Kingdom of Saudi Arabia
Aviation Investigation Bureau

AVIATION INVESTIGATION REPORT
AIB-2013-0002

Onur Air
Airbus 300-605R, Registration TC-OAG
King Abdulaziz International Airport – Jeddah
Kingdom of Saudi Arabia

Abnormal Runway Contact (ARC) – Nose Gear Retracted (SCF-NP)

10th Jumada-II 1433 H – 01 May 2012 G

TABLE OF CONTENTS

GLOSSARY

AIB	Aviation Investigation Bureau	IIC	Investigator-In-Charge
ATPL	Airline Transport Pilot License	IP	Interested Parties
ARC	Abnormal Runway Contact	ILS	Instrument Landing System
ASD	Aviation Safety Division	KAIA	King Abdulaziz International Airport
ATC	Air Traffic Controller	KSA	Kingdom of Saudi Arabia
BEA	Bureau d' Enquêtes et d'Analyses - France	N	Newton (measurement of force)
CAVOK	Ceiling and Visibility are OK	NLG	Nose Landing Gear
°C	Degrees Celsius	LH (L)	Left Hand Side/Left
CMM	Component Maintenance Manual	MLG	Main Landing Gear
CVR	Cockpit Voice Recorder	MBD	Messier-Bugatti-Dowty
DFDR	Digital Flight Data Recorder	METAR	Meteorological Terminal Aviation Routine Weather Report
DGCA	Directorate General of Civil Aviation	No.	Number
EASA	European Aviation Safety Agency	PF	Pilot Flying
EADS	European Aeronautic Defense and Space Company	PIC	Pilot in Command
FAA	Federal Aviation Agency	PM	Pilot Monitoring
FO	First Officer	PMIA	Prince Mohammed Bin Abdulaziz International Airport
FRS	Fire and Rescue Service	PN	Part Number
GACA	General Authority of Civil Aviation	RH (R)	Right Hand Side/ Right
ICAO	International Civil Aviation Organization	SAR	Stand Alone Recommendation
		SCF-NP	System Component Failure or Malfunction (Non-Powerplant)
		S & ER	Safety & Economic Regulation
		S/N	Serial Number
		SQ	Standard Quality
		SVA	Saudi Arabian Airlines
		UTC	Coordinated Universal Time
		VSB	Vendor Service Bulletin
		Cc/min	Cubic centimeter/minute
		ft	feet
		kg	kilogram
		kts	knots
		nm	nautical miles

INTRODUCTION

Onur Air
Airbus 300-605R, Registration TC-OAG
King Abdulaziz International Airport – Jeddah
Kingdom of Saudi Arabia

Abnormal Runway Contact (ARC) –
Nose Gear Retracted (SCF-NP)

10 Jumada II 1433 H – 01 May 2012 G

OBJECTIVE

In accordance with Annex 13 to the Convention on International Civil Aviation, it is not the purpose of aircraft accident investigation to apportion blame or liability. The sole objective of the investigation and the Final Report is the prevention of accidents and incidents.

Unless otherwise indicated, recommendations in this report are addressed to the regulatory authorities of the State having responsibility for the matters with which the recommendations are concerned. It is for those authorities to decide what action is to be taken.

CONDUCT OF THE INVESTIGATION

The Aviation Safety Division (ASD) of the General Authority of Civil Aviation/Safety and Economic Regulation (GACA/S&ER) was originally assigned investigative responsibility for this accident. On 01 May 2013, the investigation was assigned to the newly formed Aviation Investigation Bureau (AIB).

Initially, the ASD was notified at 14h15[1] on 01 May 2012, while the aircraft was preparing for the nose gear-up landing. The ASD immediately instituted an investigation and formed an investigation team consisting of an Investigator-In-Charge/Operations Specialist, two (2) Technical Investigators, one (1) ATS Investigator and one Flight Recorder

1. Unless otherwise indicated, all times in this report are local time. Local time in the Kingdom of Saudi Arabia is Coordinated Universal Time (UTC) plus three (3) hours.

Specialist/Photographer. This ASD team proceeded to the airport and arrived at the accident site a few minutes after the aircraft had landed. The involved States: Turkey and France were notified through their respective investigation authorities. The International Civil Aviation Organization (ICAO) was also notified.

In the days that followed, the Onur Air team joined the investigation. The Airbus team joined the investigation team almost two (2) weeks after the accident due to the delays in obtaining visas to enter the Kingdom of Saudi Arabia (KSA). The Accredited Representative from the Bureau d'Enquêtes et d'Analyses (BEA) of France representing the State of Manufacture and the Accredited Representative from the Directorate General of Civil Aviation (DGCA) of Turkey representing the State of Registry/Operator did not travel to the KSA.

On 20 May 2012, the GACA/S&ER sent two (2) Stand-Alone Recommendations (SAR) to Airbus via the BEA regarding the use of the aft doors of the A300-605R during evacuation procedures.

During the post- site investigation, the Investigator-In-Charge (IIC) and the Accredited Representative of the BEA had several teleconferences where aspects of the investigation were discussed. Tests of components were also conducted during this period.

On 28 July 2013, a Draft Final report was sent for comments to all Interested Parties (IP). Some comments were received by 26 September 2013. Following a thorough review of the initial Draft Final Report, the IP comments and the deficiency with the slides to properly reach the ground, the AIB submitted a Draft Final Report –Version 2 on 01 December 2013. The IPs were given 60 days to comment on this revised Draft Final Report. The BEA was the only IP that submitted comments regarding the Draft Final Report – Version 2. The pertinent and substantiated comments were included in the report.

On 08 May 2014, the Final Report was approved by the Chairman of the GACA Board of Directors.

SYNOPSIS

A Turkish registered aircraft, TC-OAG was performing a commercial flight for Saudi Arabian Airlines as SVA 2865. SVA 2865 was on a positioning flight from Madinah to Jeddah, KSA. During the initial approach to Jeddah, the nose landing gear did not extend. After many attempts at lowering the nose landing gear without success, fuel was burned and the aircraft landed with the nose gear retracted. The landing was executed safely. There was no fire, nor injuries.

1.0 FACTUAL INFORMATION

1.1 History of Flight

On 01 May 2012, aircraft TC- OAG, an Airbus 300-605R was performing a commercial flight for Saudi Arabian Airlines (SVA) as SVA 2865. SVA 2865 departed from Prince Mohammed Bin Abdulaziz International Airport (PMAI) Madinah at 08h50 en-route to the King Abdulaziz International Airport (KAIA) Jeddah, Kingdom of Saudi Arabia. SVA 2865 was on a positioning flight with 10 crew members and no passengers. No discrepancies were noted on this aircraft prior to departure from Madinah.

The visibility at Jeddah was good with a few clouds present. During the initial ILS approach to runway 16 Right (16R), while at 8 nautical miles (nm) and 2600 feet (ft), the landing gear handle was lowered. Both main landing gear extended and locked down and, the nose gear doors opened but the nose landing gear did not lower. The Captain who was then the Pilot Monitoring (PM) took over the controls and carried out a missed approach. The First Officer (FO) became the Pilot Monitoring (PM). SVA 2865 was then given an area to the northeast of Jeddah to carry out attempts at lowering the nose gear.

The flight crew attempted to manually free fall the nose landing gear at least ten (10) times. The nose landing gear would not lower into the locked position, but the nose gear doors remained open during all those attempts.
As a precautionary measure, SVA 2865 performed a fly-by of runway 16R at 500 ft. The air traffic controller confirmed that the nose landing gear (NLG) was not down.

SVA 2865 was vectored over the Red Sea to lower the fuel load, thus reducing the landing weight. During this period, the Fire & Rescue Services (FRS) at Jeddah foamed a portion of runway 16 Left (16L) between taxiway Kilo 5 (K5) and K2 (Figure 1). The majority of the FRS vehicles were standing by at the junction of taxiways K4 and K3.

SVA 2865 was vectored for an instrument approach for Runway 16L. The Auto Pilot and the Auto Throttle Systems were OFF. The surface winds were from 220° at 12 knots (kt), gusting to 19 kt and the temperature was + 37 Celsius (°C).

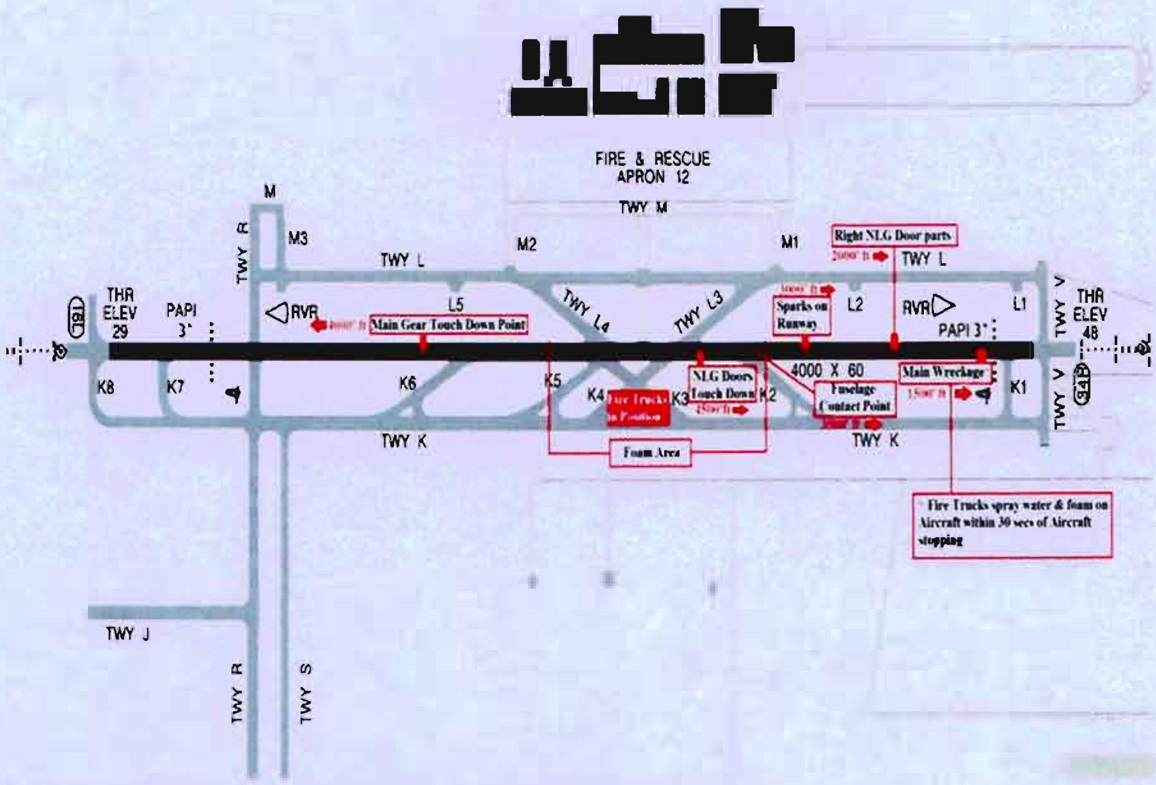

Figure1: Runway 16L/34R with details of aircraft contact areas.

The flight crew used the "Landing with Nose Landing Gear Abnormal" checklist ensuring the aircraft was properly prepared and configured for the approach, the before landing, the flare and the touchdown sequences, including when the aircraft stopped and the necessary procedures to secure the aircraft before evacuation.

The aircraft landed on its main landing gear 4000 ft past the threshold of runway 16L (Figures 1 and 12). The nose of the aircraft was slowly lowered to the runway with the nose landing gear doors touching the runway within the foamed area 4500 ft from the end of runway 16L (Figure 2). The front of the fuselage then touched the runway within the last portion of foam, 3500 ft from the end of runway 16L. The nose area of the aircraft slid on the runway, where sparks were present until the aircraft came to a full stop 1500 ft prior to the end of runway 16L (Figure 14).


Figure 2: Aircraft landing - Nose gear retracted.

As soon as the aircraft passed by the position of the FRS vehicles, the FRS vehicles gave chase to the aircraft and reached it within 30 seconds after it came to a full stop. Although there was no post-crash fire, the FRS personnel applied water and foam to the nose area of the aircraft.

All of the crew members were evacuated from the aircraft by ladder provided by the FRS. The crew was taken to the airport clinic as a precautionary measure. All were released the same day.

The accident occurred at 14h49 on runway 16L at the KAIA - Jeddah, Kingdom of Saudi Arabia.

