



FINAL REPORT

**Serious Incident of SriLankan Airlines
Flight UL266, Airbus A340-311, bearing registration 4R-ADA
at Bandaranaike International Airport, Colombo
Sri Lanka
on 02nd July 2013**

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**List of Abbreviations**

AASL	-	Airport and Aviation Services (Sri Lanka) Limited
AAIB	-	Aircraft Accident Investigation Board, Sri Lanka
ATC	-	Air Traffic Control
ATS	-	Air Traffic Services
ASN	-	Aviation Safety Notices
AP	-	Auto Pilot
ATPL	-	Airline Transport Pilot Licence
ATIS	-	Automatic Terminal Information Service
BEA	-	Bureau d'Enquêtes et d'Analyses
BIA	-	Bandaranaike International Airport
CAASL	-	Civil Aviation Authority of Sri Lanka
CAD	-	Computer Aided Design
CAT	-	Category
CMB	-	Colombo
CPL	-	Commercial Pilot Licence
CVR	-	Cockpit Voice Recorder
DCP	-	Designated Check Pilot
DGCA	-	Director General of Civil Aviation
DFDR	-	Digital Flight Data Recorder
DME	-	Distance Measuring Equipment
EASA	-	European Aviation Safety Agency
FC	-	Flight Cycle
FCOM	-	Flight Crew Operating Manual
FDP	-	Flight Duty Period
FIR	-	Flight Information Region
FMA	-	Flight Mode Annunciator
FOM	-	Flight Operations Manual
Ft	-	Feet
hrs	-	hours
IAS	-	Indicated Air Speed
ICAO	-	International Civil Aviation Organization
ILS	-	Instrument Landing System
Kts	-	Knots
L/H	-	Left Hand
MET	-	Meteorological / meteorology
METAR	-	Aerodrome Routine Meteorological Report (in meteorological code)
MOE	-	Maintenance Organization Exposition
MSN	-	Manufacturer Serial Number
PAPI	-	Precision Approach Path Indicator
PF	-	Pilot Flying
PIC	-	Pilot in Command
PNF	-	Pilot Not Flying
QAR	-	Quick Access Recorder
RA	-	Radio Altimeter/ Radio Altitude
R/H	-	Right Hand
RUH	-	Riyadh, Saudi Arabia



SIGMET	-	Information concerning en-route weather phenomena which may affect the safety of aircraft operations
SLA	-	SriLankan Airlines
SOP	-	Standard Operating Procedures
TAF	-	Terminal Area Forecast (in meteorological code)
UTC	-	Universal Time Constant
V _{app}	-	Approach speed
VCBI	-	Bandaranaike International Airport, Colombo
VOR	-	VHF Omnidirectional Radio Range



Serious Incident of SriLankan Airlines Flight UL266, Airbus A340-311, 4R-ADA at Bandaranaike International Airport, Colombo, Sri Lanka on 02nd July 2013

1. Introduction

The incident was notified to the Flight Safety Division of the Civil Aviation Authority of Sri Lanka by Quality Assurance Department of SriLankan Airlines. Subsequently the Operator was requested to remove and secure the Digital Flight Data Recorder (DFDR) and Cockpit Voice Recorder (CVR). Preliminary survey to secure vital data was conducted on the same day.

As per Section 56 of Civil Aviation Act No 14 of 2010 and the Regulations made thereunder based on Annex 13 to the Chicago Convention, Civil Aviation Authority appointed an Aircraft Accident Investigation Board (AAIB) which comprised of;

- Mr Susantha De Silva - Chief Investigator,
- Captain T.N Deen - Operations Team Member,
- Captain Lucian Ratnayake - Operations Team Member,
- Captain N.A. Keil - Operations Team Member,
- Mr Umega Seneviratne - Airworthiness Team Member,
- Mr Chaminda Wimalaratne - Airworthiness Team Member.

At the invitation of CAASL, the Air Accident Investigation Bureau of Singapore assisted the AAIB in decoding the DFDR data and by providing with the graphical projection of the same data with video animation. In addition the AAIB clarified procedures practise by the airline through discussions held with the Safety Manager and an independent Pilot from the Airline.

Further, the Authority notified the incident to the Bureau d'Enquêtes et d'Analyses (BEA), France being the State of Manufacturer and the State of Design with copy to International Civil Aviation Organization (ICAO). In addition, the Authority invited to appoint an Accredited Representative from the State of Manufacturer & Design to assist the investigation in terms of Chapter 4, Paragraph 4.10 of Annex 13 to the Chicago Convention. Accordingly, Bureau d'Enquêtes et d'Analyses (BEA- France) appointed an investigator as accredited representative and a technical advisor from Airbus Company to assist the investigation.

1.1. Synopsis

SriLankan Airlines flight UL 266 departed King Khalid International Airport, Riyadh, Saudi Arabia at 20:45 UTC on 02nd July 2013 for its destination Bandaranaike International Airport (BIA), Colombo, Sri Lanka. On approach to BIA the flight crew decided to conduct a practice auto landing on runway 22 and conducted the required briefing for an auto land which included task sharing, call outs and go-around strategy. The visibility conditions were good.

UL266, on the said auto land manoeuvre, experienced a high sink rate during the flare, followed by a hard landing and a tail strike.

The investigation identified that non detection of the speed reduction trend of approach speed and target speed during the auto land by the operating crew and the significant wind change below 40 feet above ground (which is beyond the design capability of the aircraft to correct the Rate of Descend) were the causal factors of the hard landing. The tail strike resulted from the nose up inputs (up to almost full back stick) ordered by the PF just after the touchdown.



Furthermore, the Investigation team isolated two possible points of tail strikes and were unable to rule out any one of them.

The circumstances aforementioned led the aft fuselage belly of the aircraft to be damaged. In addition, the right main landing gear exceeded the design load limits requiring replacement. The incident caused no injuries to passengers and crew.

1.2. Objective

In accordance with Annex13 to the Convention to the International Civil Aviation, objective of this investigation and the final report is to prevent recurrence of similar incidents and not to apportion blame or liability. Therefore unless otherwise indicated, recommendations in this report are addressed to the regulatory authorities of the States having responsibility for the matters with which the recommendation is concerned. It is for those authorities to decide regarding what action is required to be taken.

**2. Factual Information:**

Operator : SriLankan Airlines Ltd
Airline Centre
Bandaranaike International Airport, Colombo
Katunayake
Sri Lanka

Registered Owner : A340 MSN 32 Limited
701, Chancery House
Lislet Geoffroy Street
Port Louis
Mauritius

Aircraft Make and Model : Airbus, A340 -311 (MSN 032)

Aircraft Nationality : Sri Lanka (4R)

Aircraft Registration : 4R-ADA

Place of Incident : Runway 22
Bandaranaike International Airport-Colombo
Katunayake, Sri Lanka

Date and Time : 02nd July 2013, approximately 0215hrs (UTC);
0745hrs (Local time)

Local time zone : + 0530hrs

2.1. History of Flight:

SriLankan Airlines flight UL265, Airbus A340, registration 4R-ADA departed for Riyadh (RUH) on 01st July 2013 for a double sector flight with 60 minute turnaround at Riyadh International Airport. The aircraft arrived eventless at RUH with a delay of 34 minutes. UL 266 departed RUH with a total delay of 01hr and 25 minutes from the scheduled time of departure.

On 02nd July 2013, flight UL 266, touched down on VCBI runway 22 at 0215 UTC (0745hrs Local time with a total delay of 01hr 34 minutes from the schedule time) encountering a hard landing and a tail strike.

2.2. Injuries to Persons:

There were no injuries to passengers, crew or ground personnel.

2.3. Damage to Aircraft: Aft fuselage belly was damaged. Damage was observed on Section 17 and Section 18 Skin panels between frame 67 to 83 approximately (Bulk door forward frame to aft pressure bulkhead area). There were scratch marks on the belly area and few rivets were damaged and some rivets were missing. Skin buckling was also noted. Some components of the Right Main Landing Gear had exceeded the design load limits.



Figure 1 – Aircraft scratch marks



Figure 2 - Aircraft scratch marks

2.4. Other Damages: A runway light was scraped. No other damages were observed to the runway or the associated Navigational Aids and equipment except for non-inscribed paint marks on the runway.

2.5. Personnel Information:

Flight Crew

a) *Pilot-In-Command*

Licence : Valid ATPL (ATPL /A/645) issued by the DGCA Sri Lanka based on Greek Licence number GR-004007; valid till 30th Nov 2013

Age : 62 years, Male



Aircraft Ratings : A340 issued on 26th Sept 2011

Flying Experience : Total: P1 20,487hrs
Total on type (A340): 4,230hrs (with SriLankan Airlines 1,500hrs)

b) First Officer

Licence : Valid CPL (CPL/A/492) issued by the DGCA Sri Lanka; valid till 08th October 2013.

