Aviation Safety Council

Investigation Report

Korean Air Flight 691

AIRBUS A300-B4-622R, HL-7297

Loss Cabin Pressure at FL320, 30 NM South of Waypoint SALMI

On Route B-576, Taipei FIR

On May 11, 2006

ASC-AOR-07-10-001

OCTOBER 01, 2007

This Page Intentionally Left Blank

According to the Aviation Occurrence Investigation Act of the Republic of China, Article 5：

The objective of the ASC ‘s investigation of aviation occurrence is to prevent recurrence of similar occurrences. It is not the purpose of such investigation to apportion blame or liability.

Further, according to the International Civil Aviation Organization (ICAO) Annex 13, Chapter 3, Section 3.1：

The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability.

Thus, based on both the Aviation Occurrence Investigation Act of the Republic of China, as well as the ICAO Annex 13, this aviation occurrence investigation report shall not be used for any other purpose than to improve safety of the aviation community.

This Page Intentionally Left Blank

Executive Summary

On May 11, 2006 at 0046 UTC[1] (Coordinated Universal Time), Korean Air (KAL) flight number KE0691, an AIRBUS A300-B4-622R aircraft with registration number HL-7297, departed from Incheon International Airport, Republic of Korea to Chiang Kai Shek International (CKS) Airport, Taipei, Taiwan, Republic of China (ROC) The flight departed with128 occupants on board including 117 passengers, 9 cabin crew members and 2 flight crew members.

About 0217 UTC, the KE0691 encountered the situation of loss of cabin pressure while cruised at FL 320, 30 NM south of SALMI[2] on route B576,Taipei Flight Information Region(FIR). The flight crew executed emergency descent by following the QRH (Quick Reference Handbook). The 230 out of 267 passenger oxygen masks were dropped automatically during emergency descent. The aircraft was level-off at 10,000 feet and the cabin pressure control was recovered after flight crew reset the system. The aircraft landed safely at CKS airport. No aircraft damage and occupants on board sustained injury in this occurrence.

According to the Aviation Occurrence Investigation Act, and Annex 13 to the Convention on International Civil Aviation (Chicago Convention), which is administered by the International Civil Aviation Organization (ICAO), the Aviation Safety Council (ASC), an independent agency of the ROC government responsible for civil aviation occurrence investigation, composed a team to conduct the investigation of this occurrence. The investigation team included members from the ROC Civil Aeronautical Administration (CAA), the Korean Air, the Bureau D'enquetes et D'analyses pour la Securite de L'aviation Civile (BEA) the state of

[1] Taipei Local Time is UTC +8 hrs, and Incheon Local Time is UTC +9 hrs.
[2] SALMI: Way point on route B-576, Taipei FIR.

manufacture, the Korean Aviation and Railway Accident Investigation Bureau (KARAIB) the state of operator, were invited as the Accredited Representatives (AR) of this investigation based on ICAO Annex 13.

The investigation was accomplished on 01 August 2007, based upon the analysis by the Safety Council, the following are the key findings of the KE0691 accident investigation.

Findings as the result of this Investigation

The Safety Council presents the findings derived from the factual information gathered during the investigation and the analysis of the CI611 accident. The findings are presented in three categories: **findings related to probable causes, findings related to risk, and other findings**.

The findings related to the probable causes identify elements that have been shown to have operated in the occurrence, or almost certainly to have operated in the occurrence. These findings are associated with unsafe acts, unsafe conditions, or safety deficiencies that are associated with safety significant events that played a major role in the circumstances leading to the occurrence.

The findings related to risk that have the potential to degrade aviation safety. Some of the findings in this category identify unsafe acts, unsafe conditions, and safety deficiencies that made this occurrence more likely; however, they can not be clearly shown to have operated in the occurrence. They also identify risks that increase the possibility of property damage and personnel injury and death. Further, some of the findings in this category identify risks that are unrelated to the occurrence, but nonetheless were safety deficiencies that may warrant future safety actions.

