

**SOUTH AFRICAN CIVIL AVIATION AUTHORITY  
(SACAA)**

**SERIOUS INCIDENT INVESTIGATION REPORT**

ACCIDENT INCIDENT INVESTIGATION DIVISION (AIID)  
REF: CA18/3/2/0717

**FINAL REPORT**

**Boeing B747-400  
G-BYGA  
Group 'A' L/E Flaps retracted on Takeoff  
from O.R. Tambo Airport,  
SOUTH AFRICA.  
11 May 2009**

This Serious Incident Investigation Report is issued in the interest of Aviation Safety and to prevent any similar occurrence.



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Boeing B747-400, G –BYGA, Group ‘A’ Leading edge slats retracted on take-off roll – O.R. Tambo Airport, SA. – 11 May 2009.

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**Purpose of Accident/Incident investigations**

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

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

**THE SOUTH AFRICAN CIVIL AVIATION AUTHORITY**  
**ACCIDENT INCIDENT INVESTIGATION DEPARTMENT (AIID)**  
**SERIOUS INCIDENT INVESTIGATION FINAL REPORT**

**Boeing B747-400 Aircraft G-BYGA**  
**At OR Tambo Airport, South Africa,**  
**On 11 May 2009**

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## **EXECUTIVE SUMMARY**

On the 11<sup>th</sup> May 2009, a Boeing 747-400 aircraft operated by an airline with appropriate certification and holder of an Air Operator Certificate was involved in a serious incident during takeoff from OR Tambo Airport at Johannesburg, South Africa.

The serious incident involved the un-commanded retraction of the automatic Group 'A' leading edge flaps on rotation for a period of about 23 seconds. Subsequent to the initiation of the retraction of the Group 'A' leading edge flaps, the aircrew was faced with unexpected stall warnings. The pilot flying was able to prevent the aircraft from stalling, with support from the other crew members and to keep the aircraft flying until the leading edge flaps re-extended and normal performance capability returned.

At no time was the aircrew aware that the Group 'A' leading edge flaps had retracted or as to the circumstances leading to the stall warnings. They were however aware that the thrust reverser in-transit EICAS amber message on the P2- Pilots Center Instruments Panel did display during takeoff roll prior to rotation.

After discussing the occurrence and not being sure about what had been the cause of the event, the crew elected to return to the airport where an uneventful landing was carried out approximately 2 hours later.

Subsequent investigation revealed that two thrust reverser (TR) in-transit EICAS amber messages were received from the applicable sensors with the No.3 TR signal originating at 125.6kt and No.2 TR at 159.9kt. Ground testing revealed that the reversers were not fully stowed against the stops and that one of the four locking gearboxes on both No.2 and No.3 engines had unlocked. Note that the other thrust reverser locks were still in place and that the translating reverser cowls did not move during the event.

No evidence was found that the thrust reversers had in fact deployed.

The automatic retraction of the Group 'A' leading edge flaps based on dual thrust reverser in-transit signals from either both inboard or both outboard engines was part of the original 747-400 type design that was certified in January, 1989.

All model 747 airplanes will automatically retract the Group 'A' LE flaps upon movement of the reverse thrust handle. This is to prevent thrust reverser efflux air from impinging directly onto the flap panel surfaces in order to improve the fatigue life of the panels and their attachments. The original type design (certified in January, 1989) of the 747-400 airplane added the auto-retract feature based upon receipt of a thrust reverser unlock signal from engines No.1 & No.4 or from engines No.2 & No.3.

Factors that prevented this serious situation from becoming an accident include the timely and skillful response to the airplane's performance loss by the pilot flying (PF), the activation of the airplane's stall warning system (stick shaker), and that the Group 'A' leading edge flaps' re-extended when the air/ground logic went to 'air' mode.

Following the event Boeing issued a service bulletin calling for the de-activation of the TR stow signal from the Flap Control Unit on Rolls Royce powered Boeing 747-400 aircraft to prevent a recurrence.

The probable cause for the occurrence of this serious incident is attributed to the loss of a significant amount of lift on rotation, during the takeoff, caused by the automatic LE flap retraction logic retracting the Group 'A' LE flaps on receipt of spurious thrust reverser unlock signals from the no. 2 and no. 3 engines. The possibility of such an occurrence had not been identified during amendment of the retraction logic.

The investigating authority acknowledges the action taken by The FAA and Boeing but does consider it essential that all software logic altered by amendments from the original type certification be revisited to identify any other hidden combinations that may lead to control issues and even possible loss of the aircraft.



**VIEW OF THE B747-400 G-BYGA WITH GROUP 'A' LEADING EDGE FLAPS EXTENDED ON THE LEFT HAND WING (RIGHT HAND WING LE FLAP CONFIGURATION IS SIMILAR).**

# SERIOUS INCIDENT INVESTIGATION FINAL REPORT

## Boeing B747-400 Aircraft G-BYGA At OR Tambo Airport, South Africa, On 11 May 2009

### Glossary

ACAS	Aircraft Collision and Avoidance System
AD	Airworthiness Directive
AGL	Above Ground Level
AMSL	Above Mean Sea Level
AMM	Aircraft Maintenance Manual
AOC	Air Operation Certificate
ASB	Alert Service Bulletin
APU	Auxiliary Power Unit
ATC	Air Traffic Controller
ATPL	Airline Pilot Transport License
CAS	Computed Air Speed
CMC	Central Maintenance Computer
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
DME	Distance Measuring Equipment
EGLL	Heathrow International Airport
EICAS	Engine Indication Crew Alert System
FAA	Federal Aviation Administration
FAJS	O.R. Tambo International Airport
FCU	Flap Control Unit
FL	Flight Level
FOAM	Foreign Operations Aircraft Maintenance
Ft	Feet
HF	High Frequency
IAS	Indicated Air Speed
ILS	Instrument Landing System
JNB	Johannesburg
Kt	Knots
LE	Leading Edge
LHR	Heathrow International Airport

MEL	Minimum Equipment List
METAR	Meteorological Aeronautical Report
MHz	Megahertz
NTSB	National Transport Safety Bureau (USA)
PALT	Pressure altitude
PF	Pilot Flying
PIC	Pilot in Command
PRSOV	Pressure Relieve Shut Off Valve
QAR	Quick Access Recorder
RAD ALT	Radio Altimeter
RALT	Radio Altitude
REV	Reverse Thrust
SACAA	South African Civil Aviation Authority
SAT Com	Satellite Communication
TCAS	Traffic Collision and Avoidance System
TR	Thrust Reverser
TRCP	Thrust Reverse Cowl Position
UK	United Kingdom
VHF	Very High Frequency
V <sub>1</sub>	Take-off Decision Speed
V <sub>R</sub>	Rotation Speed
V <sub>2</sub>	Take-off Speed



# SERIOUS INCIDENT INVESTIGATION FINAL REPORT

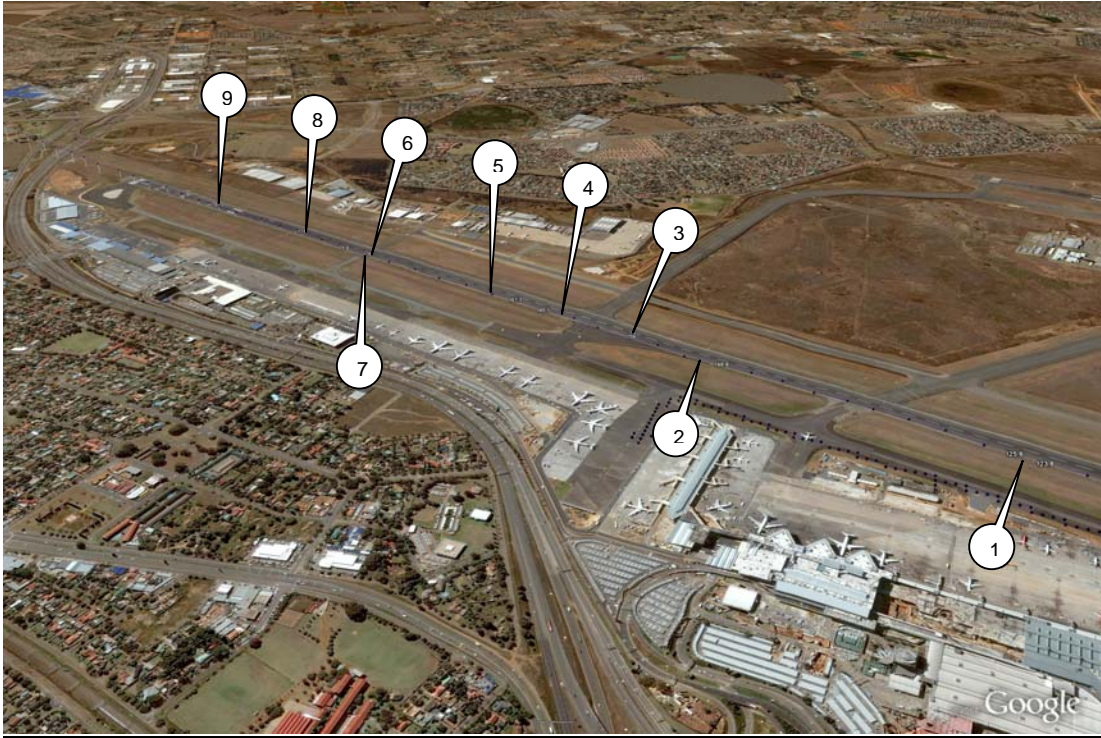
## Boeing B747-400 Aircraft G-BYGA At OR Tambo Airport, South Africa, On 11 May 2009