1.2 Injuries to Persons

	Crew	Passengers	Total	Others
Fatal	0	0	0	0
Serious	0	0	0	0
Minor/None	10	0	10	0
Total	10	0	10	0

1.3 Damage to Aircraft

The aircraft sustained substantial damage (Figure 3).

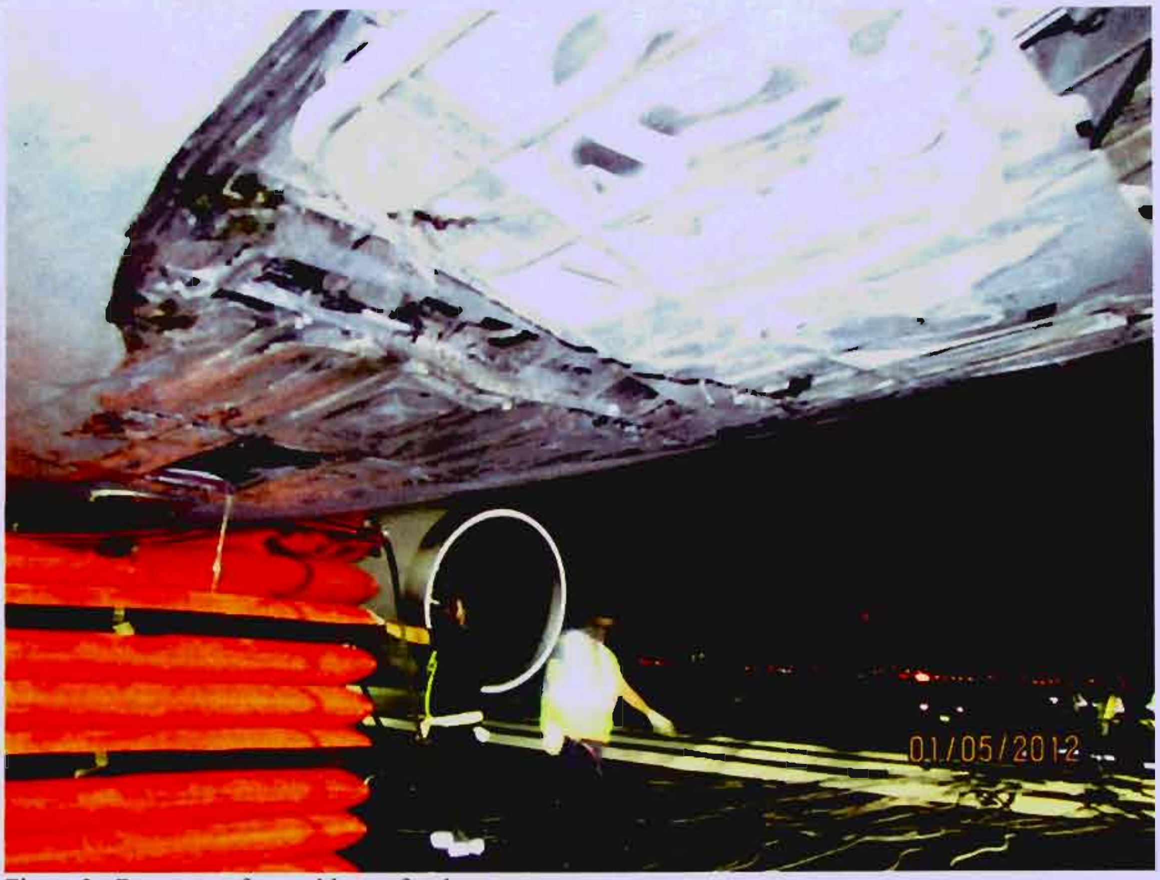

Figure 3: Damage to forward lower fuselage area.

1.4 Other Damage

There was some damage to the surface of Runway 16L.

1.5 Personnel Information

1.5.1 The Captain

1.5.1.1 General

The Captain was a Turkish national employed by Onur Air. From the initial landing gear discrepancy until completion of the landing, the Captain was the PF.

1.5.1.2 Qualifications

The Captain held a Turkish Airline Transport Pilot License (ATPL), Number TR-A-03077 initially issued on 08 June 1994. This ATPL was re-issued on 02 March 2011 and was valid until 22 February 2016. He held type ratings as follows: A310/300-600 Pilot in Command (PIC) valid until 23 February 2013.

The Captain held a valid First Class Medical Certificate issued on 08 December 2011, which was valid until 14 July 2012. The medical certificate contained no limitations.

The medical microbiology tests conducted within 24 hours of the accident were negative.

1.5.1.3 Flying experience

Total Flying Hours	9200
Hours on Type Last 90 Days	134
Hours on Type Last 30 Days	51
Hours on Type Last 7 Days	21
Hours on Type Last 24 Hours	8
Hours of rest prior to duty	24+

1.5.2 The First Officer (FO)

1.5.2.1 General

The FO was a Greek national employed by Onur Air. From the initial landing gear discrepancy being known until the completion of the landing the FO was the PM.

1.5.2.2 Qualifications

The FO held a Greek ATPL, Number GR-001592 issued on 22 November 2005, which was valid until 24 February 2016. His licence had been validated by the DGCA of Turkey on 09 February 2012 and was valid until 09 February 2013. He held type ratings as follows: A310/300-600 valid until 23 February 2013.

The FO held a valid First Class Medical Certificate issued on 21 November 2011, which was valid until 27 December 2012. The medical certificate contained the following limitations: "Shall have available corrective spectacles for near vision and carry a spare set of spectacles."

The medical microbiology tests conducted within 24 hours of the accident were negative.

1.5.2.3 Flying experience

Total Flying Hours	15957
Hours on Type Last 90 Days	154
Hours on Type Last 30 Days	85
Hours on Type Last 7 Days	30
Hours on Type Last 24 Hours	8
Hours of rest prior to duty	24+

1.6 Aircraft Information

1.6.1 General

Aircraft Manufacturer	Airbus Industries
Year of Manufacture	1995
Type & Model	A300-605R
Nationality	Turkey
Serial Number	747
Registration	TC-OAG
Certificate of Airworthiness	1592 – Valid until 19 April 2013
Total Hours	54832
Total Cycles	18308
Maximum Take-off Weight	171,700 kg
Engine Manufacturer	General Electric
Type & Model	CF6-80C2A5

1.6.2 Aircraft Airworthiness

The last A and C checks were accomplished on 16 April 2012 at 54779 Flying Hours and 18284 Flying Cycles. The maintenance checks A7, C14 and ATA 32 were performed by Jordan Aircraft Maintenance Limited. The NLG up-lock mechanism was not required to be internally inspected.

1.6.3 Landing Gear System

1.6.3.1 General

The landing gear system consist of a tricycle type landing gear with a forward retracting nose gear and two (2) inboard retracting main landing gears. This system also includes a tail skid located in the lower rear of the aircraft fuselage to prevent or limit structural damage to the aircraft in case of takeoff or landing with excessive nose up attitude (Figure 4).

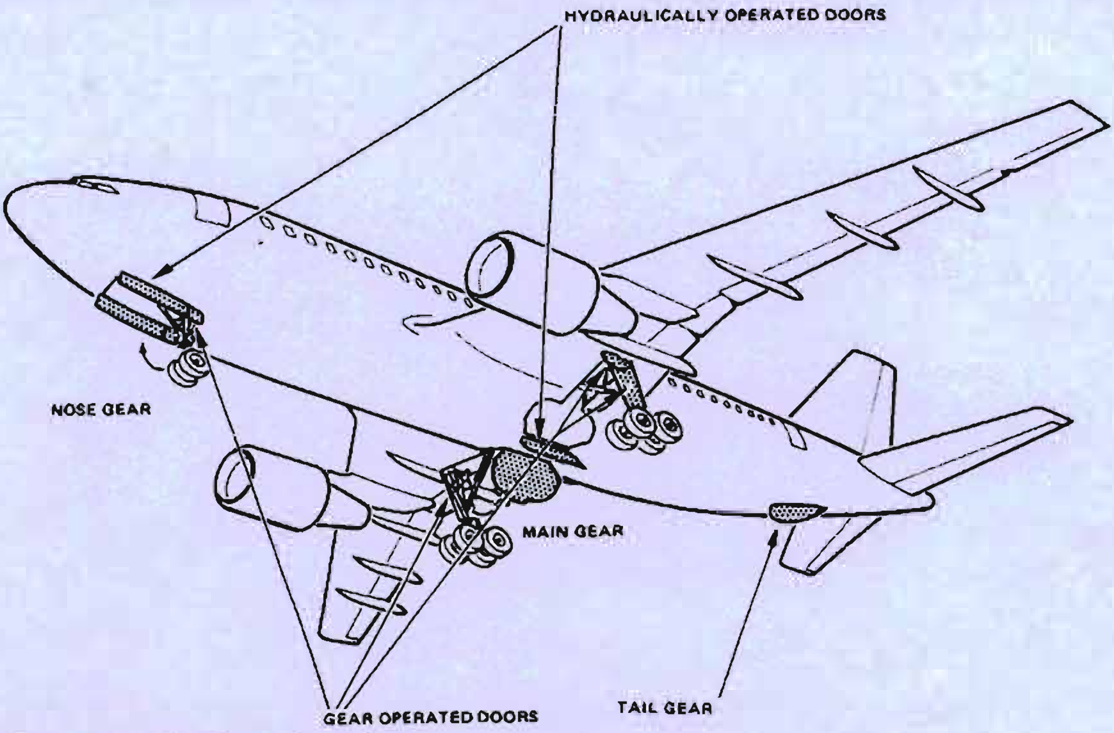

Figure 4: Landing Gear of aircraft.

The left and right main landing gear and the nose gear are retractable under hydraulic power with the landing gear retracting into the aircraft structure. When the landing gear is retracted, the associated landing gear doors are normally closed.

1.6.3.2 Landing Gear Extension and Retraction Control

The landing gear normal extension and retraction is controlled through a three position lever located on the center instrument panel (Figure 5).

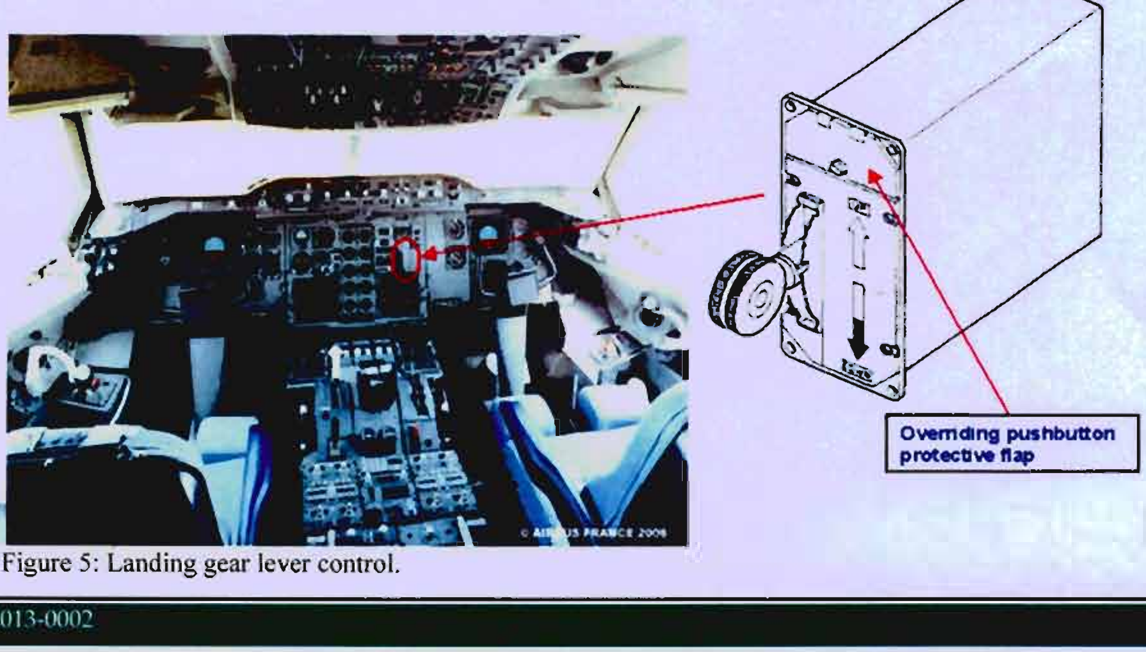

Figure 5: Landing gear lever control.