Age : 29 years, Male

Aircraft Ratings : A340 issued on 25th Oct 2011/ A330 issued on 05th Oct 2012/ A320 issued on 11th Aug 2010

Flying Experience : Total: P2 -2162.33 hours

Total on type (A340) : 1041.48 hours

c) Relief Pilot

Licence : Valid ATPL (ATPL/A/548) issued by the DGCA Sri Lanka; valid till 14th July 2014

Age : 41 years, Male

Aircraft Ratings : A330/A340 issued on 28th Oct 2009, Cruise Pilot Rating on 28th Oct.2009

Flying Experience : Total: P2 -5427.43 hours

Total on type (A340) : 2168.37 hours

2.6. Aircraft Information:

Type and Model : Airbus A340 -311

Manufacturer's Serial Number: 032

Date of Manufacture : Aug-1994

Certificate of Registration : No. 146, Registered in Sri Lanka Civil Aircraft Register

Certificate of Airworthiness : Valid till 18th September 2013

Total Airframe Hours : 90,711.18 Flight Hours / 16747 Flight Cycles (as at 02nd July 2013)



Total Cycles

:

Engine	Serial Number	Tot hours	Total cycles
No. 1	740276	66,521.22	12,629
No. 2	741960	54,035.17	9,964
No. 3	740324	70,818.96	12,733
No. 4	741969	50,264.23	9,136

Engines

: 04 Numbers, CFM56 5C2F Engines

Weight and Balance

: The aircraft was properly loaded. Load Sheet is attached to this Report as Appendix 02.

2.7. Meteorological Information:

The MET forecast was available to the crew through the weather reports issued by the Department of Meteorology (Area Forecast and Route forecast) and the ATIS (on frequency 127.20MHz).

The prevailed weather conditions at BIA were as follows;

- At UTC 01:40:00 reported surface wind 240/07kts (9999 SCT016 28/23 1009.2)
- At UTC 02:10:00 reported surface wind 240/07kts (9000 –SHRA BKN016 27/23 1009.6)
- At UTC 02:10:30 (five minutes prior to touch down) reported heavy rain and visibility 5 km.
- At UTC 02:12:30 (three minutes prior to touch down) reported surface wind 240/10kts and runway surface wet.

The landing was conducted in daylight in CAT I weather conditions. It was evident that there were dynamic changes of wind from 155ft RA to 34ft RA prior to the event, which is described in paragraph 3.2.6 of this Report.

2.8. Aids to Navigation: Instrument Landing System (ILS) Runway 22 was serviceable and operational. Very high frequency Omni directional Radio range and Distance Measuring Equipment (VOR/DME) at BIA was serviceable and operational. Right side PAPI for runway 22 was unserviceable. Aircraft on board navigational systems were serviceable.

2.9. Communication: Communication between flight crew and ATC was satisfactory and effective.

2.10. Aerodrome Information:

- Name of the Aerodrome – Bandaranaike International Airport;
- Location Indicator - VCBI;
- Reference point (latitude/longitude) – N 07 10.8, E 079 53.1
- Elevation – 29ft
- Runway identification – 22
- Runway markings – standard
- Runway length – length 3350m
- Obstructions – Nil
- Runway conditions – paved asphalt with monsoon drains from either sides
- Lighting – runway/taxi way lights were serviceable.
- Runway inspection – 24hours physical inspection and runway light integrity monitoring system was available for ATC for monitoring.
- Last runway inspection prior to the incident was on 01st July 2013 at around 1700hrs local time.

Aerodrome meets the requirements to support CAT I instrument landing system certification standards.

Beyond the ILS reference point on to the approach side of runway 22 there is a service road going across the ILS glideslope path.

Vehicular movements on this road is not controlled by ATC or any other designated authority and vehicular movements on this road is not monitored or recorded.

2.11. Flight Recorders: The aircraft was fitted with a Digital Flight Data Recorder, Model 18, Honeywell International Inc. product (part number: 980-4700-003 and Serial number: 7204) and a Cockpit Voice Recorder, Model 13, Honeywell International Inc. product (part number:980-6022-001 and Serial number: 120-07482). The Quick Access Recorder fitted to the aircraft was capable of recording 890 parameters with 25 hours of recording duration (Vender: Penny & Giles, part number: D51438-1).

Sri Lanka has an agreement with the Air Accident Investigation Bureau of Singapore for cooperation in aircraft accident investigation. Accordingly, assistance from the Air Accident Investigation Bureau of Singapore was obtained for DFDR and CVR data downloading, decoding and subsequent analysis and animation.

Data extracted from the DFDR pertinent to this incident is attached as Appendix 03.

2.12. Wreckage and Impact Information: It was observed during the Runway inspection a scratch mark about 14 meter long on the centre line ending at a position abeam PAPI lights of Runway 22. The scratch mark was across the centre line by few degrees offset of the centre line. Further it was observed that one of the centre line lights was scraped but found to be serviceable. No debris or particles of the aircraft found on the runway or its precincts.



Figure 3 – Runway scratch mark

2.13. Medical and Pathological Information: Pathological and toxicological examination on flight crew was not conducted as the crew had departed after the flight.



2.14. Fire: There was no fire subsequent to the incident.

2.15. Survival Aspect: Not applicable

2.16. Test and Research: Report on all functional tests is at Appendix 4 to this Report.

2.17. Organizational and Management Information:

2.17.1. The Operator, SriLankan Airlines Ltd

2.17.1.1. SriLankan Airlines operates twenty one (21) aircraft which comprises of six A340, seven A330, eight A320 aircraft covering a network spanning Europe, Middle East, Far East and the sub-continent with CAT III capability.

2.17.1.2. SriLankan Airlines Flight Operation Department is responsible for safe and efficient operation of flights in accordance with regulations and laid down procedures. The Department maintains qualified technical crew and ground staff to carry out the duties and responsibilities of Flight Operations.

2.17.1.3. SriLankan Airlines Crew Planning and Resource Management is responsible for the management of the crew planning and scheduling. Further they deal with crew scheduling matters and produce appropriate crew detail solutions to assure that the Airline is complimented with the required crew in accordance with the company procedures.

2.17.1.4. Aircraft in SriLankan Airlines fleet are maintained by SriLankan Airlines Ltd in accordance with the scope of the approval granted in its MOE by CAASL. Engineering and Maintenance Division of SriLankan Airlines Ltd is a holder of EASA Part 145 maintenance organization approval.

2.17.1.5. SriLankan Airlines had obtained authorization from the CAASL to conduct low visibility operation up to CAT IIIB operations.

2.17.2. The Airport Operator, Airport and Aviation Services (Sri Lanka) Limited

2.17.2.1. Airport and Aviation Services (Sri Lanka) Ltd is a fully government owned company with statutory powers to develop, operate and maintain civil airports in Sri Lanka including Bandaranaike International Airport (BIA). The Company also provides the service of Air Navigation Services including Air Traffic Services within Colombo Flight Information Region (FIR).

2.17.2.2. BIA is an International Aerodrome certified by the CAASL. It is operation for 24hrs. The Runway at BIA is certified for CAT I operations.

2.17.2.3. Air Traffic Control Service is provided by licensed Air Traffic Controllers employed by AASL. On the day of incident all relevant Air Traffic Control Units had been manned adequately and was functioning appropriately.

2.17.2.4. Meteorological Service at BIA is provided by Observers and Forecasters of the Department of Meteorology, Government of Sri Lanka. Adequate weather reports on observed weather (METAR) and forecast weather (TAF) have been issued for the particular date and time of the incident. No SIGMETs have been issued appropriate to the time intervals.



2.17.3. The Regulator, Civil Aviation Authority of Sri Lanka

2.17.3.1. CAASL is responsible for the registration and issue of certificate of airworthiness to aircraft, licencing of personnel and certification of air operators and continued post certification surveillance. It is also responsible for the certification and surveillance of aeronautical service providers.

2.18. Additional Information: SriLankan Airline is an ISO 9001:2008 Certified quality Organization.

2.19. Useful or effective investigation techniques: AAIB examined the available evidence on excluding principle to determine the causes of the incident and the analysis included examination of safety issues and safety deficiencies.

3. ANALYSIS

3.1. General

SriLankan Airlines is certified for CAT III operations and as a result the crew needs to maintain the recent experience requirements as prescribed in the promulgated Standards. The Regulator's requirement relating to the conduct of practice auto landing by airlines is specified in SLCAP 4510. SriLankan Airline's procedure to comply with this requirement is stated under Section 3.4.27.2 of the approved FOM and a flight crew member is required to conduct one practice auto landing within a period of 45 days in CAT I or better conditions.