Other findings identify elements that have the potential to enhance aviation safety, resolve an issue of controversy, or clarify an issue of unresolved ambiguity. Some of these findings are of general interest and are not necessarily analytical, but they are often included in ICAO format occurrence reports for informational, safety awareness, education, and improvement purposes

The findings related to the probable causes

1. A broken flange in the automatic mode motor drive component caused the FWD outflow valve failed and the subsequent failure of both auto modes in driving the FWD outflow valve. The failed valve in both auto modes caused the cabin pressure loss.
2. The flight crew did not apply the manual mode to control the cabin pressure.
3. There is no integrated procedures defined when both of cabin pressure regulators failed and rapid decompression happened, whether the flight crew shall continuously complete the “CABIN PRESS REG FAULT” procedure or direct to the “EMERGENCY DESCENT” procedure.

The findings related to risk

1. The flight crew did not follow the standard procedure to initiate a turn when conducted the “EMER DESCENT” procedure.

Other findings

1. The flight crew members were properly certified and qualified in accordance with applicable Korean Civil Aviation Regulations.
2. There was no evidence indicating the crew had any physical or psychological problems, nor any use of alcohol or drugs.

3. The aircraft was operated within allowable weight and balance limitations.
4. There were no adverse weather conditions at the time of the occurrence.
5. The LIEBHERR AEROSPACE did not conduct more detailed exploration on that damaged flange of the motor drive component.

Safety recommendations

To Korean Air

1. Ensure the flight crew to follow the specific emergency procedures and enhance the operating proficiency. (ASC-ASR-07-10-001）
2. Review and integrate the related emergency procedures to the loss of cabin pressure. (ASC-ASR-07-10-002)

To Korean Minstry of Construction & Transportation

1. Monitor and survey the safety recommendation #1 and #2 to Korean Air. （ASC-ASR-07-10-003）

To LIEBHERR-AEROSPACE/France

1. Conduct more detailed exploration on the damaged flange of the motor drive component（ASC-ASR-07-10-004）

Contents

Executive Summary ..... **i**

Contents ..... **v**

Tables ..... **vii**

Figures ..... **ix**

1 Factual Information **1**

1.1 History of Flight 1

1.2 Injury to Persons 2

1.3 Personnel Information 3

1.3.1 Background and Experience of Flight Crew 3
1.3.1.1 The Captain (CM-1) 3
1.3.1.2 The First Officer (CM-2) 3
1.3.2 Flight Crew's Medical Conditions 4
1.3.2.1 The Captain (CM-1) 4
1.3.2.2 The First Officer (CM-2) 4
1.3.3 72 Hour History 4
1.3.3.1 The Captain (CM-1) 4
1.3.3.2 The First Officer (CM-2) 5

1.4 Aircraft Information 5

1.4.1 General Information 5
1.4.2 Maintenance Records 6
1.4.2.1 Outflow valves maintenance Requirements 6
1.4.2.2 Malfunction records 7
1.4.3 Maintenance Action 7
1.4.4 Related Systems 8
1.4.4.1 Cabin Pressure Control System 8
1.4.4.2 Cockpit Warning System 11
1.4.4.3 Passenger Oxygen System 12
1.4.4.4 Prerecorded Announcements 13
1.4.5 Weight and Balance 14

1.5 Meteorological Information 14

1.6 Flight Recorders 15

1.6.1 Cockpit Voice Recorder 15
1.6.2 Flight Data Recorder 15
1.6.3 Radar Track 15

1.7 Survival Aspects 16
1.8 Test and Research 17
1.8.1 Inspection of FWD out flow valve assembly 17
1.9 Additional Information 19
1.9.1 Summary of Interview with Flight Crew 19
1.9.1.1 Flight crew 19
1.9.2 Summary of Operation Manuals 22
1.9.2.1 Flight Operations Manual 22
1.9.2.2 Flight Crew Operating Manual 25
1.9.3 Summary of Quick Reference Hand Book 30
2 Analysis 33
2.1 General 33
2.2 Related factors 33
2.2.1 Cabin pressure control 33
2.2.2 Flight crew disposition procedures 34
2.3 Others 36
2.3.1 Emergency descent procedure 36
3 Conclusions 37
3.1 The findings related to the probable causes 38
3.2 The findings related to risk 38
3.3 Other findings 38
4 Safety recommendations 41
4.1 Safety recommendations 41
Appendix1 DFDR tabular data and plots 43
Appendix2 Radar track and plots 47
Appendix3 Out Flow Valve Assembly Test Result 57