The landing gear lever has three (3) positions: UP, Neutral and Down.

For landing gear retraction or extension:

- The landing gear lever is selected UP or DOWN.
- The landing gear electro-valves supply retraction (or extension) hydraulic lines with the Green system hydraulic pressure.
- The doors are unlocked.
- The door sequence valves allow door opening by actuators.

When the doors are fully open, the actuators remain pressurized (during extension or retraction) and the sequence valves direct hydraulic pressure which results in:

- Gear unlocking.
- Gear retraction (or extension) by actuators.
- The door sequence valves allow door closing by actuator.
- When fully closed, the doors are locked and then the door actuators remain pressurized closed.
- The flight crew then moves the landing gear lever into the neutral position.
- The gear electro-valve connects the Green hydraulic system extension and retraction lines to the hydraulic system reservoir for the returning of hydraulic fluid.

1.6.3.3 Landing Gear Annunciator Lights

When the nose, the left and the right main landing gears are down and in the locked position, the flight crew would normally acknowledge the three (3) green annunciator lights signifying a normal landing gear extension (Figure 6).

Red annunciator lights indicate the landing gear is not in the selected landing configuration. Amber annunciator lights indicate the landing gear doors are not up and locked.

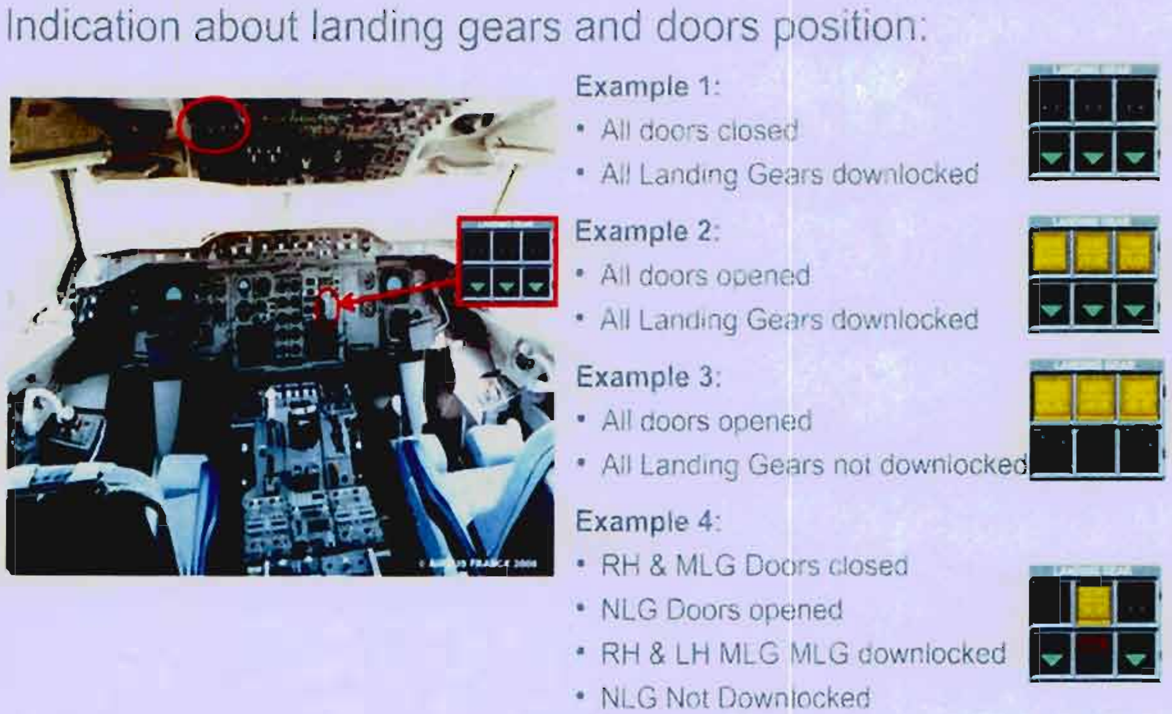

Figure 6: Landing gear annunciator position lighting panels and annunciator indications.

1.6.3.4 Landing Gear Gravity Free Fall Extension System

The aircraft has a gravity extension system for lowering the landing gear in case of hydraulic or electrical power supply failure (Figure 7). A hand crank is stowed in the right side console. A protected fitting is provided in the cockpit floor for insertion of the hand crank. A mechanical means for visual confirmation of the landing gear being down and locked are installed in each wing and through a viewing window located in the avionics compartment.

Intentionally left blank

A300-600

AIRCRAFT MAINTENANCE MANUAL

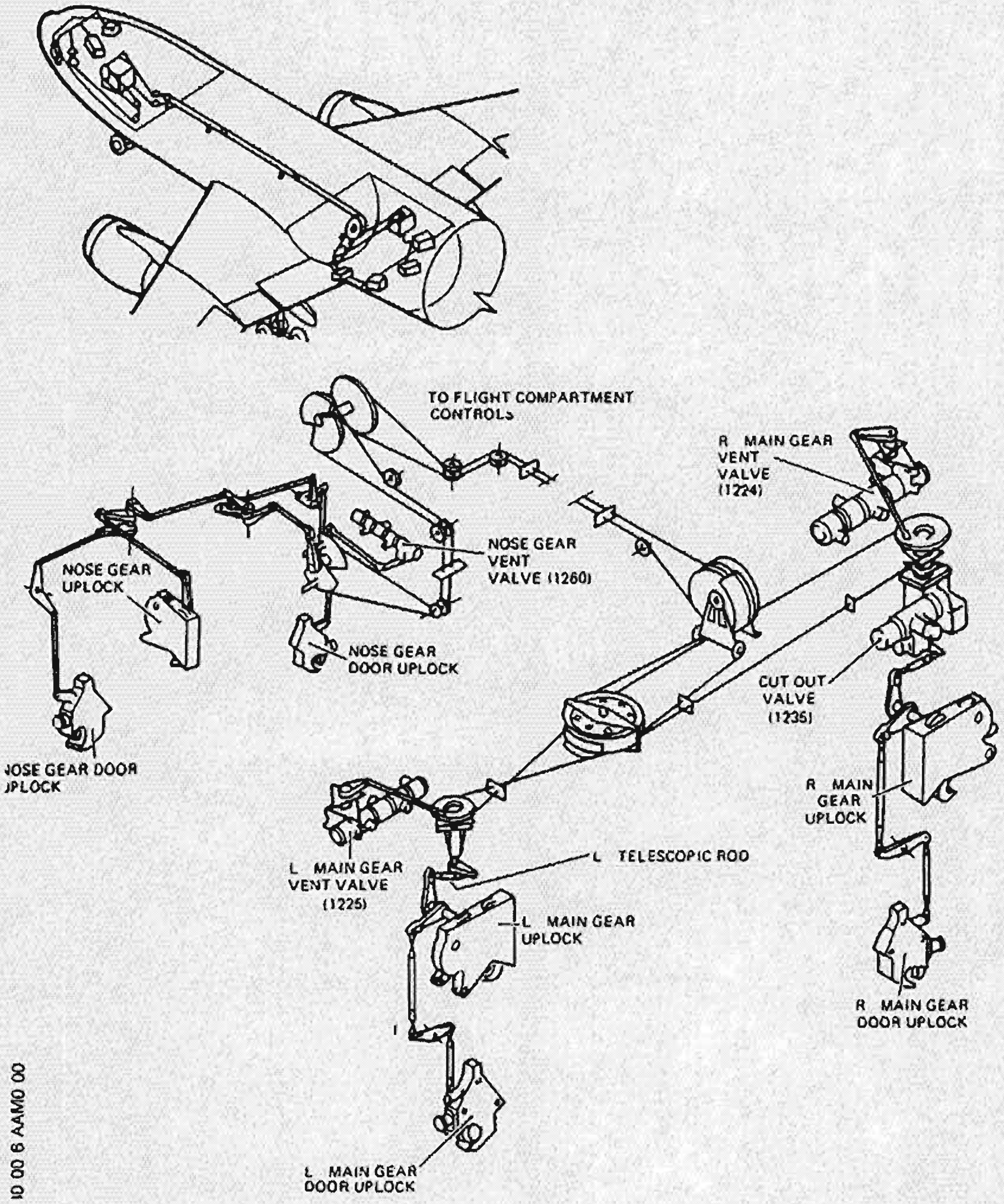

Figure 7: Schematic of Landing gear free fall system.

In the event of a normal extension system failure, the landing gear can be extended mechanically from the flight compartment by means of a crank handle. Rotation of the Free Fall handle controls landing gear equipment activation (Figure 8).

Number of Turns	Equipment Activation
0-7	Shut-off of high pressure supply and connection to reservoir return upstream of the sequence valves
12-14	Connection of the actuating cylinder retraction chambers to reservoir return
14-16	MLG door up-lock release
16-18	NLG door up-lock release
17-19	MLG up-lock release
18-20	NLG up-lock release
20.5	Stop. Free Fall System activation complete

Figure 8: Number of Free Fall handle turns vs equipment activation.

1.6.3.5 NLG Up-Lock Description and Operation

The NLG up-lock is a hydro-mechanical unit which is hydraulically or mechanically unlocked. It automatically locks the nose gear at the end of the retraction travel and keeps it locked until the unlocking mechanism is operated.

The NLG up-lock has two independent commands: operation by the Green hydraulic system pressure or by the activation of mechanical means in case the aircraft loses hydraulic pressure or electrical power.

The movement of levers and mechanical linkages within the NLG up-lock allows the nose landing gear to be unlocked and extended into position.

1.6.3.6 NLG Up-Lock Internal Mechanisms

The NLG up-lock assembly contains two (2) sub-assemblies: the mechanical and the hydraulic assembly. The mechanical assembly includes the NLG up-lock case incorporating internal cams and levers and electrical switches (Figure 9).

The NLG up-lock case contains:

- A cam that rotates according to the landing gear motion by control device;

- The cam includes a ramp and linkages which guide the roller to the sequence valve that incorporates a slide valve that hydraulically controls the movement and position of the landing gear doors;

- The NLG up-lock case also includes a locking lever which prevents the mechanical assembly from moving into the "unlocked" position. The hinge pin of the locking lever also has a normal mode unlocking lever that is controlled by the internal hydraulic actuating cylinder;

- Two NLG up-lock case springs actuate the lever which helps in the mechanical unlocking during emergency or free fall mode; and

- A cam for emergency mode mechanical unlocking is controlled by a lever control device located outside of the NLG up-lock assembly.

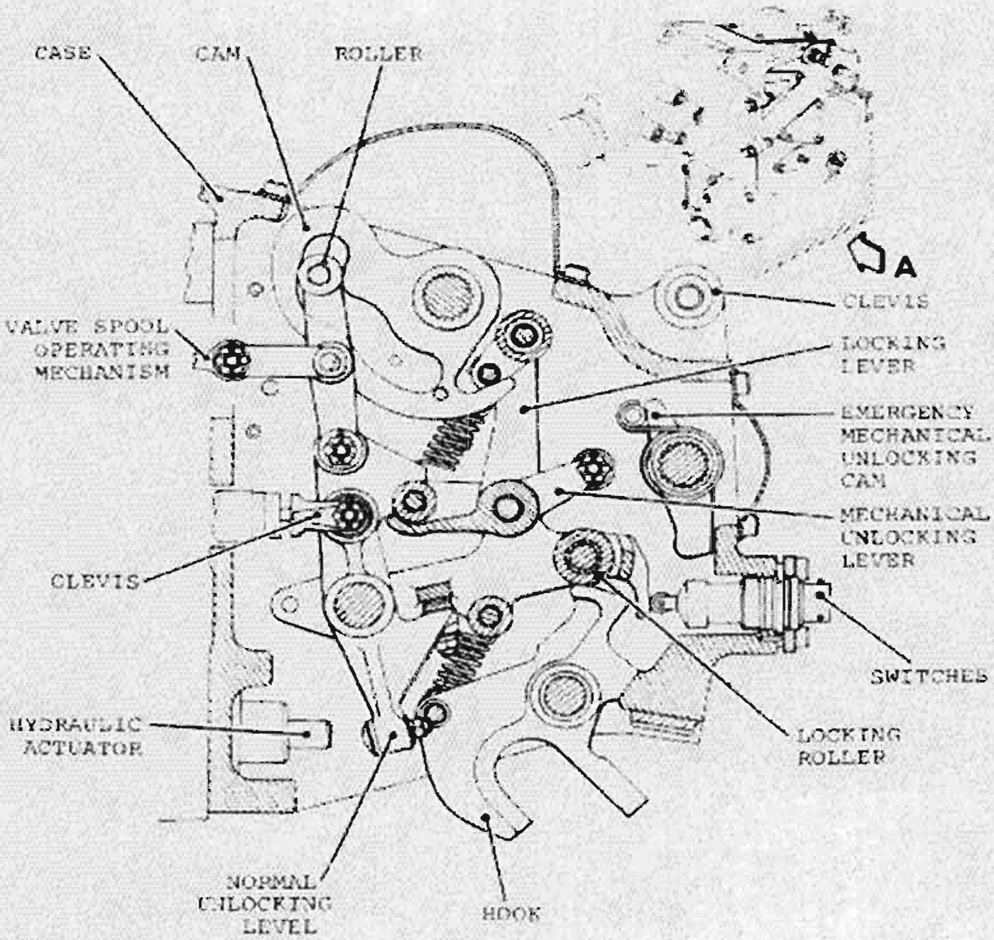

Figure 9: Diagram of NLG up-lock assembly

1.6.3.7 Hydraulic Assembly

The hydraulic assembly includes the sequence valve that incorporates a slide valve which controls the supply of hydraulic pressure to the actuating cylinder. The slide valve hydraulically controls the position of the landing gear doors.