In this incident, the PIC was to renew his currency on practice auto landing prior to 05th July 2013 to retain his competency as required by the Airline. Hence, the PIC elected the flight UL 266 to meet this requirement.

On being cleared by Approach Radar Control at 2000ft for final approach on Instrument Landing System (ILS) on Runway 22 at VCBI, PIC took control for a practice auto land as planned. After being established on ILS, Approach Radar Controller handed over the aircraft to the Tower, who cleared the aircraft to land.

The Manufacturer recommends the protection of ILS beam during an auto landing on CAT I, CAT II and CAT III facilities. However, in this instance there is no confirmation on flight crew informing ATC about the practice auto landing as the Airline procedure did not make it a mandatory requirement during practice auto landing.

Therefore, as mentioned in above paragraph, crew did not inform the intention of planned practice auto land during any one of the phases, en-route, initial approach and final approach.

Prevailing Meteorological conditions of runway 22 were above CAT I minima. The initial stages of the approach was stable until about 110ft Radio Altimeter height on ILS.

3.2. Based on DFDR Data

3.2.1. Maintenance of V_{app} speed on an Auto land.

3.2.1.1. It was revealed during the DFDR analysis that the aircraft speed was lower than the target speed starting from height of 105ft measured by the Radio Altimeter until the touch down. The aircraft is designed to adjust the speed automatically to maintain the target speed (V_{app}) in the event a variation of speed is detected during the approach for an auto land, with auto thrust engaged in the speed mode. This was evident through the increase of engine parameters, until approximately 35ft Radio Altimeter at which time the 'RETARD' mode was automatically engaged, commanding 'IDLE' thrust automatically.



3.2.1.2. It was further evident through DFDR data that the speed variation was increasing progressively and at 60ft Radio Altimeter and at that time the speed difference was (-)10knots.

3.2.1.3. At the time of the touch down the difference between the target and the actual speed was minus 24 Knots. As per the A340 Standard Operating Procedures on Flight Parameter Deviation Calls for CAT II/III approach, PNF shall monitor the pitch during touchdown and he must call out 'PITCH PITCH', which was not evident as being done by the flight crew. Further, PNF shall monitor the speed during final approach. When speed goes below speed target -5Knots or above speed target +10Knots, PNF must call out 'SPEED', which too was not done by the flight crew in this event.

3.2.1.4. The RETARD mode is only available during automatic landing (AP engaged in LAND mode). It is engaged exclusively based on Radio Altimeter value, irrespective of the speed and, reduces thrust automatically to IDLE for landing. Further during automatic landing at 10ft Radio Altimeter, a synthesized 'RETARD' call out is generated from the aircraft prompting the flight crew to move the thrust levers to idle in order to confirm thrust reduction.

3.2.1.5. The speed variation (- 10knots) from 105ft to 54ft takes place within a period of 2-3 seconds and at the same time it increases to (-)24 knots within another 3-4 seconds. At this period of time, the PNF is awaiting the indications on the FMA for FLARE and THRUST IDLE callouts. Although he is supposed to callout the speed variation, the available time and the task load, questions the human capacity to handle this in the given circumstances, unless the speed trend arrow indicated the trend of the speed variation within the next 10 seconds if the acceleration is constant or unless the PNF has completely disregarded such information.

3.2.2. Wind changes

3.2.2.1. During the initial stage of approach the wind direction was between 240⁰ and 201⁰. There was a wind change of approximately 19Knots head wind to approximately 08Knots tail wind within a period of 10 seconds to touch down, with a variant wind gradient. The aircraft encountered 5Knots per Second tail wind gradient below 35ft Radio Altimeter.

3.2.3. High rate of descent

3.2.3.1. Consequent to the factors stated at 3.2.1 and 3.2.2, the aircraft experienced a high rate of descent with a vertical acceleration of 2.12g at the time of landing.

3.2.4. Possibilities of tail strikes

3.2.4.1. A tail strike is an occurrence that directly depend on the Pitch, Roll angle and Compression of the oleo strut of the main wheels. At 2:15:36UTC, (i.e. 1 second after the touchdown), the configuration of the aircraft was, pitch and roll angles were respectively +9.9° and +0.7° (right)'; auto pilot 'engaged'; oleo strut 'compressed and damaged' due to vertical acceleration of '2g' and weight on wheels 'on. The aircraft touched down on auto landing without the inputs of the Pilots at a speed lower than the target speed, with a high rate of descent and with the aforementioned Pitch, Roll angle and Compression of the oleo strut configurations favourable for a tail strike. In addition, it was revealed that the AUTO LAND touch down occurred when the aircraft was in a Roll angle of 1 degree to the right and changing to a 3 degree to left abruptly.

3.2.4.2. Once the Pitch angle and Roll angle of the time frame 02:15:36UTC marked in the Ground Clearance Diagram in the FCOM PRO-NOR-SOP-21 P 5/12, it is a probable point at which a tail strike is imminent. (Figure 4)

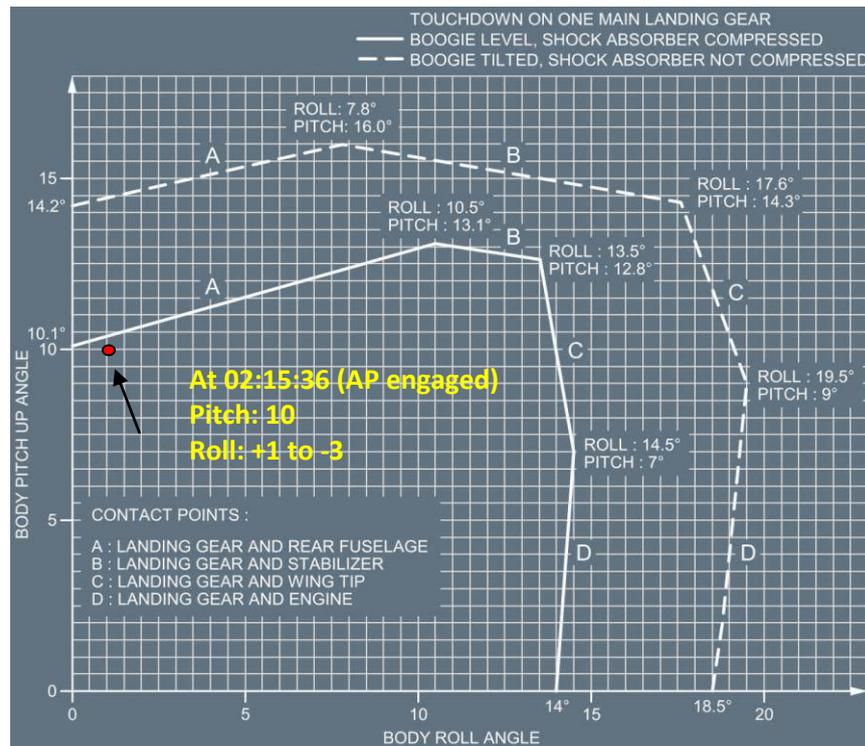


Figure 4 – Ground Clearance Diagram

3.2.4.3. Further after the touch down at 02:15:38UTC time frame, it is noted that the configuration suggests a possibility of (another) tail strike (pitch angle '11'; vertical acceleration "1g"; weight on wheels "on"). Half a second after the touch down, there was a roll side stick input of 11° to the right, which led into a disconnection of auto pilot that occurs at roll inputs greater than 6 degrees. In addition the Roll angle at this time frame was 1 degree to left and changing to a 1 degree to the right.

3.2.4.4. Once the Pitch angle and Roll angle of the two time frame (02:15:38 UTC) marked in the Ground Clearance Diagram in the FCOM PRO-NOR-SOP-21 P 5/12, it is evident that the tail strike is also prominent (Figure 5).

