail clearance. At V_r, rotate the aircraft smoothly at about 2.5 – 3° /sec to aim initially at 15° nose up but not above the pitch limit indicator on the PFD. (Note: The Airbus Standard Operating Procedure (SOP) initial pitch target of 15° occurs after lift-off). The SRS does not provide any guidance on rotation rate. On the Airbus A340-500 tail strike occurs at 9.5° (Airbus A340-300 11.3°) landing gear compressed or 13.5° (Airbus A340-300 15.8°) uncompressed, so pitch altitude should be carefully monitored during the rotation and lift off transition."

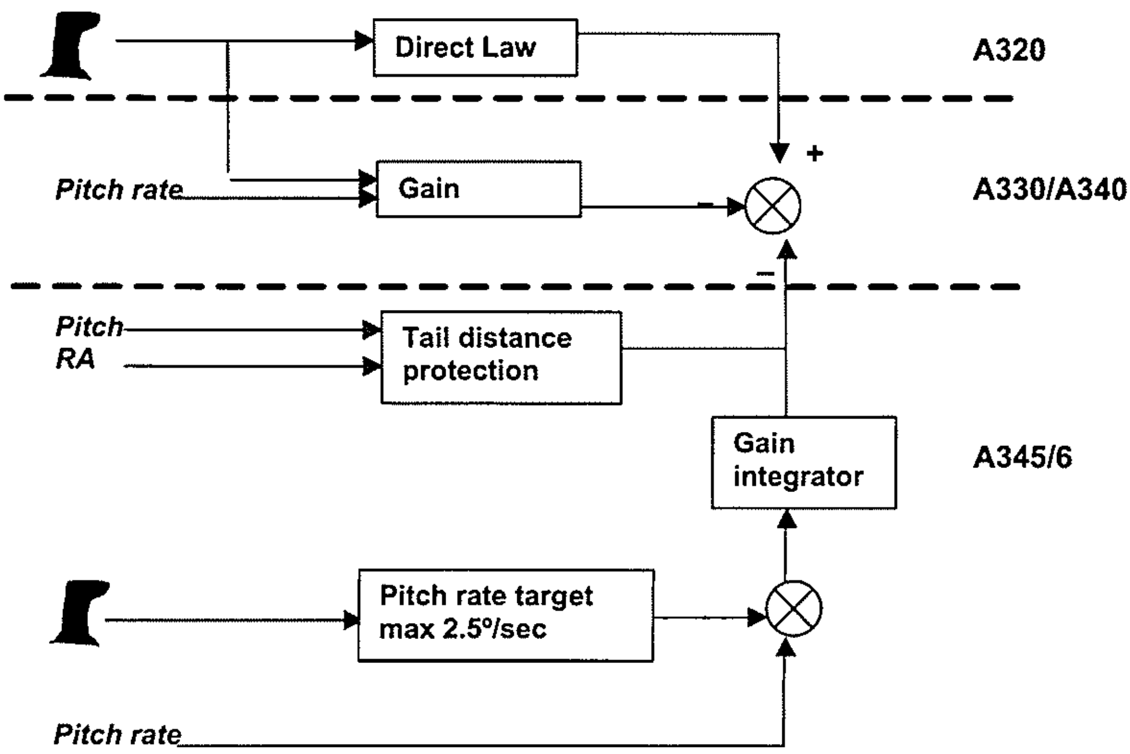
The FCTM 07-07 page 1, on the subject of tail strikes on take-off, refers the reader to the A330 FCTM 09-40 (this section is not present in the A340 FCTM). This reference states, "The best way...is to make a positive rearwards stick movement to initiate rotation and to maintain a relatively constant rate of approximately 3° per second. At about 8° of pitch attitude, relax the stick slightly forward, aiming for lift off at 10 to 11°."

1.6.16 Tail Strike Awareness

A high emphasis was put on the possibility of tail strikes in all the Airbus A340 Introduction letters (see above in 1.6.2 to 1.6.4), Operational and Training Documentation when reference was made to rotation and take-off techniques of the A340-family. Most of the operator's pilots interviewed stated that the risk of tail strike was the single most emphasised hazard at take-off.

The different variants of the A340-family had different levels of tailstrike avoidance architecture employed in the pitch control systems. The FCTM 07-07 describes it as follows:

The pitch control law of the A330/A340 has been adjusted to the size, the inertia and the tail-strike tendencies of each aircraft. Refer diagram below.



Basically the take-off rotation law is a direct law, which has been damped essentially on A330, and all A34Os by a pitch rate return which acts on the elevator deflection when the pitch rate increases.

On the longer A340s (the A340-500/600) more prone to tailstrike, two factors assist the pilot to achieve a continuous pitch rate while minimizing the risks of the tailstrike:

- *the pitch rate target factor (a given stick input corresponds to a specific pitch rate target; a deviation of the pitch rate from the target adjusts the direct law elevator deflection);*
- *the tail distance "protection" factor, which decreases the direct law elevator deflection, when the tail distance from the ground as computed by the FCPC gets too small, (it must be clear that this is not a "hard" protection).*

These adjustments of the take-off rotation law to each aircraft model allow a similar flying technique for all those aircraft.

During development of the Airbus A340 training program at the operator, reference was made to a graph, which appeared to show that a significant proportion of the operator's pilots were rotating at greater than 3° per second. This may have contributed to an emphasis upon rotation technique and tail strike avoidance in Airbus A340 training. However, this graph has been found to be erroneous and actual data indicates that there was no 'over-rotation' problem on the Airbus A330. The incorrect graph also found its way into the Airbus A340 recurrent ground school presentation.

Stemming from a UAE GCAA requirement for Airbus to oversee certain aspects of the operator's Airbus A340 training, a senior Airbus instructor observed that the operator's pilots were operating correctly, with the exception of their rotation technique. However, he went on to point out that rotation technique should not be taught in the CCQ Course as it was the same for all 'family' types.

1.6.17 Use of the Side Stick Order Indicator during Take-off

The operator's documentary presentation of the correct rotation technique appears in FCOM 3 SOPs, FCOM 3 Supplementary Techniques, FCOM Bulletin and in the FCTM. These documents refer variously to a 'positive' side stick movement or '2/3 back stick' to initiate a rate of rotation (*of the nose of the aircraft*) of either '3°' or '2.5 - 3°' or a maximum of '4°' per second, towards an airborne pitch attitude target of '12.5°' or '15°'.

The Airbus A340-500 and Airbus A340-600, (partly because of the tail strike implications of greater body length than the Airbus A330-200 and Airbus A340-300), have an additional pitch attitude function in the flight control law at rotation to protect against a tail strike. As previously mentioned, it was found that changes to side stick input, during the initiation of rotation could lead to an undesirable Pilot Induced Oscillation (PIO), and the rotation technique described in FCOM 3 aimed to minimize this effect. However, it led pilots to ask the inevitable question, "how to judge 2/3 back stick?"

Whilst training at the European operator, members of the Airbus A340 Project Group were made aware of a 'in-house' technique with that operator, whereby pilots were instructed to select side stick input by reference to the SSOI. This equated 2/3 back stick input to the SSOI at approximately 9° above the horizon on the PFD pitch scale. The Project Group verbally queried use of this reference with Airbus, whilst undergoing further training in Toulouse, and was told that it should not be used. However, when the operator's pilots began IOE in Toulouse, some Airbus instructors demonstrated use of the SSOI as a means of calibrating a pilot's judgment of 2/3 back stick. This was illustrated during taxi operations, but not during the take-off rotation. The implication appeared to be that this was acceptable, or even desirable and would achieve correct rotation.

Prior to the arrival of the Airbus A340-300, a training captain raised (by e-mail) a number of operational queries with a member of the Airbus A330/A340 Standards Group. One question addressed use of the SSOI, stating that he had understood from his CCQ course that it should not be used to reference take-off pitch input but he had heard that pilots returning from IOE in Toulouse had been shown this. The reply included, ***"Nothing wrong with having the cross in your cross-check on rotation. A two thirds deflection of the sidestick corresponds to approx 9 degrees of the***

cross and this is what most AI [Airbus] pilots will practice on taxi, to get the feel of what 2/3 deflection represents". It goes on to remind the reader not to be distracted from the main reference of pitch rate, ***"However, don't let all this distract you from the ultimate requirement from the square aircraft symbol to travel at about 2.5°/sec over the pitch scale! Remember the bottom line: rotation technique is the SAME for all Airbus FBW, it is the aircraft behavior which varies according to type".***

A copy of this response was provided to the lead ground school instructor responsible for the design of the Airbus A340 recurrent course ground school phase modular lectures. In part at least, this promoted an understanding amongst ground school instructors that it was acceptable to refer to use of the SSOI as an aid to judgment of the side stick input required for take-off rotation, although this was not included in the 'PowerPoint' lesson plan on this topic.

In a subsequent addition to the e-mail response from Standards, a member of the Project Group added: ***"This is the method*** *(another operator)* ***used. Airbus was upset with them for using it and we have a statement from Airbus saying that the cross is not to be used for rotation. Having said that, I want to be able to demonstrate to a trainee how much the stick needs to be moved prior to the take-off. The term, 'calibration of the side stick force and movement' seems appropriate. Airbus is now re-evaluating their position on this and we will ask them for that in writing. In the meantime I will be putting in the next FCTM take-off module that the cross can be used in the way described in the above paragraph".*** This proposed amendment was yet to be published at the time of the incident.

The investigation also located an internal Airbus document entitled Instructor Support (dated December 2000), which provides guidance on rotation technique and refers to initial use of 7.5 - 10° deflection of the SSOI during rotation. However, the text warns that this is not a parameter to "monitor". The use and distribution of this document was not determined.

Additionally, internal e-mails between the operator's pilot instructors revealed that some instructors were teaching that the actual 2/3 rearward stick deflection should be made at a particular rate, over a certain number of seconds.

The captain indicated that he was formally taught about the rotation technique using the "cross" during his most recent ground school phase. He stated he was taught to set the cross at 9° and hold it there until airborne, once the SRS had settled down to follow the SRS-bars. He tried the technique in the Airbus A340-300 simulator during heavy weight take-offs and it was fine. He also used the technique while flying the Airbus A330-200 with no incident. The only time it did not work was during the incident at Johannesburg when he attempted to use the technique during his first take-off with the actual Airbus A340-300 aircraft. According to the pilot other pilots using the same rotation technique, indicated that they got airborne uncomfortably close to the end of the runway at Johannesburg.

1.6.18 **Take-off Distance**

A performance specialist from the manufacturer calculated the theoretical distance the aircraft should have taken from the beginning of the take-off roll to the lift-off point and found it to be approximately 3400m. These calculations were based on the parameters the pilots provided as:

Take-off mass: 232.4 tons
Flex. Temperature: 35°C
Temperature: 19°C
Air Bleeds: OFF

1.6.19 Wheel and Wheel Brake Systems

According to the FCOM Vol 1 Chapter 32, the aircraft was fitted with two independent brake systems to actuate the main wheel brakes. The normal system uses the green hydraulic system pressure whilst the alternate system uses the blue hydraulic system pressure backed-up with a hydraulic accumulator. The braking commands come either from the brake pedals or the autobrake system. The dual channel Brake and Steering Control Unit (BSCU) control all braking functions. A change over between the two channels takes place at each DOWN landing gear lever selection or in case one channel fails.

The brake system also includes an antiskid and autobrake system. The antiskid provides maximum braking efficiency by maintaining the wheels at the limit of an impending skid. At skid onset brake release orders are sent to the normal and to the alternate servo-valves as well as to the ECAM system, which displays the released brakes. Full braking performance is achieved only with brake pedals at full deflection. An ON/OFF switch activates and deactivates the antiskid system and nose wheel steering. The principle of operation is that the speed of each main gear wheel (given by a tachometer) is compared with the aircraft speed (reference speed). When the speed of the wheel decreases below 0.88-times reference speed, brake release orders are given to maintain the wheel slip at that value (best braking efficiency).

The autobraking system is armed by the pilots when they depress either the LO, MED or MAX button to select a given deceleration rate and the following arming conditions are met:
- Green pressure available
- Antiskid electrically powered
- No failure in the braking system
- At least two PRIMs are available
- At least one ADIRU is available

The autobraking is initiated by the ground spoiler extension command and for MAX mode the nose landing gear compressed signal is also required. Disarming of the autobrake system occurs by either pressing the pushbutton, loss of one of the arming conditions, sufficient deflection to one brake pedal, ground spoiler retraction or flight condition for ten seconds.

While the antiskid and nose wheel steering switch is in the ON position the antiskid system will operate in either the normal or alternate brake mode. The antskid system is deactivated either:
- electrically (antiskid and nose wheel steering switch OFF, power supply failure or BSCU failure)
- hydraulically (blue and green system low pressure, brakes are supplied by the brake accumulator only)

It must be kept in mind that during this incident the pilots suspected tyre damage, but did not expect a brake failure. They did consult the FCOM, Volume 3 extensively relating to the flap defect and briefly referred to the part relating to landing with abnormal landing gear, but dismiss that as an option as there were no known problem, to them, with the landing gear retraction and extension system. The perceived brake failure during the landing was in essence an Anti-Skid system failure due to the wheel damage. However in the FCOM Volume 3, Section 3.02.32 Page 13, under "LOSS OF BRAKING" the procedure is described as:

- **IF AUTOBRAKE IS SELECTED:**
  - BRAKES PEDALS ....PRESS

    This will override the autobrake.
- **IF NO BRAKING AVAILABLE :**
  - REV ....MAX
  - BRAKE PEDALS ....RELEASE

    Brake pedals should be released when the A/SKID & N/W STRG selector is switched OFF, since the pedal force or displacement procedures more braking action in alternate mode than in normal mode.
  - A/SKID & N/W STRG ....OFF

    The braking system reverts to alternate mode.
  - BRAKE PEDALS ....PRESS

    Apply brakes with care, since initial pedal force or displacement produces more braking action in alternate mode than in normal mode.
  - MAX BRK PR ....1000 PSI

    Monitor brake pressure on the BRAKES PRESS indicator. Limit brake pressure to approximately 1000 psi and at low ground speed, adjust brake pressure as required.
- **IF STILL NO BRAKING :**
  - PARKING BRAKE .... USE

    Use short successive parking brake applications to stop the aircraft. Brake onset asymmetry may felt at each parking brake application. If possible, delay use of the parking brake until low speed to reduce the risk of tire burst and lateral control difficulties.

Neither in the FCOM Volume 3 nor in the QRH, there is any procedure described relating to the Anti-skid system failure or landing with some of the main wheel tyres damaged. The only part of a procedure that could be related to this Anti-skid defect was found in "LDG WITH ABNORMAL L/G" (Vol 3, 3.02.32, Page 8) and is as follows:

- **If one or both MAIN L/G abnormal :**
  - A/SKID & N/W STRG .... OFF

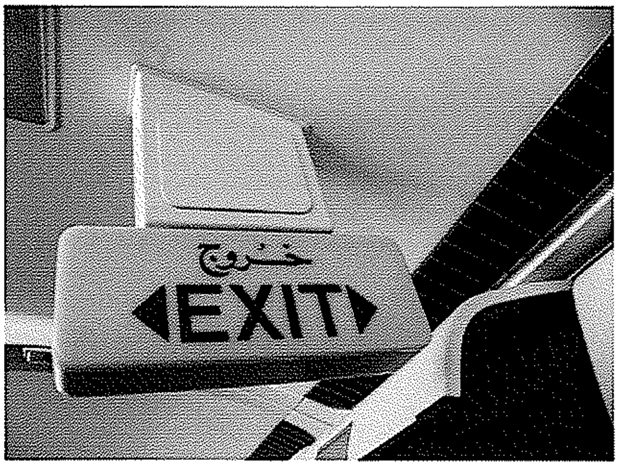
    With one landing gear not extended, the reference speed used by the anti-skid to detect a wheel blockage is not correctly initialized. Consequently, the anti-skid must be switched off to prevent brake release.