Tables

Table 1.2-1 Injury table 2
Table 1.3-1 Basic Information of Flight Crew 3
Table 1.4-1 Basic information of the aircraft 5
Table 1.4-2 Basic information of the engines 6
Table 1.4-3 Maintenance Requirements of out flow valve 6
Table 1.4-4 Basic information of the FWD out flow valve 7
Table 1.4-5 KE0691 Weight and Balance Data 14

This Page Intentionally Left Blank

Figures

Figure 1.1-1 Flight path of the KE0691..... 2
Figure 1.4-1 BITE test results..... 7
Figure 1.4-2 Pressure Control System 9
Figure 1.4-3 Motor drive components..... 10
Figure 1.4-4 Out flow valve control modes 11
Figure 1.4-5 Priority Block Diagram..... 14
Figure 1.8-1 Normal flange..... 18
Figure 1.8-2 Damaged flange..... 18

This Page Intentionally Left Blank

1 Factual Information

1.1 History of Flight

On May 11, 2006 at 0046 UTC[3] (Coordinated Universal Time), Korean Air (KAL) flight number KE0691, an AIRBUS A300-B4-622R aircraft with registration number HL-7297, departed from Incheon International Airport, Republic of Korea to Chiang Kai Shek International (CKS) Airport, Taipei, Taiwan, Republic of China (ROC) The flight departed with128 occupants on board including 117 passengers, 9 cabin crew members and 2 flight crew members.

About 0217 UTC, the KE0691 cruised at FL 320, 30 NM south of SALMI[4] (Figure 1.1-1) on route B-576, Taipei Flight Information Region(FIR). The "CAB PRESS REG #2 FAULT" message appeared on ECAM (Electronic Centralized Aircraft Monitoring) accompanied with chime signal. The message confirmed by flight crew from the indicated cabin vertical speed which showed +1,000 feet per minute and the cabin altitude continually increasing passed 9,000 feet. After the CM-2 switched off the SYS 2 by following the "ECAM Action", the "CAB PRESS REG #1 FAULT" message appeared on ECAM. The cabin vertical speed increased to +3,000 feet per minute and cabin altitude passed over 10,000 feet. And then flight crew executed emergency descent by following the QRH (Quick Reference Handbook). The 230 out of 267 passenger oxygen masks dropped out automatically during emergency descent. The aircraft was level-off at 10,000 feet and the cabin pressure control was recovered after flight crew reset the system. The aircraft landed at about 0302 UTC safely at CKS airport. No aircraft damage and occupants on board sustained injury in this occurrence.

[3] Taipei Local Time is UTC +8 hrs, and Incheon Local Time is UTC +9 hrs.
[4] SALMI: Way point on route B-576, Taipei FIR.