3.2.4.5. Also there is no evidence found to rule out continuation of the tail scraping in between these two time frames.

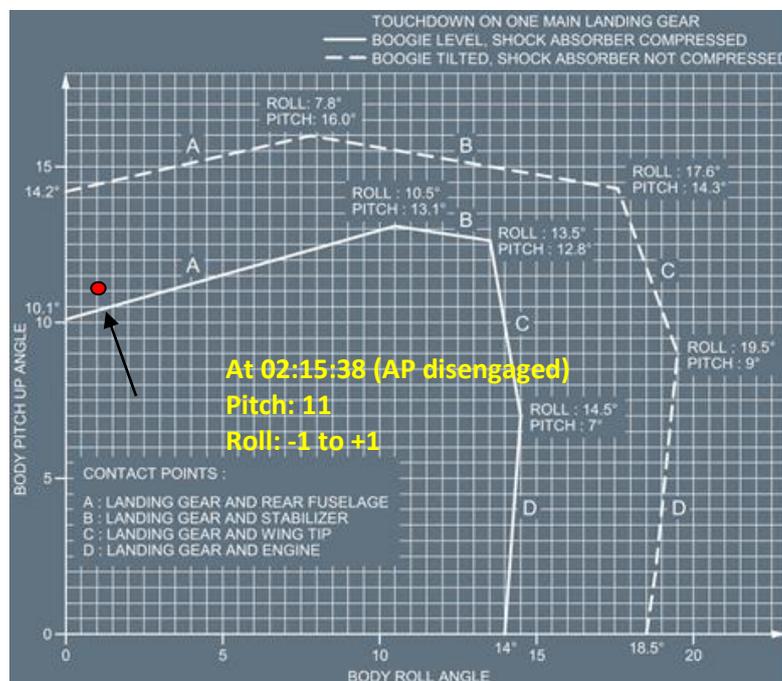


Figure 5 – Ground Clearance Diagram

3.2.5. Factual evidence on tail strike (analysis based on factual evidence on damaged to the aircraft)

3.2.5.1. Observation of the actual frames of the structure that had been damaged due to the tail strike of the said aircraft, revealed that the frame numbers from 67 to 77 represents the actual tail strike area, 67 being first and 77 being last from the front of the aircraft.

3.2.6. Attributes to tail strike

3.2.6.1. At the crucial height of 40 feet there is evidence of a significant increase in tail wind amounting to 13Knots within 2.5 Seconds causing a substantial drop in the lift of the aircraft (refer diagram below provided by the Manufacturer's report). Analysis of the parameters with the help of DFDR data revealed that facing this adverse wind conditions (windshear) the system design was not able to maintain the speed target.

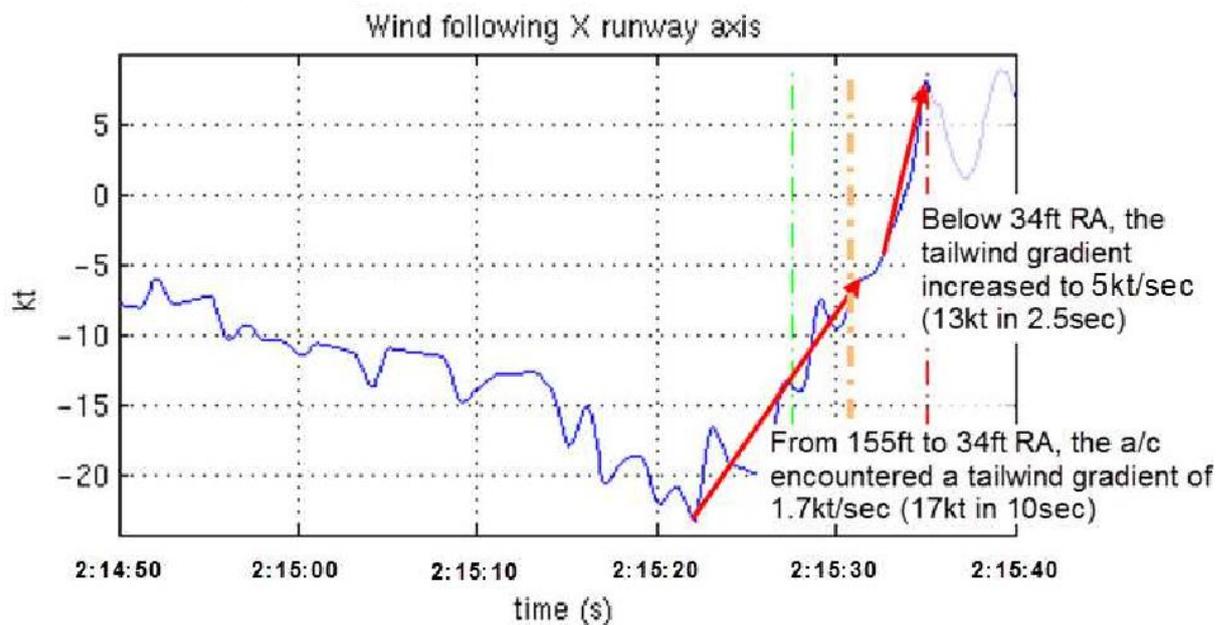


Figure 6- Wind variation along the longitudinal axis (head wind and tail wind)

3.2.6.2. The control inputs given by the PIC subsequent to the initial touchdown took the aircraft into an attitude conducive for a tail strike as the depiction of parameters in the Ground Clearance Chart evidently confirms the same.

3.3. Ground Equipment

3.3.1. BIA, ILS for Rwy 22 Ground equipment was installed on 18th June 2012 and found to be serviceable on the date of occurrence. The last calibration of the equipment was done on the date of installation and no reports were available to confirm any errors or deviations on the performance of the ILS. Further there had not been any significant malfunctions or inaccuracies reported by ILS users. It was revealed that as per ATC log entries and Electronics & Air Navigation Engineering Division of AASL that there was no unserviceability of ILS Rwy 22 at the time of the incident.

3.3.2. However CAT I ILS on Rwy 22 facility radio beams have not been protected from ground moments of aircraft & vehicles in the precincts of the Rwy, in order to practice CAT II or CAT III auto landings. At a location immediately opposite the Localizer beam antennas there exists a road with a considerable local traffic probably causing some interference to the beams. Controlling of such road traffic does not fall under the authority of ATC, & hence obtaining records for the purpose of assessing if there had been a considerable cause of interference is beyond the scope of this investigation.



3.3.3. Right hand side PAPI was unserviceable at the time of the incident. No evidence was available to indicate a notification of flights by ATC was found.

3.4. Organization – Air Operator

3.4.1. Crew Composition- The Airline adapts a three crew operation for this particular flight in view of mitigating fatigue related risks. The flight is conducted during the night with restrictive FDPs for two crew operations and use of the Cruise Pilot provides the facilitation of conducting a turnaround instead of a layover. As per the Regulatory provisions a crew can extend the FDP with the use of a Relief Pilot.

3.4.2. Cruise Pilot - In Operators procedures stipulates cruise pilot's responsibilities, quote "A Cruise Pilot is a First Officer who is suitably qualified to relieve the Pilot in Command for the purpose of in-flight relief in the cruise phase of a flight from top of climb to top of descent. When a Cruise Pilot is occupying the left hand seat, he will perform PNF duties and the First Officer shall perform PF duties. The Cruise Pilot will make operational decisions such as;

- a) Flight level changes
- b) Weather avoidance
- c) Direct routings etc,

any decision that will affect long term routine operation, such as diversions, etc, must be made by the designated Pilot-in-Command." unquote.

3.4.3. Inflight Rest -. The Airline did not issue guidance for the management of inflight rest and instead, allowing the crew to decide on the best method. Further, it was revealed during the crew interviews that the correct utilization or the privileges of the cruise pilot is not properly understood by the crew. In the Second Sector, RUH/CMB, the aircraft was air born at 2103 UTC. During the interview the crew stated that the PIC had started the rest approximately 20 min to 30 min after take-off, i.e 2133UTC at most and it was evident that the top of climb was reached at 2140UTC (flight plan records).

3.4.4. Inflight Management of rest

3.4.4.1. Although the flight can be conducted with two crew with marginal timings on duty time limitations, the Airline practiced a layover pattern in the past and introduced the relief pilot to minimize fatigue, ceasing the layover pattern and instead utilizing extension of flight duty period through inflight relief.

3.4.4.2. The total duty during this flight was 14hrs 14min leaving only 31min for the duty limit of the Airline which is a better standard than the Regulatory requirement. The flight is executed all through the night and the fatigue levels are relatively higher than a day flight.

3.4.4.3. The Airline used a predictive tool (SAFE) on fatigue risk management and it says if the Captain takes the third sleep his alert level would be the highest during the most critical phase of flight, i.e landing at VCBI. However it was evident during the crew interviews that they discussed the actual scheduling of rest patterns before the flight which they believe as the most practical way of managing rest.

3.4.4.4. Further, the crew is supposed to have a rest of 3hrs or more for each member according to ASN 23 Chapter 2, Paragraph 11.2 for the extension of FDP and it was not evident being practiced



during this flight. Although the crew claim that they were alert enough during the flight, it was evident that the crew was not well rested during the analysis of CVR recordings.

3.4.5. Flight Duty Period - The actual FDP of the crew was 14hrs 14min. As per the Regulatory provisions the FDP shall be recorded from the reporting time to time of chocks on. The data submitted by the Crew Scheduling Department with regard to the recording of FDP indicates that the reporting time as 1749hrs whereas the scheduled reporting time was at 1735hrs. In the automated system maintained by the Crew Scheduling Department starts recording the FDP one hour before the actual departure leaving room for omitting last minute changes between the actual departure to the schedule departure, which is in this case approx. 15 minutes.