The tyre pressure indicating system has a sensor, which measures the pressure of each tyre. The tyre pressure information is transmitted to the ECAM for cautions and system page display. The Airbus A340-300 aircraft operated by the operator were not new and were built to the previous operator's specifications. When the present operator acquired them, substantial modifications took place, both to the cabin interiors and also to improve various operational systems and equipment. However, unlike other aircraft operated by the operator, this optional system for continuously monitoring of the tyre pressures was not installed.

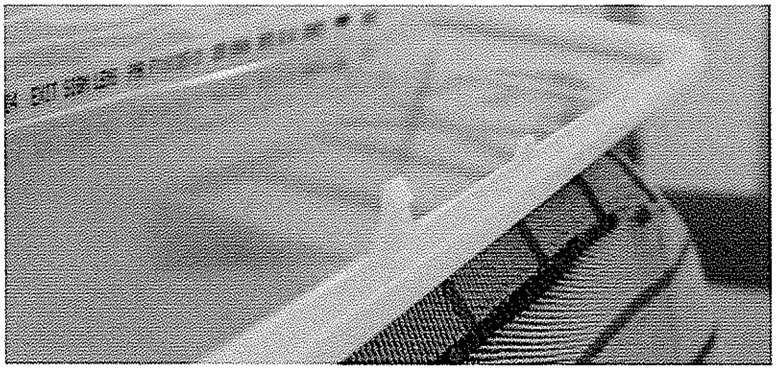
1.6.20 Exit Lights

The aircraft was fitted with EXIT lights at all the passenger entry/exit doors, either above the doorframe or next to the doorframe inside the cabin area. There were also EXIT lights fitted on fittings hanging from the cabin ceiling in the doors 2L, 2R, 3L and

3R areas above the isles. The EXIT lights consist of housings fitted to the interior area of the passenger cabin doorframes or fittings attached to the ceiling in the passenger cabin area. A lens was fitted to the housing on which the word "EXIT" was printed. With the ceiling mounted fittings, two lenses were fitted on each side of the light fitting.



The lenses were fitted with small hook-like retaining lugs and these lugs clips into place on the light fittings to secure the lenses to the fittings.

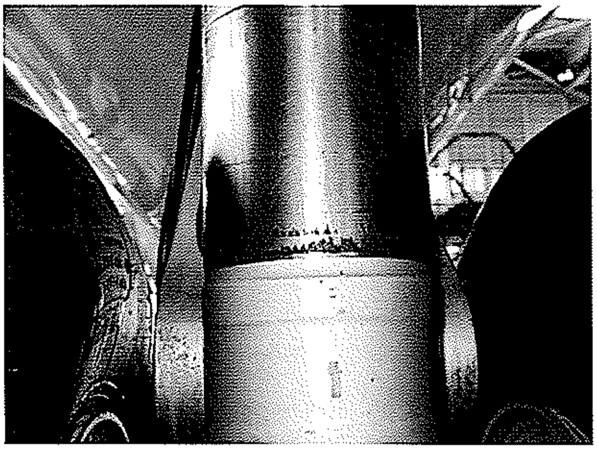


The cabin crew reported that during the landing with the damaged tyres the lenses of several of the lights came adrift and fell to the passenger cabin's floor. The investigator inspected a similar aircraft of the operator (A6-ERM) and found that the fittings on the doorframes were more rigid than the fittings that were hanging from the ceiling of the passenger cabin. To remove the lenses of these lights, the lens are pulled either at the upper or lower side of the lens, away from the fitting and the retaining lugs would disengage releasing the lens. The investigator observed one of the lenses fitted to the fitting hanging in the cabin area was not properly attached to the fitting at the top. Feeling the tightness of the fit of the other lenses for security, it was observed that 8 lenses fitted snugly to the light fittings and 7 lenses could be removed from the light fittings by applying a much smaller force. When the light fittings fitted to the cabin's ceiling were tapped with an certain intensity the lenses came adrift.

1.6.21 Mass and Balance

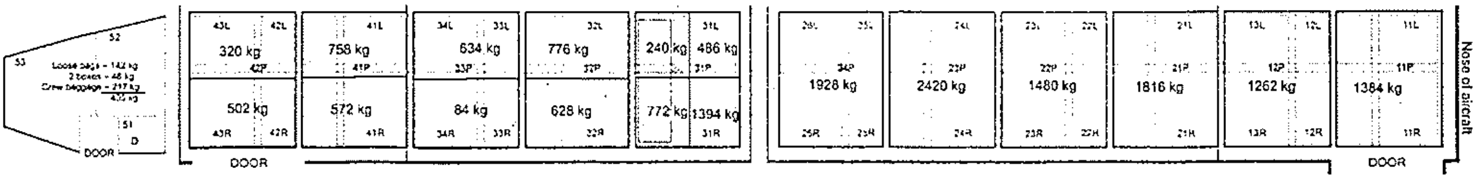
The aircraft was loaded according to a loadsheet produced by a computerised system. The information of the incident aircraft (A6-ERN) was not on the system yet as it was the first flight of the aircraft to Johannesburg and the information of the operator's other Airbus A340-300 (A6-ERM) was used as it was similar to the incident aircraft.

When the first officer executed the walk-around inspection before the flight he noticed that the nose landing gear oleo was totally compressed. The grease mark left on the surface of the oleo leg was an evidence of this (refer to photograph). He enquired about this from the ground engineer and was informed that the forward cargo hold was loaded and the rear cargo hold was still being loaded.



During the push-back the first officers checked with the ground engineer and he informed them that the extension was normal.

After the incident during the take-off the pilots suspected a loading error, because of their perceived rotation problem. The cargo was removed in a structured method after the incident and was weighed. All the masses of the loaded pallets and containers were recorded and was presented as follows:



All the values of the masses and balance of the cargo and passengers were rechecked by the loading company and by the safety staff of the operator. It was determined that the mass of the aircraft was as indicated on the loadsheet as 232380 kg and the stabilizer trim setting of the aircraft was 4.9° nose up. The aircraft was thus loaded as indicated on the original loadsheet and the trim settings were as it was set-up on the aircraft during the take-off.

1.7 Meteorological Information

1.7.1 The pilot obtained a weather report issued by the Aviation Weather Centre, Johannesburg International at 1400Z. The report was prepared for the flight with an Estimated Time of Departure of 1715Z. The Terminal Area Forecast (TAF) for Johannesburg International Aerodrome was as follows:

FAJS 090900z 091212 31009kt 9999 SCT045 BECMG 1416 CAVOK BECMG 0103 25010kt SCT010 TEMPO 0306 3000 BR BKN008 BECMG 0709 SCT025 BECMG 1012 FEW035CB SCT040 TX23/12TN11/03z=

1.7.2 Before the flight the pilots obtained the meteorological conditions from the ATIS system and at that time it was reported to be:

Wind direction	290°	Wind speed	5 knots	Visibility	CAVOK
Temperature	19°C	Cloud cover	None	Cloud base	N/A
Dew point	08°C	QNH	1018 hPa		

1.7.3 The actual recorded surface wind conditions were obtained at the threshold of Runway 03L where the overrun took place. The recording indicated that the surface wind direction at the time of the incident was on the average 270° at a speed of 6 knots. These were very closely related to the values the pilots obtained from the ATIS system.

1.7.4 During the preparations for the landing the pilots obtained the meteorological conditions again from the ATIS system and it was as follows:

Wind direction	270°	Wind speed	5kt/g21kt	Visibility	CAVOK
Temperature	19°C	Cloud cover	None	Cloud base	N/A
Dew point	10°C	QNH	1018 hPa		

1.7.5 As the fuel dumping operation was nearly completed the approach control informed the pilots that the surface wind was changing to a northerly direction becoming 360° at 7 knots. This caused a runway change to Runway 03.

1.8 Aids to Navigation

1.8.1 The aircraft was fitted with modern advanced navigation systems, but these systems did not have a bearing on the events leading to this incident.

1.9 Communications.

1.9.1 During the take-off when the incident occurred the pilots was in contact with Johannesburg International Aerodrome's traffic control tower on 118.1 MHz. After the incident the pilots were in contact with Johannesburg International's radar controller on 124.5 MHz. All these communications were recorded on the recording system of the Air Traffic System.

1.9.2 The ground controller made the first recorded comments about the incident when he observed the aircraft overrunning the end of the runway. By their comments they perceived that the aircraft did not "rotate". Further comments followed and the following is one of these comments of significance:

There where the runway lights stop, he went past. I am telling you he took the approach light with, but I saw (expletive)-all sparks and (expletive). I am telling you (expletive). He didn't rotate at all, he just went into this black and then he went. I am telling you past the (expletive) last light, the runway's lights.

During a later communication with the pilots the ATC indicated they observed the aircraft only "rotated" after Juliet-Taxiway.

1.9.3 A further comment suggested that the controllers was used to Airbus A340-300's displaying poor climb performance.

1.9.4 Approximately a minute and a half after take-off the pilots advised the radar controller that they have probably impacted something at the end of the runway. A short while later they requested to enter a holding pattern and that a runway inspection should be carried out. The radar controller directed them to a holding area and told them he will get back to them with the outcome of the inspection.

1.9.5 On three occasions the controller reported the findings of the runway inspections:

- The first report was that nothing was found on the runway.
- The second report relating to the runway inspection indicated that they observed tyre run marks into the grass south of the runway end. They estimated the overrun to be about 170 to 200m into the grass area and there was two-runway end lights damaged.

- The third report the pilots received relating to the runway inspection was when they were in the approach phase. Two tyre fragments were found, the one approximately the size of an A4 sheet of paper and the other fragment much larger.

1.9.6 The pilots also communicated with the maintenance control centre at their home base via satellite phone to verify the procedure to deal with the flap fault and the way forward with the flight.

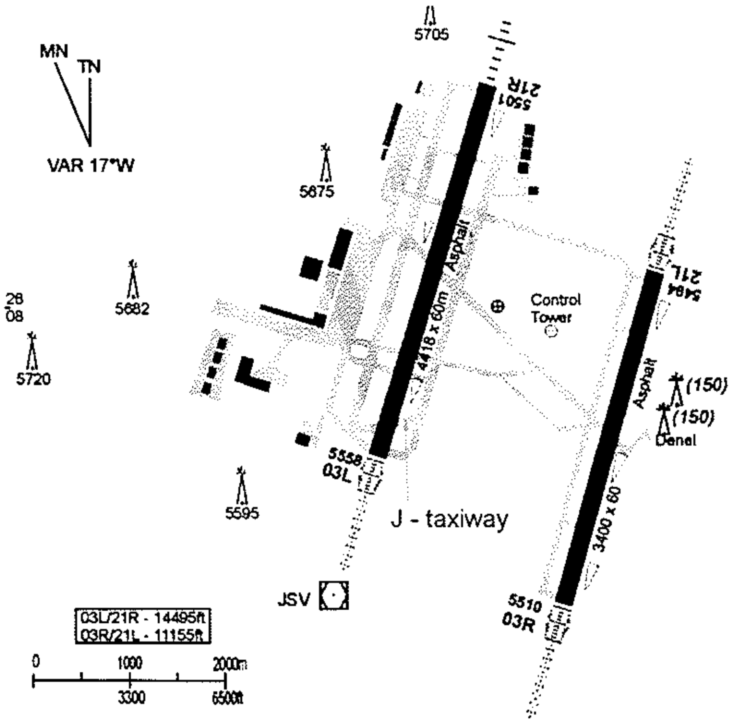
1.9.7 A further communication the pilots made with home base was with the Senior Manager Network Control. The captain informed him about the situation, discussed a few different possibilities that might have caused the incident and different options on the way forward.

1.9.8 The pilot-in-command also communicated with the aerodrome control centre to inform them about the flight returning and the need for a parking bay when they return.

1.10 Aerodrome Information

1.10.1 The aerodrome information for Johannesburg International Aerodrome is as follows:

Aerodrome Location	Johannesburg Int. Aerodrome, FAJS	
Aerodrome Co-ordinates	S26° 08' 01 E028° 14' 32"	
Aerodrome Elevation	5558 ft	
Runway Designations	03L/21R	03R/21L
Runway Dimensions	4418 x 60m	3400 x 60m
Slope	+1.2%/-1.2%	+0.4%/-0.4%
Runway Used	21R (take-off) and 03R (landing)	
Runway Surface	Asphalt	
Approach Facilities	ILS Cat II, VOR, NDB, PAPI, Runway lights.	



1.10.2 The aircraft overran the end of Runway 21R and damaged twenty five of the runway end/approach lights of Runways 21R and 03L. The initial area at the end of Runway 21R is an area covered with asphalt. This area proceeds in the runway direction from the end of the runway where the end lights were situated to the third row of lights. From there onwards the area was covered with grass and the rows of approach lights were mounted on concrete plinths.

1.10.3 It was noted during the incident investigation that although the plinths appeared to be level with the grass area, that the soil on the edges of some of the plinths were eroded away to such an extent that it exposed a step on the side of some of the plinth of up to 50 mm. These edges were considered contributory to the tyre damage. Although one does not expect aircraft wheels to roll over this area, it does present a safety hazard as this incident proved.

1.11 Flight Recorders

1.11.1 The aircraft was fitted with a Cockpit Voice Recorder (CVR), a Digital Flight Data Recorder (DFDR) and a Quick Access Recorder (QAR). All these recorders were operational during the incident. The recorders were removed and downloaded at an approved aircraft maintenance organisation after the incident.

1.11.2 Cockpit Voice Recorder

The cockpit voice recorder (Fairchild, Model A200S, S/N 00473) was downloaded on 12 April 2004. The recordings on all the channels were of good quality, but a fair amount of the cockpit conversations between the pilots were lost by the load radio-telephony (ATC-related) recorded by the CVR. The CVR was capable of recording a maximum of two hours conversation. However, since the elapsed time between taking off and the engines being shut down exceeded this period, the CVR did not record the actual take-off. The two-hour recording started after the incident when the aircraft was already flying and the pilots was busy attempting to correct the "flaps locked" defect. Considering the full extent of the CVR recordings, the investigator's perception of the pilots' behaviour was that they were very professional in the handling of the aircraft and the following of procedures relating to the operation of the aircraft. It could also be determined from the CVR recordings that the pilots were totally unaware of what had gone wrong during the rotation of the aircraft during the take-off roll and to the cause of why the aircraft had over-run the end of the runway.

1.11.3 On an occasion when there were questions about whether they had impacted the runway end lights or the approach lights, the first officer was positive that they had impacted the lights. The following phrases suggests this:

Capt	No debris found, so they don't see us off the end of the runway.
CP	No, but we did, no but we did.
Capt	It might just get rough at the end.
CP	There were lights, I saw it.