The sequence valve incorporates a mechanism that controls the movement of the slide valve. The sequence valve causes the nose gear door closure upon completion of the nose gear extension or retraction. When the gear doors are opened, the sequence valve is in a position where the landing gear doors are being held opened by hydraulic pressure.

The hydraulic actuator is a double acting cylinder that contains a rod that extends and unlocks the hook, releasing the nose landing gear. Pressure to the hydraulic actuator is received through a restrictor that reduces the flow of hydraulic fluid, slowing the travel of the hydraulic actuating cylinder rod that extends and moves the normal unlocking lever.

When the nose gear is commanded to extend:

- Hydraulic pressure is supplied to the NLG up-lock and operates the unlocking piston which extends, moving the unlocking lever; and

- The unlocking lever pivots and operates a second lever. This action moves the locking roller installed on the locking lever and releases the hook.

At this point, the NLG leg, via external linkage, causes the cam to turn. If the NLG leg does not extend, the cam does not rotate.

The NLG up-lock case springs and the weight of the landing gear operates the hook. The NLG up-lock roller disengages from the hook and the landing gear extends.

1.7 Meteorological Information

The routine aviation meteorological report (METAR) valid for the Jeddah airport at 14h00 local (11h00 UTC) reported: Surface winds of 200 degrees at 18 kt, visibility and clouds CAVOK, the temperature was 37°C and the dew point was 20°C. The barometric pressure was 1003 Hectopascals. The conditions were similar during the approach and landing of SVA 2865.

1.8 Aids to Navigation

All navigation equipment at Jeddah was reported as serviceable.

1.9 Communications

While the flight crew was burning off excess fuel prior to landing, the air traffic controller initially informed the flight crew that runway 16L had been foamed from the intersection at Taxiway K5 to the end of the runway. This information was later corrected by the air traffic controller on two (2) occasions that the runway had been foamed only between Taxiways K5 to K3. Taxiways K5 and K3 both joined the runway at the same place, across from Taxiway L4. This information was not challenged by the flight crew of SVA 2865.

1.10 Aerodrome Information

1.10.1 General

Jeddah has three (3) parallel runways: 16 Left (L)/34 Right (R), 16 Center (C)/34 C and 16R/34L (Figure 10). All runways are covered in asphalt. The airport elevation is 48 feet above sea level. The landing and accident took place on runway 16L.

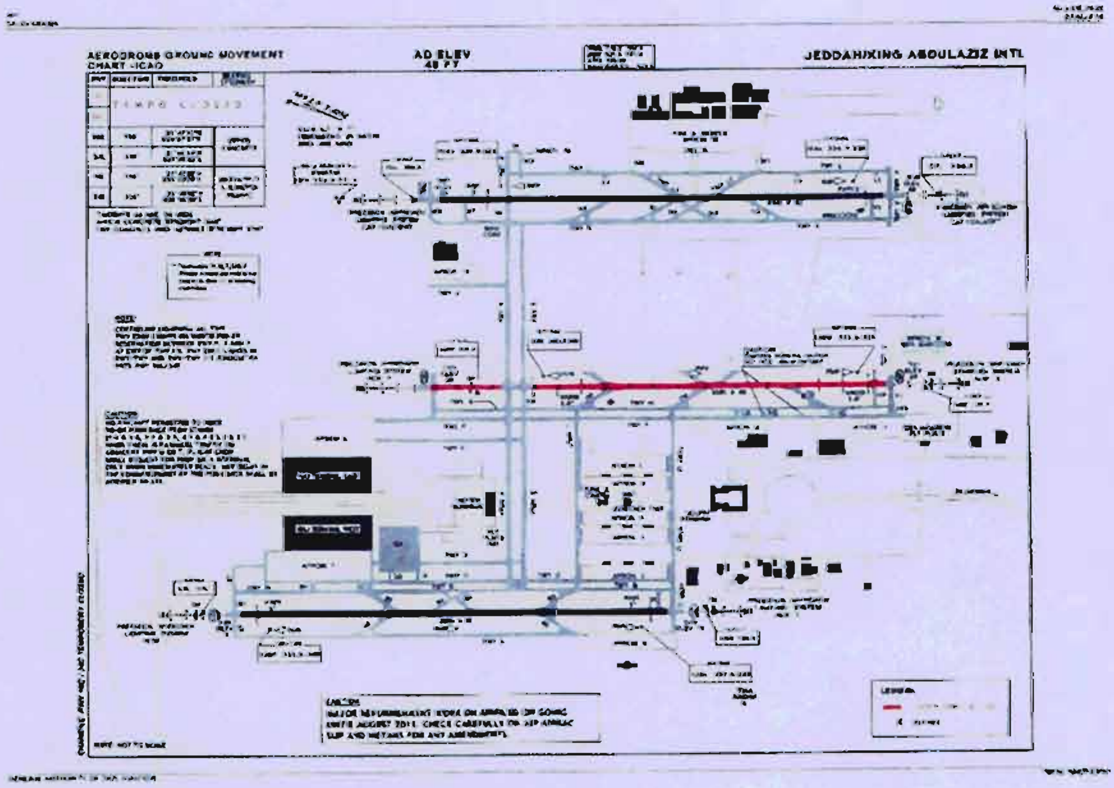

Figure 10: King Abdulaziz International Airport – Jeddah.

1.10.2 Airport Operations

Some vehicles that accessed the area around the aircraft (Figure 11) were not equipped with rotary beacons as required by airport regulations.

Figure 11: Two (2) vehicles without rotary beacons.

1.10.3 Airport Security

The purpose of the Airport Security is to ensure that only authorized personnel and equipment can access the accident site area. The accident site includes all debris, traces and the main wreckage area. At the initial stage, only the Fire Rescue Service (FRS) personnel and equipment have access to the accident site/main wreckage area to save lives and property. Nobody else has access to this area, until it is secured by the FRS.

The cordoned-off area must be wide enough to allow free movement of the FRS vehicles and keep all other personnel, including the security personnel, away from a possible fire/explosion.

The area was not cordoned off. Only a few security guards were present around the aircraft and the access to the aircraft was not questioned by those security guards. They seemed to assume that those present around the aircraft were authorized to be there. The access to the aircraft/main wreckage site was not controlled. Personnel other than FRS personnel and the investigators from the GACA/S&ER were allowed to approach the aircraft without being challenged.

1.10.4 FRS Cameras

The FRS videoed the aircraft landing and aircraft rescue operations. The recordings made by the FRS played an important role by supplying and confirming information of the aircraft landing and rescue operations.

1.11 Flight Recorders

1.11.1 General

Both recorders were hand carried on 01 May 2012 to the GACA/S&ER facilities for downloading of the data. The downloading took place on the 1st and 2nd of May 2012.

1.11.2 Digital Flight Data Recorder (DFDR)

The Digital Flight Data Recorder (DFDR) installed in TC-OAG was manufactured by Allied Signal; Part Number: 980-4700-003, Serial Number: 1958, Date Code: 9649, Unit Weight: 18 LBS MAX, NOM Voltage: 115V AC, NOM Power: 10 Watts.

The memory type was solid state memory chips; the record configuration was 64 words per second and 12 bits per word; the duration was of 32 hours and 57 minutes of data and the useful flight data was of 18 flights including the accident flight, which had a duration of 9240 seconds. The parameter list used was the Flightscape Company A306-A313_64_SGC108-C209.ffd. There were 328 valid parameters and the recording quality was good with a low error rate. The download procedure was in accordance with the GACA DFDR/Cockpit Voice Recorder Laboratory Manual. The downloaded data confirmed the flight crew attempts of lowering the landing gear.

1.11.3 Cockpit Voice Recorder (CVR)

The CVR installed in TC-OAG was manufactured by Fairchild; Part Number S200-0012-00, Serial Number: 02002, Date: 11/98, Unit Weight: 15.5 LBS, NOM Voltage: 115V AC with NOM Power: 12 Watts or 28V DC with NOM Power: 9 watts.

The memory type was solid state memory chips; the recording durations were as follows: 30 minutes for Channel 1/Spare High Quality, Channel

2/Co-Pilot HQ, Channel 3/Pilot HQ, Channel 4/Cockpit Area Microphone HQ and, 120 min. for Channel 4/Cockpit Area Microphone Standard Quality (SQ) and Channel 5/Combined spare + co-pilot + pilot SQ. The recording quality was good. The download procedure was in accordance with the GACA DFDR/CVR Laboratory Manual. The voice recorder confirmed the flight crew attempts to manually lower the landing gear.

1.12 Wreckage and Impact Information

1.12.1 Impact Information

The main landing gear touched down smoothly on Runway 16L at the 4000 foot mark. The aircraft nose doors contacted the runway at the 8623 foot mark of the runway in the end portion of the foamed area.

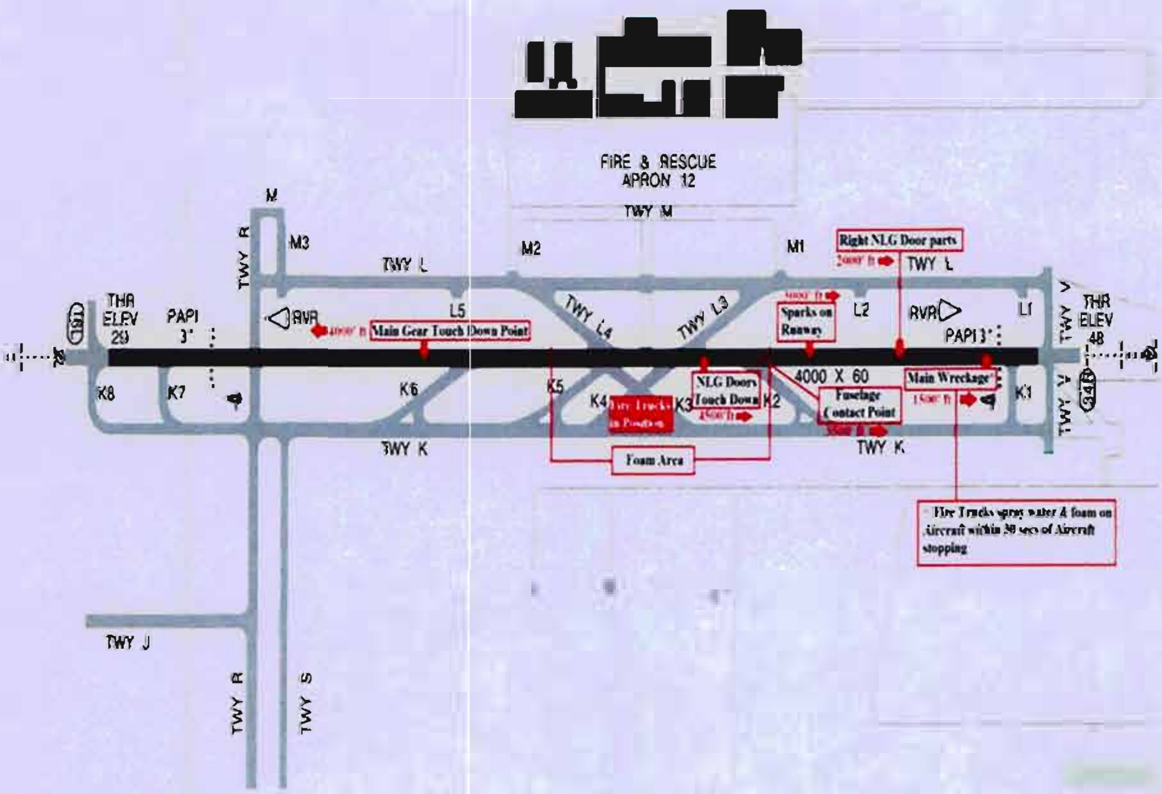

Figure 12: Runway 16L/34R with details of aircraft contact areas.