3.4.6. Crew Scheduling - Crew Scheduling of the Airline is conducted by Crew Scheduling and Optimization Department headed by a manager and he is trained on Crew Scheduling/Crew Fatigue & Risk Management, Human Factors in Aviation but no evidence of trainings on regulatory requirements under ASN 23.

3.5. Crew Training

3.5.1. There is a disparity in the approved training programme and the conducted training programme on low visibility training for PIC. Airline conducts various reactivation training using different code numbers. The training programme classified under current and non-current pilots contradicts the recent experience requirements stipulated by the Authority and as well as the definition in the Airline FOM. The other crew members were adequately trained on all the required training programmes to support the present deployment and Auto Landing.

3.5.2. It was revealed that though it is recommended in Operators procedures, most of the crew do not obtain ATC clearance prior to carry out the auto land unless in low visibility condition.

3.5.3. Further, the manoeuvres, such as the speed variation during auto land and such mandatory items were not highlighted by both the Manufacturer and the Operator in the training programmes as they are part of the Standard operating Procedures (SOP). Evidence on the confirmation on receipt of such training is unavailable for analysis.

3.5.4. The Manufacturer recommends a go around below 80 ft to be practised during low visibility training programmes. In addition, it is advisable to practise rejected landing giving the flight crew the competence to handle the aircraft safely at low heights. Such training was absent in the operator's training programmes.

3.6. Flight Dispatch Procedure

3.6.1. It was not possible to evaluate if the flight has been overloaded with luggage, since manipulation of hand luggage and carryon baggage is possible.

3.7. Aircraft Equipment

3.7.1. Aircraft functional tests on 4R-ADA were carried out, in order to determine whether the aircraft equipment were functioned properly at the time of the incident. It was observed that all equipment functioned satisfactorily. Report on compliance to Manufacturers maintenance requirement is at Appendix 4.



4. CONCLUSION

4.1. Findings:

4.1.1. Aircraft

4.1.1.1. The aircraft was holding a valid certificate of airworthiness, validated by the State of Registry, Sri Lanka and renewed accordingly.

4.1.1.2. The aircraft was holding a valid certificate of registration.

4.1.1.3. The Aircraft equipment relevant to Auto Landing have functioned satisfactorily.

4.1.2. Operator

4.1.2.1. The flight crew was in possession of valid licenses, ratings and were experienced and medically fit to operate the flight.

4.1.2.2. The Operator is having a valid Air Operator Certificate and have conducted significant number of auto landings over the past years to BIA in similar and better weather conditions.

4.1.2.3. The subject flight was equipped, dispatched and maintained in accordance with the national regulations.

4.1.2.4. It was found that the flight crew has executed non Standard Operating Procedure during the conduct of a practice auto landing. The deviations observed during the conducted procedure were as follows;

4.1.2.4.1. Non adaptation of Manufacturer recommendations in conducting auto land to CAT I facility.

4.1.2.4.2. It was found from the recordings of the Cockpit Voice Recorder, there was no call outs from the PNF when there was an approximate decrease of 10 Knots from V_{app} on final approach as per SOP – A330/ A340, Chapter 3 on Flight Parameter Deviation call outs for CAT II / III approaches.

4.1.2.5. It is found that crew were not aware of the limitations of the privileges of the cruise pilot. Exercising Cruise pilot privileges by a first officer acting as a cruise pilot shall be strictly limited to flight phase between top of climb to top of descent. During the crew interviews above fact was evident from the statements of the crew and the cruise pilot statements shows his uncertainty on times of reliving duties of PIC.

4.1.2.6. It is found that the practice of airline on exercising privileges of a cruise pilot during relief duties, deviates from the stipulated standards specified in the paragraph 2.1.4.1.1 of Annex 1 (Paragraph 1.3.1.1 of ASN 55).

4.1.2.7. It is found that the airline has adapted a system to record the duty period against 2.1.9(b) of ASN 23. As per the 2.1.9.b, commencement of duty period is from the 'required time' of reporting to duty, whereas the airline calculates the reporting time deducting one hour from actual time of departure of the aircraft through an automated system.

Above system adapted by Airline may result in a difference of few minutes to an hour or so hampering safety in terms of onset of fatigue especially in FDP restrictive flights and in certain cases violating prescribed flight time limitations.



4.1.2.8. It is found that Organization change of the Company, Manager Crew Scheduling to Manager Crew Operations and Optimization was not properly detected and amended accordingly in the FOM by the Airline.

4.1.2.9. Accountability of scheduling is delegated to a person whose credentials do not have evidence of training on promulgated regulations on duty time limitations, ASN 23.

The Airline Scheme of Recruitment suggest various entry level qualification requirements. However, it does not specifically mention the knowledge requirement on promulgated regulation on duty time limitations. Nor they say about providing of training after the employment on the subject matter.

4.1.2.10. The managing of crew rest as per paragraph 11.2 of ASN 23 has not been properly adhered to.

4.1.2.11. It is found that the Airline Training Section did not provide the appropriate training programme on CAT II / III for PIC during induction. As per paragraph 6.13.1 of DCP Manual, DCP did not detect the above lapse prior to checking on low visibility. Further the approving Authority did not detect the same prior to issuance of the licence.

4.1.2.12. The approved Training Programme for the airline does not indicate the practising of rejected landing.

4.1.2.13. It is found that there is no records on practising all parameter deviation call outs during simulator training sessions.

4.1.2.14. The Procedure laid down in Airline publications does not make it mandatory to obtain the ATC clearance prior to conducting an Auto Landing. Therefore, it was revealed that the ATC was not informed of the intention to carry out an auto land.

4.1.2.15. Every instructor is expected to cover all the items in the training programmes during their briefings. However, there is no method of recording what exactly being briefed.

4.1.2.16. It is found that the Operator has adapted some mechanism to mitigate human factors and fatigue related risk factors by introducing inflight relief crew patterns on certain flights. However, management of safety related to such issues are found to be not effective. At the same time collection of data relating to human factors, fatigue and human behaviour is very important for proper management of SMS by the Operator.

4.1.2.17. It is found that Operator did not notify the serious incident to Authority or DGCA within the expected time frame to instigate an investigation into it.

4.1.2.18. It is found that the Operator did not take action to produce operating crew to Authority or DGCA for pathological investigation.

4.1.2.19. It is found that Duty Network Control Manager did not follow the procedure to retain DFDR and CVR as he was not properly informed.

4.1.2.20. It was found that during the training in the simulator for Cat II and Cat III, only go around is carried out (below 200ft) and this scenario does not include to a rejected landing.



4.1.3. ATS Provider

4.1.3.1. The ATS providers were also not aware of the procedures on additional precautions to be taken during a practice Auto Landing at BIA.

4.1.3.2. It is found that a method to detect actual surface winds is limited only to a windsock closed to the runway. Further surface wind is also measured and indicated at the Control Tower for the notification to flight crew by the Controllers through a sensor fixed on top of Control Tower. Surface wind reading obtained from such sensors do not give real value of specific wind prevailing on runway touch down area. Also no facility is available for cockpit crew to ascertain existence of critical winds during final phase of landing.

4.1.4. Manufacturer

4.1.4.1. It was found that the design capabilities of the model Airbus A340-311 for Auto Land during RETARD mode are inadequate to mitigate all risk factors involved. The RETARD mode completely disregarded the Auto Thrust correction for the speed difference just above 40ft resulting high rate of descent in touch down due to change of wind.

4.1.4.2. It is found that identification of mandatory items, such as Indicated Air Speed (IAS), Rate of Descent, Pitch Attitude, Bank Angle, Localizer and Glide slope are not included in the Airbus foot print or in the Operator Training Programmes.



4.2. Probable Causes:

4.2.1. Hard landing

It was evident that the crew did not anticipate a hard landing as they did not detect the speed variation, which occurred at 105ft RA height and reached its maximum value at the touch down point. The subsequent correction from the system to regain the target speed was completely diminished (negated) as the design features are incapable of adjusting the speed when the RETARD mode is engaged at 35ft as it solely depend on the RA input. In addition the prevailing local weather conditions were such that the longitudinal wind inversion and the tail wind gradient was beyond the limitation of the design. This scenario resulted in a hard landing with high pitch angle and with high vertical acceleration.

4.2.2. Tail strike

The tail strike may have resulted due to the hard landing or due to the involuntary control inputs at the time of hard landing and the subsequent control inputs given by PIC, which took the aircraft in to a higher pitch attitude when the oleos of the main wheels were compressed.



5. SAFETY RECOMMENDATIONS

5.1. Operator

5.1.1. The Operator requires to record the duty times from the actual reporting time and maintain the official documents in the same manner.