1.11.4 At different point during the flight the pilots either spoke with each other or with other persons about the over-run and these occasions were as follows:

The pilots speaking to each other:

Capt	I calculated in ????? We were full aware that, you know, it is going to be a long rotation, alright.
CP	*We did not screw up on the (unreadable words).*
Capt	No, we were higher on the weights. Alright we entering the hold, can I get in contact with ???

During a further occasion when the incident came under discussion was during the following excerpt where the pilots were wondering about the loading of the aircraft and a possible forward centre of gravity condition:

CP	...... prior to any freight is being moved, prior to anything being touched in the aircraft.
Capt	It should be weighed and ..
CP	We want everything being checked. By somebody else, not by who put it on, OK, because I have a feeling that's what happened.
Capt	Maybe
CP	Because
Capt	Forward C of G, it didn't come off
CP	It didn't come off
Capt	I wasn't gonna go like that, I could have gone TOGA though, but I couldn't see outside.
CP	Yea, I mean I was seeing the nose came up, it looked like we getting airborne, the nose dropped and you were stuck at nine degrees. You may have dropped it.
Capt	I was way up to ten and bring it back to nine, because I went over to .... (Loud R/T with pilots carrying on in background)

The captain also shared their concern about the possible forward centre of gravity with the Senior Manager Network Control (SMNC) and told him about the compressed nose oleo during the pre-flight walk-around inspection. He mentioned further in his conversation with the SMNC the following:

Presuming we got the numbers all correct and we have double, triple checked them. The only thing we can think is either the weight was wrong or the centre of gravity is wrong or it's .... as far as we can tell we did the proper technique.

A following phrase of the captain, which suggests that he was not sure about the cause of the over-run, was as follows:

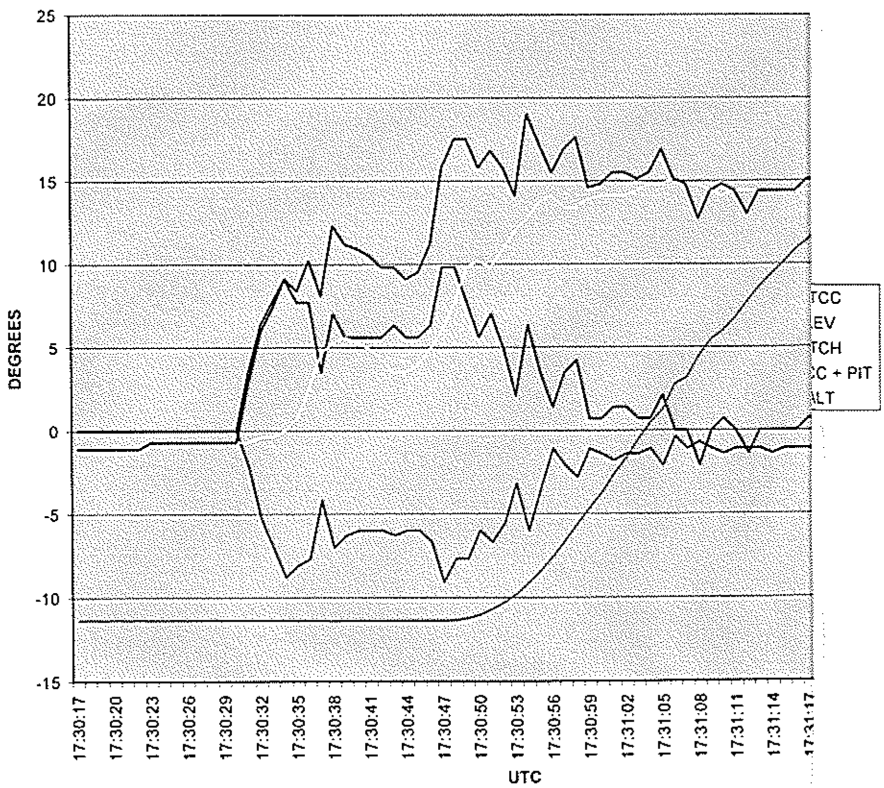
OK, as far as I can tell, we have done everything from aat we can. Off-course we're concerned with the take-off ...... thwhat's caused anything to happen. We were aware that it wout like I said it got airborne too late and I think before we do it aςo duty limits and all the rest of that, ehhm. I would be concerneading.

At a later stage in the flight another reference to the situ

Capt	Alright, the main thing is that we're safe. The onlş ehh, no we did get airborne.
CP	And if you think about it our take-off weight was tı used two thirty four, OK.
Capt	OK
CP	One forty four fifty two fifty seven, one plus four n
Capt	And you would agree I was at nine degrees.

1.11.5 **Flight Data Recordings**

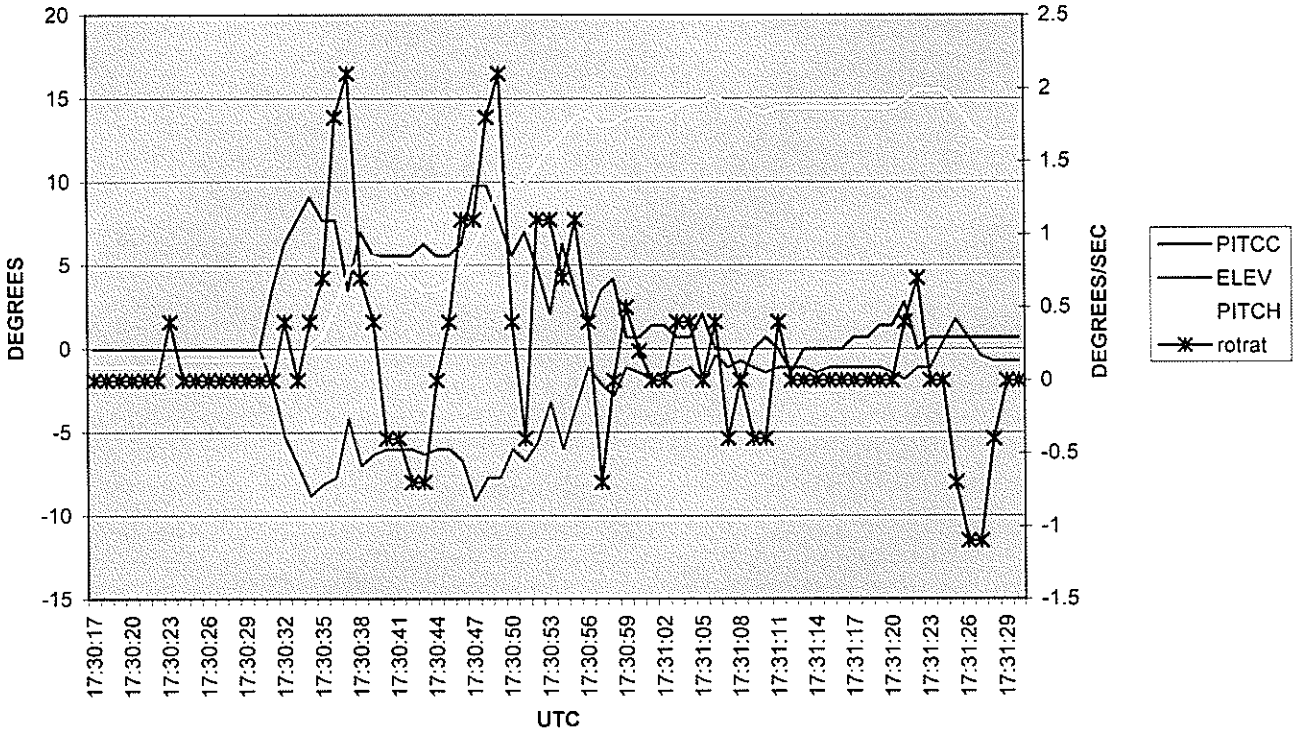
The DFDR (Allied Signal Part No. 980-4700-003, Ser Nded on 10 April 2004 at an approved aircraft maintenance organe data was also forwarded to the manufacturer's flight safea was transferred into an Excel Spreadsheet to be able to carŋ as to why the aircraft did not rotated and took-off as expecteh was produced by plotting the pitch control (PITCC), eleva pitch attitude (PITCH), a sum of the pitch control and pitch altitude (RALT) of the aircraft in relation to the time (UTC):



One can determine from the graph that the pilot starteput at

17:30:31 during the take-off run. Approximately a second later the aircraft started to pitch the nose upwards. Eight seconds after the initial stick input the aircraft reached a maximum pitch angle and then the aircraft started pitching down again and reached a minimum pitch angle approximately four seconds later. By referring to the graph representing the sum of the pitch control and pitch attitude it suggests that after the side-stick was moved to approximately the nine degree position at 17:30:35 it was held in that proximity until 17:30:45 when the angle was suddenly increased dramatically. From this time onwards the pitch angle started increasing again and the aircraft lifted off seventeen seconds after the initial side stick input.

1.11.6 A second set of graphs to reflect the rotation rate (rotrat), the pitch angle (PITCH) of the aircraft and pitch control inputs (PITCC & ELEV) in relation to time (UTC) was plotted and is as follows:

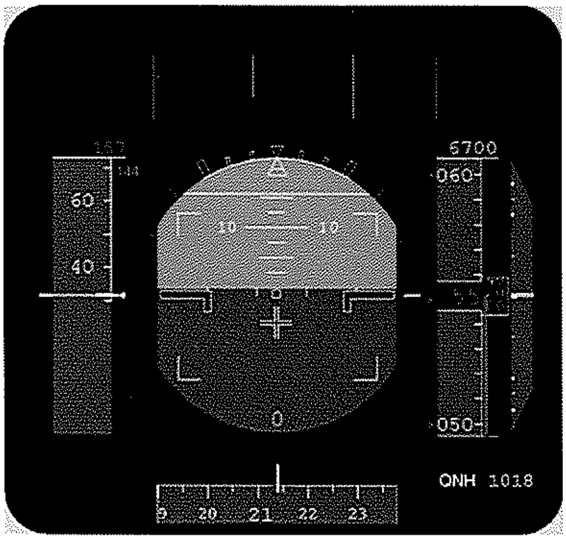


Considering these graphs one can conclude that there was an initial rotation rate and with the slackening off of the rearward movement on the sidestick the rotation rate became negative where after it increased again until the aircraft took-off.

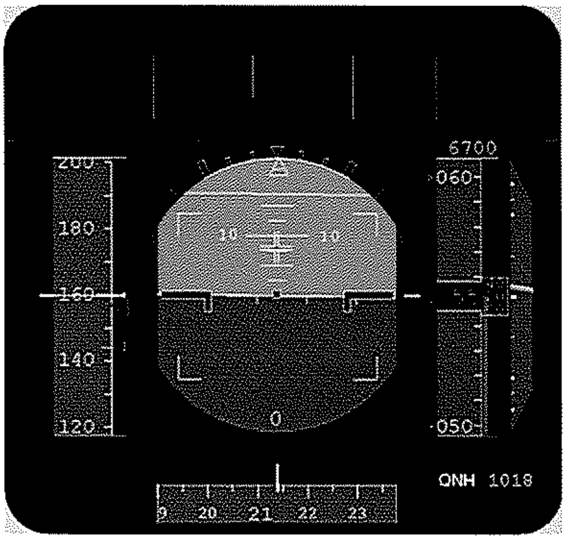
1.11.7 Taking the rest of the DFDR data into consideration, a representation of the significant events during the take-off could be represented as follows:

Time UTC	-	Event
17:29:31	-	Rolling take-off run commences, with both A/C packs selected off.
17:29:40	-	CAS 32 knots Captain's sidestick nose down input as per SOP.
17:29:55	-	CAS 74 knots Captain's sidestick neutral.
17:30:31	-	CAS 153 knots (VR + 1 knot) – 1st rearward input on Captain's sidestick.
17:30:32	-	CAS 154 knots nose wheel air/ground switch in flight mode.
17:30:33	-	CAS 158 knots (V2 + 1 knot).

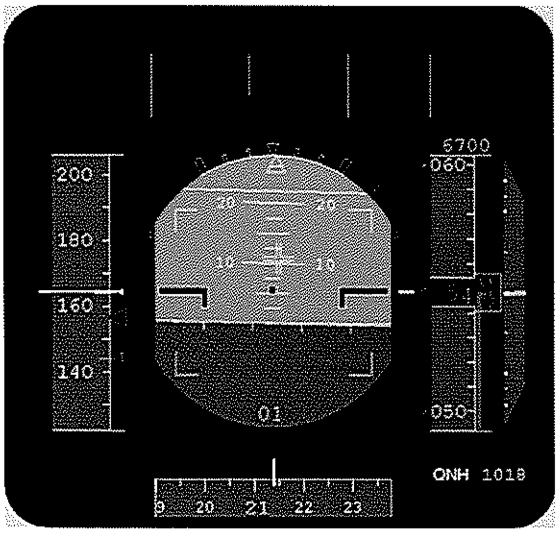
17:30:34	-	Captain's sidestick nose up input +9.1°
17:30:37	-	Maximum pitch attitude rotation rate +2.1°/sec.
17:30:39	-	Nose up pitch attitude + 5.6° Nose rotation rate zero.
17:30:40	-	Rotation rate -.7°/sec.
17:30:43	-	Nose up pitch attitude decreased to + 3.5°
17:30:45	-	Earliest estimated point at which end lights impact took place.
17:30:46	-	Captain's sidestick nose up input.
17:30:47	-	Maximum rearward input on Captain's sidestick.
17:30:48	-	CAS 174 knots – both main wheel air/ground switches in flight mode.
17:30:49	-	First Radio Altimeter positive climb increase (7 feet).
17:30:49	-	TOGA



1.11.8 The manufacturer's safety section used an animation program to represent the Primary Flight Display for the take-off sequence. This animation was forwarded to the investigator-in-charge and this animation assisted in visualising the events as it occurred. The movement of the SSOI is observed until the stage where the aircraft is rotated and become airborne. The first event was the forward application of the sidestick at 32 knots and the associated movement of the SSOI to below the horizon display.

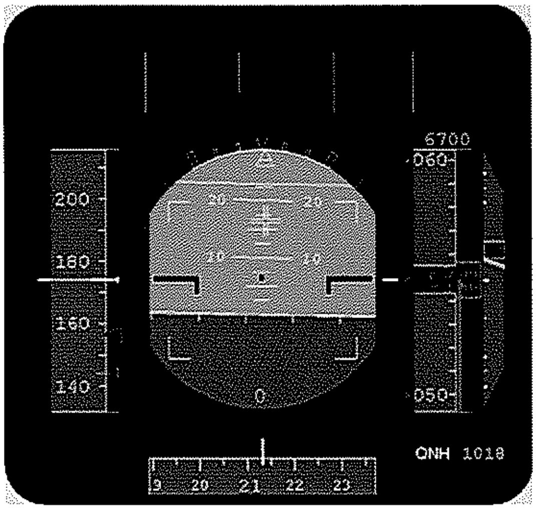


1.11.9 The next event observed is when the pilot moved the sidestick backwards for the aircraft to rotate at V_R. One can observe that the SSOI moved up to a position in the region of or are on the way to the 9° position above the horizon display on the primary flight display.



1.11.10 As the nose of the aircraft moves up during the rotation of the aircraft one can observe that the pilot attempt to maintain the SSOI in the region of the 9° position on the horizon display. The problem however was that with the rotation of the aircraft the horizon display has moved downwards and thus the 9° position on the horizon display too. One observe that the nose of the aircraft lower during this action.