### 1 Factual Information

#### 1.1 History of the flight

- 1.1.1 At approximately 1835Z on 11 May 2009 during night time conditions, a Boeing B747-400 registered G-BYGA, departed Runway 03L at O.R. Tambo Airport (FAJS) on a scheduled international passenger flight with 3 cockpit crew, 15 cabin crew and 265 passengers on board the aircraft to Heathrow International Airport (EGLL).
- 1.1.2 The take-off was planned at reduced-power and the first officer was the handling pilot for the departure. The calculated V<sub>1</sub>, V<sub>r</sub>, and V<sub>2</sub> speeds based on the weight and atmospheric conditions at takeoff were 150kt, 168kt, and 176kt respectively. However, during the take-off roll, the No.3 Engine Thrust Reverser EICAS amber message ('REV') displayed on the P2-Pilots Center Instruments Panel before V<sub>1</sub> at approximately 125.6kt on the P2 pilots center instrument panel and shortly thereafter, the No. 2 Engine Thrust Reverse EICAS amber message ('REV') displayed at approximately 159.9kt prior to rotation(V<sub>R</sub>) of 168kt. At this stage, the Group 'A' LE flaps retracted automatically as designed with the aircraft still in the ground mode.
- 1.1.3 The aircraft rotated at approximately 173kt with 20 units of flaps selected and became airborne at approximately 176kt. See Photo 1 for the take-off path of the aircraft. The stick shaker subsequently activated at 176kt intermittently for 8 seconds within a period of 15 seconds and significant aircraft buffeting was experienced. In order to counteract the stall warning and buffeting, the PF (who also had aerobatic flying experience and being familiar with aircraft buffeting) continued to fly the aircraft with the PIC calling out the aircraft heights AGL. The undercarriage was selected up at a CAS of 177kt and the Group 'A' LE flaps immediately extended automatically. The stick shaker stopped at a CAS of approximately 186kt. The Group 'A' LE flaps had been in the retracted position for approximately 23 seconds during the occurrence. After the auto re-extension of the Group 'A' leading edge flaps the aircraft's performance returned to normal.
- 1.1.4 Although the retraction of the Group 'A' LE flaps would have been shown as a color change on the flap indicator EICAS display, this change is hardly visible and the flight crew may not have noticed it. There was no independent indication available to the crew that the applicable group of LE flaps had been retracted by the aircraft system.
- 1.1.5 Whilst climbing through an altitude of 7000ft, the crew notified the ATC of an emergency and requested ATC to "standby". The Captain requested further climb with PAN, PAN, PAN message informing ATC of No. 2 and

No. 3 engine problems and that they would be returning back to O.R. Tambo Airport. The aircraft climbed to FL 150 and after fuel was dumped, the aircraft landed safely on Runway 03R at approximately 2008Z.



**PHOTO 1: GOOGLE EARTH VIEW OF THE TAKE-OFF PATH FROM RUNWAY 03L AT FAJS**

ITEM NO.	TIME (Z)	CAS (knots)	Height above Ground (feet)	OCCURRENCE
1	18:36:15	125.6	0	No.3 'REV' EICAS message display
2	18:36:24	150	0	V1
3	18:36:28	159.9	0	No.2 'REV' EICAS message display
4	18:36:31	167.3	0	Group 'A' LE started auto retract
5	18:36:32	168	0	Vr
6	18:36:37	175.9	0	Aircraft wheels off ground
7	18:36:37	176	4	Stick Shaker started intermittent
8	18:36:38	176	8	V2
9	18:36:45	181.6	56	Group 'A' LE started auto extend

**FIGURE 1: TABLE OF ACTUAL TAKE-OFF PATH FROM RUNWAY 03L AT FAJS AS EXTRACTED FROM THE DFDR DATA. THE V1, VR AND V2 DATA IS CALCULATED DATA OBTAINED FROM THE FLIGHT CREW.**

## 1.2 Injuries to Persons

1.2.1 There were no reported injuries to the occupants onboard the aircraft.

## 1.3 Damage to the aircraft

1.3.1 The aircraft sustained no damage.

## 1.4 Other Damage

1.4.1 No other damage to property on the ground was sustained.

## 1.5 Personnel information

1.5.1 Flight crew qualifications and experience:

### Pilot In Command (Pilot Monitoring)

License Category	ATPL (UK)
Medical Expiry Date	05 January 2012
Total Flying Hours	11000.0
Total on Type	8500.0
Total on Type last 90 days	145.0

### First Officer (Pilot Flying)

License Category	ATPL (UK)
Medical Expiry Date	17 November 2013
Total Flying Hours	9300.0
Total on Type	1950.0
Total on Type last 90 days	205.0

## 1.6 Aircraft Information

1.6.1 General Information

### Airframe:

Type	Boeing B747-400
Serial Number	28855
Manufacturer	Boeing Aircraft Company
Year of Manufacture	1998
Nationality	United Kingdom
Aircraft Status	Type Certificated Aircraft
Total Airframe Hours (At time of Accident)	45815.0
Aircraft Cycles	5303

Last Check 4A+2C Inspection (Hours & Date)	45400.0	09 April 2009
Hours since Last Inspection	415.0	
Certificate of Airworthiness (Issue Date)	13 December 2008	
C of R (Issue Date) (Present owner)	26 February 2008	
Operating Categories	Transport	

Engine No.1:

Type	Rolls-Royce RB211-524G2
Serial Number	13432
Hours since New	55006.0
Cycles since New	13632.0
Hours since Overhaul	26834.0
Cycles since Overhaul	4311.0
Hours since Installation	8537.0
Cycles since Installation	1100.0

Engine No.2:

Type	Rolls-Royce RB211-524G2
Serial Number	13337
Hours since New	53382.0
Cycles since New	8198.0
Hours since Overhaul	17721.0
Cycles since Overhaul	2135.0
Hours since Installation	8955.0
Cycles since Installation	1148.0

Engine No.3:

Type	Rolls-Royce RB211-524G2
Serial Number	13159
Hours since New	74437.0
Cycles since New	9558.0
Hours since Overhaul	17401.0
Cycles since Overhaul	2207.0
Hours since installation	12329.0
Cycles since installation	1573.0

Engine No.4:

Type	Rolls-Royce RB211-524G2
Serial Number	13470
Hours since New	39159.0
Cycles since New	5563.0
Hours since Overhaul	12553.0
Cycles since Overhaul	1602.0

Hours since installation	12553.0
Cycles since installation	1602.0

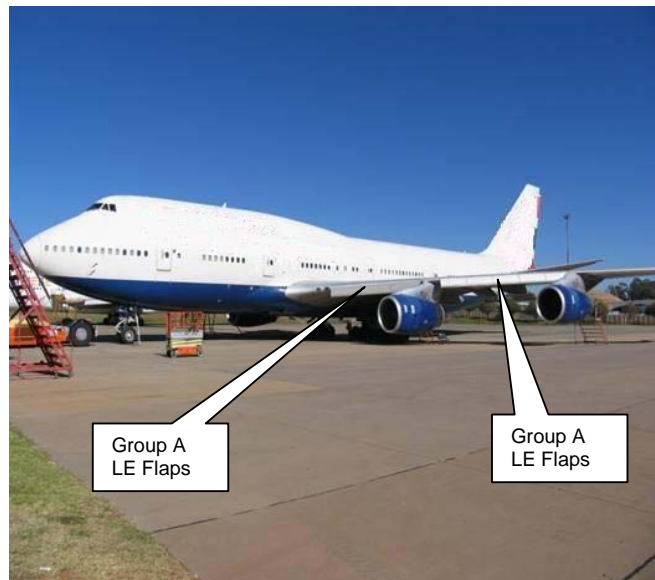
### 1.6.2 The leading edge flaps system

#### Description and Operation:

The LE flaps are utilized during the takeoff and landing phases. There are two modes of operation, Primary and Alternate. The primary mode is the normal method of controlling the LE flaps and is initiated by manually moving the flap lever to a selected detent and then the LE Flaps will operate with pneumatic power. If pneumatic power is not available the FCU will switch to electric drive motor operation. Alternate operation is initiated by an arm and control switch that separately controls the electrical drive motors.

There are 28 LE (14 on each wing) flaps which are divided in two categories, variable camber (22) and Krueger (6). The variable camber flaps are numbered from left to right 1A through 10 on the left wing and 17 through 27 on the right wing. The Krueger flaps are numbered 11 through 13 on the left wing and 14 through 16 on the right wing.

The Schematic Sketch Fig. 2 below indicates the configuration of the left-hand LE flaps. .



**Photo 2:** VIEW OF THE B747-400 G-BYGA WITH GROUP 'A' LEADING EDGE FLAPS EXTENDED ON THE LEFT HAND WING (RIGHT HAND WING LE FLAP CONFIGURATION IS SIMILAR).

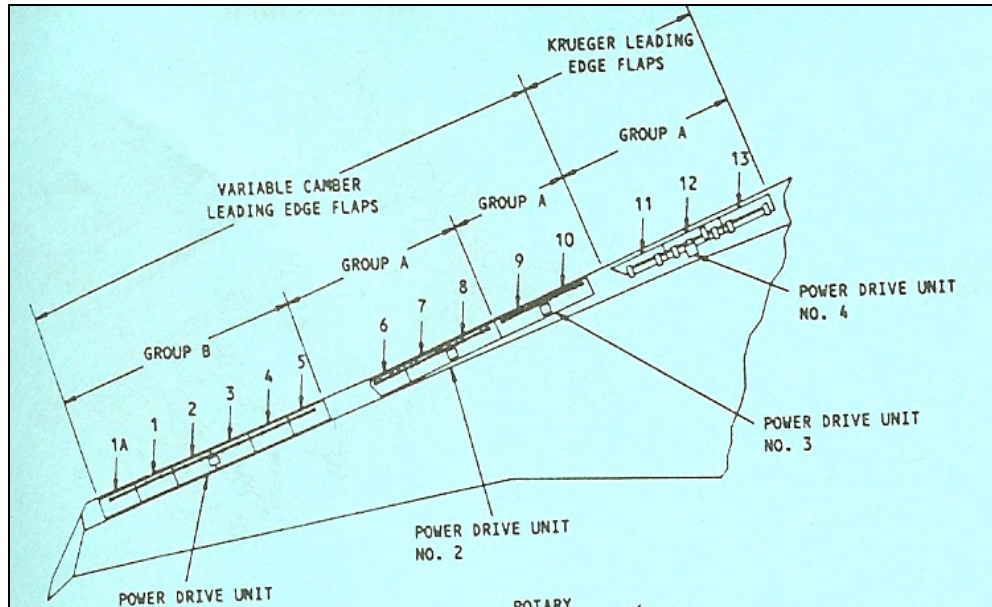
The following indicates the configuration of the left-hand LE flaps displayed on Figure 2 below. The right-hand LE flaps configuration is similar:

Group A: Variable Camber LE Flaps – 6 to 10 (Inboard of No. 1 Engine) and Krueger LE Flaps 11 to 13 (Inboard of No. 2 Engine)

Group B: Variable Camber LE Flaps – 1A to 5 (Outboard of No. 1 Engine)

No.1 Engine is located between 5 and 6 Variable Camber LE Flaps.