5.1.2. The Operator must have proper guidance on utilization of cruise pilot's privileges only during the cruise phase as defined by the Authority.

5.1.3. The Operator needs to adapt the layover system or the in-flight relief with proper guidance on managing rest based on scientific principles.

5.1.4. The Operator needs to review and amend the training programmes to eliminate disparities in the terminologies, eligibility criteria, training schedules in coordination with the approving authority. Thereby, selection of correct training programme for personal concern may not be an issue for the approving authority and as well as for the airline.

5.1.5. The Operator's FOM recommends the practice of informing ATC about the intended auto land without specifically highlighting whether it is conducted for CAT I or CAT II/III certified aerodromes. It is recommended that the Airline practice this in any aerodrome in the event they conduct an auto land.

5.1.6. It is recommended that in the Operator's CAT II/III Training programmes include obtaining ATC clearance prior to conducting auto lands.

5.1.7. It is recommended that during CAT II/III auto landing a rejected landing be included in the training programme.

5.1.8. It is recommended to subject the flight crew for a physiological and psychological investigation following a serious incident.

5.2. ATS Provider

5.2.1. Low level wind shear alert system needs to be incorporated in BIA. Or else ATS Operator shall establish methodology to notify critical wind changes on the runway through a quickest means possible.

5.3. Manufacturer

5.3.1. It is recommended that EASA study the need to require new specifications for an Auto land function, in order to provide additional cues to crew members when its performance is degraded, for example when a speed decrease is detected and will not be compensated by the auto-thrust / throttle system.



Members of Aircraft Accident Investigation Board, Sri Lanka

Mr Susantha De Silva - Chief Investigator

Captain T.N Deen - Operations Team Member

Captain Lucian Ratnayake - Operations Team Member

Mr Umega Seneviratne - Airworthiness Team Member

Captain N.A. Keil - Operations Team Member

Mr Chaminda Wimalaratne - Airworthiness Team Member

Appendix – 01- Photo expression of the aircraft



Figure 7 - Aircraft scratch marks (Nose to Tail View)

View towards tail



Figure 8 - Aircraft scratch marks (Nose to Tail View)



Figure 9 - Aircraft scratch marks



Figure 10 - Aircraft scratch marks



Appendix - 02 - Load Sheet

LOAD SHEET
ALL WEIGHTS IN KILOGRAMS

APPROVED *[Signature]* EDNO 01

18660

FROM/TO FLIGHT A/C-REG VERSION CREW DATE TIME
RUH CMB ULO266 4RADA 18J296Y 3/14 01JUL13 2227

LOAD IN COMPARTMENTS WEIGHT DISTRIBUTION
14745 2/4408 3/6640 4/2120 5/1577

PASSENGER/CABIN BAG 20756 175/ 93/ 40/ 6 TTL 314 CAB
PAX 0/ 18/290 SOC BLKD 313

TOTAL TRAFFIC LOAD 35501 ✓
DRY OPERATING WEIGHT 132610 ✓
ZERO FUEL WEIGHT ACTUAL 168111 ✓ MAX 178000 L ADJ
TAKE OFF FUEL 41200 ✓
TAKE OFF WEIGHT ACTUAL 209311 ✓ MAX 260000 ADJ
TRIP FUEL 34500
LANDING WEIGHT ACTUAL 174811 MAX 188000 ADJ

BALANCE AND SEATING CONDITIONS LAST MINUTE CHANGES
DOI 111.00 LIZFW 120.82 ✓ DEST SPEC CL/CPT WEIGHT/IND
LITOW 110.69 MACZFW 33.5 ✓ CMB 1M Y - 72
MACTOW 28.5 ✓ " 02B C4 - 40
STAB TO 4.6 NOSE UP ✓
BASED ON FUELDENSITY .775 KG/LTR
A18.B64.C116.D110.
CABIN AREA TRIM

UNDERLOAD BEFORE LMC 9889 LMC TOTAL 112

LOADMESSAGE AND CAPTAINS INFORMATION BEFORE LMC
-CMB.175/93/40/6.T14745.2/4408.3/6640.4/2120.5/1577.PAX/0/18/290
.PAD/0/0/0
SI Saudi Ground Services Company
PAX WEIGHTS USED M 72 F 72 C 35 I 10
DOW ADJ WGT/IND
ADDITIONS
CMB PORTWATER X10.50 175 0.50#
DEDUCTIONS
NIL
NOTES
CMB C 2193 M 0 B 571/ 10905 0 0 T
END LOADSHEET EDNO 01 ULO266 01JUL13 2227

[Signature]

19296



Appendix - 03 - Extracted Data from the DFDR

Publication of the Appendix 03 withheld in compliance with Section 61 of Civil Aviation Act No 14 of 2010.



Appendix – 04 – Aircraft Equipment Test

On 2nd July 2013 SriLankan Airlines Airbus A340 Aircraft 4R-ADA was subjected to a tail strike. The Airworthiness Engineer who had visited the scene initially noted that there had been no tech log entry pertaining to the tail strike.

As per entry made by Captain on “Auto Land Summary” sheet, last landing made at VCBI “UNSAT”. This contradicts with “Journey Log” entry made by Captain, which says “Auto Land Successful – Yes” Airworthiness Section of CAASL has informed Manager Quality Assurance (MQA) to remove DFDR and CVR on board.

Details of removed DFDR & CVR are were as follows;

DFDR

- P/N - 980-4700-003
- S/N - 7204
- Manufacture - Honeywell
- Mod status -18

CVR

- P/N - 980-6022-001
- S/N - CVR 120-07482
- Manufacture - Honeywell
- Mod status -13

There upon the investigation panel commenced the investigation where during such time DFDR data down load and animation was developed along with CVR recordings.

During this period it was under discussion and negotiations were carried out, to purchase Flight scape software communication with the company to verify the ability of software capability to meet the requirement of the investigation by purchasing software the intended purpose of the investigation board was conveyed to the company.

The team decided to ensure the serviceability of all on board systems related to the investigation and thereupon following was tested;

- 1) Auto flight
 - a. FLT MAN & GUID ENV COMPTR
 - b. FLT CONTROL UNIT
 - c. MCDU

- 2) Flight controls
 - a. SFCC
 - b. FCPC
 - c. FCSC
 - d. FCDC

- 3) Navigation
 - a. AIRDATA INERTIAL REF UNI
 - b. GLOBAL POS SYS SENSR UNIT
 - c. INTERROGATOR-DME__DME-700
 - d. RECEIVER-ADF__ADF-700
 - e. RECEIVER-ILS
 - f. ENHANCED GPWC MK V



- g. TRANSCEIVER-RADIO ALTIMETER
- h. RECEIVER-VOR,MKR

Functional test on the following were carried out;

- 4) BITE TEST OF RADIO ALTIMETER
- 5) TEST OF THE LAND CAT 3 CAPABILITY
- 6) BITE TEST OF AUTO FLIGHT SYSTEM TEST
- 7) BITE TEST OF THE INSTRUMENT LANDING SYSTEM
- 8) OPS TEST OF THE INSTRUMENT LANDING SYSTEM
- 9) ANGLE OF ATTACK SENSOR TEST
- 10) SYSTEM TEST OF THE AIR DATA REFERENCE
- 11) INTERFACE TEST OF THE IR
- 12) BITE TEST OF DME
- 13) BITE TEST OF VOR/MARKER
- 14) BITE TEST OF ADF
- 15) GROUND VOCABULARY TEST OF THE EGPWS
- 16) OPS TEST OF THE EGPWC BY BITE
- 17) BITE TEST OF THE TCAS
- 18) OPS TEST OF THE PROBE ICE OPS
- 19) OPS TEST OF THE FCPC
- 20) BITE TEST OF EFCS
- 21) OPS TEST OF THE FCSC
- 22) OPS TEST OF FLAP & SLAT SYS
- 23) WING TIP BREAK ENGAGEMENT TEST
- 24) SYS TEST OF SFCC
- 25) BITE TEST OF EFCS

All test were found satisfactory.

Through the functional Test Aircraft warning on Sink rate was also found serviceable. The impact on auto land which open defect were reviewed through analyzing carried forward defects. In reviewing installed software and data base versions at face value there were no concerns. Considering airline requirement and investigational requirements the Technical Disposition (TD) was recommended.

- 1) Removal (partially) of section 17 lower skin panel & replacement
- 2) Complete removal and replacement of section 18 lower skin panel
- 3) Removal replacement of frames as described in the TD

As it was believed there will be minimal loss of evidence in respect to the ongoing investigation, the following was approved under certain conditions as mentioned below.