1.11.11 Seconds after the pitch angle had decreased a sudden increase in backwards movement of the sidestick is observed when the SSOI moves upwards on the display. At this time one observe



a positive rate of climb indication on the rate of climb indicator to the right-hand of the display and the SSOI disappear from the display when the aircraft become airborne and change to the flight mode.

1.11.12 BSCU-Memory

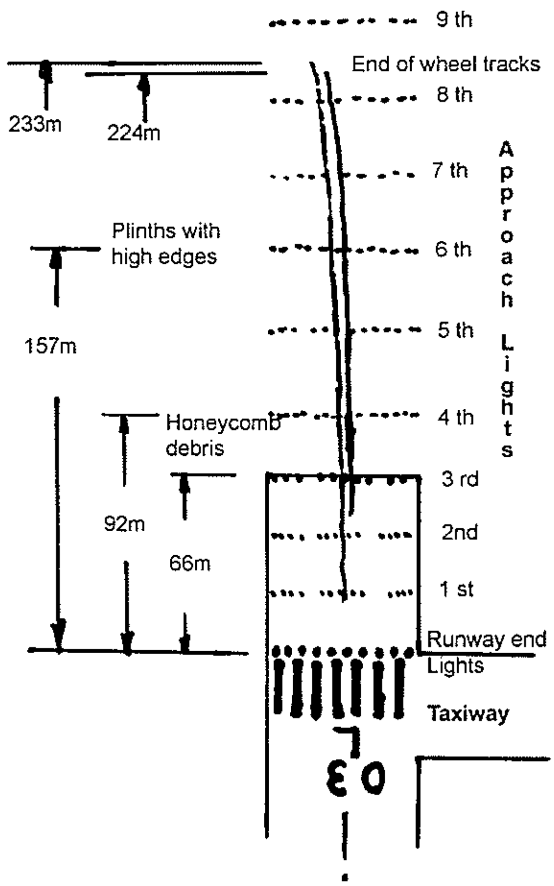
The BSCU memory was downloaded and forwarded to the Flight Safety Section of the manufacturer for analysis. These data was related to the data available of the landing and the conclusion was that:

- During the first 10 seconds after touch down there was no braking action as auto-brake LOW was selected and the actual deceleration was higher than the target in LOW
- The auto-brake disconnected, probably due to crew action on the pedals
- During 24 seconds the deceleration is low although the crew applied brake pressure. This was probably due to anti-skid action. As there were three wheels tyres burst and some damage to the wheel tachometers, an inaccurate reference speed computation can be suspected. The anti-skid was disconnected and the deceleration increased.

1.12 Wreckage and Impact Information

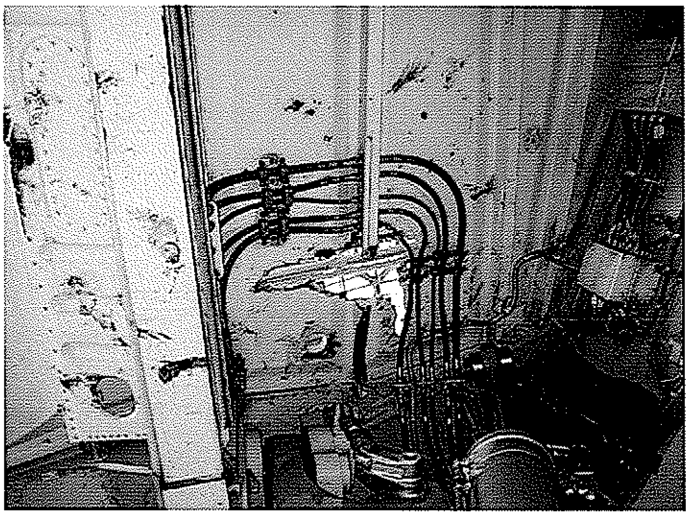
1.12.1 Take-off

The aircraft departed the runway at the threshold of Runway 03L. The wheels impacted the runway end lights of Runway 21R and then the approach lights of Runway 03L, a total of twenty-five lights. The wheel tracks could be observed on the initial overrun area, which was asphalt covered and then onto the grass covered area. The asphalt covered overrun area ended at the third row of approach lights from the threshold of Runway 03L (66m in length). Large fragments of tyre were recovered in the area of the sixth row of approach lights and it was the plinths of this row of lights that had the high edges. However rubber fragments of the failed tyres were spread over most of the area where the tyre tracks were observed. Smaller fragments of honeycomb structure were recovered in the area of the second and third rows of approach lights. It was thus difficult to predict where the tyres had failed. All the lights fittings were observed to be of the



frangible type. Relating to the DFDR information the aircraft was at a recorded ground speed of approximately 190 knots (351 Km/h) when the tyres impacted with the light fittings.

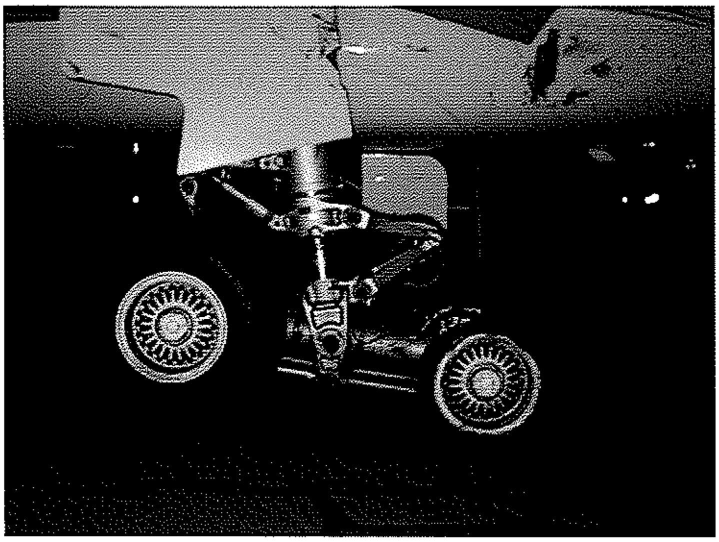
1.12.2 All the tyres on the rear wheels on the main landing gear bogies probably failed during the take-off (wheels no's. 5,6,7 & 8). The debris that was thrown from the failed tyres impacted the rear area of the left-hand wing-to-fuselage fairing and punctured a hole of approximately 10cm by 15cm into this fairing. The wing panel above the left-hand main wheel well also suffered a puncture hole and the composite flap drive shaft in the area above the right-hand main landing gear failed due to tyre debris impact. The flap drive shaft failure caused the flap system to detect that the right-hand wing flaps will not retract evenly and it activated the wingtip flap brake to engage in order to prevent an asymmetric flap situation from developing. The pilots became aware of the problem when the defect report on the ECAM system appeared.



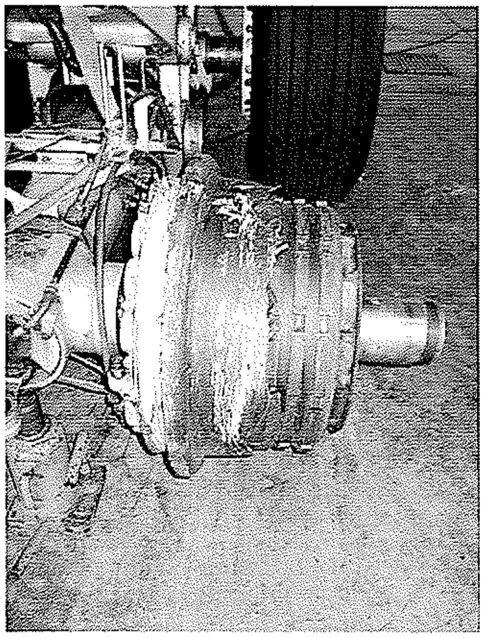
1.12.3 Many other impact marks were observed on the fuselage surfaces, wings and as far as the horizontal and vertical stabilizer, related to tyre fragments contacting the aircraft surfaces during the failure sequence of the tyres.

1.12.4 **Landing**

The pilots was initially given the landing runway as Runway 21L, but during the initial approach the surface wind changed and they were vectored towards Runway 03R, which they preferred due to the operational ILS. The first signs of the touch-down point of the aircraft was at approximately 770m from the threshold. Approximately 355m from the touch-down marks one could observe the marks that appear to be the first contact of one of the right-hand main



wheel rims with the asphalt surface of the runway. At 506m from the touch-down point there were marks observed on the runway surface which appeared to be the wheel rim of one of the left-hand main wheels contacting the asphalt surface of the runway. Several such grooves were cut into the runway surface from the starting points mentioned above for the full distance of the aircraft's landing roll to the point where the aircraft came to rest. The aircraft came to rest at 250m from the end of Runway 03R and it could be heard on the ATC recordings how the last few tyres failed. It is estimated that the tyres from three of the forward main wheel (wheels no's: 2,3 & 4) failed at this time.



1.12.5 The tyre cases of the wheels that failed were totally destroyed down to the wheel rims. The wheel rim of number 8 main wheel suffered a radial failure at the middle of the hub. The maintenance engineer managing the aircraft's repairs was of the opinion that this was possibly due to a severe force of the impact during the take-off run weakening the structure of the hub and the loads imposed on the hub during the landing with the failed tyre caused it to fail. Alternatively the tyre failure caused the bead wire bands to cut into and caused the hub to fail. However it was evident that the outboard segment of the failed hub had moved away from the inner segment and kept on rotating until the aircraft came to rest. The inner segment ceased to rotate when the braking action was applied. It was probably during the time when the outer hub segment moved outboard that the tacho-generator drive was uncoupled as this drive is driven by the outboard segment of the wheel hub (in the wheel cap). It is also probably during the time when the tacho-generator drive became uncoupled that the crew received the number eight brake message.

1.13 Medical and Pathological Information

1.13.1 Both the pilots were in possession of valid medical certificates.

1.14 Fire

1.14.1 No pre or post-impact fire occurred. In the investigator's experience, one usually observes brake fires when a high-energy stop after an unusual landing was performed, but during this incident no such fires was observed. This could possibly be due to the relative low brake action during the landing.

1.15 Survival Aspects

1.15.1 The pilots, cabin crew and most probably all the passengers wore safety harnesses during the take-off and the landing. The forces associated with this incident were not considered to such an extent that it would cause injuries to the occupants of the aircraft.

1.15.2 There was no need for an evacuation of the passengers via the escape slides, which also reduced the risk of further injuries.

1.16 Tests and Research.

1.16.1 **Aircraft**

The investigator requested the supervisors of the maintenance crew in charge of the repairs to the aircraft to carry out check-outs of the instrumentation on the PFD's relating to the rotation instrumentation for accuracy. This was checked and the investigator was ensured that the information displayed was accurate.

During the ground run after the repairs was completed the investigator accompanied the ground engineers on the engine ground run. After the start-up of the first engine the SSOI and the four corner angle points appeared on the flight displays indicating the limits of travel of the control sticks. The left-hand side stick was moved from the 0° position through its full travels left and right and up and down. It was also moved to the different corners of the white displays. During these movements the control movements were monitored on the ECAM displays and were found to be satisfactory. The side stick was pulled backwards and the cross was placed on the 10° position on the PFD with the aircraft on it wheels. The maintenance engineer then made a print of the elevator position on the maintenance display. This process was carried out for the 5° and 0° positions. These values were communicated with the manufacturer's flight safety section and they concluded that the elevator positions for each set of readings were in accordance to the theoretical values of the sidestick deflection.

The aircraft was taken for a test flight after the maintenance actions were completed. During the test flight the investigator observed the SSOI display after the engines were started and the check-out the pilots carried out during the pre-flight checks with the sidesticks to ensure the correct movements of the controls and the SSOI display on the PFD.

The aircraft was set up to carry out a TOGA powered take-off. The pilot gave a nose down stick input from the start of the take-off run to about 80 to 100 knots when the stick was centralized. The V_1 to V_r came up and on the V_r call, the pilot moved the side stick back and the investigator observed the cross movement on the PFD panel display to about 10° nose up then the aircraft's nose started pitching up. The nose up pitch was follow by the aircraft leaving the runway surface after a few seconds and the SSOI disappeared the moment the main wheels lifted off. An interesting observation was that the horizon on the PFD moves down the moment the rotation starts and this creates the perception that the stick input is becoming too much although no change in stick inputs was affected.

The test flight schedule was completed and the aircraft performed as required with no further incident and only one minor defect that were observed.

After the test flight the investigator and flight crew observed another Airbus A340-300 of the operator take-off on the same runway as the aircraft used during the incident. The aircraft rotated and was airborne approximately three quarters down the runway. It further climbed and reached approximately 150 to 200 feet by the time it reached the end of the runway. It was unknown what the load, power setting and other parameters of the take-off for the observed aircraft was, but the captain who flew the test flight commented that the aircraft taking-off is displaying the typical take-off profile that they had planned for these aircraft.

1.16.2 Simulator Flight Trial Sessions

Both the pilots were subjected to a flight trial session in the simulator under the observation of UAE GCAA investigators. The pilots were observed in different sessions and the investigator-in-charge received reports of these sessions. In essence the following was observed:

Session with Captain (14 April 2004):

The objectives of the flight trials were to:

- Check the take-off distances were according to the approved Operating Handbooks of the aircraft
- Subjectively assess the take-off profile based on the parameters obtained from the Quick Access Recorder (QAR)
- Verify the take-off technique used by the captain.

The flight trials were flown in the Airbus A340-300 simulator using all the data and conditions as obtained from the QAR and other conditions as it was at the aerodrome during the take-off.

The findings of these flight trials were reported as:

- Take-off distances obtained in simulator are all within approved aircraft performance limits
- The simulator did take-off without incident when the captain used the take-off technique that he described, but the evaluators described it as "unnatural"
- The captain used the same rotation technique as he did during the incident during the flight trial. He selected 9° pitch attitude during rotation using the SSOI instead of the aircraft pitch indicator on the PFD
- The SSOI on the PFD indicates the sum total of the captain and first officer side stick inputs. Thus maintaining a 9° pitch using the SSOI after the captain's SSOI decreases (after rotation) will still lead to a de-rotation.
- Maintaining a 9° pitch using the SSOI referenced to the horizon on the PFD after rotation will produce an approximate aircraft pitch of 5°.
- The take-off technique demonstrated by the captain was incorrect and had significantly increased the take-off distance. The captain also verbally described that the initial selection of the take-off rotation should be carried out using the SSOI.

It was recommended that the operator issue an instruction to all pilots and instructors to highlight the need for utilising the proper take-off technique as per the manufacturer's operating instructions.

Session with First Officer (19 April 2004):

The objectives of the flight trials were to seek confirmation and inputs from the first officer about the take-off profile flown by the captain during the incident take-off.

The flight trials were flown in the Airbus A340-300 simulator using all the data and conditions as obtained from the QAR and other conditions as it was at the aerodrome during the take-off.

Three take-off's were flown with the first two flown by the left-hand seat pilot and the first officer observing. During these take-off's the simulator was flown as close to the profile and technique (SSOI selected to the 9° position on the PFD) as it was flown during the incident. The first officer flew the third take-off based on the take-off technique as he observed.