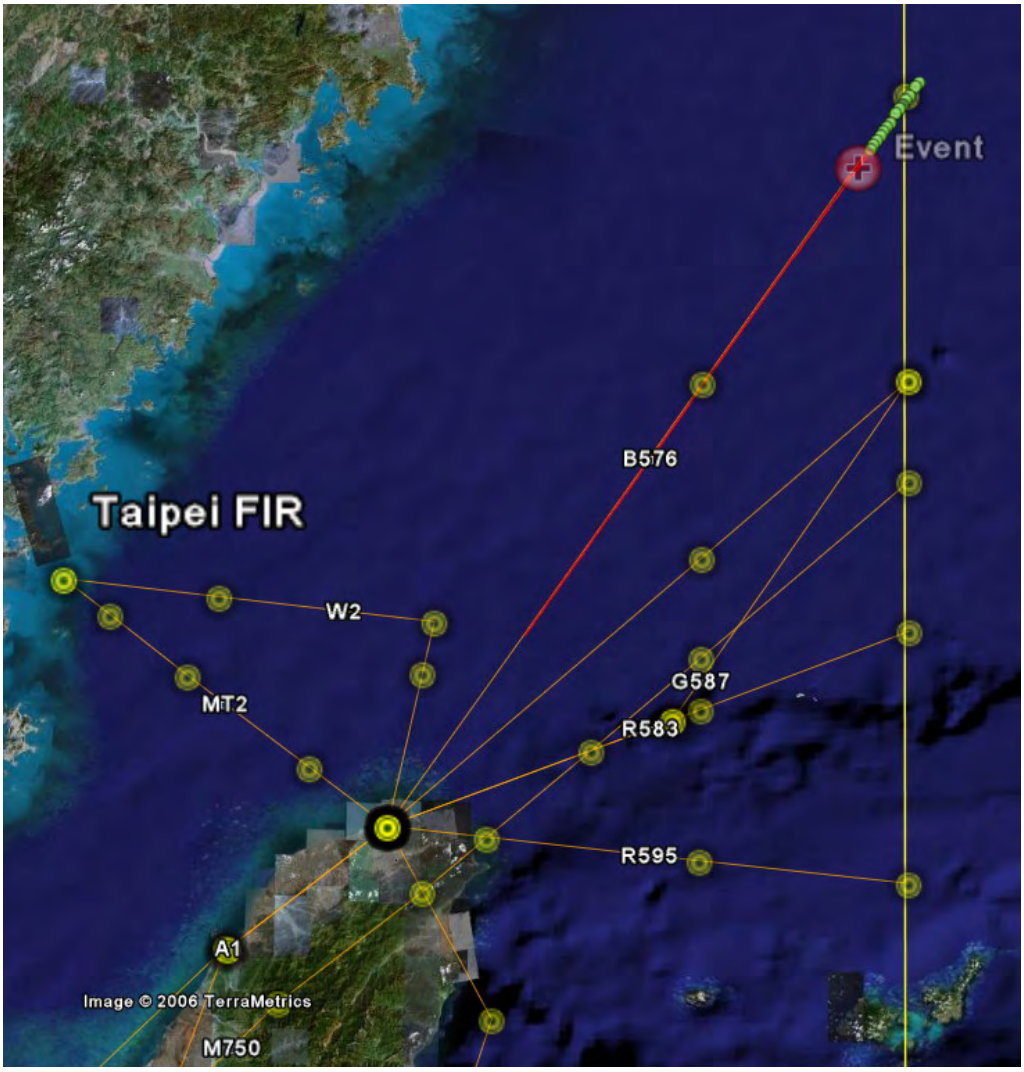


Figure 1.1-1 Flight path of the KE0691

1.2 Injury to Persons

There were 2 flight crew members, 9 cabin crew members and 117 passengers on board. Non of the occupants on board sustained injury in this occurrence.

The injury distribution is summarized in Table 1.2-1.

Table 1.2-1 Injury table

Injuries	Crew	Passengers	Others	Total
Fatal	0	0	0	0
Serious	0	0	0	0
Minor/None	0/11	0/117	0/0	0/128

Total	11	117	0	128

1.3 Personnel Information

1.3.1 Background and Experience of Flight Crew

1.3.1.1 The Captain (CM-1)

CM-1 is a nationality of the Republic of Korea who had served in military as a pilot and no records of flight time history during his military service. He joined KAL in Feb. 1996. He completed and passed the first officer flight check of A300-600 in May 2004, and was promoted to a captain of A300-600 in March 2005. His total flight time to date of the occurrence was 6,688:00 hours which included 1,320:00 hours on A300-600.

1.3.1.2 The First Officer (CM-2)

CM-2 is a nationality of the Republic of Korea. He joined KAL in April 2005 and started the initial training of A300-600 in April 2005. He completed and passed the first officer flight check of A300-600 in April 2006. His total flight time to date of the occurrance was 533:00 hours which included 172:00 hours on A300-600.

Table 1.3-1 Basic Information of Flight Crew

Item	**CM-1**	**CM-2**
Gender	Male	Male
Age as of Occurrence	42	30
Date of joining in KAL	Feb. 12,1996	Apr. 25, 2005
License type	Airline Transport Pilot No.1623	Commercial Pilot No. 5012
Type rating **Expiry date**	A300-600 Oct. 31, 2006	A300-600 F/O Aug. 31, 2006

Medical class **Expiry date**	1st class airman Oct. 31, 2006	1st class airman Aug. 03, 2006
Latest flight check	Sep. 01, 2005	Apr. 13, 2006
Total flight time	6688:00	533:00
Flight time in last 12 months	610:00	175:00
Flight time in last 90 days	161:00	122:00
Flight time in last 30 days	30:00	30:00
Flight time in last 7 days	5:47	12:17
A300-B600 flight time	1320:00	172:00
Flight time on the day of occurrence	2:20	2:20
Rest time before Occurrence	Over 24 hrs	13 hrs

1.3.2 Flight Crew's Medical Conditions

1.3.2.1 The Captain (CM-1)

There is no limitation note on the Airman Medical Certificate issued by Korea authorities.