No 2 Engine is located between No. 10 variable Camber and No.11 Krueger Flaps.



**FIGURE 2: THE LE FLAPS ON THE LEFT-HAND WING**

### 1.6.3 LE Flaps Auto Retract and Extend

Description and Operation:

All model 747 airplanes will automatically retract the Group 'A' LE flaps upon movement of the reverse thrust handle. This is to prevent thrust reverser efflux air from impinging directly onto the flap panel surfaces in order to improve the fatigue life of the panels and their attachments. The original type design (certified in January, 1989) of the 747-400 airplane added the auto-retract feature based upon receipt of a thrust reverser unlock signal from engines No.1 & No.4 or from engines No.2 & No.3.

### 1.6.4 LE Flap Indication in Flight Deck

Description:

During normal LE flap operation there is no separate indication on the flight deck for the position of the LE flaps. The expanded 'FLAPS' display appears automatically on the main EICAS for non-normal configurations

such as alternate flaps, flap asymmetry, and LE or TE flap disagreement with flap control lever position. The retraction of the Group 'A' LE flaps is shown as a color change on the flap indicator EICAS display which is hardly visible on the display.

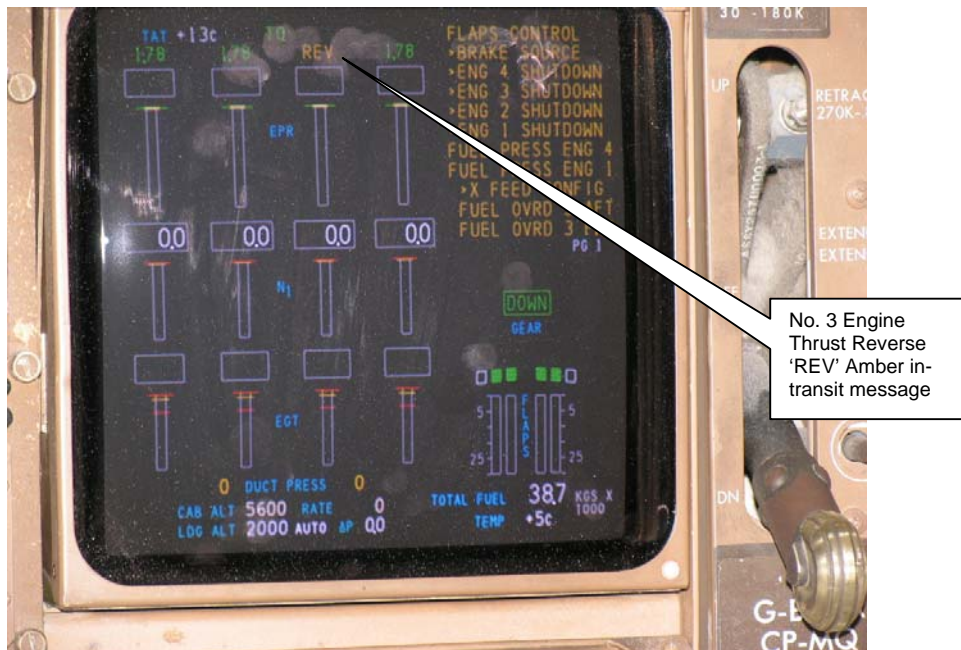
#### 1.6. 5 Dual 'REV' amber EICAS message displayed during take-off

Description:

- a) During the takeoff roll the No. 3 'REV' amber EICAS message displayed on the P2 – Pilots Center Instrument Panel. Some seconds later, a No. 2 engine 'REV' amber EICAS message displayed on the P2 – Center Instrument Panel.
- b) The 'REV' amber EICAS message indicated to the flight deck crew that the specific thrust reverser was out of the stowed and locked position and in transit [Note that in this case both engines #2 and #3 had one TR gearbox unlock, however the other locking gearbox and the air motor brake remained engaged and neither reverser deployed].
- c) The aircraft air/ground logic then signaled the Group 'A' LE flaps to re-deploy (extend) and this occurred automatically.



**PHOTO 3: VIEW OF FLIGHT DECK LAYOUT OF G-BYGA INSTRUMENT PANELS**



**PHOTO 4: VIEW OF P2- CENTER INSTRUMENT PANEL & 'REV' AMBER EICAS MESSAGE**  
 [Photo taken during simulation]

#### 1.6.6 Condition of the aircraft before departure

- a. The aircraft arrived on the inbound flight at O.R. Tambo Airport from Heathrow Airport, UK on the morning of 11 May 2009. According to the Aircraft Technical Report from the technical logbook, the Speed-brakes failed to auto deploy on landing. The Speed-brake auto deployment failure was consequently rectified through maintenance rectification performed as per the Boeing 747-400 Maintenance Manual 27-62-00 PB12 by a Ground Engineer at O.R. Tambo Airport.
- b. According to the history in the Aircraft Technical Logbook no similar problem was recorded.
- c. According to the Aircraft Technical Logbook the aircraft was certified serviceable before departure.

#### 1.6.7 Weight and Balance

- a) The Maximum Certified Mass for the aircraft is 396 890 kg and the Take-off Weight for the aircraft at the time was 365 000 kg. The aircraft was thus 31 893 kg below the Maximum Certified Mass during take off.
- b) The total fuel on board the aircraft prior to take-off was approximately 128169 kg. After fuel burn-off and fuel was dumped, the fuel quantity after landing was 39900 kg. According to calculations the approximate landing weight for the aircraft was thus:  
 $365\,000 - (128\,169 - 39\,900) = 276\,731$  kg.
- c)



Maximum Take-Off Weight	396 890 kg
Maximum Landing Weight	285 760 kg
Zero fuel weight on flight plan	236 800 kg
Take-off weight on flight plan	365 000 kg
Approximate landing weight	276 800 kg

## 1.7 Meteorological Information

The Weather information was obtained from the official weather report submitted by the South African Weather Services.

Wind direction	Variable	Wind speed	3 knots	Visibility	CAVOK
Temperature	17°C	Dew point	06°C	QNH	1027

The following METARS show light winds and fine weather conditions at the time of the incident:

- *FAJS 111800Z 01005KT CAVOK 12/06 Q1027 NOSIG=*
- *FAJS 111830Z VRB03KT CAVOK 13/06 Q1027 NOSIG=*
- *FAJS 111900Z VRB03KT CAVOK 13/05 Q1027 NOSIG=*

The following TAF shows good forecasted weather conditions at 1800Z:

*FAJS 111600Z 1118/1224 31008KT CAVOK BECMG 1208/1210  
SCT040  
TEMPO 1211/1214 25008KT SCT040TCU BECMG 1216/1218 02006KT  
CAVOK TX19/1212ZTN09/1204Z=*

## 1.8 Aids to Navigation

1.8.1 The aircraft was fitted with the following Navigational and Radio Equipment:

- ATC Transponder
- DME
- HF COMM
- RAD ALT
- SAT COMM
- TCAS/ACAS
- VHF COM
- WEATHER RADAR X.

## 1.9 Communications

1.9.1 At approximately 1835Z, the ATC JNB tower cleared G-BYGA for takeoff on Runway 03L with the wind light and variable.

- 1.9.2 Shortly after the aircraft became airborne, the crew reported PAN, PAN, PAN with an engine problem on No. 2 and 3 engine request climbing clearance.
- 1.9.3 The crew was given climb clearance to FL150 and notified JNB tower that a considerable amount of fuel have to be dumped prior to landing back at O.R. Tambo Airport.

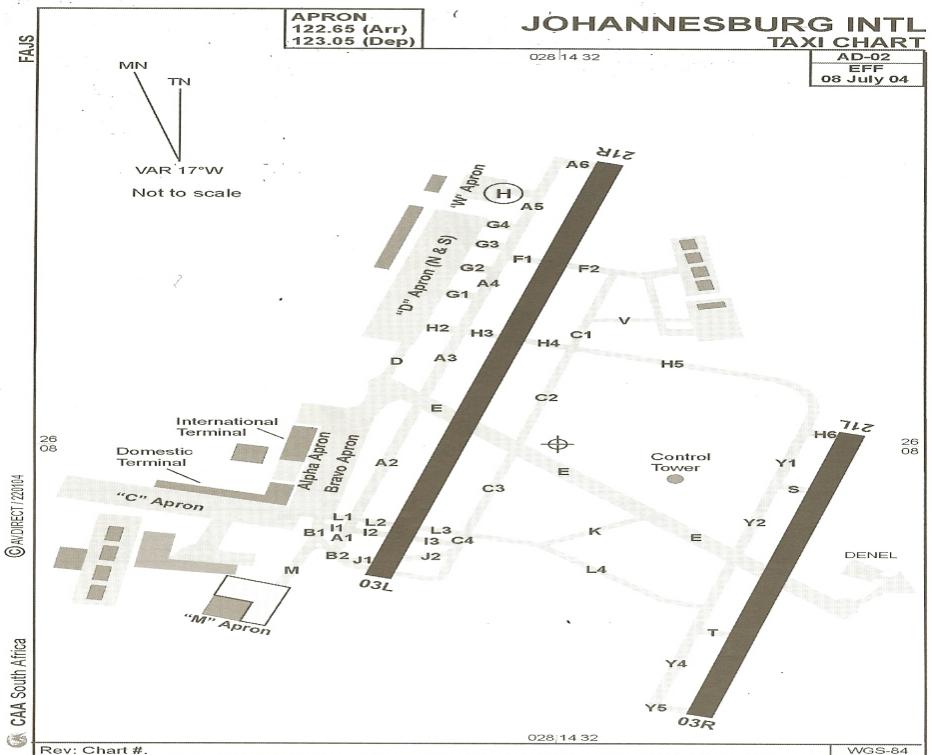
**1.10 Aerodrome Information**

- 1.10.1 The aircraft G-BYGA utilized Runway 03L at O.R. Tambo (FAJS) Airport for take off when the incident occurred.
- 1.10.2 Due to the uncertainty of the cause of this incident the Flight Deck Crew elected to return to O.R. Tambo Airport. They were notified by ATC that the ILS on Runway 03L was unserviceable. An uneventful landing on Runway 03R followed.