The findings of these flight trials were reported as:

- The first officer agreed with the take-off profile that was flown including the use of the SSOI (positioned at 9°) on the PFD
- The first officer's take-off and rotation was almost similar to the actual take-off profile as per the QAR data. The SSOI was observed at 9° pitch on the PFD instead of the aircraft pitch indicator during initial rotation. The first officer did not hold this initial attitude for too long and increased the attitude shortly after that to 9° pitch on the aircraft pitch indicator.

During interviews with the GCAA Flight Operations Inspector and the operator's Flight Safety Department's staff the investigator determined that the first officer realised the error with the rotation technique the captain applied during the take-offs that he had to observe.

Session with Investigator-in-charge (17 May 2004):

The investigator-in-charge was provided with an opportunity to observe a flight trial of take-off's flown using the take-off technique as it was utilised during the incident take-off under the same conditions as recorded. During both take-off's the "aircraft" rotated and flew off the runway surface without serious indications of an over-run. The investigator could clearly observe the effect of the "de-rotation" and the distance of the "aircraft's" take-off run. Observations were also made of the lights on the apron and related to what the first officer told the investigator when he was interviewed.

The conditions and parameters of the landing were programmed into the simulator and the approach and landing was flown. The "aircraft" reacted similarly to what was observed during the investigation and came to rest in more or less the same position as it had during the actual incident.

After the session of the flight trials in the simulator the investigator had a clearer understanding of the circumstances and conditions that had prevailed during the incident. It was also concluded that the simulator was not able to present an exact representation of the reaction of the aircraft during the take-off conditions similar to the incident flight at the Johannesburg International Aerodrome. In each case the simulator "aircraft" took-off without incident.

1.17 Organizational and Management Information

1.17.1 Operator

The operator was launched in 1985 and is one of the world's fastest growing airlines. It has received more than 250 international awards for excellence since it was launched. One of these top awards they received in 2004 was the aviation's top finance award when they were recognised as "2003 Airline of the Year". During 2004 the operator was in possession of a fleet of over 50 aircraft and they plan to double their fleet of aircraft to be more than 130 aircraft in just eight years. In December 2003 the first of 28 ultra-long range Airbus A340-series aircraft joined the operator's fleet. This is to accommodate rapid expansion of operations to serve 76 cities in 54 countries. The operator's fleet of 67 wide-bodied aircraft is one of the youngest in the skies, with an average age of approximately four years. They were one of the first operators to have ordered the new Airbus A380, which is still being developed and is considering adding 45 of these aircraft to their fleet. The operator is also the launch carrier for the Airbus A340-600 HGW.

1.17.2 The United Arab Emirates General Civil Aviation Authority (UAE GCAA) issued the operator with an AIR OPERATOR'S CERTIFICATE (Number: AC01) on 1 March 2004 and it was valid until 28 February 2006. The certificate certified that the operator was authorised to operate in international commercial air transportation.

1.17.3 The last audit carried out at the operator prior to the incident by the UAE GCAA was a Base Inspection carried out from 4 to 11 October 2003. A report relating to this inspection was produced by the Flight Operations Inspectors and submitted to the Director Flight Safety and Security and the Chief of Flight Operations of the GCAA. The memo indicated that: *the inspection was only the first phase audit which was focused on the operator's training organisation documentation, manpower, planning and facilities.*

1.17.4 The audit report was forwarded to the operator's Senior Vise President, Flight Operations with a letter dated 19 November 2003. The letter indicated that twelve findings were made. With the exception of one finding all the findings were on a level three and only the one finding was indicated as a level two finding. According to the letter a Level 2 finding is:

Non-compliance with company procedures, which may lower the organization operation, safety and security standard and require corrective action between three to six months.

A level 3 finding on the other hand is defined as:

Minor non-conformities, which are considered only and warrant attention.

The level two finding related to the security of examination papers. The audit team determined that although they were told that only lead instructors and synthetic ground trainers had access to the examination papers, the clerical staff also had access to the papers.

1.17.5 Some of the level three findings that could have been related to this incident was as follows:

Expansion Program

Due to the addition of aircraft to the operator's fleet during 2004 an estimated additional 256 flight crewmembers will be needed. The Training Department of the operator will need to initiate early planning to supply the training needs of the expansion program. The audit team did find evidence that there were plans to improve the training complement. However there was no planning to enhance the ground training staff capability.

Training Quality Control

The audit team came to the conclusion that the documentation issued by the training department did not cover the aspects of how to achieve and maintain quality control on training provided adequately. They strongly recommended that the flight check form used during training should be revisited as some Designated Check Airmen has a tendency to inappropriately grading the candidates during their assessment of them.

Training Records

Training records are kept at both the training department and at the flight operations department of the operator for their pilots. This dual system make tracing of the files and up-dating of the training files difficult. It was recommended that a central filing system should be introduced to effectively monitor all the pilot training and test requirements.

Deletion of FCTM Contents

Pages in the FCTM were deleted deliberately. There was no indication of who deleted the information and the deletion was not carried out according to the standard amendment procedures.

PPC/IR Check Form

Differences were noted on a check form that was submitted to the GCAA in relation to the original form that was found on the records of the Training Department. In the report it is suggested that this will only happen if different persons handle the form. Entries made by staff other than the TRE is an unacceptable practice and must be avoided.

Common Topics in the B777 and A330 FCTM

The manuals of the different types of aircraft are prepared by their individual manufacturers and are bound to be different although certain topics are common to any aircraft, like ETOPS, RNP, RVSM and others. There is a need identified to maintain contents standardization and commonality. It is recommended that the ICAO Annex 6 standards and recommended practices should be adhered to.

A330 FCTM and Document Updating

The A330 FCTM is in two separate manuals and the control page, revision record and effective pages documents should be in both manuals.

Several of the other manuals were not updated with current updates.

1.17.6 The operator responded on the audit findings with a letter dated 17 December 2003. They accepted the findings and responded by detailing their corrective actions and the time scales for these actions. The GCAA accepted the response from the operator and agreed upon it. In a memo to the Director Flight Safety and Security of the GCAA the Flight Operations Inspector assured him that the GCAA Flight Operations department will continue to monitor the progress of the corrective actions until they can be considered closed. The operator's actions relating to the level 2 finding about the examination papers were to be implemented as follows:

- A dedicated secure cabinet will be establish to store exam copies
- A secure folder will be established with restricted access to store electronics masters
- A documented procedure will be set to control access to paper copies.

The operator's actions relating to level 3 findings included the setting up of a development team to review the training needs, a quality assurance department to monitor all the aspects of the training department, the development of an IT-system for all crew member's records and procedures to keep documentation current and reliable.

1.17.7 Scheduling of Pilots

The operator's policy to schedule pilots for flights with Airbus aircraft was with the provisions of the CCQ and MFF principles in mind. These provisions to be able to take part in MFF as discussed in 1.5 above (required by the JAR-OPS and accepted by the GCAA), was met as both the pilots have completed the initial type rating training and line flying training. Within the operator's policy however two other principles were followed:

- After the Initial Operating Experience, including a line check, the crew members were provided an uninterrupted consolidation period (no return to flying another type) of at least 50 flying hours, before they can take advantage of MFF. In the case of this incident, no provisions were made in this policy or in the JAR-OPS for "variant experience" restrictions on two Airbus A340 pilots flying together on different variants of the same type.

- Relating to transitions (type ratings) and command courses, newly trained crew will not fly together. In the case of this incident, a captain or first officer were considered as "new" from the month a command or type rating was awarded, until the end of the next month. No provisions were made relating to variants of a type.

1.17.8 **Simulator**

According to the operator's Flight Training Policy Manual, Chapter 22, the operator's Full Flight Simulator (FFS) are compliant with international standards laid down by JAA specifically JAR STD 1A. The target accreditation for the simulator is a minimum of a

Level C or optimally Level D (in the operator's case Level D was attained). Furthermore according to the operator's Flight Operations Manual, Chapter 3, Page 3, all the operators Full Flight Simulators are approved for Zero Flight Time and can be used for most pilot qualifications in place of an aircraft. All simulators purchased for the operator's specific flight crew training are based on a data package reflecting a "tail number aircraft" operated as part of the operator's fleet for that aircraft type. The UAE GCAA has granted dispensation to the operator's Designated Check Airmen (DCA) to conduct checks on simulators approved for that purpose.

1.17.9 United Arabic Emirates - General Civil Aviation Authority

The General Civil Aviation Authority was created in 1996 by Federal Cabinet Decree (Law 4) to regulate Civil Aviation and provide designated aviation services with observance to the safety and security to strengthen the aviation industry within the UAE and its upper space. Since 1996 the Authority has made considerable progress and embarked on bold new initiatives to provide a better service to its civil aviation clients and stakeholders. Since 1996 many new projects and innovations have been initiated with generally excellent result, such as modernization of the air traffic control center program, Radar equipments and establishing of new facilities to serve the growth of the civil aviation within the UAE.

The GCAA is not managed on the user-pay principle. They are however a non-profitable organization, but do charge a fee for the issue of the different licenses, certificates and authorizations. They have attained an ISO9001 certification.

The Flight Operations Department carries out oversight of the air operators in the GCAA. There are 3 main air transport operators about 12 air charter operators and three governmental VIP operators of which one operates Boeing 747's, to transport the President.

The process to obtain an air operator license is as recommended in the ICAO documentation. They have developed a comprehensive checklist with a preliminary assessment phase and then a phase where meetings are held with the operator management structure to discuss their application and operation manuals need to be submitted and ratified. Base inspections needs to be carried out in the different areas like flight operations, engineering, safety & security, etc. After these processes the operator is granted a license and gets issued an AOC. The full licensing process is carried out in the GCAA.

After this the operator is subjected to yearly audits according to a predetermined schedule. Base inspections get carried out at such occasions. In the operator's case they were audited more than once a year due to the size of the operation. The previous audit was carried out during October 2003 and they were scheduled to be audited from 3-5 May 2004, but when the incident occurred the flight operations department engaged with the airline in a much more active way and concentrated to a large extend on the training aspects of the operation.

The A340's were introduced during November 2003. The documentation was approved and the training was carried out. The Airbus philosophy is that one need to do a base aircraft and then there can be Cross Crew Qualifications (CCQ) for crews to be able to fly the different type groups of Airbus aircraft. The base aircraft in this case was the A330 and the conversion training consisted of a five-day period to lecture the differences and to be able to teach the different techniques. The JAA, FAA and the GCAA certified this principle. During the introduction phase the requirements were modified a bit to accommodate the basic requirements of 50 hours and 20 sectors. The pilots can accumulate 50 hours very quick, but the 20 sectors will take a longer period, so they let them fly with an European operator for a period to give them exposure to the aircraft. For the local group they also had an Airbus instructor to assist in the training up of the pilots to standard.

According to the flight operations inspector Mixed Fleet Flying (MFF) is a reality for the Airbus types. They would like to roster for mixed types in order that the pilots could be used more effectively and meet the minimum requirements to stay current while operating long-haul flights. He agrees that there would be weight differences between the different aircraft types and that would have some effect. For the CCQ Airbus prescribes certain standards, the operator has accepted these standards and is even more through with the institution of the standards.

Relating to the question whether the operator is not expanding a bit too fast and are not able to keep up with the expansion relating to human resource issues? In the flight inspector's view they are expanding at a very high rate, but the GCAA is keeping a close watch on the operations. They concentrated the last audit on the training section after the incident they will keep a good watch over this aspect.

1.18 Additional Information

1.18.1 Training

In the Outcomes Based Education system "Outcomes" relate to "**demonstrable and assessable end products** of a learning process. They are statements regarding elements of competence" (SAQA Guidelines for Assessment, 2001: 21). They go beyond the specification of subject content and can include reference to actions, roles, knowledge, understanding, skills, values, attitudes that a learner has to perform to demonstrate competence, the criteria against which these will be assessed, etc.

The matter of demonstrating competence is to show or prove practical application of skills, knowledge and understanding against a determined set of criteria and the ability to transfer these skills, knowledge and understanding to new situations and environments. It means that skills and activities, as knowledge and understanding are equally important. Competence is measured against set standards and not against other people's abilities and knowledge.

In very simple terms the process of training deals with three components that need to build the trainee to the point where he/she are able to demonstrate the outcomes required to be able to perform the task the training was meant to prepare him/her for. These steps are attaining:

- Knowledge

  The trainee will need to complete a process where the theoretical knowledge of how the task needs to be executed is imparted to him/her. This process of imparting knowledge can be by a few methods for example by classroom teaching, reading assignments, computer base teaching, newsletters, etc. During the conversion training of pilots in this instance it was obvious that the pilots have already attained a high level of knowledge of how the other Airbus aircraft fly and the operational requirements of the different aircraft they operate. The knowledge requirement the pilots needed to attain, dealt with the differences of the Airbus A340-300 to the other aircraft (Airbus A330-200 and A340-500) that they have already flown. However one need to keep in mind that knowledge is not only attained by formal means, but a large amount of knowledge humans add to their knowledge banks are attained by informal methods, like a talk to a colleague, reading an article in a book, etc. The problem with this type of knowledge gained is that it is not necessary validated as correct. The implication is that if such knowledge is used in a critical situation the wrong results could be obtained. Manufacturers of aircraft attempt to reduce these types of knowledge to an absolute minimum by describing in detail the procedures to operate the aircraft safely in the Pilot Operating Handbooks of the aircraft and these procedures are usually captured in the operator's operating procedures relating to the operation of the aircraft type.

- Experience

When the knowledge is applied to certain conditions and the trainee is put in a situation where the knowledge is applied to execute a set of actions he/she builds up a set of experiences. The more times the knowledge is applied under controlled conditions and the trainee is provided with feedback about his/her actions the more experience he/she builds up in the learning phase. These experiences grow into skills to execute the task correctly and safely. In the case of pilot training under the operator's conditions the pilots are subjected to flying simulators after the sessions to impart the knowledge of the aircraft type to them. This is to be able to build on their experience of flying the type of aircraft under controlled conditions. The flight instructor needs to assess the pilot's performance under these controlled conditions and point out to him/her the errors in his/her performance relating to the knowledge (prescribed operating procedures) attained. During this time the pilot is able to validate the knowledge he/she has obtained by experiencing how the aircraft react and if the knowledge put over into practice, does not provide the required results, it is possible that the pilot had either incorrectly interpreted the knowledge obtained or the knowledge he is applying as a technique is incorrect and need to be corrected. The trainee will either discover the errors him/herself if he/she do not obtain the required outcomes to the actions he/she executed and correct it or the errors will be pointed out to the trainee by the instructor. In these ways the experiences of the trainee contribute to him/her attaining the required skills to execute the task correctly and safely.

- Skills

During the process of building on experiences the trainee transform the attained knowledge he/she experienced to skills to execute the task he/she was trained to master at a certain level of excellence. The more times the person experience a certain set of actions, the more skilled the person will become to handle that set of actions and actions related to the experienced situations. The pilots in this situation already attained a high level of skills relating to flying the different types of aircraft and during the conversion training need to build on the skills they already possess to attain the skills they require to fly the different aircraft type. According to the manufacturer of the aircraft involved in this incident the further amount of skills needed to fly the different variant to the type of aircraft was very limited because they designed the different aircraft types and variants in such a way that the sensations involved is very similar.