1.3.2.2 The First Officer (CM-2)

There is no limitation note on the Airman Medical Certificate issued by Korea authorities.

1.3.3 72 Hour History

1.3.3.1 The Captain (CM-1)

CM-1 conducted local flight from 1810(0910 UTC) to 2130(1230 UTC) on May 09 and stayed at home for rest on May 10. He departed from home

to Incheon International Airport at around 0600 local time on May 11(2100 UTC on May 10) to perform KE0691 Flight.

1.3.3.2 The First Officer (CM-2)

CM-2 conducted duty flight from 0930 (0030 UTC) to 1710 (0810 UTC) on May 09, received simulator training from 1100 (0200 UTC) to 1700 (0800 UTC) on May 10. He departed from home to Incheon International Airport at around 0600 local time on May 11 (2100 UTC on May 10) to perform KE0691 Flight.

1.4 Aircraft Information

1.4.1 General Information

The basic information of the occurrence aircraft are shown in Table 1.4-1.

Table 1.4-1 Basic information of the aircraft

No.	Item	Description
1	Aircraft Registration Number	Republic of Korea-registered HL7297
2	Type of Aircraft	A300-B4-622R
3	Manufacturer	Airbus Industries
4	Serial Number	609
5	Date of Manufacturing	April 19, 1991
6	Delivering Date	July 05, 1991
7	Operator	Korean Air
8	Owner	Korean Air
9	Certificate of Airworthiness (Effective Date)	February 15, 2005 ~ N/A
10	Total Flight Hours	28,526
11	Total Cycles	24,400
12	C Check Interval	15 Flight Months (FM)
13	Type and Date of the Latest Heavy maintenance	5 year, 3,000 FC and 30 FM checks on June 07, 2005

There were two Pratt & Whitney PW4158 engines installed on the occurrence aircraft. The basic information of the engines are shown in Table 1.4-2.

Table 1.4-2 Basic information of the engines

Description	No. 1(L/H)	No.2(R/H)
Serial No.	P724871CN	P724019CN
Date of Manufacturing	September 04, 1993	July 19, 1989
Date of Installation	September 16, 2004	April 19, 2005
Flight Hours after installed	3,481	2,480
Total Flight Hours	18,483	23,755
Total cycles	20,484	23,454

1.4.2 Maintenance Records

1.4.2.1 Outflow valves maintenance Requirements

There are 4 related maintenance tasks to out flow valve assemblies in KAL's A300-600 Maintenance Program Document (MPD). The details are shown in Table 1.4-3

Table 1.4-3 Maintenance Requirements of out flow valve

No.	Task	Interval
1	Operation test of auto system controls (1, 2 and manual, and automatic transfer)	1C (15 flight months)
2	Remove, clean and reinstall out flow valves	1C
3	Operation test of out flow valves in " MAN PRESS" control mode	2C
4	Operation test of out flow valves in ditching configuration	2C

1.4.2.2 Malfunction records

No cabin pressurization control system malfunction had been recorded since January 1, 2006.

1.4.3 Maintenance Action

The contracted maintenance staff in Taipei (China Airlines, CAL ground staff) performed the Built in Test Equipment (BITE) test in accordance with Aircraft Maintenance Manual (AMM) to FWD out flow valve on Cabin Pressure Controller panel after the aircraft landed at CKS International Airport. The result showed the valve was failed (shown as Figure 1.4-1). The function of the Cabin Pressure Control System met the operational requirements after the replacement of the FWD out flow valve.

Figure 1.4-1 BITE test results

The basic information of the FWD out flow valve is shown in Table 1.4-4

Table 1.4-4 Basic information of the FWD out flow valve

Part No.	88005B0306

Serial No.	693
Installed Date	2005.07.26
Removal Date	2006.05.11
Time Since Installed (TSI)	1,870 Hrs
Time Since Overhaul (TSO)	28,175 Hrs
Time Since New (TSN)	28,175 Hrs
Repair Vendor	LIEBHERR AEROSPACE

1.4.4 Related Systems

1.4.4.1 Cabin Pressure Control System

In accordance with A300-600 AMM dated on June 01, 2005:

The pressure control system is a fully automatic, electrically operated system. It consists of two identical independent automatic systems operating two out flow valves only. One situated forward of the air conditioning bay and the other aft of the bulk cargo compartment(shown as Figure 1.4-2).