- 1) Complete replacement of lower panel section 18
- 2) Frame 72-74
 - a. Frame 72 replacement of lower side frame segment (RH)
 - b. Frame 73 replacement
 - c. Frame 74 partial replacement

Under the following conditions;

- 1. No repair/replacement or any other maintenance activity to be carried out expect for the above mentioned tasks



2. Task Cards, Drawings to be submitted to the investigation board prior to accomplishment of tasks
3. Section 17 lower skin panel may be removed only to facilitate the removal of lower skin panel section 18
4. CVR Rack not to be disturbed
5. In the event any hydraulic lines are removed for access depleted quantity of fluids to be recorded
6. Investigation Board to be informed of removal of any part/components in order to obtain access to facilitate above repair.
7. During repair any deviations from TD_K48_S3_01290_2013 ISSUE A to be informed to the investigation board and prior approval to be obtained.

All discarded Skin Panels, Frames and any other part/component to be discarded shall be kept in storage as advised by investigation board.

Further, the investigation team reviewed following packages along with none routine work cards.

A2 check carried out from 21.12.2012 to 22.12.2012 as per the AMS AMD 194 dated on 28.08.2012 (latest MPD amendment). Work cards including NRCs cross check with tally sheets as well as SriLankan Airlines AMS.

Details of the work as follows:

- 1) A 2 carried out at 88347 of Total Flying Hours and 16190 Ft Cycles.
- 2) This is within the AMS scope and found satisfactory.
- 3) A2 work cards checked and found satisfactory. Issued CAA SL Form 01.
- 4) Maintenance planning carried out by production planning as per approved EPM procedure.
- 5) Quality checks for installed parts during the A2 check carried out by QA and all EASA Form – 01s copy attached to the task cards.
- 6) Task cards signed by certifying staff with AL authorization number.
- 7) CAA SL Form – 01 signed by AL-125 –Category C license holder (checked with PEL and ok)
- 8) All NRCs raised by SLA Engineering during the A2 check are fully accomplished and NRCs signed.
- 9) Routing Engine Bore scope inspection carried out for #2, #3 and #4 and Task cards signed.

A3 check carried out from 19.02.2013 to 20.02.2013 as per the AMS AMD 194 dated on 28.08.2012 (latest MPD amendment). Work cards including NRCs cross check with tally sheets as well as SriLankan Airlines AMS.

Details of the work as follows:

- 1 A 3 carried out at 89195 of Total Flying Hours and 16372 Ft Cycles.
This is within the AMS scope and found satisfactory.
2. A3 work cards checked and found satisfactory .Issued CAA SL Form 01.
3. Maintenance planning carried out by production planning as per approved EPM procedure.
4. Quality checks for installed parts during the A3 check carried out by QA and all EASA Form – 01s copy attached to the task cards.
5. Task cards signed by certifying staff with AL authorization number.
6. CAA SL Form – 01 signed by AL-231 –Category C license holder (checked with PEL and ok)
7. All NRCs raised by SLA Engineering during the A3 check are fully accomplished and NRCs signed.
8. Routing Engine Bore scope inspection carried out for #2 and #4 and Task cards signed.



A4 check carried out from 23.04.2013 to 24.04.2013 as per the AMS AMD 198 dated on 21.03.2013 (latest MPD amendment). Work cards including NRCs cross check with tally sheets as well as SriLankan Airlines AMS.

Details of the work as follows:

1. A 4 carried out at 89885 of Total Flying Hours and 16530 Flight Cycles.
 - This is within the AMS scope and found satisfactory.
- 2 A4 work cards checked and found satisfactory .Issued CAASL Form 01.
- 3 Maintenance planning carried out by production planning as per approved EPM procedure.
- 4 Quality checks for installed parts during the A4 check carried out by QA and all EASA Form – 01s copy attached to the task cards.
- 5 Task cards signed by certifying staff with AL authorization number.
- 6 CAASL Form – 01 signed by AL-231 – Category C license holder (checked with PEL and ok)
- 7 All NRCs raised by SLA Engineering during the A4 check are fully accomplished and NRCs signed.
- 8 Routing Engine Bore scope inspection carried out for #1, #3 and #4 and Task cards signed.

Also 46 Carried Forwarded Defects has been observed including 45 minor (paint scratch, missing placards and Eroded areas within SRM limits).

CFD raised on 23.04.2013 – Slight Hydraulic leak in #2 engine L/H “C” duct actuator. CFD raised due to the unavailability of the Spare parts. But deferred till “when item available”.

Therefore, upon evaluation of physical aircraft systems and related documentation it could be said that the investigation team has not found any conclusive evidence to find any shortcomings in the Airworthiness aspect of the aircraft.