Figure 12 shows the details of the aircraft landing points, location of the aircraft contact points for landing gear and the aircraft wreckage site on the runway. The location of FRS vehicles and areas that were foamed are also identified. The runway had been foamed from Taxiway K2 to K5.

A small amount of debris from the nose gear doors and linkages was deposited on the runway along the landing path. The aircraft doors initially contacted the runway as identified in Figure 13.

Figure 13: The two lines in the runway indicate the contact area between the aircraft nose landing gear doors and the runway.

The markings from the aircraft structure contacting the runway were noticeable (Figure 13). The aircraft continued to roll on the main gears into the area of the runway that had been foamed. At the 10,623 foot mark, the fuselage contacted the runway beyond the foamed area (Figure 14).

Figure 14: Contact point of fuselage on the runway.

Sparks were generated due to the friction between the aircraft structure and the runway, but there was no fire (Figure 15). The aircraft continued down the runway with the nose doors being torn away from the fuselage. Small pieces of metal and fiberglass material were deposited along the aircraft landing path.

Figure 15: Sparks from friction resulting from the aircraft contact with the runway.

1.12.2 Wreckage Information

The aircraft came to rest at the 11,127 ft mark,1500 ft from the end of Runway 16L. As a precaution, the FRS personnel sprayed the forward nose gear area with water and foam.

The runway and the wreckage trail were documented and the evidence marks on the runway and debris field was plotted.

Debris was located on the following locations on the runway:

- Parts of the nose gear doors and nose gear door linkages were found on the runway at the 8623 feet mark;
- A small amount of airframe debris was deposited as the aircraft skidded down the runway;
- The majority of the aircraft damage was confined to the lower forward fuselage area aft of the nose landing gear wheel well as depicted at Figure 3.

An examination of the aircraft NLG showed the NLG up-lock was holding the nose gear in the up position.

1.13 Medical and Pathological Information

There was no evidence that incapacitation or physiological factors affected the flight crew performance.

1.14 Fire

1.14.1 General

Sparks were present when the fuselage contacted the runway surface and lasted until the aircraft came to a stop. There was no fire during the landing roll or after the aircraft stopped. Some smoke entered the cabin of the aircraft.

1.14.2 Fire Fighting

1.14.2.1 Pre-Response

Approximately 30 minutes prior to the landing of SVA 2865, the FRS foamed the center portion of the runway between Taxiways K5 and K2 (Figures 1 and 12).

1.14.2.2 Initial Response

The FRS vehicles were on standby at the intersection of Taxiways K3 and K4. As the aircraft passed by these locations, the FRS vehicles gave chase to the aircraft. The FRS vehicles reached the aircraft in an expedited manner after it stopped and FRS personnel started spraying foam on the lower portion of the fuselage.

In order to evacuate the smoke from the cabin, FRS personnel opened the L2, L3 and R4 doors. Since those doors were still in the "Armed" position, their related slides inflated (Figure 16). A crew member then disarmed the other doors prior to their opening.

Figure 16: Wreckage site: Rear slides inflated and not usable. Fuselage markings on runway.

1.15 Survival Aspects

1.15.1 Evacuation

The FRS inspected the aircraft which revealed there was no evidence of fire.

The crew members of SVA 2865 were informed that there was no fire and opened both L1 and R1 doors. There was no emergency evacuation performed by the crew. The FRS personnel installed a small ladder at the L1 door where all ten (10) crew members departed the aircraft. The crew members had no difficulty exiting the aircraft.

1.15.2 Aft Doors Slides

During the FRS initial response, the L2, L3 and R4 doors were opened to evacuate the smoke from the cabin. Since those doors were still in the "Armed" position, their related slides inflated.

The relative position of the aft slides to the ground, in this case, the L3 and R4 slides shows a very steep angle of the slides (Figure 16). Only the tip of the slides touched the ground. There was no portion of the slides that could decelerate the sliding/falling of a person using it. The use of these slides during an evacuation of passengers/crews could lead to serious injuries to their users.

The Airbus Airworthiness requirements for the Airbus 310, A300-600 and A300-600R (AI/V-C 600/78 Issue 9 November 1994) stated under Article 25.809 f, 1, ii: "It must be of such length that the lower end is self-supporting on the ground after collapse of one or more legs of the landing gear".

The Federal Aviation Administration (FAA) Title 14 paragraph 25.809(f) (1), amendment 15 (1964) and AC25-17 stated: "To be self-supporting, the bottom end of the slide should rest on the ground. If it does not rest on the ground, the slide must be usable and look usable to passengers. When the passenger uses the slide, the bottom end should rest on the ground and allow the passenger to egress, the slide readily". When the bottom end of the slide rests on the ground, the slide could be at 90 degrees to the ground. This definition does not specify what length of the slide should be self-supported on the ground in order to decelerate the fall/sliding of a person. It further assumes that passengers who never used those slides, can assess their usability in emergency situations; such as, when the aircraft may be on fire and the evacuation takes place at night in adverse weather conditions.

1.16 Tests and Research

The test and examination of the aircraft and applicable components involved a full range of investigative efforts that included on site investigation, aircraft maintenance records review, testing of various NLG system components, and other applicable reviews and consultations with other investigation organizations.

1.16.1. On-site Aircraft Nose Landing Gear Observations

During the initial examination of the aircraft after the accident occurred, the aircraft nose was lifted and investigative photographs were taken at the accident site:

The examination indicated the following:

- The Free Fall linkage in the nose wheel well was in a Free Fall not activated position;

- The landing gear was centered and the sliding tube was extended (chromed surface). There was no evidence of any binding or interference between the nose wheels and the NLG doors;

- The NLG up-lock assembly hook was fully engaged around the NLG up-lock roller;

- The NLG shock absorber targets were aligned with the sensors;

- The linkage between the NLG door and the NLG door sequence valve was disconnected most probably due to the landing on the nose gear doors; and

- There was no evidence indicating the prevention of the NLG from free falling into the extended position.

At the conclusion of the initial examination, the nose gear free fall crank handle mechanism was activated. The NLG Gravity Extension system operated without hesitation. A video of the nose gear free fall was made for reference and showed the free fall system operating normally.

During the initial free fall of the landing gear, it was reported that a maintenance technician attached a strap to the landing gear possibly affecting the free fall of the NLG. It was determined that a maintenance technician placed a strap under the nose landing gear strut to ensure the NLG did not inadvertently fall from the NLG wheel well and injure someone.

1.16.1.1 Examination of Tensioned Cables in the NLG Free Fall system

It was reported the Free Fall cables were below the specified cable tension. The under tension condition of the Free Fall cables could possibly result in the delay of the nose gear free falling by at least one (1) turn of the gravity extension hand crank. The flight crew indicated the free fall system operated as per the Flight Manual with no "hard points" noted when turning the gravity extension hand crank.

1.16.2 Removal of Suspected Components for Testing

A test and research plan was initiated for the investigative and functional testing of affected components. These components were selected due to being a part of the components that would affect the operation of the nose landing gear. After an examination of these components, the NLG up-lock assembly was inspected internally for abnormalities. A test and research plan was initiated to test and verify the operation of removed components associated with the NLG operation. The following NLG systems components were removed for testing and failure analysis:

Nomenclature	Part Number	Serial Number
NLG Up-lock	A25421001-2	U173
L/H NLG Door UP-Lock	A25431001-2	U1576
R/H NLG Door UP-Lock	A25431001-2	U1582
L/H NLG Sequence Valve	A25271-1-1	Unknown
RH NLG Sequence Valve	A25271-1-1	Unknown
Cut Out Valve	A2524003	U132
Restrictor	A25474	H229A

The components removed for review were subject to the following examinations:

- Detailed inspection;
- Binocular examination of damages;
- Scanning electron microscope examinations;
- Failure mode of areas (static and fatigue);
- Striation and initiation localization of any cracks;
- Material Examination;
- Cross section on each metallographic plan and optical microscope observations;
- Hardness measurement;
- Electrical conductivity measurement;
- Chemical analysis; and
- Synthesis Report.

The plan also called for testing, disassembly, cleaning, non-destructive testing, and dimensional check if required. These components were tested by the component manufacturer, Messier-Bugatti-Dowty (MBD). A brief summary of the testing of the components is noted. The complete testing results are documented in a report in Appendix A. The results of the testing and examination are as follows:

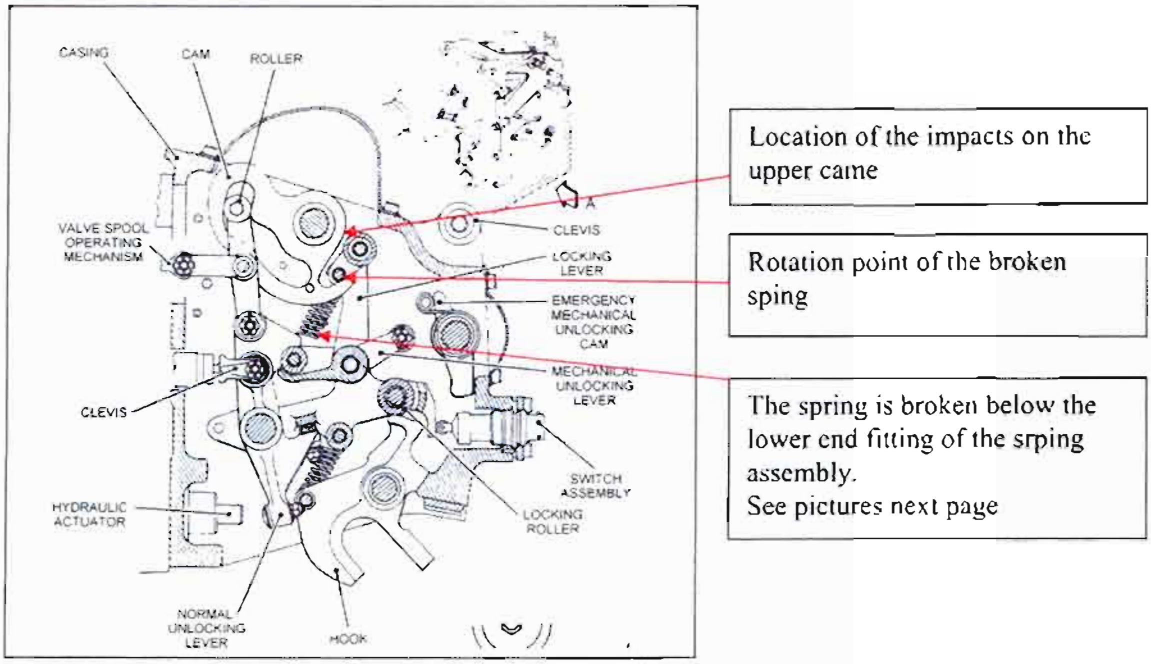

Figure 17: Reference to pictures.

1.16.2.1 NLG Up-lock, A25421001-2, Serial Number (S/N) U173.

Date of Testing: 03 to 05 September 2012 & 10 – 11 September 2012
Testing Performed by: MBD and European Aeronautic Defense and Space Company (EADS)
Purpose of Test: Investigative functional test and review
Testing Details documented in Appendix A

The NLG up-lock and its associated internal parts were subjected to extensive examination and testing. During the testing of the NLG up-lock Assembly, the following was noted:

- During the application of Subtask 32-31-20-700-007-A01 load test, the slide valve load test force of 191N was applied. The limit for the test was not to exceed 170N.

- During the application of subtask 32-31-20-790-004-A01 (2) (b) leakage test, the hook unlocked under a pressure of 206 bar as a minor leak from a plug had been observed.