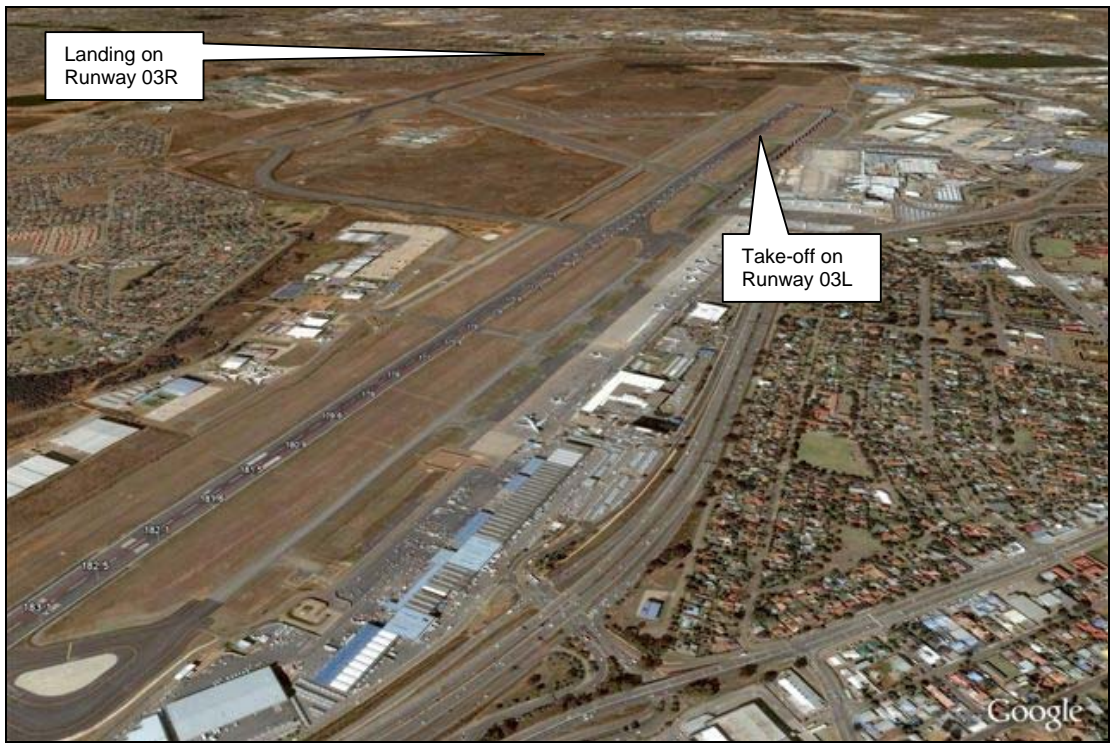
Aerodrome Location	O.R Tambo Airport. FAJS	
Aerodrome Co-ordinates	S26° 08.01' E028° 14 32'	
Aerodrome Elevation	5558ft	
Runway Designations	03L/21R	03R/21L
Runway Dimensions	4418 x 60m	3400 x 60m
Runway Used	Runway 03L	
Runway Surface	Asphalt	
Aerodrome Status	Licensed	
Approach Facilities	ILS LLZ NDB VOR UHF DME; ILS GP	



Extracted from Google Earth



**FIGURE 2: AERONATICAL INFORMATION PUBLICATION (AIP) OF FAJS RUNWAYS**



**PHOTO 5: GOOGLE EARTH VIEW OF RUNWAY 03L AND 03R AT FAJS**

## 1.11 Flight Recorders

### 1.11.1 Description

The aircraft was equipped with three flight recorders:

- Digital flight data recorder (DFDR)
- Cockpit voice recorder (CVR)
- Quick access recorder (QAR).

The DFDR and CVR were mandatory fitment recorders for this aircraft, with the recorded flight data stored within crash-protected memory modules located in the aft section of the aircraft. The DFDR recorded aircraft parameters as defined by regulatory requirements. The QAR is utilized by the operator for flight data and aircraft system monitoring activities and is identical to the data that is stored in the DFDR. The amount of parameters recorded by the QAR is as configured by the operator. The information recorded on the QAR was not crash-protected, but instead stored on a removable media-card.

### 1.11.2 Flight recorder retrieval

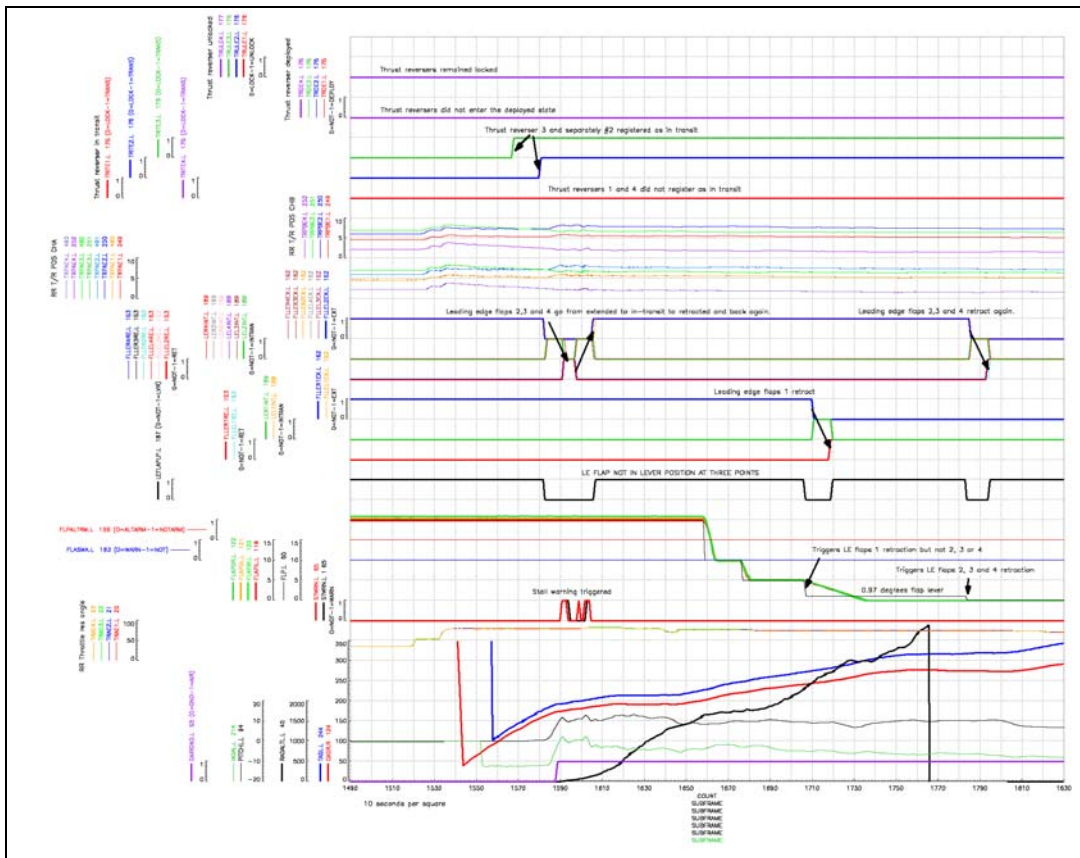
1. The removal and securing of the DFDR and CVR was undertaken under SACAA supervision on 12 May 2009.
2. The DFDR and CVR were sent to the AAIB for data downloading, reading and analyses.
3. The QAR removable media-card was downloaded by the operator.