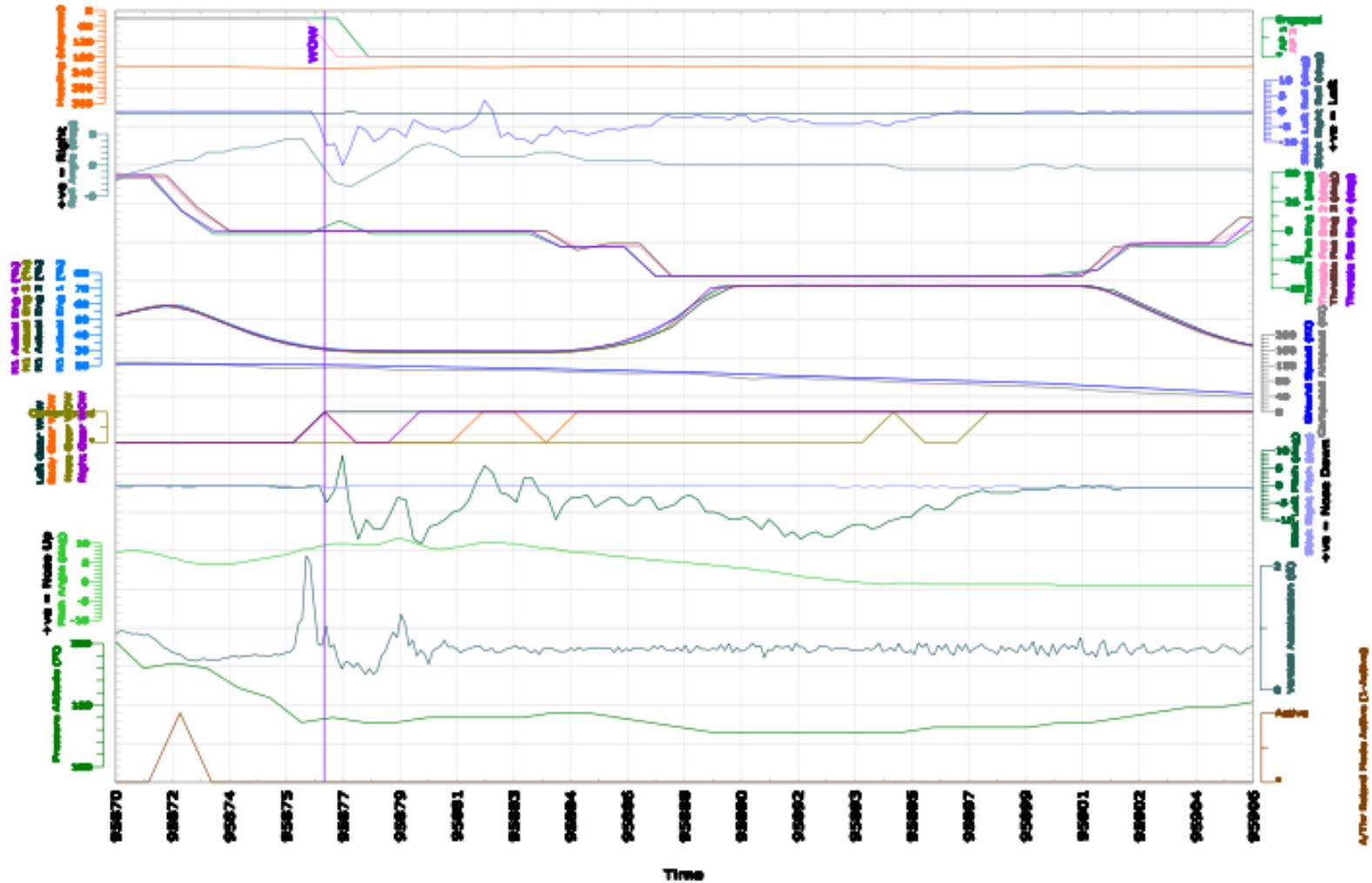
Mr. Umega Seneviratne- Member of AAIB

Mr. Chaminda Wimalaratne- Member of AAIB

Appendix – 06 – Graphs on 4R-ADA Landing Auto Flight Parameters

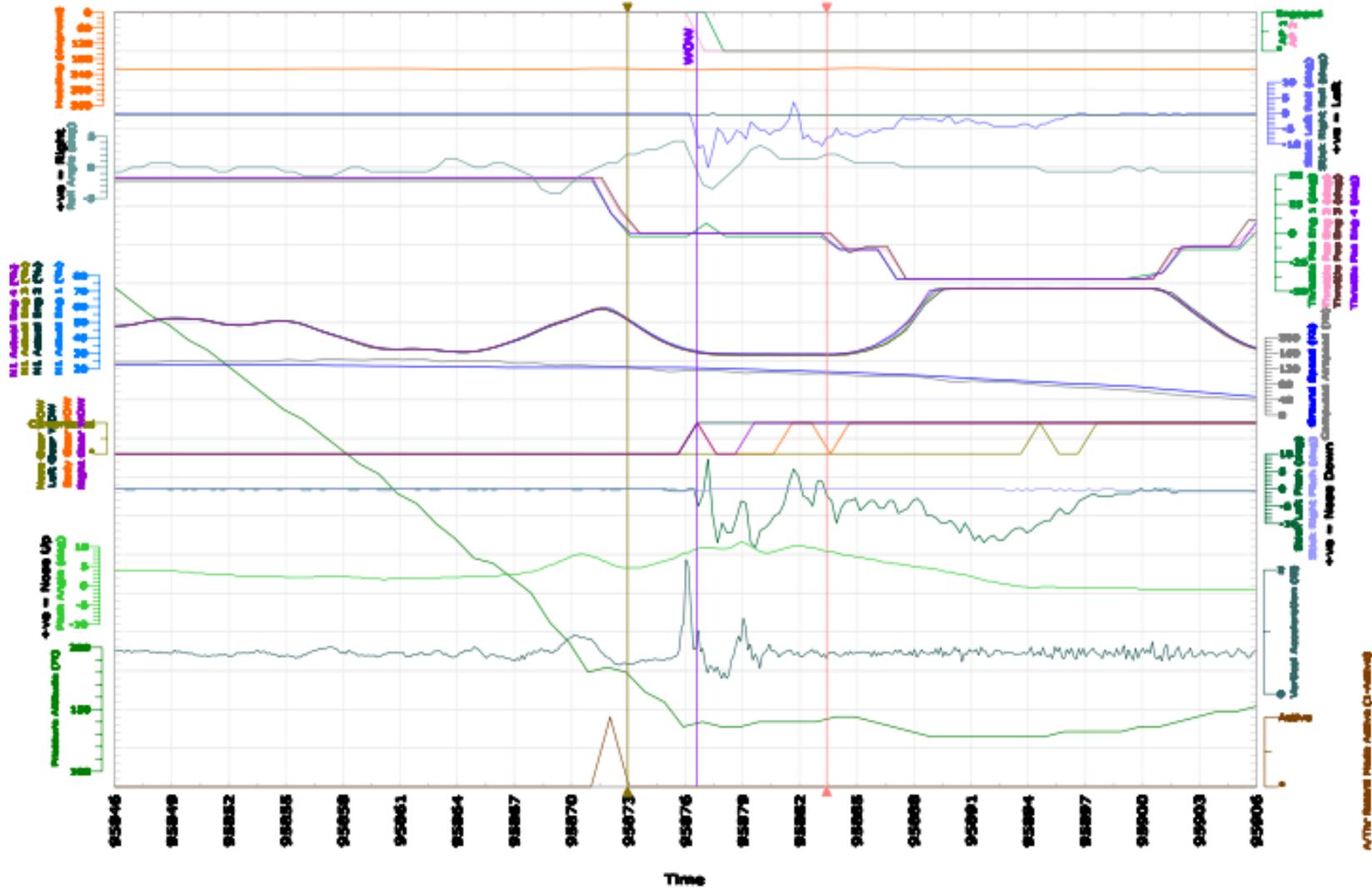
Graph 01 - 4R-ADA Landing Auto Flight Parameters 50 ft

4R-ADA Tail Strike 02 July 2013



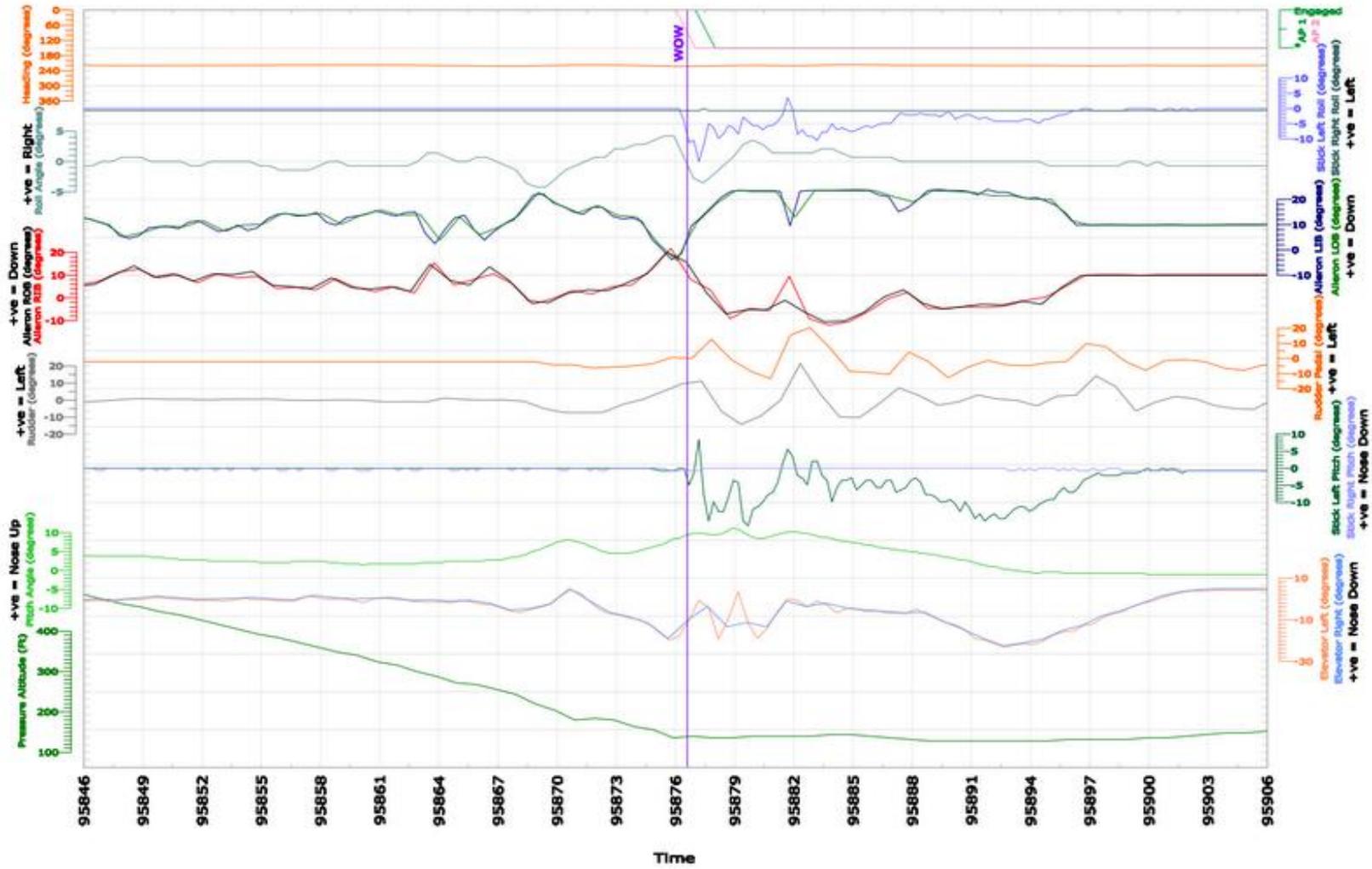
Graph 02 - 4R-ADA Landing Auto Flight Parameters 300 ft

4R-ADA Tail Strike 02 July 2013



Graph 04 - 4R-ADA Landing Pitch Roll Yaw 300 ft

4R-ADA Tail Strike 02 July 2013





Appendix – 07 - Answers from AIRBUS and BEA, France

Appendix – 08 - ATC Transcripts

Appendix – 09 - CVR Transcript

Appendix - 10- First Interview with PIC

Appendix - 11 - Second Interview with PIC

Appendix - 12 - First Interview with First Officer

Appendix - 13 - Second Interview with First Officer

Appendix - 14 - Interview with Relief Pilot

Publication of the Appendices 07, 08, 09, 10, 11, 12, 13 and 14 withheld in compliance with Section 61 of Civil Aviation Act No 14 of 2010.