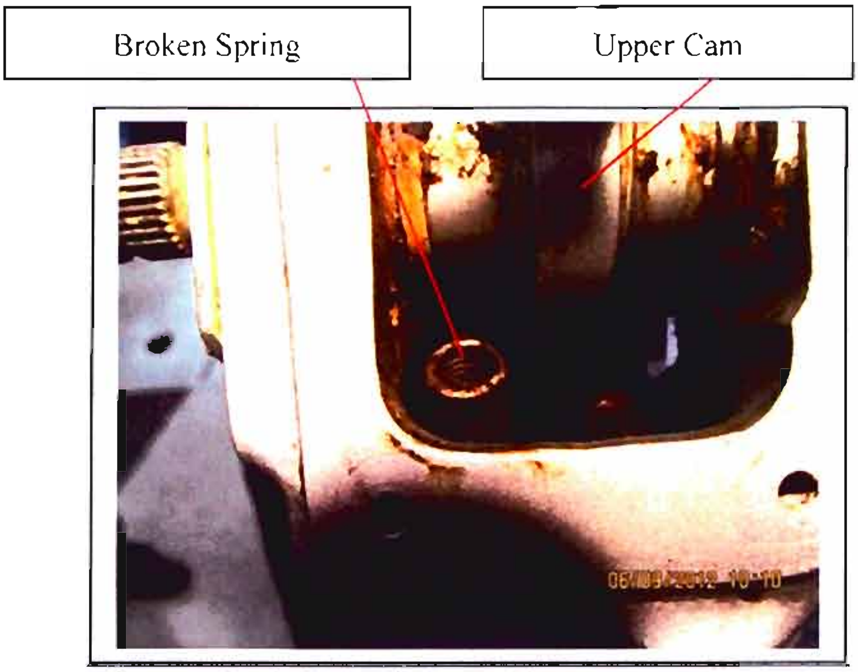

Figure 18: Spring broken in NLG uplock assembly.

The unit was sent to be disassembled for internal examination. During the stripping process, the investigation team found one spring, P/N GA71102, was broken (Figure 18). A detailed view of the broken spring coil is shown in Figure 19.

Photo 7.2: Long ½ spring
(No cleaning)

Figure 19: Detailed view of fractured area of broken spring.

These spring sections were identified as the "long spring" and the "short spring." According to the component maintenance manual, the broken spring was one of the two springs, which actuate the mechanical unlocking lever during the emergency lowering of the nose landing gear. During testing, the broken long spring made contact with the cam which could have prevented the free fall unlocking mechanism to function properly.

Further examination of the spring by microscope indicated that the breakage of the spring started with fatigue and continued for some time with the spring static breakage eventually occurring.

The NLG up-lock was tested to simulate any affect a broken spring could have upon the NLG up-lock operation. The placement of the broken spring was performed as representative as possible. In this case, the spring placement against the upper cam prevented the rotation of the NLG up-lock cam, preventing the hook assembly from performing the unlock function.

Figure 20: Spring jammed in NLG up-lock.

The long spring had the capability of rotating with an angular trajectory of nearly 180 degrees. Figure 20 shows the broken long spring making contact with the cam, preventing the free fall and normal unlocking mechanism to complete the unlocking cycle.

The spring, Part Number GA71102, was found fractured as a result of the fatigue process initiated at the third coil of the spring. The cam of the NLG up-lock was also inspected, revealing damage on the cam resulting from verifiable hard contact points made by the long spring during NLG operation. Some of these marks indicated the long broken spring had been in a position perpendicular to the cam body during the NLG operations and could have prevented normal operation of the NLG up-lock in both normal and free fall operations.

Further detailed examination of the damaged area of the cam is noted on Figure 21. The damage areas identified as areas A, B, and C are a result of contact with the broken section of the long spring.

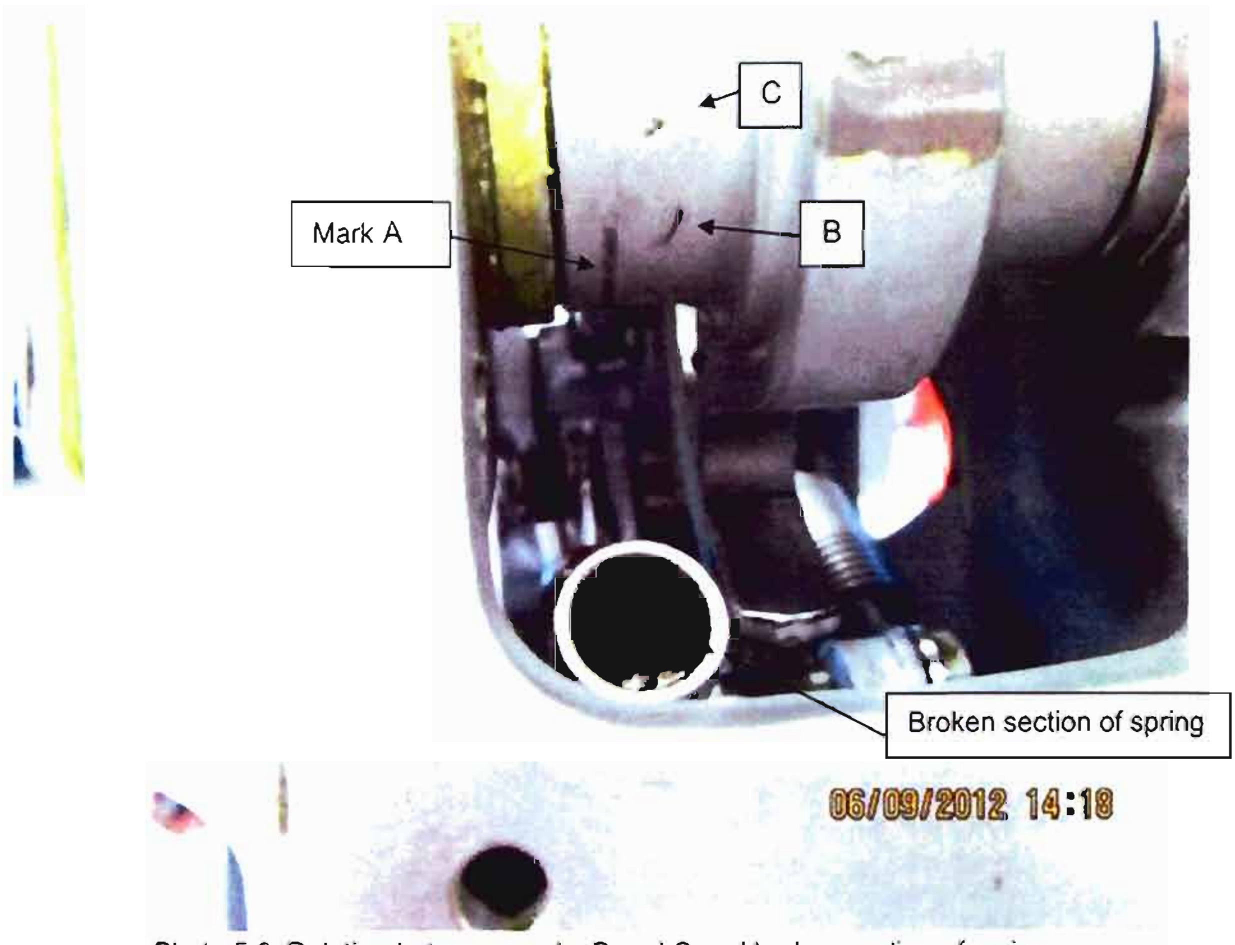

Photo 5.6: Relation between marks B and C and broken section of spring
(Photo by GACA at Molsheim investigation after mechanism cleaning)

Figure 21: Damaged areas of NLG up-lock found during investigation.

Figure 21, photograph 5.6 detailed the marks noted on the cam and are identified showing the relationship between the broken spring movement in the NLG up-lock and the marked areas of the cam.

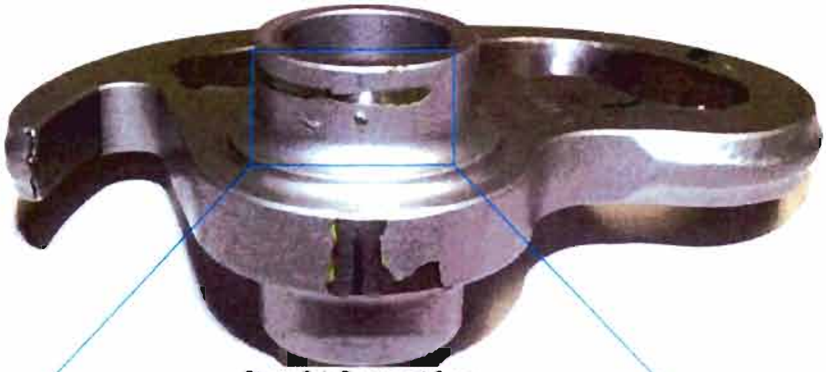
Photo 5.1: Damaged Cam

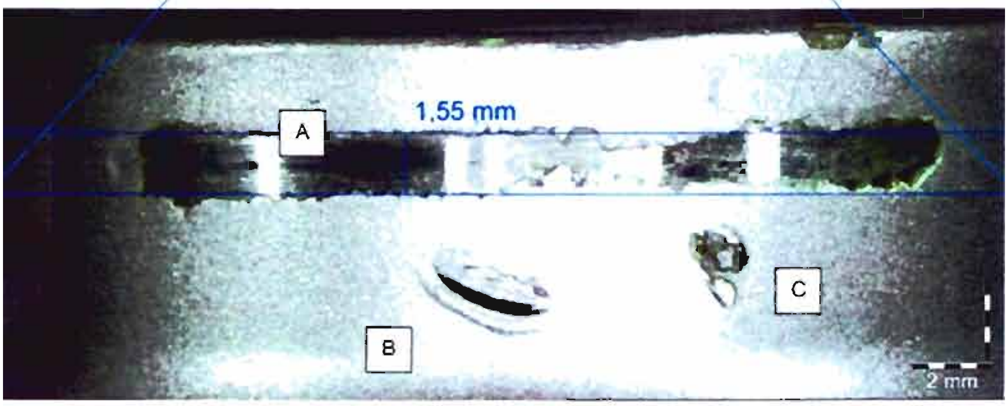

Photo 5.2: Detail of damaged area(damages A, B and C)

Figure 22: Photo 5.2, Damage areas of cam. Areas A, B, and C in relationship to Photo 5.1

As identified in Figure 22, Photos 5.1 and 5.2, the wear marks noted on the long spring are related to the "mark A" on the cam. An enlarged view of the spring contact surface area shows the width of the marks on the spring body (Figure 23, Photo 5.3) is equivalent to the marks width on the cam (Figure 22, Photo 5.2, Area "A").

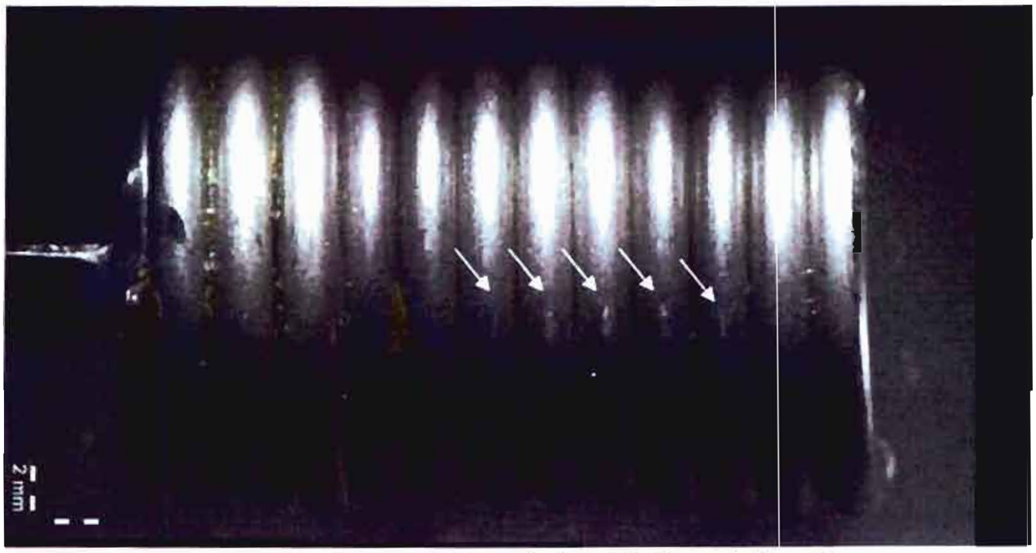

Photo 5.3: Wear marks on spring body related to mark A on Cam

Figure 23: Photo shows wear marks on long spring.