### 1.11.3 QAR Data from Graph

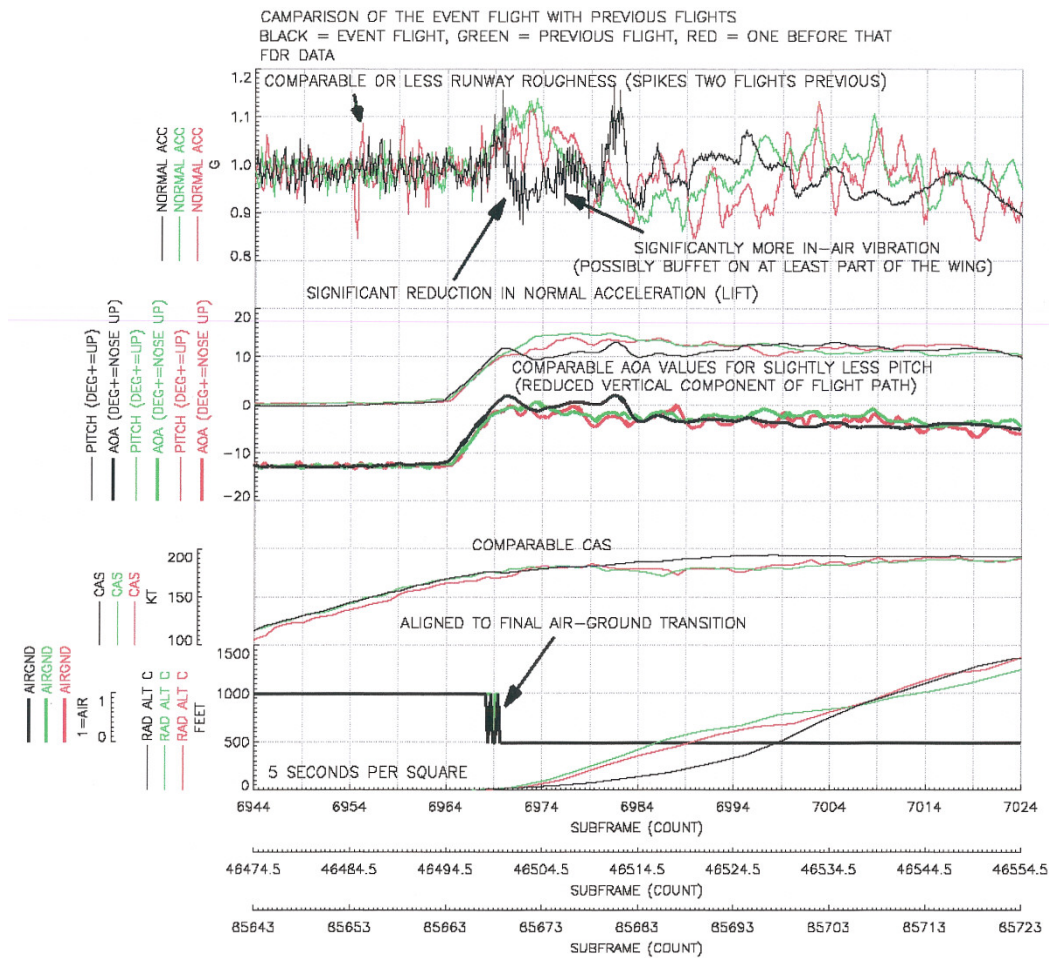
The following data information is available on the combined QAR Graph 1 as shown below:

- The red line shows the computed air speed (CAS) during takeoff roll, point of rotation and aircraft weight off wheels at approximately 175kt.
- The red stall-warning line shows the stall-warning was triggered just after the aircraft became airborne for approximately 3 seconds and again for another 2 seconds within a period of 13 seconds.
- The black line shows the radial altitude 10secs and 20secs after rotation with the radial altitude of approximately 10ft to 100ft respectively. The aircraft then climbed steadily to the required flight level to dump fuel and to turn back.
- The thin black line shows the pitch attitude decreasing (nose down attitude) as the aircraft became airborne from Runway 03L.
- On the upper section of the graph, the green line (Thrust Reverser No. 3) and blue line (Thrust Reverser No. 2) shows the thrust reversers in transit, 12secs and 8secs respectively prior to rotation.

- The purple and magenta lines illustrates No. 2, 3 and 4 leading edge flaps retracting, in transit and then extending again in approximately 20 to 25 seconds just before and just after the aircraft rotated.



**GRAPH 1: QUICK ACCESS RECORDER (QAR) GRAPHS**



**GRAPH 2: QUICK ACCESS RECORDER (QAR) GRAPHS**

1.11.4 DFDR Data

The following parameters were recorded on the DFDR.

TIME (Z)	R/ ALT (High Centre feet)	P/ ALT (Sample 1)	GS KPH	CAS (Sample 4-kts)	RR ENGS N3 SPDS (Average-%)	STICK SHAKER	LE FLAP (Sample 1)	ENG REV TRANSIT	DISTANCE (meters)
18:35:37	0	5206	0	0	82.47	NIL	EXT		0
18:35:38	0	5205	1.8	0	82.68	NIL	EXT		0.5
18:35:43	0	5206	25.9	0	92.82	NIL	EXT	#3 TRCP 8.25%	20.6
18:35:48	0	5204	63	34.0	93.77	NIL	EXT		87.5
18:35:58	0	5197	135.2	70.3	94.14	NIL	EXT		372.5
18:36:06	0	5193	188.9	97.0	94.27	NIL	EXT		740.3
18:36:11	0	5190	220.4	112.8	94.36	NIL	EXT		1029.4
18:36:15	0	5185	246.3	125.6	94.27	NIL	EXT	# 3	1292.3
18:36:24	0	5172	298.2	147.9	94.25	NIL	EXT		1980.6
18:36:28	0	5170	318.5	159.9	94.27	NIL	EXT	# 2	2326.8
18:36:31	0	5170	333.4	167.3	94.29	NIL	'A' RETR In Transit	#2+ #3	2601
18:36:37	4 ROTATE	5135	359.3	176	94.53	Intermittent		#2 TRCP 8.25%	3184.9
18:36:38	12 AIRBORNE	5142	359.3	175.8	94.58	ACTIVE		#2+ #3	3284.7
18:36:39	20 L/G Selected 'UP'	5161	359.3	177	94.58	ACTIVE	'A' RETR	#2+ #3	3384.5

18:36:40	24	5176	359.3	178	94.53	ACTIVE		#2+ #3	3484.3
18:36:45	56	5232	364.8	181.6	94.55	NIL	'A' EXT In Transit	#2+ #3	3987.9
18:36:46	64 L/G Retracted	5244	364.8	182.1	94.66	Intermittent		#2+ #3	4089.3
18:36:51	120	5306	368.5	185.8	95.39	ACTIVE		#2+ #3	4598.6
18:36:52	136	5325	368.5	186.6	95.3	Nil		#2+ #3	4701
18:36:54	168	5338	372.3	187.5	95.31	Nil	EXT	#2+ #3	4907.8
18:37:35	1412	6434	396.3	194.3	93.80	NIL	EXT	#2+ #3	9332

The following significant parameters were extracted from the DFDR:

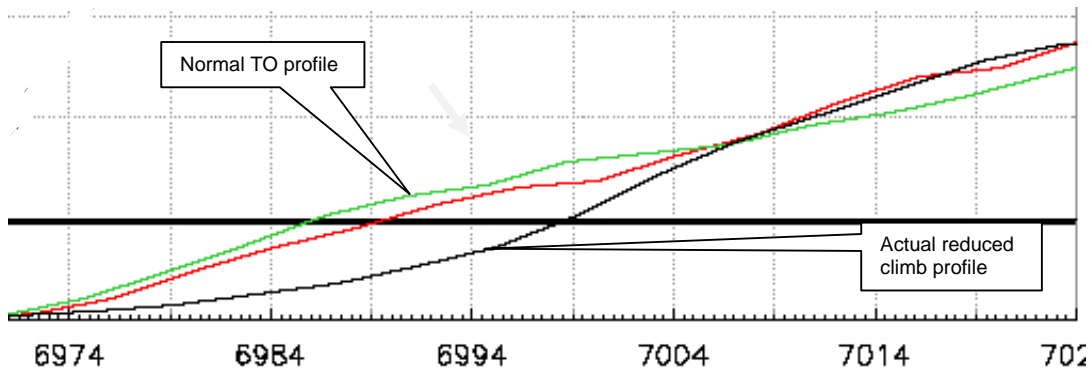
- 18:35:37** Aircraft started takeoff roll with Eng N3 average speeds at 82.47%.
  - 18:35:43** No.3 engine TRCP 8.25%.
  - 18:36:15** No 3 engine thrust 'REV' EICAS message displayed with Eng N3 average speeds at 94.27% during take-off roll at 125.6kt
  - 18:36:28** No.2 Engine Thrust 'REV' EICAS message displayed with Eng N3 average speeds at 94.27% during takeoff roll at 159.9kt.
  - 18:36:31** Group 'A' LE flaps auto-retracted as designed at 164kt (aircraft still in ground mode).
  - 18:36:37** Aircraft became airborne at 176kt with stick shaker intermittent. No.2 engine TRCP 8.25%.
  - 18:36:38** Aircraft airborne with No 2 & No 3 engine 'REV' EICAS message displayed.
  - 18:36:39** Group 'A' LE flaps in retracted position. The undercarriage selected 'UP' at 177kt.
  - 18:36:40** No 2 stick shaker active at 178kt with aircraft at 24ft RA.
  - 18:36:45** Undercarriage retracted at 181.6kt with aircraft at 56ft RA. Group 'A' LE flaps started auto-extend.
  - 18:36:46** Undercarriage in retracted position at 182.1kt.
  - 18:36:52** Stick shaker stopped at approximately 186kt with the RA at 132ft.
  - 18:36:54** Group 'A' LE flaps fully extended at 187.5kt.
- At 19:52:00: No. 2 engine TR-in-transit message cleared at approximately 15000ft AMSL.

- At 19:55:00: Aircraft descended for landing at OR Tambo International Airport (FAJS). All engine TR's deployed normally during landing and No. 3 Engine TR-in-transit message cleared after TR stowed during touchdown.

## 1.12 Event Information.

1.12.1 The aircraft started with the take-off roll on Runway 03L at O.R. Tambo Airport when No.3 thrust reverser 'REV' amber EICAS message displayed on the P2 center instrument panel at an CAS of approximately 125.6kt before V<sub>1</sub>. Shortly thereafter, No 2 engine thrust reverser 'REV' amber EICAS message displayed prior to rotation (V<sub>R</sub>) at 159kt. The Group 'A' LE flaps retracted automatically just before the aircraft became airborne with the initial climb speed (V<sub>2</sub>) of approximately 176kt. The airplane's stall warning system monitors the position of both leading and trailing edge flaps. With the retraction of the Group 'A' LE flaps, the stall warning system, by design, will reset the stick shaker activation point to that associated with a flaps up configuration. For this event, the stick shaker activated at a lower angle of attack that it normally would have at the flaps 20 configuration thus providing the crew with a timely stall warning. The stick shaker was activated intermittently for approximately 8 seconds at an IAS of 176kt as the Group 'A' LE flaps extended automatically as designed.