ASSESSMENT

An essential part of the learning process is to be assessed in order that the person has attained the required level of competence. Assessment is a structured process for gathering evidence and making judgements about an individual's performance in relation to registered national standards and qualifications. The assessment must assess the **learner's ability to perform**. Furthermore **Assessment criteria** are described as statements that describe **the standard** to which learners must perform the actions, roles, knowledge, understanding, skills, values and attitudes stated in the outcomes. They are a **clear and transparent expression of requirements** against which successful (or unsuccessful) performance is assessed. (SAQA Guidelines for Assessment, 2001: 16-21).

In the latest Guideline for Integrated Assessment (SAQA, 2005:7) the guideline attempt to describe that **Integrated Assessment** must judge the quality of the observable performance, but also the quality of thinking that lies behind it. Assessment tools must encourage learners to give an account of the thinking and decision-making that underpin their *demonstrated performance*. Some assessment practices will be of a more practical nature while others will be of a more theoretical nature.

OPERATOR PILOT TRAINING

Considering the conversion training of the pilots in this instance, one needs to keep in mind that the pilots complete the different aspects of theoretical training first and then advance to the practical aspects of their training when they proceed to the simulator training (refer to 1.5.2 **Cross Crew Qualification**). During this aspect if one relate to the operator's A340 FLIGHT CREW TRAINING MANUAL (Chapter 07.07 TAKE-OFF), the training of the pilots could be considered in certain respects as a type of outcomes based training. The module in the training manual includes points like training objective, schedule, equipment, instructor's action, trainees' action and common errors. There is however not much mentioned about the assessment criteria, although it is captured in certain respects in the Training Objective of the module which states:

To perform a take-off and initial climb to acceleration altitude in accordance with the standard procedures

The module refers to all the applicable documents that describe the standard procedures under the heading "Equipment" and the outcome of this module could thus be accepted as that the pilot will be able to perform a take-off with the aircraft within the norms of the standard procedures. During the simulator sessions, the simulator instructors should thus attempt to carry out an integrated assessment action in order to judge the quality of the pilot's observable performance. During these observations he/she should also attempt to determine the quality of thinking that underlie the pilot's decision-making. This would be a difficult action to attain, but with careful observation and letting the trainee brief each procedure as he/she execute it, one would be able to make some judgements in respect of the trainee's understanding of the action he/she is engaged in. Finally the instructor has to make a decision considering the evidence gathered during the assessment whether the trainee has accomplished the required competence and skills to execute the task safely and correctly. The assessment actions have a dual purpose, on the one hand to assist the trainee to carry the procedure out correctly (for example the take-off) and to correct any actions that is not according to the standard operating procedures. In the second instance it involves a judgement to decide whether the trainee has attained the required skills to be able to execute this set of tasks in order that he/she may be certified to for example fly the aircraft safely.

1.18.2 **Flight Operational Quality Assurance**

An US FAA Advisory Circular (AC No. 120-82, dated 12 April 2004) describe a Flight Operational Quality Assurance (FOQA) program as:

A voluntary program for the routine collection and analysis of flight operational data to provide more information about, and greater insight into, the total flight operational environment. A FOQA program combines these data with sources and operational experience to develop objective information to enhance safety, training effectiveness, operational procedures, maintenance and engineering procedures, and air traffic control (ATC) procedures.

The advisory circular describe the program as:

A FOQA program is used to reveal operational situations in which risk is increased in order to enable early corrective action before that risk results in an incident or accident. FOQA should interface and be co-ordinated with the operator's safety programs.

In a FOQA program, data are collected from the aircraft by using special acquisition devices, such as QARs, or directly from the FDR. Using one of several available transmissions, data are periodically retrieved and sent to the air carrier's FOQA office for analysis. This office usually resides within the flight safety organization at the air carrier. The data are then validated and analysed using specialized processing and analysis software.

It is obvious that the larger number of parameters that are monitored, the better the quality and capability of the operator's FOQA program. However the operator can choose to monitor the parameters that would provide them with the essential information to make informed decisions on the performance of the aircraft and crew. The oversight of this program is usually in the safety section of an airline and the information is handled confidential and with great care in order to keep the flight crew's confidence in the program. The most important aspect of the FOQA program should be to use it as a tool to improve the man-machine interface and not to apportion blame.

The manufacturer also has a FOQA system available to their customers called FOMS for Flight Operations Monitoring. The package contains tools and methods. The tools involve a QAR read-out software package and a Line Operations Analysis System. The methods encompass a Flight Safety Manager Handbook with guidelines to manage a Safety Office and the Flight Operations Monitoring handbook with information on how to manage a FOQA program and analyse events.

The UAE Civil Aviation Regulations (Part IV, Subpart B, paragraph 2.8) required that an operator of an aircraft with maximum certified mass over 20 000kg shall establish and maintain a flight data analysis programme as part of its accident prevention and flight safety programme.

The operator's safety section indicated that at the time of the incident the data for the Airbus A340-300's was available from the QAR's, but a full-scale flight data monitoring and analysis programme was still under development. The programme was instituted in August 2004, but even if the programme was operational during the time of the incident, it does not monitor the parameters relating to the control deflections and low rotation, or rotation reversal. These parameters are not even monitored on the aircraft (Airbus A330-200) that had an active FOQA program. This suggests that it would have been most unlikely that an event of the nature of this incident would have been detected. Checking with a local operator that operates similar aircraft types, it was apparent that they do not monitor the parameters that would indicate an excessive de-rotation rate during take-off either and would have not detect a similar event either.

In the current situation several parameters relating to the take-off conditions are monitored, but the take-off roll distance in relation to the take-off run available on individual runways, is not monitored. There is a present development being planned in response to the Approach and Landing Accident Reduction initiative to monitor the actual ground roll and associated deceleration rates, but this type of monitoring will need an extensive database of runways and comprehensive event monitoring.

There were data available for six take-offs the captain had performed with the Airbus A330-200. Two of these take-offs were after the captain had attended the recurrent training sessions during March 2004 and the last data set was a take-off from Johannesburg International Aerodrome a few days before the incident. The conditions of the take-off in each case could have been different, but the pertinent information reviewed was related to the rotation of the aircraft. The graphical data suggests that in all the take-offs the inputs to rotate the aircraft and the rotation of the aircraft was a "classical A330 rotation" according to the safety officer of the operator. During each rotation the stick inputs was positive and the aircraft reacted with a nose up pitch. The initial stick input followed with a slight relaxation forward and then a second rearward movement just prior to main wheels lift off. This is not consistent with maintaining the SSOI at a given displacement (progressively feeding in forward stick) on the PFD throughout the rotation. However it was interesting to note that the graphical data of the captain's first take-off after the recurrent training sessions suggests that although the rotation appeared to be as usual, the pitch rate seemed to be more erratic after lift-off than the in the other take-offs. On the graphical data of the Johannesburg take-off it appeared that there were a second forward movement of the side-stick (related movement of the elevator) and not just once like in the previous take-offs. This made the aircraft's pitch rate to become a small amount more negative than in the previous take-offs for a second or two.

1.18.3 Human Response Time

Response time = Perception + Recognition + Decision + Reaction

The perception and decision time is the time it takes to view a hazard and figure out what to do about it. The reaction time is the time it takes to perform a particular function once a decision has been made. The response time for removing one's hand from a hot skillet is relatively quick and is on the order of about a half second. In this example, a natural response to excessive heat bypasses the visual sensors, allowing for a quicker response time. Driving an automobile requires a high degree of visual processing, which tends to extend response times.

What can be gleaned from the previous discussion is that response time is a distributed quantity because of variability in people, as well as in situations that require a response. The accident reconstruction community often assumes a maximum 2.5 - 3.0 second response time. This may be applicable for most accidents with obvious hazards. Other accidents involving less defined or confusing hazards may result in longer response times. Examples of other factors extending response time are age, time of day, lighting, etc. suggesting that response time is typically characteristic of a particular set of circumstances encountered in an accident.

During an Experimental Study of Collision Detection Schema Used by Pilots during Closely Spaced Parallel Approaches (Pritchett & Hansman, 1996) carried out at the Aeronautical Systems Laboratory, Department of Aeronautics & Astronautics, Massachusetts Institute of Technology the subjects, comprising of pilots and non-pilots, were tasked to fly a parallel approach in simulator conditions. The subjects flew the approach with the aid of five different displays. All these displays were based on a moving map principle, with a top-down view, heading-up orientation, iconic presentation of the other aircraft's positions and a text presentation of the other aircraft's altitudes. A workload component were introduced by having the subject to keep their aircraft's wings level by means of a side-stick referenced to an artificial horizon and turbulent conditions were simulated. While the subject was "flying" the approach different scenarios were introduced of the aircraft on the parallel approach, 2000 feet apart, converging towards the subject's aircraft with different intercept angles. The subjects were briefed beforehand about the controls and were allowed as many practice runs as they requested.

During the "flight" phase of the experiment the subject's primary task was to keep the wings level, but the side-stick commands did not affect the flight path. Their secondary task was to press a red button on the side-stick as soon as they thought the aircraft on a parallel approach was blundering towards them, as evidenced by the traffic display.

The part of this experiment the investigator found relevant to this incident was that reaction times under workload effects were very much the same during the experiment. The difficulty of the wings levelling task was controlled by generating high or low amounts of turbulence in bank, and thereby creating a high or low workload for the subject to attend to away from the traffic display. The experiment determined that most of the performance measures were nearly identical when comparing the data from runs with high workload against runs with low workload. The average reaction time in the high workload runs was 9.74 seconds, compared with 9.73 seconds for the low workload runs. Furthermore when different scenarios were introduced relating to high and low convergence rates and low and high turn rates, the reaction times also averaged in the region of 10 seconds.

1.18.4 Other Human Factors Terms - Explanations

Canalized attention – fixation

Canalized attention tends to occur in high stress situations, where a person becomes preoccupied with one thing to the exclusion of the others. Obviously, this becomes a problem when the person fails to perform a task or process information of a higher or more immediate priority and thus fails to notice or has time to respond to cues requiring attention. This is exacerbated when a *mindset* is formed from pre-learning.

False hypothesis

The term false hypothesis has been used to refer to the phenomenon whereby an idea, once formed, can become very resistant to challenge, even when information is available that would contradict the idea. This phenomenon can seriously disrupt fault diagnosis because a premature, incorrect diagnosis of the problem may become unconsciously entrenched, even when the available evidence contradicts it. Pilots are particularly susceptible to this phenomenon:

1. in ambiguous situations;
2. when a particular outcome is expected; or
3. when workload is high, time is limited or the pilot is distracted.

Common scenarios or ideas have a strong tendency to become default assumptions. The concept of false hypothesis is closely related to the issues of confirmation bias and *mindset*.

Situational Awareness

Situational awareness requires pilots to have a clear mental model of what is happening. This can be broken down into 3 levels:

1. An accurate perception of what is happening.
2. Clear understanding of what is happening.
3. An ability to predict and comprehend what will happen in the near future.

Situational awareness forms the critical input to decision-making, which is the basis of all subsequent actions.

Mindset

Mindset is a tendency to use a particular method or type of solution based on learned rules, instructions or previous experience.

Sense of time

The sense of time is also subject to the number and the emotional significance of the stimuli to which human senses are exposed. A sequence of many stimuli is felt to be fascinating, if a demanding task has to be performed, for example, if there is a favorable environment or our brain is challenged by and occupied with a task. The fact that there is potential danger in the rapid course of events can only be recognized as such in retrospect with corresponding distance to events. Time does indeed pass evenly. We appear, however, to gauge it according to the intensity of psychic events. If the brain is not capable of working faster, we alter the concept of time, an unconscious and for this very reason calamitous procedure. Our memory too is by no means straightforward. Trivial matters are concentrated on or totally eliminated, decisive seconds stick in the mind as if in slow motion.

Cognitive capability

For almost a hundred years it has been recognized that cognitive performance capability is linked in some way to the amount of load placed upon the individual (Yerkes/Dodson). Capability increases with increasing demand up to a point of optimum performance and declines thereafter towards confusion and panic. It has also been determined that cognitive capacity is rapidly used up by basic emotions such as fear, and that fear may not be confined to threats to survival but extends to threats to one's social standing and status (Abraham Maslow).

Confirmation bias (*Additional relevant information*)

Confirmation bias refers to the phenomena whereby having formed an assessment of an ambiguous situation, a person will sometimes treat information which does not fit their assessment as though it were less reliable than information which does fit their situation assessment. For example, it has been observed that when diagnosing a fault in a system people commonly develop a theory of what is wrong and then search for information, which will confirm their theory. People however, are less likely to attempt to dis-prove their suspicions and may disregard information, which would contradict their ideas.

While originally a concept drawn from cognitive psychology, confirmation bias has been highlighted as a risk in aviation environments by several authorities including Green et al (1991) and Campbell and Bagshaw (1991).

1.19 Useful or Effective Investigation Techniques

1.19.1 No such techniques were employed during the incident.

2. ANALYSIS

The analysis of the circumstances related to this incident need to be considered from the point of view that the aircraft rolled down the runway, attained the required speeds in reasonable time, but did not rotate adequately and lift-off as it was intended to do. The first considerations would be about the environment like the meteorological conditions and the runway, then the performance of the aircraft and then the performance of the different personnel.

2.1 ENVIRONMENT

Considering the meteorological conditions, it was determined that there were no adverse meteorological conditions that could have had an effect on the circumstances of this incident. The surface wind was a 6 knot headwind at an angle of 60° to the right of the take-off direction.

The aerodrome is a high elevation aerodrome and Runway 21R used during the incident take-off have an up-slope of 1.2%, but considering the other observed flights taking-off from the same runway this conditions should not have had a bearing on the ability of the aircraft to take-off within the planned take-off profile.

All the runway light fittings were of the frangible type, but the ground speed of the aircraft at the time when the tyres contacted them, was approximately 190 knots. During the inertia of such an impact one would expect the tyres to fail, frangible light fittings or not. A negative point relating to the over-run area was the exposed edges of some of the approach lights plinths in the grass-covered over-run area of the runway, however judged by the debris distribution, it suggests that the tyres that failed, had done so when it impacted the first set of runway end lights. The plinths with exposed edges would thus not have had such a serious effect and furthermore it appeared that the aircraft was probably partially airborne at that stage due to the failure of the rear main tyres on the main landing gear bogies. No tyre failures occurred on the nose wheels or the centre landing gear wheels as they were off the ground.

Although one do not expect aircraft wheels to roll over the overrun area of the runway, it is still a safety issue if an incident such as this or an aircraft suffering a rejected take-off/over-run event occur, that the aircraft will sustain damage due to the light plinths not being totally flush with the overrun surface.

2.2 AIRCRAFT

The aircraft was a much more complex issue, one need to consider its operation in different aspects.

2.2.1 Performance Profiles

When all the facts were considered relating to the incident aircraft's performance and mass and balance, it was concluded that the aircraft had performed as it was meant to perform, but one need to consider how different design features of the aircraft had contributed to this incident at different levels.

The fly-by-wire type aircraft was not new to the aviation industry at the time of this incident and with such technologically advanced systems, the manufacturer's design philosophy was that these different aircraft types and variants (Airbus A340's and A330's) should react similarly relating to their flying characteristics. However it was found during the investigation that these views were not totally accepted by the operators of these aircraft. The investigator was not totally convinced about these facts either.