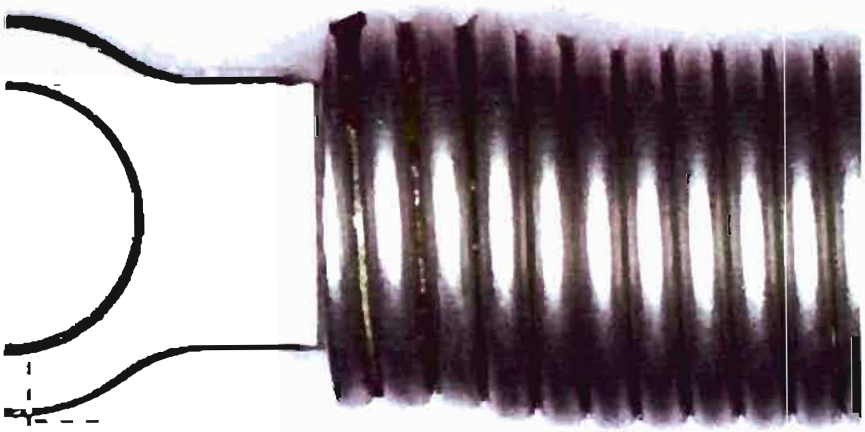

Photo 5.7: Deformation of broken spring body

Figure 24: Deformation of spring

The deformation of the broken long spring body is noted in Figure 24, Photograph 5.7. The relationship between the deformation of the broken long spring and the contact area on the cam can be viewed in Figure 25, Photograph, 5.8.

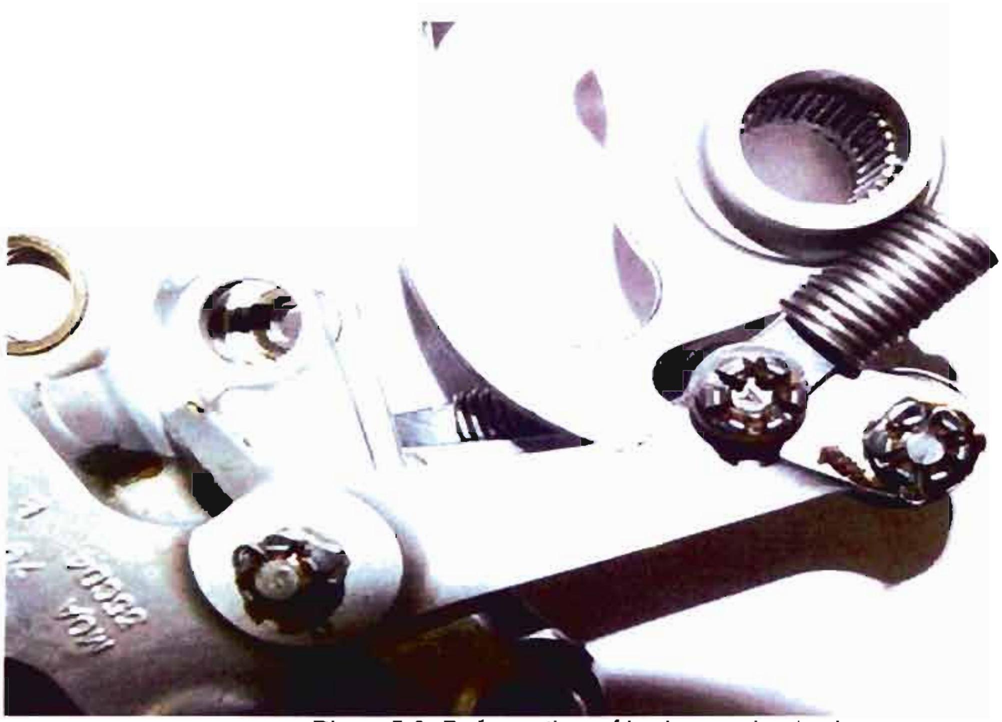

Photo 5.8: Deformation of broken spring body

Figure 25: Cam and deformation of broken long spring against cam.

The previously mentioned photographs clearly show that the broken long spring had been contacting the cam on numerous occasions.

The historical traceability of the NLG up-lock indicated this component had accumulated 54,640 flight hours, 18,254 cycles at an age of 17.24 years.

1.16.2.2 Spring P/N GA71102

Date of Testing: 28 May 2013
Testing Performed by: MBD
Purpose of Test: Investigative functional test and review
Testing Detailed documented in Appendix A

The spring, P/N GA 71102, was found broken in the NLG up-lock. The service history of the NLG up-lock indicated that the unit had warranty seals installed on the cover plates indicating that no internal maintenance had been performed to the unit since its assembly by the manufacturer.

Tests performed by MBD (Molsheim) were performed on altered (altered to match the broken spring) new springs by placing axial compression loads on the spring and testing the spring until a rupture occurred. The test springs failed under varying compression test period and loads ranging from ten (10) seconds to one (1) minute, with the springs failing in the first, second, and third spring coil, respectively. The results of these tests confirmed that spring jamming was very unpredictable. The compression tests resulted in huge discrepancies of the spring mechanical behavior that was hard to predict.

1.16.2.3 NLG Up-lock Spring Historical Criteria

Date of Testing: 03 to 07 September 2012 & 10 – 11September 2012
Testing Performed by: MBD
Purpose of Test: Investigative functional test and review

Two modifications had been previously made to the type of spring used inside the NLG up-lock. The initial spring installation in the NLG up-lock had evolved from PN A80013 to PN A80013-1, through a Vendor Service Bulletin (VSB) 470-32-035 to prevent uncoupling as a result of an improper resetting after the emergency unlocking of the landing gear on the aircraft. Spring PN A80013-1, evolved to the present spring installation, P/N GA71102, through VSB 470-32-463 in order to eliminate the risk of failure of the springs, which connected the unlocking lever. It was reported in 2006 that MBD had launched a comparative test program between spring GA71102 and a modified spring. However, the test results were not conclusive enough to launch a spring product improvement. No improved spring replacement scheme had been initiated since that time.

1.16.2.4 Left Hand Door Up-lock Assembly, A25431001-2, S/N U1582

Date of Testing: 04 to 05 September 2012 & 10 – 11 September 2012
Testing Performed by: MBD
Purpose of Test: Investigative functional test and review
Testing Detailed documented in Appendix A

This component passed all the tests except test 2.B.4.b: locking of the unit with roller positioned at 33 mm from centerline. As per the Component Maintenance Manual (CMM), a load had been applied on the unit in a hydraulic functioning (210 bar) and observed that the door up-lock hook had locked at 80 Newtons (N), which was outside of the limit range of 100-200N. This abnormality was considered as minor by MBD. The unit was sent to be disassembled for internal examination. During the initial disassembly, no abnormality was noted. The internal examination found the LH spring was stretched. This spring was the one of the pair that made the connection between the rotating cam shaft and the hook. Longitudinal marks on the spring showed possible contact between the springs and the NLG up-lock casing during mechanical operation. No other abnormalities were noted.

1.16.2.5 Right Hand Door Up-lock, A25431001-2, S/N U1576

Date of Testing: 03 to 07 September 2012 & 10 – 11 September 2012
Testing Performed by: MBD
Purpose of Test: Investigative functional test and review
Testing Detailed documented in Appendix A

This component passed all the tests except test 2.B.5.b: locking of the unit with roller positioned at 37 mm from centerline. As per the CMM, a load had been applied on the unit in a hydraulic functioning (210 bar) and observed that door up-lock hook had locked at 70 N which was found out of the limit range 80N-160N. This abnormality was considered as minor by MBD Industries. The unit was sent to be disassembled for internal examination. The internal examination found the evidence showing possible contact between the springs and the casing during mechanical operation. No other abnormality was found.

1.16.2.6 RH NLG Hydraulic Sequence Valve, A25271-1-1, H335

Date of Testing: 04 to 07 September 2012 & 10 – 11 September 2012
Testing Performed by: MBD and EADS
Purpose of Test: Investigative functional test and review
Testing Detailed documented in Appendix A

The unit was sent to be disassembled for internal examination. A dent was found on the sequence valve body at the area between the actuating lever and the body surface. The broken lever of NLG RH hydraulic sequence valve was examined with a scanning electronic microscope. An examination determined that the lever had broken by static load due to the impact during the accident.

1.16.2.7 LH NLG Hydraulic Sequence Valve, A25271-1-1, S/N H301

Date of Testing: September 04 to 07 2012 & 10 – 11 September 2012
Testing Performed by: MBD and EADS
Purpose of Test: Investigative functional test and review
Testing Detailed documented in Appendix A

The hydraulic sequence valve passed all the tests. The unit was sent to be disassembled for internal examination. A dent was found on the component body at the area between the actuating lever and the body surface. This dented surface could represent a mechanical stop on the unit cam. MBD decided to send the unit to EADS for further examination. All tests were passed. The broken lever of NLG LH hydraulic sequence valve was examined with a scanning electronic microscope. An examination determined the lever had broken by static load due to the impact during the accident.

1.16.2.8 Cut- Out Valve, P/N A25240003, S/N U132

Date of Testing: 11 February 2013
Testing Performed by: MBD
Purpose of Test: Investigative functional test and review
Testing Detailed are locate in a proprietary BEA Report

The testing of the Cutout Valve confirmed that the valve tested per the CMM and did not contribute to the accident.

1.16.2.9 Restrictor, P/N A25474, S/NH229A

Date of Testing: 26 March 2013
Testing Performed by: MBD
Purpose of Test: Investigative functional test and review
Testing Detailed documented in Appendix A

During normal operation, the hydraulic fluid pressure drop should be approximately 50 bars (737.5 PSI) at a flow rate of 600 +/- 100 cc/min. If there is no flow because of jamming, the pressure may rise to 206 bars. The unit was inspected and tested in accordance with the CMM. Some small particles were found in the restrictor filter, but no particles were clogging the filter or restrictor hole.

1.16.3 Airbus - MBD Report Number C32PR1310465

An examination of the test results as documented in the Airbus - MBD Report Number C32PR1310465, dated 04 June, 2013, has noted:

- Spring failure inside the NLG up-lock could lead to the blocking of the NLG leg extension by normal and emergency commands.

1.17 Organizational and Management Information

Onur Air was a commercial air carrier certificated by the Directorate General of Civil Aviation of Turkey. This air carrier, based in Istanbul, Turkey was authorized to conduct scheduled and unscheduled cargo and passenger operations. Onur Air operated twenty six (26) aircraft to 12 domestic destinations within Turkey and three (3) international destinations. At the time of the accident, Onur Air was operating TC-OAG under a wet lease contract with Saudi Arabian Airlines. Onur Air had operational control of the aircraft during this flight.

1.18 Additional Information

The following information became available during the technical investigation:

- Effective 20 July, 2012, Airbus released a Mandatory Service Bulletin Number A300-32-6111 for the inspection of up-lock springs.

- Effective 30 July 2013, the European Aviation Safety Agency (EASA) issued an Airworthiness Directive Number (No.) 2013-0150 due to the reporting of NLG and Main Landing door and up-lock spring ruptures on some models of A300, A310 or A-300-600. This document is located in Appendix A.

2.0 ANALYSIS

2.1 General

The analysis will discuss the flight operations, the flight crew members, operational procedures, the air traffic control, the aerodrome, the aircraft, the meteorological conditions, the FRS response, and the survivability aspects.

2.2 Flight Operations

2.2.1 Crew Qualifications

The flight crew members were certified and qualified on the A300-605 aircraft. Both flight crew members had received the appropriate and approved training.

2.2.2 Operational Procedures

The flight crew performed their duties in accordance with the approved crew flight manual and check list. The PM utilized the emergency hand crank to lower the nose gear, but these efforts were ineffective due to a mechanical abnormality in the NLG up-lock. The flight crew actions did not contribute to this accident.

2.2.3 The Flight Crew Actions

The flight crew performed their duties in a satisfactory manner.

2.3 Air Traffic Control

Jeddah Air Traffic Control activities did not contribute to this accident.

2.4 Communications

All communications between the flight crew, Jeddah Tower and associated FRS did not contribute to this accident.

2.5 Aids to Navigation

Navigational aids at Jeddah were functioning properly and did not contribute to this accident.