1.12.2 Graph 3 shows the portion of the flight profile for a normal takeoff (green line) and the event takeoff (black line). The altered flight profile for the event takeoff is due to the reduction of lift capability caused by the retraction of the Group 'A' LE flaps. A normal climb profile was re-established once the Group 'A' LE flaps extended back out. Refer graph 2 above.



**GRAPH 3:** The normal TO profile versus the actual reduced climb profile

## 1.13 Medical and Pathological Report

1.13.1 Not applicable to this report.



## **1.14 Fire**

1.14.1 There was no fire.

## **1.15 Survivable Aspects**

1.15.1 The Cockpit Crew, cabin crew and passengers were properly restrained with seat belts and there were no impact forces involved.

## **1.16 Test and Research**

1.16.1 Troubleshooting and investigation was initiated in Johannesburg, South Africa by the operator's engineers with SACAA Accident Investigators to determine the factual cause for the No. 3 and No. 2 engine thrust reverser 'REV' amber EICAS messages displayed on the P2-Pilots Center Instruments Panel, followed by the auto retraction of the Group 'A' LE flaps.

The aircraft was ferried to London to continue troubleshooting and investigation as resources for troubleshooting in Johannesburg is limited. For this ferry flight the No. 2 and No.3 thrust reversers were locked out as per MEL for the aircraft and the LE flap auto retract based on the thrust reverser un-stow feature was disabled.

1.16.2 The Operator's engineers carried out the initial investigation and review of the Quick Access Recorder Data from the event flight. Their review supported the flight crew reports of No.2 and No.3 engine 'REV' amber EICAS indications on the P2 Pilot Center Instrument Panel during take-off. Their review also identified that the Group 'A' LE flaps retracted during the ground roll, and extended again after lift-off.

During the initial investigation, the Thrust Reverser Cowl Positioning (TRCP) reading for the engines were noted which showed No. 3 Engine TRCP during the take-off roll as 8.25% and No. 2 Engine TRCP when the aircraft became airborne also as 8.25%. According to the Aircraft Maintenance Manual for the RB211 Series Engines, the TRCP is normally between 3% to 5%. If the TRCP is between 5% and 8%, with the reverse thrust levers in the forward thrust position, the TRCP must be adjusted to give the correct indication as mentioned above.

The Thrust Reverser Cowl Position (TRCP) also referred to as the translating cowl, is monitored by an independent resolver, driven by the thrust reverser system gearbox in the No. 4 position on each engine and has independent output signals. A proximity switch which monitors movement of the thrust reverser cowl, triggers the 'REV' amber indication on the P2 Pilot Center Instrument Panel.

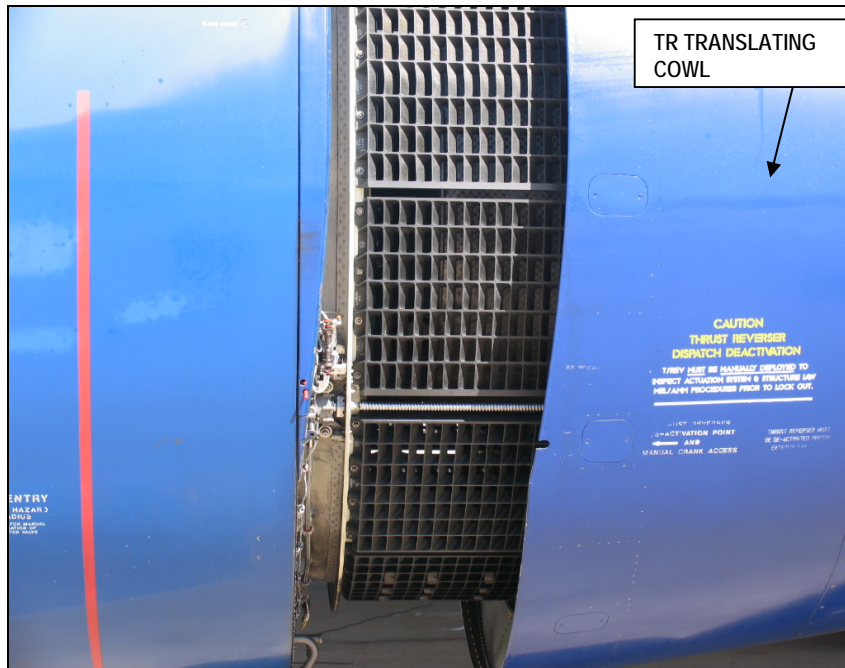


PHOTO 6: SHOWS THE TRANSLATING COWL IN THE EXTENDED POSITION



PHOTO 7: SHOWS THE TRANSLATING COWL IN THE FWD STOWED POSITION.

The Operator's engineering investigation and review concluded the following:

- *The Group 'A' LE flaps auto-retract system operated per design in response to No.2 and No.3 engine 'REV' amber EICAS indications.*

- *The changes in the EICAS display of the flap position, as a result of the Group 'A' LE flaps auto-retract system operation, is minimal.*
- *There was no indication of any failure of the thrust reverser gearbox or air motor brake locking systems during the event flight. The no.2 position locking gearboxes may unlock following a 'REV' amber indication, per design.*
- *The increase in TRCP readings with increasing engine power appear to be typical for this fleet, but no physical movement of the thrust reverser cowl was found.*
- *The No.2 and No.3 engine 'REV' amber indications during the event flight were the result of high power engine operation with the thrust reverser configured normally for flight, but displaced rearwards within the acceptable range of travel (as defined by the indication system).*
- *The No.2 and No.3 engine TR's were stowed in their normal forward positions when the aircraft arrived at JNB, but were at the rearwards range of position during engine start, taxi, take-off and flight. The No.1 and No.4 engine TR's did not change position during the transit at JNB.*
- *There is no record of thrust reverser deployment, or activities requiring thrust reverser deployment at JNB. The aircraft Auto-Speed-Brake system was tested during transit at JNB. In three checks carried out at LHR, the Auto-Speed-Brake test resulted in thrust reverser deployments.*
- *When the thrust reverser is driven forward, the position the thrust reverser stops at is not precisely fixed. The thrust reverser compresses a seal at the forward end of its travel. The thrust reverser stops moving forward when the resistance of the seal matches the forward driving force. The ability of the thrust reverser air motor to drive the thrust reverser forward is broadly related to the pneumatic supply duct pressure. The APU stowed the reverser further forward when the low APU duct pressure was corrected at LHR.*
- *The thrust reverser stow position using the low pressure APU air was not checked in JNB. The APU duct pressure was observed to be as low as 11 psi with no demands in JNB. The APU duct pressure was 14 psi with no demands at LHR before rectification, and cycling the thrust reversers resulted in TRCP readings of 5.3 on the No.2 engine and 6.0 on the No.3 engine. During engine start for the event flight, the TRCP readings were 5.38 on the No.2 engine and 6.63 on the No.3 engine. It was not proven, but is conceivable that the position of the No.2 and No.3 thrust reversers at the start of the event flight is consistent with thrust reverser functions at the low APU duct pressure during the event.*
- *There is no guarantee that the thrust reverser system is isolated from aircraft pneumatic supplies after engine shutdown, if the engine bleed switch is selected 'ON'. During the Auto-Speed-Brake tests, the reversers were deployed several times after observing that the engine PRSOV was Open or Regulating with APU bleed air available. There was*

*no need to select the engine Start switch. Normal procedure for the Operator is to leave the engine bleed switch selected 'ON'. The APU may be used during aircraft towing to and from the departure stand.*

- *The Stow Sensors on No.1, 2, and 3 engines were rigged outside of the AMM requirements for Dim. B. The overlap on these sensors was higher than nominal because the targets were set too far forward. Setting the target in a forward position delays the trigger of the 'REV' amber indication when the reverser sleeve moves rearwards, and reduces the probability of spurious 'REV' amber indications due the Stow Sensor failures. However, setting the target too far forward also reduces the ability of the indication system to warn of a poorly stowed thrust reverser.*

## **1.17 Organizational and Management Information**

1.17.1 This was a Scheduled International flight operated from Heathrow Airport to O.R. Tambo Airport.

1.17.2 The Operator was the holder of a UK AOC approved for passenger and cargo operations. The Operator had a valid AOC issued on 11 July 2008. The AOC was valid until 15 July 2009, issued pursuant to Article 6 of the Air Navigation Order and has satisfied the Operator Certificate requirements certified in Annex 111 to Regulation EC No. 3922/1991 of the European Parliament and the Council.

1.17.3 The Operator's AMO:

According to the available records, the AMO that certified the last transit and daily checks at LHR (Heathrow), in accordance with the operator's Approved Maintenance Program on the aircraft prior to the incident was in possession of a valid AMO Approval Certificate.

1.17.4 The contracted AMO at O.R. Tambo Airport :

According to the available records, the AMO that certified the last transit check at JNB on the aircraft, in accordance with the Operator's Approved Maintenance Program prior to the incident was in possession of a valid AMO Approval Certificate Number. The AMO at O.R. Tambo Airport was contracted by the operator to carry out maintenance at JNB in accordance with an IATA Standard Ground Handling Agreement.

## **1.18 Additional Information**

1.18.1 Similar Incidents

At a previous event an operator reported an aborted take-off due to the un-commanded auto retraction of the LE flaps. It was reported that during takeoff, the reverse thrust lever came into contact with objects that was left near the lower EICAS screen while the throttles were advanced. This contact of the objects and the thrust reverser lever caused the auto retract system to retract the Group 'A' LE flaps.