The reality is that there will be differences between twin-engine and four-engine aircraft performance, purely from the standpoint of when the aircraft suffer an engine failure the thrust-loss will be a difference between 50% and 75% of the total thrust available. The certification requirements were thus different and with the more power available the twin-engine aircraft is thus a higher performance aircraft at take-off than the four-engine aircraft under normal conditions. This fact set the pilots up to have a different perception of the four-engine aircraft and also different expectations relating to for example take-off performance. They expected that the aircraft would take-off at a further point down the runway as experienced during the previous day's take-off and was thus not so easily alarmed during the incident take-off. If one refers to the typical ground roll distance calculated for the incident conditions by the manufacturer, the aircraft should have lifted off at approximately 77% of the runway length. At an approximate ground speed of 180 knots (92,6 m/s and not considering the acceleration) the aircraft would have covered the rest of the runway available in approximately 11 seconds.

Furthermore it was well known to the pilots and even to the ATC that the Airbus A340-300 was a "lower performance" aircraft related to ground roll and it's rate of climb. This was confirmed by the mass-to-thrust ratio of the aircraft in relation to the other two types/variants Airbus aircraft of the operator's fleet. The use of Flexible Take-off Thrust does have an effect on the climb profile of the aircraft, although the performance of the aircraft during take-off and initial climb meet the certification requirements with these power settings. However one needs to question whether such a low profile is really necessary and if it could not be increased by a certain amount, although one understand that it would have a long-term effect on engine performance and that fuel consumption might be increased by a small margin.

The Airbus A340-300 was not fitted with similar tailstrike avoidance architecture as the Airbus A340-500, which made it more vulnerable to tail-strikes and from early communications with the pilots, to the operating procedures and training interventions, it was clear that the performance and tailstrike avoidance aspect of the aircraft were well emphasised. This could have had two outcomes, on the one side it would have made the pilots very aware of the prescribed operating procedures and on the other hand it could have led to fixation of the pilot on their rotation technique.

2.2.2 Flight Display Architecture

The design of the PFD would have included an analysis of the potential risks that could arise from displaying an excessive amount of information. Essential information (Pitch and Roll attitude, speed, etc) would be included. However, the presentation of the SSOI, not critical to aircraft flight, introduced a risk of misuse that was not identified to it's full extent. With hindsight it is easy to see that removal of this information from the PFD, at an earlier point, for example when the nose wheels leave the runway surface, it would have resulted in a different outcome to the take-off.

2.2.3 Movement of the Side-Stick Order Indicator

The fact that fore and aft movement of the side stick appeared on the PFD as vertical movement of the SSOI, which could be related to an equivalent aircraft pitch attitude (in degrees) introduced the potential for misinterpretation. This was evidenced to the point that, in pilot training ⅔ back stick had been equated to +9° on the pitch attitude scale.

2.2.4 Tyre Pressure Indication

As the aircraft left the end of the runway, the rear wheels of the main bogies hit a number of objects and several tyres burst. However, in the absence of a Tyre Pressure Indication System (TPIS) and an associated ECAM warning of low tyre pressure, the crew had to rely on their own analysis of the vibration and ECAM FLAPS LOCKED message, to determine what had gone wrong. They included the possibility of tyre failure and advised ATC. However, airport technical staff initially found no evidence of damage, or tyre debris and it was only on the third inspection, as the aircraft was being radar vectored towards its approach that the crew were able to confirm a problem with one, or more of the wheels. It is also worth noting that, had the flaps been unaffected, the crew would have remained in ignorance of the problem and, in all likelihood, the aircraft would have continued towards it's destination.

2.2.5 Brake Failure during Landing

Due to the LOW auto-brake selection no wheel braking action occurred during the first ten seconds, which suggests that the braking system operated as selected. At approximately 70 knots, the braking became inefficient due to the erroneous anti-skid function. The destruction of several main wheel tyres caused the tachometer generators to supply erroneous signals to the anti-skid system and it released the brake pressure. After the auto-brake was disconnected the deceleration was still low but one need to keep in mind the failure of the Number 8 wheel rim hub and associated anti-skid failure, which resulted in the indication the pilots noted. Theoretically this failure should not have affected the other wheels or the system as a whole if all the wheels were intact, but with the other failed main wheel tyres, anti-skid action are not totally predictable due to conflicting wheel tachometer signals and inaccurate reference speed computations. No Abnormal or Emergency procedure for this condition was found in either the FCOM or QRH where a landing needs to be performed with main wheel tyres damaged and the resultant erroneous anti-skid operation. One do understand that the pilots will only become aware of the failure once the aircraft has landed and the braking action is not as expected, but if such a procedure is in the FCOM the pilots become aware of it and could be trained for these conditions.

Another point to ponder was that probably all the main landing gear wheels on the rear of the main landing gear's bogies had failed and that would reduce the braking effect significantly in any event. The failure of the forward main wheel tyres was probably after the application of brakes without the anti-skid system active and occurred when the aircraft came to a halt.

2.2.6 Exit Lights

Besides the normal use of the exit lights to indicate the position of the exit doors to the occupants of the aircraft, these lights are very important when there is an emergency evacuation condition. Particularly in these conditions, traumatised passengers need to be guided out of the aircraft. If the lenses of these lights come adrift under hard landing conditions or high vibration conditions as was proved during the incident flight, the basic purpose of the lights are compromised. It appeared that the lugs attaching the lenses to the plastic fittings are inadequate and do not provide sufficient support to properly secure the lenses to the light fittings, especially during hard landing or high vibration conditions.

2.2.7 Simulator

The simulator used during the pilots training to the Airbus A340 was the A340-300 simulator. This simulator was certified as a zero flight time simulator and was accepted to perform as close to the actual aircraft as could be. During the simulator trials it was however observed that even if the simulator was flown as close to the incident conditions as possible it would take-off each time. It can thus be concluded that although the simulator simulated the flight conditions very close to the actual aircraft, it was not exactly the same as the aircraft. This obviously contributed to the situation that when the captain used the technique to rotate the aircraft with the aid of the SSOI, it made him to believe that it was a correct technique to rotate the aircraft and transit to flight.

2.3 CREW

The information obtained from the data recorders and the cockpit voice recorder as well as interviews with the pilots and simulator sessions with both pilots, it was determined that the captain who was the pilot-flying at the time of the incident, used an incorrect technique to fly the aircraft during the rotation to lift-off. This technique was very close to the technique described in the FCOM, with the inclusion of the incorrect technique of flying the SSOI to the 9° position on the PFD attitude indicator. It appeared to the investigator during the interviews with the pilots and from an analysis of the CVR that both of the pilots were very professional in the conduct of their duties. They were also totally unaware of what the cause was for the aircraft not to rotate and take-off properly. Furthermore both the pilots were inexperienced on the variant of the aircraft, which put them in a situation where it was more difficult to identify/recognize an unusual situation. The question then arises why the captain used the different technique and added to it what was the roll of the first officer? The following aspects will now be addressed relating to the above deliberation:

2.3.1 Pilot Training

After the above discussion about the pilots' training and in particular the captain's recurrent training, it is essential to ask the question about how this aspect had contributed to the circumstances of this incident. In the following paragraphs these aspects will be deliberated on.

Although MFF is operationally attractive in economies of resource, it may be in the commercial interest of a manufacturer to understate the challenges of introducing and maintaining the concept and minimize the costs of CCQ training. Furthermore pilot expectancy of the performance of the different variants of a certain type could give rise to human factor considerations.

The manufacturer of the aircraft promulgates a single rotation technique for all their FBW aircraft, which takes into account individual type characteristics without compromising the rotation performance of the other types. The potential consequences of failing to apply this technique correctly vary from type to type. However the reality is that all aircraft rotation characteristics and performance (eg. thrust to weight ratio) do vary and this is further exacerbated between differing FBW types. ie. twin engine versus quad, Airbus A340-500 light versus Airbus A340-500 heavy etc.

Reference to rotation technique is made in several operational documents and whilst not greatly different in essence, the descriptions and values do vary substantially. However, there is no reference in the operator's documentation to use of the SSOI.

Tail strike avoidance is referred to frequently.

Aircraft handling techniques such as the transition to flight would normally be addressed in flight training, either in the simulator or the aircraft itself. It was unusual to present such a technique in a ground school syllabus, which would normally be confined to addressing aircraft systems and procedural training, particularly as reinforcement of this was not addressed in the subsequent simulator-training program.

At the initial line training of the Airbus A340-500 in Toulouse pilots experienced PIO, as a result of further inputs to the side-stick. To eliminate such scenario the pilots were advised to apply positive side-stick movement and maintain it until the transition to flight had taken place.

The relatively low thrust-to-weight ratio of the Airbus A340-300 was considered to present a higher risk of tail strike during take-off than other Airbus types of the operator. This concern was emphasized to pilots during CCQ and recurrent training, and was regularly highlighted in management communications regarding the Airbus A340-300. Tail strike had become the subject of frequent discussions between pilots on the fleet, almost to the point of obsession, perhaps reflecting an undue concern as to the risk.

Based on the Airbus A340-500 & Airbus A340-300 scenario, as described above, some pilots adopted a "tip" for correct side-stick position. This was a reference to the 9° of the SSOI on the PFD.

The adverse observations of a visiting manufacturer's representative, regarding the pilots of the operator's inconsistent rotation techniques, together with misinterpretation of Airbus A330 recorded flight data trends, raised management concern regarding tail-strikes. As a result, a module entitled "avoiding tail strikes" was incorporated in the recurrent ground school syllabus. Part of this module included a section referring to take-off technique.

Several training staff of the operator had been shown the use of the SSOI as a means of either calibrating their wrist movement prior to take-off, or of measuring their stick input during the initiation of rotation (originating from the European operator and/or manufacturer and the operator's pilots who had been trained by them). Knowledge of this technique had passed to instructors in the ground school and one or more instructors had discussed this with pilots during recurrent training. Previous Airbus A340-300 take-offs from Johannesburg (and an earlier training flight of the operator from New York's JF Kennedy Aerodrome with the European operator) were anecdotally reported as having used more runway than expected and having crossed the end of the runway lower than expected. That well-regarded pilots and general industry perceptions of Airbus A340-300 performance had encountered these perceived concerns further raised the pilot expectations of low performance.

The operator's CCQ ground training course exceeded that of the manufacturer and also met the minimum regulatory standard. However, given the pace of introduction of the Airbus A340-500's and Airbus A340-300's, together with the demands of the MFF concept and the planned operational network, it could be argued that more classroom lectures would have provided additional knowledge.

2.3.2 Human Performance - Captain

In analyzing his performance, the investigation sought to determine why it was that the Captain, an experienced and able pilot, had applied an incorrect take-off technique and had been oblivious to an unsafe condition until the aircraft departed from the paved surface of the runway.

The Captain was highly regarded by his peers, the Training Department and Management of the operator, for his professional capability and his adherence to SOPs, (he had in the past served as a Line Check Captain). Like many other Airbus A340 pilots, he was concerned about the risk of tail strike and when he became aware, in the recurrent ground school training, of a 'new' rotation technique that would work equally well on all FBW types, he embraced it fully. He did not appreciate that use of the SSOI was not a new technique but merely a tip to gauge one's correct use of the existing technique of selecting 2/3 back side-stick. In common with the ground school instructor and others in the operator, he was unaware of the potential implications of using the SSOI throughout rotation and not to limit it to only the backwards moving of the side-stick. That he was subsequently able to successfully apply the technique in the Airbus A340-300 simulator and in line operations in the Airbus A330, reinforced in his mind that the use of the SSOI was a valid means of judging 2/3 back stick and correctly transitioning the aircraft to flight. The knowledge he gained about the SSOI (9° target) was thus validated during his experiences in the simulator and in flying the other aircraft (although it was incorrect information and not an approved procedure), but he did not reach the deduction that when the nose rise during rotation, the horizon will "lower" relative to the aircraft symbol and if he then follow the 9° target the aircraft will de-rotate. This bit of information was not shared with him either.

The Captain was concerned about being the "first to strike the tail", and emphasized this and other aircraft performance issues (long take-off run, slow rotation, airfield elevation, the crew's unfamiliarity with the type) in his pre-flight conversations with the First Officer. He developed a <u>mindset</u> to apply the 'correct' rotation technique (as he understood it), with accuracy. There was obviously also a level of stress involved because it was the first time he would execute a take-off in the actual aircraft. However, he did not mention this to the First Officer.

He initiated the rotation correctly by selecting approximately 2/3 back stick but did this by reference to the SSOI. As the rotation began, he continued to focus all of his attention on the SSOI and maintaining it at 9°, rather than aircraft pitch attitude. Subsequent tests showed this to be highly demanding in terms of concentration. It is likely that he had no remaining capacity to observe other cues as to aircraft behavior and the external environment, due to <u>*fixation*</u> upon the SSOI. The fact that the SSOI remained in view after initiation of rotation, served no apparent purpose and, in this instance, it acted as a vehicle for the Captain's continued fixation. Task <u>*fixation*</u> *(as described under '<u>Canalized Attention</u>' – see 1.18.4 Additional Information)* is a well-understood phenomenon and has been identified in many accidents.

He remained essentially oblivious to the developing situation for 15 seconds, from the point at which he made the initial side-stick input, until he felt the aircraft leaving the runway and running over the runway end/approach lights. A combination of vibrations and possibly the First Officer's call of "TOGA" alerted him to the abnormal condition. Once alerted, the Captain's reaction was rapid and correct, and thereafter his performance as Captain and as PF was quite normal. In the subsequent management of the event, returning the aircraft to a safe landing on Johannesburg International Aerodrome, his Cockpit Resource Management (CRM), communication and overall performance was excellent. When the Captain detected that the aircraft did not decelerate as required during the landing and both crew then attempted to use the normal brakes without success, the aircraft was dangerously close to going out of control. The quick analysis of the situation, by both pilots and the subsequent selection of the nose wheel steering/anti skid switch to off undoubtedly prevented further damage to the aircraft.

2.3.3 Human Performance – First officer

The First Officer, as the PNF, was responsible for monitoring that the Captain safely accomplished the take-off. In analyzing his performance, the investigation sought to determine why he did not detect that an unsafe condition was developing, after the initial rotation and before the aircraft departed from the paved surface of the runway.

The First Officer was also regarded as professionally knowledgeable and competent and had been a Training Captain in a previous airline. He was aware to some extent of the Airbus A340-300's reputation as a "poor performer" but, unlike the Captain, had not been exposed to information on the use of the SSOI during rotation.

During the take-off, the First Officer said that after he made the "rotate" call, he observed the initiation of rotation thereafter, by the SSOI and the nose upwards movement. His expectation was that the Captain would be using conventional pitch attitude, to reference the rotation. Shortly afterwards, he was aware that the rotation had ceased and reversed, but believed that the Captain was correcting for an initial over-rotation to avoid tail strike. He expected the aircraft to become airborne, believing the take-off was continuing, but the anticipated aircraft response was not apparent. The abnormal condition persisted for a maximum of 5 seconds, during which, he made no further calls nor intervened on the flight controls, until the vibration consistent with the aircraft leaving the paved surface of the runway. At that point he stated that he called "TOGA"

The Pilot's understanding and expectation was that the aircraft performance would be marginal. This was confirmed, in his mind, by the apparent delay in rotation from the V_R call being made. When he observed the nose dropping, he found himself in a novel situation, which he rationalized as tail strike avoidance. This was supported by his confidence in the Captain's capabilities and he was anticipating the transition to flight. His *false hypothesis* conflicted with the actuality of the situation and, at this stage he saw no need to (and did not) intervene.