2.6 Aerodrome, Jeddah Airport Operations

2.6.1 Airport Operations

Some vehicles used by Airport Operations were not equipped with rotary beacons and not all First Responder vehicles were painted with an identifying color scheme. This rendered the vehicles identification difficult.

2.6.2 FRS Response

The FRS response was very quick. As the aircraft passed by the fire trucks parking location, the vehicles gave chase to the aircraft. The FRS vehicles reached the aircraft within 30 seconds after it stopped and FRS personnel started spraying foam on the forward, lower portion of the fuselage.

The FRS helped evacuate the crew from the aircraft using a ladder as there was no urgency to evacuate. In order to evacuate the smoke from the cabin, FRS personnel opened the L2, L3 and R4 doors. Since those doors were still in the "Armed" position, their related slides inflated. A crew member then disarmed the other doors prior to their opening.

The FRS paramedics took both flight crew and the cabin crew to the airport clinic as a precautionary measure for a precautionary medical checkup. One (1) manned FRS unit was continuously present at the accident site until all recovery activities were complete.

2.7 The Aircraft

The aircraft was properly certificated and had been maintained in accordance with approved procedures. There was no evidence of airframe failure or systemic malfunction prior to the accident.

However, the aircraft NLG up-lock case contained a broken spring that jammed the NLG up-lock mechanism, not allowing the nose landing gear to extend and lock into position.

2.7.1 Aircraft Maintenance

Aircraft maintenance/personnel actions did not contribute to this accident. The broken spring in the NLG up-lock was hidden from a preflight or general visual inspection performed by aircraft maintenance personnel.

2.7.2 Aircraft Performance

The aircraft performance or handling characteristics did not contribute to this accident.

2.7.3 Aircraft Instrumentation

All aircraft instrumentation and indication systems were performing properly and did not contribute to this accident. The nose gear indication lights were operating properly, warning the crew that the nose gear was not down and locked.

2.7.4 Aircraft Systems

All aircraft systems were operating properly except for the NLG up-lock. A spring in the NLG up-lock was broken and jammed the NLG normal and free fall operations.

2.7.4.1 Aircraft Landing Gear System Operation

As the aircraft approached Jeddah for landing, the following actions occurred:

- The landing gear lever was selected to the DOWN position;
- The landing gear electro-valves supplied Green system hydraulic pressure to the landing gear selector valve located on the upper area of the hydraulics compartment;
- The main landing gear operated normally, extending and locking into place, resulting in two green lights appearing on the cockpit landing gear annunciator panels;
- The up-lock sequence valve directed Green hydraulic system pressure to the nose gear door hydraulic actuators and the NLG door up-lock unlocking pistons causing the NLG doors to open;
- The free fall mechanism NLG up-lock release control was disengaged from the door sequence slide valve;
- The NLG gear door sequence valves allowed the hydraulically actuated NLG doors to open;

- The NLG sequence valves also directed Green hydraulic system pressure to the hydraulic actuator piston with hydraulic pressure being supplied through a hydraulic restrictor;

- As the hydraulic actuator piston extended and contacted the normal unlocking lever, a mechanical jam caused by a broken NLG up-lock case spring that was jammed against the cam, did not allow the NLG to unlock;

- In the NLG up-lock, a spring (long spring) was found broken;

- According to a metallurgical analysis conducted by EADS, an accurate calculation could not be made to determine how long this spring had been broken;

- The ends of the broken spring were still attached to the respective mounting points at the locking lever and the mechanical unlocking lever;

- The loose ends of the broken spring were free to move in any angular position about their mounting point; and

- The long end of the broken spring became a mechanical stop as the long spring wedged against the cam as noted in photograph at Figure 20.

The hydraulic actuator normally extended and applied pressure to the normal unlocking lever, moving the hook to unlock the NLG. However, due to the mechanical stop caused by the broken spring jammed against the cam, the internal mechanisms were not able to rotate and be actuated. The internal slide valve of the NLG up-lock remained pressurized keeping the NLG doors open.

The broken spring caused a mechanical jamming of the cam and would not allow the locking lever to rotate, preventing the NLG hook to rotate and unlock the NLG.

When the landing lever was DOWN and the NLG was still in the UP and locked position, the landing gear indicator light for the NLG was RED and the NLG door indication was AMBER. The NLG doors remained opened.

The flight crew made at least 10 attempts to lower the NLG by utilizing the free fall extension method.

When performing the free fall extension method, the FO removed the crank handle from the right console and inserted its end into a protected fitting in the cockpit floor. The crank handle was turned approximately 20 turns to complete the free fall of the landing gear. No hard points were noted by the flight crew when turning the crank handle.

During the crank handle turning process, linkages in combination with cables, shut off the Green system hydraulic pressure, allowing the hydraulic pressure to return to the hydraulic reservoir. Three vent valves allowed hydraulic fluid from the landing gear and door actuating cylinders to return hydraulic fluid to the reservoir return. For the nose gear, the mechanical release mechanism on the NLG up-lock was not effective due to the broken spring being jammed against the cam, not allowing any movement of the internal mechanisms in the NLG up-lock to function.

2.7.4.2 NLG Up-lock

All evidence concludes that there were no appreciable deficiencies noted in any testing of the components except for the NLG up-lock that had a broken spring P/N GA71102, which was contained in the NLG up-lock case. EADS Innovation Works Report Number 2012-12165-IW/MS/MF noted the broken spring could have prevented the normal operation of the NLG up-lock.

This investigation has provided the following facts:

- Spring, P/N GA71102, located in the NLG up-lock, had been broken for an undetermined period of time;
- The broken pieces of the spring were attached to their respective mounting points;
- The loose ends of the broken spring were free to move in any angular position about their mounting points;
- The long end of the broken spring became a mechanical stop between the cam and the long broken spring mounting point;
- During the site investigation, at the conclusion of the initial examination, the nose gear free fall crank handle mechanism was activated. The NLG Gravity Extension system operated properly without any hesitation. The investigation could not determine why this system operated properly after the crew had repeatedly and

correctly used the crank handle mechanism. Although this remained unexplained, the following possibility was considered: The broken spring was freed from the cam by the violence of the aircraft impact with the runway.

2.7.4.3 NLG Up-lock Spring

As documented by the AIB and by the cooperating investigation agencies, the broken spring caused a mechanical jamming of the locking lever and would not allow the locking lever to rotate, preventing the nose landing gear hook to rotate and unlock the NLG.

2.8. Meteorological Conditions

The meteorological conditions at Jeddah Airport were not a concern, nor did they contribute to this accident.

2.9 Survivability

This accident was survivable. It was determined that the rear slides of the aircraft would not be preferred for use if the aircraft landed with the nose gear retracted.

The tip of the slides touched the ground thus giving a very steep angle with the ground. If used, a person would tumble off the aircraft rather than slide down with no portion of the slide absorbing the fall/decelerating the person.

2.10 Safety Organization Actions

The European Aviation Safety Agency (EASA) has issued an Airworthiness Directive No. 2013-0150, effective 30 July 2013, due to the reporting of NLG and Main Landing door and up-lock spring ruptures on some models of A300, A310 or A-300-600 aircraft. Airworthiness Directive No. 2013-0150 stated: "The springs are positioned in pairs and in case of rupture of one spring the other one remains to fulfill the function whereas the rupture of both springs will disable the locking function or the emergency unlocking function. This condition, if not detected and corrected, could prevent proper free fall extension of the MLG or NLG, possibly leading to loss of control of the aeroplane on the ground, consequently resulting in damage to the aeroplane and injury to occupants."

3.0. CONCLUSIONS

3.1 Cause Related Findings

1. The NLG up-lock contained a spring, Part Number GA71102 that was broken as a result of fatigue initiated at the third coil of the spring.

2. The spring had been broken for a prolonged period of time, as noted by the spring linear wear marks on the outside area of the spring coils.

3. Damage observed on the NLG up-lock resulted from hard contact with the broken spring during normal NLG operation.

4. The fracture process of the spring was initiated at the third coil level. At least 6000 cycles of fatigue (number of striations) have been estimated by fatigue striation measurements. The crack on the spring started on the internal surface of the spring which was not shot peened.

5. The normal and free fall extensions of the NLG failed due to a mechanical blockage created by the broken spring jammed against the cam.

3.2 Other Findings

1. The aircraft was properly certificated and had been maintained in accordance with approved procedures.

2. The landing gear free fall cable system was out of tolerance by one (1) turn. This condition did not have an effect on the free fall operation of the landing gear system.

3. The meteorological conditions did not contribute to this accident.

4. The flight crew was certified and qualified on this type of aircraft.

5. The flight crew performed their duties in accordance with the approved procedures.

6. All communications with the Jeddah controllers and FRS were satisfactory.

7. The FRS response was efficient and appropriate.

8. Not all KAIA Airport Operations vehicles were equipped with rotary beacons.

9. The Security surrounding the aircraft was inappropriate.

10. The angle of the slides situated at the number 3 and 4 doors was beyond 60 degrees with the ground, with only the tip of the slide being self-supporting on the ground.

11. The certification of the slides was not specific regarding the useable/recommended slope of the slide in relation to the ground.

12. The certification of the slides did not specify what length of the slide should be self-supported on the ground in order to decelerate the fall/sliding of a person.

13. At the time of the accident, the Aircraft Inspection Program did not contain a scheduled maintenance action to inspect the springs for condition of the NLG up-lock.

14. Effective 20 July, 2012, Airbus released a Mandatory Service Bulletin Number A300-32-6111 for the inspection of up-lock springs.

15. Effective 30 July 2013, the European Aviation Safety Agency (EASA) issued an Airworthiness Directive Number (No.) 2013-0150 due to the reporting of NLG and Main Landing door and up-lock spring ruptures on some models of A300, A310 or A-300-600.

4.0 SAFETY RECOMMENDATIONS

Safety Recommendation AIB-2013-0002-01

On 20 May 2012, GACA/S&ER issued a Stand Alone Recommendation (SAR). This SAR indicated that "Airbus Industries amend the A300-600 FCOM and the Quick Reference Handbook Sections 10.04 and 20.01 to emphasize/warn about then non- use of the aft evacuation slides (Left 3 and 4 and , Right 3 and 4) following a landing with the nose gear retracted."

Airbus Response: The aircraft was successfully qualified and certified in accordance with relevant requirements.

The AIB understands this model of aircraft was certified with the applicable certification requirements (AI/V-C 600/78 issue 9 dated November 1994). Notwithstanding, the deployed chutes of the L3, L4, R3 and R4 doors show that if the related chutes are used in similar condition, serious injuries to their user(s) would occur.

The AIB recommends that the European Aviation Safety Agency (EASA) evaluate, revise and modify the certification requirements of CF-25 certified aircraft related to the Emergency Exit arrangements; by specifying the portion of the slide that should be self-supporting on the ground for its useful and safe use.

Safety Recommendation AIB-2013-0002-02

On May 20, 2012, GACA/S&ER issued a Stand Alone Recommendation (SAR). This SAR indicated "Airbus Industries includes a warning in Chapter 08 of the Cabin Crew Manual of the A300-600 about the non-use of the aft evacuation slides (Left 3 and 4 and Right 3 and 4) following a landing with the nose gear retracted."

Airbus Response: Airbus has responded noting the aircraft was successfully qualified and certified in accordance with relevant certification requirements and this manual was issued to the operator and was no longer updated by Airbus.

Irrespective of previous certification requirements, the AIB recommends that Airbus informs all the operators of this model of aircraft so the operators can emphasize the warning regarding the use of the slides of the L3, L4, R3 and R4 doors in similar circumstances.

Safety Recommendation AIB-2013-0002-03

The AIB recommends that Airbus evaluate methods to inspect the NLG up-lock to verify the condition of springs, P/N GA71102.

Safety Action Taken: The EASA has issued Airworthiness Directive No. 2013-0150 for the inspection/replacement of normal extension and retraction up-lock springs.

5.0 APPENDICES

Appendix A - Technical and Investigative Reports;

Airbus A 300-600 Service Bulletin Number A300-32-6111

European Aviation Safety Agency Airworthiness Directive No. 2013-0150

Technical Report for Airbus A300-600, Onur Air, Aircraft Registration TC-OAG.

BEA Technical Document: tc-g120501_tec01/Date of issue 14/02/2013

EADS Report: 2012-12165-IW/MS/MF

SAFRAN Inspection Report: No. JJH120903 issue 00