On 13 March 1997 a Boeing B747 Service Bulletin (SB) Number 747-27A2356 was issued to operators operating the B747-400. The SB notified operators of a change to be implemented on the Reverse Thrust Isolation Valve Switches in the thrust levers. The SB was issued to prevent accidental auto retraction of the Group 'A' LE during takeoff. This SB change revised the operating position of the thrust reverser isolation valve switches in the thrust levers. FAA Airworthiness Directive 98-24-26 mandates incorporation of this bulletin.

This SB was incorporated on the incident aircraft (G-BYGA).

The possibility of such an occurrence occurring during rotation on takeoff appears not to have been identified during amendment of the retraction logic.

## **2.0 Event Analysis**

- 2.1 On 11 May 2009 at approximately 1835Z a Boeing B747- 400, registered as G-BYGA, took off on Runway 03L at O.R. Tambo Airport, South Africa to Heathrow International Airport, United Kingdom. This was a scheduled passenger flight with 3 cockpit crew, 15 cabin crew and 265 passengers on board.

The take-off was planned as a reduced-power takeoff with 20 units of flaps selected and with the first officer the handling pilot and the captain the pilot-monitoring. During the take-off roll and before  $V_1$  the No.3 Engine Thrust Reverser 'REV' amber EICAS message displayed on the instrument panel. At 159.9kt, 9.9kt after  $V_1$  the No. 2 Engine Thrust Reverser 'REV' amber EICAS message also displayed on the P2 pilots center instrument panel. The Group 'A' LE flaps retracted automatically 2 seconds later at approximately 167.3kt which was approximately 0.7kt prior to  $V_R$  (168kt).

The Group 'A' LE flaps are designed to auto retract when the system detects No.2 and No. 3 Engine Thrust Reverser are in the deployment stage and the aircraft is on the ground (landing phase). However the Group 'A' LE flaps auto retracted in the take-off phase of the flight. During take-off and in flight there was no actual unlock of the subject thrust reversers.

The aircraft rotated and became airborne at approximately 176kt. During these events the flight deck crew did not notice that the Group 'A' LE flaps had automatically retracted.

The stick shaker started activating almost immediately after about 1 second at a radio altitude (RA) of approximately 4ft. The stick shaker activated intermittently for approximately 8 seconds within a period of 15 seconds.

The PF successfully controlled the aircraft during the stall warning and buffeting phase with the PIC calling out the aircraft height AGL. At

18:36:45, the Group 'A' LE flaps auto extended at 181.6kt at a RA of 56ft and the aircraft performance returned to normal. The crew notified the ATC of an emergency and that they would be returning back to O.R. Tambo Airport. The aircraft climbed to FL 150 and after fuel was dumped, the aircraft landed safely on Runway 03R at approximately 2008Z.

### **3.0 Conclusion**

#### **3.1 Findings**

- 3.1.1 The flight deck crew were properly rated and licensed for the flight in accordance with existing air navigation regulations.
- 3.1.2 The first officer was the handling pilot (PF) and the PIC the pilot-monitoring the take-off.
- 3.1.3 The aircraft had a valid Certificate of Airworthiness and had been maintained in compliance with the regulations and was certified airworthy for this flight.
- 3.1.4 The aircraft weight and balance was within the specified limits for this flight.
- 3.1.5 The aircraft was on a scheduled international passenger flight when the incident occurred.
- 3.1.6 The take-off was planned at reduced-power and the flaps set to 20 units.
- 3.1.7 During the take-off roll, No.3 Engine TR 'REV' amber EICAS message displayed on the P2-Pilots Centre Instrument Panel at approximately 125.6kt prior to V<sub>1</sub> calculated speed of 150kt. No.2 Engine 'REV' illuminated shortly thereafter at 159.9kt prior to (V<sub>R</sub>) rotation.
- 3.1.8 The subject thrust reversers did not actually unlock at the time, but the Group 'A' LE flaps auto retracted at a computed airspeed of approximately 164kt with the rotation speed (V<sub>R</sub>) being 168kt.
- 3.1.9 The cockpit crew had no notion that the Group 'A' LE flaps had automatically retracted prior to rotation as there is no separate indication on the flight deck for the position of the LE flaps during normal LE flap operation. The extended 'FLAPS' display appears automatically on the main EICAS for non-normal configurations such as alternate flaps, flap asymmetry, and LE or TE flap disagreement with flap control lever position.
- 3.1.10 Although there was no separate indication on the flight deck for the position of the LE flaps as mentioned in the above paragraph, the retraction of the Group 'A' LE flaps is shown as a color change on the

flap indicator EICAS display which is hardly visible on the P2 Pilot Center Instrument Panel.

- 3.1.11 The aircraft rotated and became airborne at a CAS of approximately 176kt.
- 3.1.12 The stick shaker started activating intermittently with the aircraft at a RA of approximately 4 ft at 176kt for 8 seconds within a period of 15 seconds. During this time the aircraft RA increased to 136 ft.
- 3.1.13 The first officer (PF) during the take-off phase, maintained control of the aircraft during the eventful take off. The PIC continued monitoring the actions of the PF.
- 3.1.14 The aircraft reached a RA of approximately 56ft at a CAS of 181.6kt when the Group 'A' LE flaps automatically re-extended and the aircraft performance returned to normal.
- 3.1.15 During this time the flight deck crew had no indication or understanding of what had caused the lack in performance of the aircraft.
- 3.1.16 The aircraft climbed to FL150 before fuel was dumped in order to configure the aircraft within the allowable landing weight.
- 3.1.17 The aircraft returned to O.R. Tambo airport and an uneventful landing was performed on Runway 03R.
- 3.1.18 The flying crew should be commended for the professional way that they controlled the aircraft during a critical stage during takeoff and thereby ensured the safety of the 283 occupants on board the aircraft.

## **3.2 Probable Cause(s)**

- 3.2.1 Loss of a significant amount of lift on rotation during the takeoff caused by the automatic LE flap retraction logic retracting the Group 'A' LE flaps on receipt of spurious thrust reverser unlock signals from the no. 2 and no. 3 engines. The possibility of such an occurrence had not been identified during amendment of the retraction logic.

## **4.0 Safety actions and recommendations**

### **4.1 Actions implemented**

4.1.1 According to the accredited representative of National Transport Safety Bureau (NTSB), Boeing Aircraft Company took several safety actions as follows:

- a) Boeing issued a Multi-Operator Message (MOM) MOM-MOM-09-0249-01B on May 20<sup>th</sup> to all 747-400 customers that operate Rolls-Royce RB211-524 engines informing them of the event, that interim action to address the problem was forth coming and that Boeing was looking at other 747/engine combinations to determine if an unsafe condition exist in those fleets.
- b) Boeing issued a MOM-MOM-09-0258-01B on May 21<sup>st</sup> to all 747-400 operators letting them know of the event and that they were looking at other 747-400/engine combinations to determine if an unsafe condition existing in those fleets. Based on the different types of TR indication systems for the GE and P&W engines, it was determined that there was not an immediate safety concern but that the review of these fleets was still on-going. Once the review has been completed a final communication would be sent out no later than June 19, 2009 on the final result of the review.
- c) Boeing developed a draft SB aimed only at the 747-400/RR engine combination fleet to be sent to the FAA for their review no later than June 1, 2009. Information gathered from the Boeing SB draft, was that the intent of the SB would be to remove the auto stow feature of the leading edge flaps based on the 'unstow' signal from the thrust reversers. The feature would still function based on reverse handle selection and air/ground logic. This would make the 747-400's Rolls Royce powered airplanes similar to the older models. This can be accomplished by re-terminating the appropriate 'unstow' signal wire, essentially disabling it.
- d) The FAA's Aircraft Certification Office in Seattle worked with Boeing on this mitigation plan and intended to mandate the SB with a short compliance time for operators.

4.1.2 The aircraft manufacturer Boeing Aircraft Company on 08 June 2009 issued an Alert Service Bulletin (ASB) no. 747-78A2181 titled, Exhaust - Thrust Reverser Control System – Automatic Leading Edge Flap Retraction System Wiring Change, in order to change the signal to the FCU.

Implementation of this change allowed for the Group 'A' LE flaps to auto-retract only when the thrust reversers are commanded by lifting the reverse thrust handle. The change given in this ASB was to be implemented within 90 days after the issue date.

The ASB also stated that the FAA will possibly release an AD related to this service bulletin. The AD will make the compliance tasks given in this service bulletin mandatory.



- 4.1.3 Subsequently the FAA issued an Airworthiness Directive 2009-13-03 with an effective date of July 6 2009 and applicable to Boeing Model 747-400 and -400F series airplanes, certificated in any category and powered by Rolls-Royce RB211 series engines.

It required that within 60 days after the effective date of this AD, the thrust reverser control system wiring to the FCU in the P414 and P415 panels be modified in accordance with the Accomplishment Instructions of Boeing Alert Service Bulletin 747-78A2181, dated June 8, 2009. Refer Appendix B.

## **4.2 Additional Safety Recommendation/s**

- 4.2.1 Whilst the actions that were already implemented should prevent a re-occurrence of this incident, it is nevertheless recommended that:

(i) Operators should ensure that Thrust Reversers are fully stowed after ground maintenance was performed and in particular to conduct a visual inspection (the gap at the front of the translating cowl) to ensure the Thrust Reversers has motored to the fully stowed position;

And

(ii) The Boeing Aircraft Company should advise operators that there may be a possible hazard to personnel/equipment in the proximity of Thrust Reversers as it may deploy during the Auto-Speed-Brake maintenance/tests.

4.2.3 The apparent increase in the number of software related incidents involving various type certificated aircraft is becoming a cause of concern. There is also a common thread through many recent accidents and it is time to train for a new type of emergency that addresses the failure modes in highly automated aircraft. The interface between pilots and aircraft automation, as well as how this should be incorporated into aviation training, requires a review. This includes addressing how automation fails, how pilots should cope with it and how to get through the failures. New phrases for automation failures that were similar to "dead foot, dead engine" slogans that helped them identify which engine had quit are now needed.