In aircraft performance terms the monitoring of thrust, speed and attitude are critical. During the interview he was frequently asked where he was looking after he had called "rotate". His answers indicated that he had no clear recollection of the specific timing of these events. He stated that he was not looking at airspeed, as he knew that V_R had been passed. Though not relevant in determining the aircraft's relative position, he recalled seeing the apron lighting in his peripheral vision, on his right-hand side, at some point during the rotation, but said that he could not see the runway end lights due to the aircraft nose up attitude. Yet, subsequent calculation indicates that the runway end lights should have been visible to the crew until just before they were crossed. However the conversations recorded on the CVR during the flight, suggested that the first officer saw the runway end lights.

It is possible that, having looked inside he had begun to move his attention to the next anticipated sequential task. This would be to identify the transition to flight, by detecting a positive climb (by reference to radio altimeter and the instantaneous vertical speed indicator). This and the other factors described suggest a short term degradation of his cognitive capability.

The precise time scale available for his separate mental processes of recognition of any abnormality, analysis of the cause and a response, is difficult to determine with absolute accuracy, but was approximately 5 seconds. One needs to keep in mind that the conditions the first officer found himself in were conducive of a longer response time from the point of view that there were not very many cues available to him of a situation that is developing into an unsafe condition. His confidence in the captain, expectancy of a 'lower performance' aircraft, experience of the previous day's take-off, tailstrike avoidance actions in mind, made him not to expect the circumstances that would cause an over-run incident. Thus one could expect that the generally accepted 2.5 to 3 seconds could not be applied during these circumstances and that his response time could be closer to the 9 to 10 seconds determined in the experimental process discussed in 1.18.3 - **Human Response Time**

2.3.4 Pilot Assessment

The captain validated the incorrect bit of information during a few different situations, some under the supervision of a simulator test instructor and some flying the Airbus A330-200. A further question now arise about how it was possible for the captain to apply the improper rotation technique (effectively validating the improper knowledge) and it was not identified on the take-offs he had performed either during the training sessions in the simulator or the two take-offs he executed after the recurrent training. These assessment opportunities should have acted like filters to be able to identify the captain's improper knowledge by his actions and to put steps in place to rectify the error.

The first filter that was breached was the assessment during the captain's simulator training. This assessment is meant to identify the application of the pilot's knowledge and experience while he is developing the required skills and to determine if the pilot attained a level of skills that would render him safe and competent to execute the required skills in a real life situation. This instructor did not identify the different rotation technique during his assessment of the captain's take-offs in the simulator. This can easily happen due to the performance of the simulator (it took off every time during the simulator trials) and in the simulator with the lower stress environment, the captain was probably in a different *mindset* and did not get fixated on the SSOI as it had happened during the incident take-off. The simulator instructor furthermore did not expect this behaviour from the captain during the rotation and could have not taken in the full consequence of the actions. With the lift-off the episode was past and the flight carried on as usual.

The second filter in the process that did not detect the different rotation technique was the FOQA system. This system only had two opportunities to detect a difference in the captain's rotation technique as he had only executed two take-offs after his recurrent training, but it also had its downfalls. The FOQA data was available and operational for the Airbus A330's, but not yet for the Airbus A340's. The captain had not taken off in an Airbus A340 during this time in anyway. Relating to his Airbus A330 take-offs, one could notice small differences in these take-offs, but it would not have been detected by the system. On the one hand the aircraft is a twin engine aircraft and rotate and lift-off quicker than the Airbus A340-300 and on the other hand the program was not programmed to identify an excessive de-rotation during the rotation for take-off (although it did not happen on the Airbus A330 take-offs).

In conclusion, taking the delicate differences between the actual aircraft and the simulator into account, it could be considered particularly important for the captain's first flight to have a back-up in the form of an instructor or a line captain in order to correct potential inappropriate actions. This would also have a reassuring effect foe the captain's first flight in the actual aircraft. The captain was concerned about a "tailstrike" and had no support from an experienced pilot to deal with it.

2.4 ORGANISATIONAL AND MANAGEMENT FACTORS

2.4.1 Operator

Expansion at the operator was at a very rapid rate in the last few years and it appears to be one of the most successful operators in the world. The introduction of the Airbus A340 fleet was well planned and executed even with the Airbus A340-300 group of aircraft that arrived. It is apparent that the operator's management would have embraced the principle of MFF to be able to meet their planned further expansions and meet the currency requirements of the pilots. The CCQ training of the pilots (appropriately approved by the UAE GCAA) was however a huge load on the pilot training section of the operator, hence the aim of the GCAA's audit a short while before the incident. It is however nearly impossible to detect the error that had lead to this incident during an audit.

Furthermore, the Airbus concept of CCQ addresses only the training requirement to transition pilots from one type of aircraft to another. It does not to account of the operator's background, nor the wider educational aspects of the aircraft type. i.e. two engines versus four engines. As a relatively new airline, the operator, had no established knowledge base of 4-engine aircraft operations, such as might be found in some other carriers who had introduced the Airbus A340's, but were already operators of Boeing 747's, or earlier 4-engine aircraft types.

The scheduling of the two pilots to fly together with both of them being new to the variant of the Airbus A340, was within the scheduling policy of the operator and complied with the requirements of the JAR-OPS as accepted by the GCAA. However with this incident in mind, it seems that this policy needs to not only cover the type of the aircraft, but also the variants.

2.4.2 United Arabic Emirates General Civil Aviation Authority

It appeared that the UAE GCAA was a well-established regulator and that they were able to meet their requirements as a regulator and overseer of the operator. They were well aware of the rather high level of expansion at the operator and was keeping a close watch on the training aspects of the operator as can be seen by the emphasis of the audit before the incident occurred.

3. CONCLUSION

3.1 Findings

3.1.1 Both the pilots were properly licensed to fly the type of aircraft and had complied with the requirements of CCQ-training to participate in MFF. It was the first flight that the captain had acted as PF in the actual Airbus A340-300 aircraft.

3.1.2 Tailstrike avoidance was much emphasized in the pilot communications relating to the introduction of the Airbus A340's. The differences in performance between the group of Airbus aircraft of the operator, like the different mass-to-thrust ratios, was also mentioned. This led to a situation where the pilots formed a *mindset* of the aircraft's performance and took longer to identify the improper take-off conditions.

3.1.3 The Captain employed an improper take-off rotation technique by reference to the SSOI on the PFD, and thus failed to apply the requisite consistent nose up side-stick input to rotate the aircraft to the normal take-off pitch attitude.

3.1.4 The Captain was made aware of the use of the SSOI to initiate take-off rotation, whilst undergoing recurrent ground school instruction. The potential hazard of using the SSOI in this manner was not universally recognized.

3.1.5 The Captain's *fixation* on the SSOI after the pitch attitude began to increase, led to a loss of *situational awareness*, which prevented him from detecting the abnormal rotation at night.

3.1.6 Presentation of the SSOI on the PFD unnecessarily enhanced the risk of a pilot mistakenly using it as a reference in managing the take-off. Furthermore, had the SSOI system logic been referenced to the nose-wheel air/ground switch, as opposed to the main-wheel switch, such that the SSOI disappeared as the pitch attitude began to increase, this incident could have been prevented.

3.1.7 The First Officer's exposure to a novel situation, reinforced by his *false hypothesis*, caused him to temporarily lose *situational awareness*. Furthermore the response time available to him to react to the situation was very marginal.

3.1.8 Having lost *situational awareness*, the First Officer was unable to determine why the aircraft was not rotating correctly and consequently did not intervene (until he called "TOGA").

3.1.9 An unofficial, but wide ranging association, relating the SSOI to an equivalent number of degrees of pitch attitude introduced the potential for misinterpretation.

3.1.10 The improper rotation technique applied by the captain, was not identified during assessment of his flight performance in the simulator or during the subsequent take-offs he had performed.

3.1.11 The FOQA system for the Airbus A340 fleet was not operational yet at the time of the incident and it would not have identified the improper rotation as an exceedance in anyway.

3.1.12 The aircraft was considered serviceable at the time of the incident and it performed in accordance with the published take-off performance data.

3.1.13 Rotation speed V_R was achieved at or close to the correct point on the runway and the aircraft had sufficient energy to rotate normally and safely transition to flight, at V_2 or greater.

3.1.14 The aircraft was loaded within the mass and balance limits during the incident take-off.

3.1.15 The absence of a TPIS denied the crew important information that would have further assisted them in accomplishing a safe return to Johannesburg International Aerodrome.

3.1.16 The tail strike protection system installed on the Airbus A340-300, is different to the advanced tail strike protection system installed on the Airbus A340-500 and the Airbus A340-600.

3.1.17 Some of the EXIT lights' lenses were not secure enough to withstand the forces imposed on the fittings during the landing with the damaged tyres. It appeared that the lugs on the lenses are inadequate.

3.1.18 The quick reaction of the crew to a non standard emergency condition during landing (the loss of braking action), prevented the aircraft from leaving the paved surface of the landing runway which would have resulted in additional, significant, damage to the aircraft.

3.1.19 Neither the FCOM nor the QRH has an Abnormal procedure related to landing the aircraft with damaged main wheel tyres and the probable associated erroneous anti-skid operation.

3.1.20 The meteorological conditions had no bearing on this incident.

3.1.21The aircraft over-ran the end of the runway by 233m and several runway end and approach lights were damaged when the aircraft's wheels impacted them. All the failed light fittings were of a frangible design.

3.1.22 Some runway approach light plinths were not flush with the over-run surface and created a hazardous situation for the tyres that impact the edges of the plinths.

3.1.23 Several tyres of the main landing gear wheels failed during the over-run and landing sequences. During the tyre failures the flap drive system was damaged by tyre debris.

3.1.24 The operator was the holder of a valid Air Operator's Certificate which was valid until 28 February 2006.

3.1.25 The operator was audited six months before the incident by the UAE GCAA. Only one level two finding was noted.

3.1.26 The simulator was unable to simulate the conditions of the incident exactly as it had occurred although it was flown as accurate as possible to the recorded data (it took-off each time). This led the investigator to believe that there were small program inefficiencies that cause the simulator to react different.

3.1.27 The operator's policy to schedule pilots to fly together, do comply with the principles of CCQ and MFF, but do not cover the different variants of an aircraft. Thus pilots new to a variant could be scheduled to fly together as was the case during this incident.

3.2 Probable Cause/s

3.2.1 During the take-off roll the captain applied an improper rotation technique by referencing the Side Stick Order Indicator to the 9° position on the Primary Flight Display. This caused the aircraft to de-rotate and not to lift-off as expected. When the aircraft over-ran the end of the runway with the associated noise, the aircraft was rotated further and became airborne with the application of full thrust.

3.2.2 The training and *mindset* of the pilots could be considered as a significant contributory factor to this incident. They were "programmed" by tailstrike avoidance information, aircraft difference information and certain expectances to perform the way they did.

3.2.3 A further contributing factor to the cause of this incident could be considered as the differences in take-off performance of the different Airbus aircraft of the operator's fleet.

3.2.4 A further contributing factor to the cause of this incident was that this was the second flight in the actual aircraft of this variant of the Airbus A340 for both flight crew members. However it was the first flight for the captain as pilot-flying.

4. SAFETY RECOMMENDATIONS

4.1 It is recommended that the operator immediately issue a clear instruction to ensure that their Airbus FBW pilots are left in no doubt that the Side Stick Order Indicator is not to be used for reference during the take-off rotation.

4.2 It is recommended that the operator immediately review and standardize their training, to clarify the correct rotation technique, to achieve the desired rotation rate, with particular reference to side stick input. Still keeping in mind the possibility of tailstrikes during rotation, but not over-accentuating this aspect.

4.3 It is recommended that the operator's training section engage with the simulator instructors to review their assessment methods in order that they would be able to identify possible improper flying techniques or habits of pilots.

4.4 It is recommended that the operator extend the route training of pilot over all the variants of an Airbus family in order that some assessment of pilots may be carried out before they are released to fly the different variants without supervision.

4.5 It is recommended that the operator review the software of their Flight Operations Quality Assurance program in order that the program would detect excessive de-rotations in the rotation phase of the take-off ground roll.

4.6 It is recommended that the manufacturer be engaged to review the display architecture involving the SSOI on the PFD after rotation has taken place (nose wheel lift-off) and the associated potential for inducing human error.

4.7 It is recommended that the operator consider the installation of Tyre Pressure Indication Systems on their fleet of Airbus A340-300 aircraft. This system will provide the pilots with additional information to assess situations where tyre failures are suspected.

4.8 It is recommended that the aircraft manufacturer need to reconsider the design of the EXIT lights fittings in order that the lenses of these lights are more secure to the light fittings. This will prevent the lenses to depart from the light fittings during hard landing conditions.

4.9 It is recommended that the SACAA inspectors tasked with audits of Aerodromes, inspect the approach lights plinths at the different aerodromes to ensure that the edges of the plinths are flush with the surrounding area. If edges are observed at the plinths, the aerodrome management should be made aware of this condition and they need to rectify the problem appropriately in order to de-lethalize the edges of these plinths.

4.10 It is recommended that the aircraft manufacturer review the aircraft's FCOM, Vol. 3 in section 3.02.32 to include an Abnormal Procedure relating to landing the aircraft with damaged main wheel tyres. This procedure should include the actions needed to switch the ANTI-SKID & NOSE WHEEL STEERING switch to the OFF position as it is described in the procedure for Landing with Abnormal Landing Gear.

4.11 It is recommended that the operator's pilots flight scheduling policy should be revised in such a way that both the type rating and variants are considered when pilots new to aircraft are scheduled to fly together. This would prevent that two pilots new to a variant, as in the case of this incident, would be scheduled to fly the variant together for the first time.

4.12 It is recommended in the interest of aviation safety that the requirements of the JAR-OPS rules relating to CCQ and MFF need to be revised in order that the CCQ training to prepare pilots for MFF include at least one flight with the real aircraft of each variant under the supervision of an appropriated experienced pilot. This recommendation is made with the conditions of this incident in mind, considering that the ZFT simulator is not absolutely the same as the real aircraft.

5. APPENDICES

5.1 The Bureau d'Enquêtes et d'Analyses (BEA) commented on the contents of this report as it was initially drafted by the investigator-in-charge of the SACAA. Most of the comments of the BEA were accepted and introduced into the final report. However the SACAA chose not to incorporate the BEA's comment relating to point 2.2.1 (Performance profiles). It stated that the third paragraph (presently fourth paragraph) is not relevant to the report and requested that if it remains in the report, the following formal comment be appended to the report:

The use of flexible take-off thrust has indeed an affect on the climb profile of the aircraft. But the BEA is of the opinion that the incident was related to a rotation technique that is not related to the climb. Moreover, the flexible take-off allows the *aircraft to meet the certification requirements at take-off, and the statement presented in the report maybe misleading.*

Compiled by :

Dr. A.L. de Kock
for Commissioner for Civil Aviation

Date : 14 December 2005

Investigator-in-charge : ....

Date : 15 December 2005

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The investigator-in-charge would like to extend his appreciation to the staff of the United Arabic Emirates General Civil Aviation Authority and the Emirates Airlines for their friendly support and assistance during this investigation. Their information was invaluable in compiling the above report.

A further word of appreciation is also extended to the staff of the Safety Section of Airbus Industries for their friendly support and assistance during the investigation.