It is therefore recommended that:

The Regulatory and certificating authorities of all States of Design and States of Manufacture should introduce requirements to:

- Review all software control and hardware control logics and combinations thereof to ensure that all probable defect possibilities are identified;
- Review the processes used to introduce modifications to control software since issuance of the original type certification, e.g. consider a recertification process; and

- Verify that appropriate resolutions for such occurrences have been developed and are in place to prevent un-commanded actions that can result in an accident.
- Improve the robustness of the software/hardware logic through the introduction of additional parameters to consider prior to an automatic change in critical control surfaces.
- Introduction of a flight deck crew “alert/approval/override” facility prior to an inadvertent change to critical control surfaces.
- Account for spurious mechanical and electrical failures and their impact on the software and hardware logic system.
- Operators should provide flight crews with more basic hand flying and simulator flight training on new generation aircraft to address the technological developments in aviation, inclusive of effective stall training.

## **5.0 APPENDICES**

5.1 Appendix A: Extract from Boeing Alert Service Bulletin 747-78A2181

5.2 Appendix B: FAA AD 2009-NM-112-AD

- END -

**Appendix A:**

**Extract from Boeing Service Bulletin 747-78A2181**



Commercial  
Airplanes

747

Service Bulletin

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**ALERT**

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**Number:** 747-78A2181  
**Original Issue:** June 08, 2009  
**ATA System:** 7834

**Summary**

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**SUBJECT:** EXHAUST - Thrust Reverser Control System - Automatic Leading Edge Flap Retraction System Wiring Change

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THIS BULLETIN IS SENT TO THE OPERATORS OF RECORD OF THE AIRPLANES SHOWN IN PARAGRAPH 1.A., EFFECTIVITY. IF AN AIRPLANE HAS BEEN LEASED OR SOLD, SEND THIS SERVICE BULLETIN TO THE NEW OPERATOR. IF APPLICABLE SPARES HAVE BEEN SOLD, SEND THIS SERVICE BULLETIN TO THE NEW OWNER.

**CONCURRENT REQUIREMENTS**

None.

**BACKGROUND**

This service bulletin will prevent the Group A leading edge (LE) flaps from automatically retracting if the flap control unit (FCU) receives dual REV Amber messages from the thrust reversers. If this service bulletin is not incorporated, the Group A leading edge flaps can automatically retract if the FCU receives dual REV Amber messages from the thrust reverser, resulting in reduced climb performance of the airplane during takeoff.

During takeoff roll, an operator experienced a REV Amber indication on the number 3 engine thrust reverser. This was followed thirteen seconds later by a REV Amber indication on the number 2 engine thrust reverser. At the time of the second REV Amber, the aircraft was beyond V1. In order to prevent impingement from the thrust reversers, the FCU of the 747-400 is designed to automatically retract the Group A leading edge flaps when a REV Amber signal is received from either both inboard or both outboard thrust reversers and the aircraft is on the ground. The FCU performed as designed, and retracted the Group A leading edge flaps. After liftoff, the air/ground logic took over and the Group A LE flaps re-deployed. During the event, the flight crew reported buffeting and momentary stick shaker activation. The aircraft jettisoned fuel and returned to the airport for an uneventful landing. All four thrust reversers deployed and stowed normally after landing.

The automatic LE flap retraction logic automatically retracts the Group A LE flaps during reverse thrust operation. This is to prevent thrust reverser efflux air from impinging onto the Group A LE flaps in order to improve the Group A LE flap panel's structural life. This function is armed when the airplane is on the ground. The Group A LE flaps retract when the FCU receives a signal from either both inboard thrust reversers or both outboard thrust reversers.

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The signal from the thrust reversers comes from either the microswitch in the thrust reverser lever or from the proximity switches on the thrust reverser cowl. The proximity switch is a magnetic device that provides a signal when a target material attached to the thrust reverser cowl is either covering half of the sensor face (this is when the thrust reverser cowl is stowed and is called "target near") or when the target has moved away approximately 0.5 inches or more (this is anytime the thrust reverser cowl is in-transit or not stowed and is called "target far"). A REV Amber indication appears on the upper Engine Indication and Crew Alerting System (EICAS) whenever the proximity switch is target far. This is not inhibited at any phase of flight.

The initial signal to the FCU comes from the microswitch when thrust reverser deployment is commanded. The signal to the FCU is maintained after stow is commanded by the proximity switches. This signal is removed once the thrust reverser is stowed.

The Group A LE flaps retract (or extend) in ten seconds. Once auto-retracted, there is a five second time delay after the thrust reverser signal is removed from the FCU before the Group A LE flaps return to the commanded position. The thrust reverser extends in two seconds and stows in three seconds. This time can slightly increase during cold weather operation.

This change will remove the thrust reverser stow signal from the FCU. The timing of the thrust reverser stow versus the time delay in the FCU accomplishes the original intent of the design. The thrust reversers are fully stowed prior to the FCU time delay lapsing and Group A LE flap movement starting. The signal from the thrust reverser lever will not be affected by this change.

Boeing Service Related Problem (SRP) 747-SRP-78-0067 is related to this service bulletin.

**ACTION (PRR 85665-R)**

- Re-Terminate thrust reverser control wiring in the P414 and P415 panels.

**EFFECTIVITY**

747-400/-400F Airplanes. Refer to Paragraph 1.A.1., Airplanes for the list of affected airplanes.

**COMPLIANCE**

The Federal Aviation Administration (FAA) will possibly release an Airworthiness Directive related to this service bulletin. The Airworthiness Directive will make the compliance tasks given in this service bulletin mandatory. See the AD for the required compliance time.

Boeing recommends that the change given in this service bulletin be done within 90 days after the original issue date of this service bulletin.

**INDUSTRY SUPPORT INFORMATION**

At the time of release of this service bulletin, warranty remedies have not been determined. A subsequent revision or Information Notice will address the warranty remedies available, if any.

**MANPOWER**

Airplanes	Total Task Hours	Elapsed Hours
Group 1	9.80	9.80 (a)

Original Issue: June 08, 2009

## **Appendix B:**

### **FAA AD 2009-NM-112-AD**



**FAA**  
**Aircraft Certification Service**

## **AIRWORTHINESS DIRECTIVE**

[www.faa.gov/aircraft/safety/alerts/](http://www.faa.gov/aircraft/safety/alerts/)  
[www.gpoaccess.gov/ft/advanced.html](http://www.gpoaccess.gov/ft/advanced.html)

**2009-13-03 Boeing:** Amendment 39-15942. Docket No. FAA-2009-0556; Directorate Identifier 2009-NM-112-AD.

#### **Effective Date**

(a) This airworthiness directive (AD) is effective July 6, 2009.

#### **Affected Ads**

(b) None.

#### **Applicability**

(c) This AD applies to Boeing Model 747-400 and -400F series airplanes, certificated in any category; Powered by Rolls-Royce RB211 series engines.

#### **Subject**

(d) Air Transport Association (ATA) of America Code 78: Engine.

#### **Unsafe Condition**

(e) This AD results from a report of automatic retraction of the leading edge flaps during takeoff due to indications transmitted to the flap control unit (FCU) from the thrust reverser control system. The Federal Aviation Administration is issuing this AD to prevent automatic retraction of the leading edge flaps during takeoff, which could result in reduced climb performance and consequent collision with terrain and obstacles or forced landing of the airplane.

#### **Compliance**

(f) You are responsible for having the actions required by this AD performed within the compliance times specified, unless the actions have already been done.

#### **Modification**

(g) Within 60 days after the effective date of this AD: Modify the thrust reverser control system wiring to the FCU in the P414 and P415 panels in accordance with the Accomplishment Instructions of Boeing Alert Service Bulletin 747-78A2181, dated June 8, 2009.

#### **Alternative Methods of Compliance (AMOCs)**

(h)(1) The Manager, Seattle Aircraft Certification Office (ACO), FAA, has the authority to approve AMOCs for this AD, if requested using the procedures found in 14 CFR 39.19. Send information to ATTN: Douglas Bryant, Aerospace Engineer, Propulsion Branch, ANM-140S, FAA, Seattle Aircraft Certification Office, 1601 Lind Avenue, SW., Renton, Washington 98057-3356; telephone (425) 917-6505; fax (425) 917-6590. Or, e-mail information to 9-ANM-Seattle-ACOAMOC-Requests@faa.gov.

(2) To request a different method of compliance or a different compliance time for this AD, follow the procedures in 14 CFR 39.19. Before using any approved AMOC on any airplane to which the AMOC applies, notify your principal maintenance inspector (PMI) or principal

avionics inspector (PAI), as appropriate, or lacking a principal inspector, your local Flight Standards District Office.

The AMOC approval letter must specifically reference this AD.

#### **Material Incorporated by Reference**

(i) You must use Boeing Alert Service Bulletin 747-78A2181, dated June 8, 2009, to do the actions required by this AD, unless the AD specifies otherwise.

(1) The Director of the Federal Register approved the incorporation by reference of this service information under 5 U.S.C. 552(a) and 1 CFR part 51.

(2) For service information identified in this AD, contact Boeing Commercial Airplanes, Attention: Data & Services Management, P.O. Box 3707, MC 2H-65, Seattle, Washington 98124-2207; telephone 206-544-5000, extension 1, fax 206-766-5680; e-mail [me.boecom@boeing.com](mailto:me.boecom@boeing.com); Internet <https://www.myboeingfleet.com>.

(3) You may review copies of the service information at the FAA, Transport Airplane Directorate, 1601 Lind, Avenue SW., Renton, Washington. For information on the availability of this material at the FAA, call 425-227-1221 or 425-227-1152.

(4) You may also review copies of the service information that is incorporated by reference at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202-741-6030, or go to: [http://www.archives.gov/federal\\_register/code\\_of\\_federal\\_regulations/ibr\\_locations.html](http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html).

Issued in Renton, Washington, on June 12, 2009.

Ali Bahrami,

Manager, Transport Airplane Directorate,

Aircraft Certification Service.