Each valve is operated by one of three motors, two of these motors are controlled independent by the two automatic systems and the third (the manual system) is controlled by a toggle switch located on the overhead panel in the cockpit. In each valve, the drive mechanism and butterfly valve are common to either system, and the two automatic systems will alternately operate both valves. Each system is used alternately for each flight, the changeover being affected automatically between flights. In the event of a system failure, automatic transfer to the other system occurs.

The system function is dependent on pre-programmed cabin altitude, aircraft altitude and pre-select landing altitude, this information is related to the pressurization controller of either of the two systems selected. The system also control automatically pressurization and depressurization procedures.

The control box comprises microprocessor controlled digital circuitry and BITE.

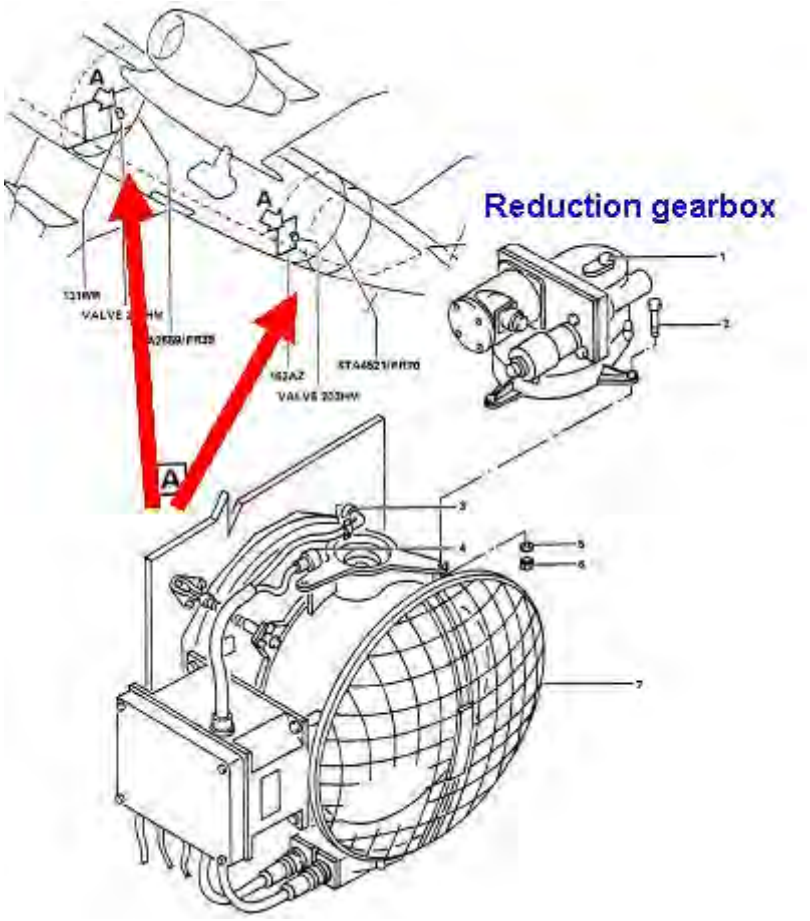


Figure 1.4-2 Pressure Control System

There are two automatic modes and one manual mode to control the out flow valve. The function is to control cabin air evacuation. The components of out flow valve are listed as follows:

- Valve assembly,

- Valve control box,
- Reduction gearbox consists of DC electric motor and brushless motor.

The operating principle of reduction gearbox valve is based upon the application of a triple actuator system including:

- A planetary type reduction gearbox with two irreversible drives,
- A double-rotor, brushless DC motor powers one drive for the automatic control system 1 and 2,
- A standard DC motor powers the other drive for the manual emergency control mode.

When operating in the normal automatic mode (SYS 1 or SYS 2), the appropriate motor on the double motor drive is activated with the input gear wheel of both automatic modes on reduction gearbox. The input drive shaft consists of two bearings, 4 play adjustment shims, a bushing, and a rotor position indicating flange with stop pin. The detail is shown in Figure 1.4-3.

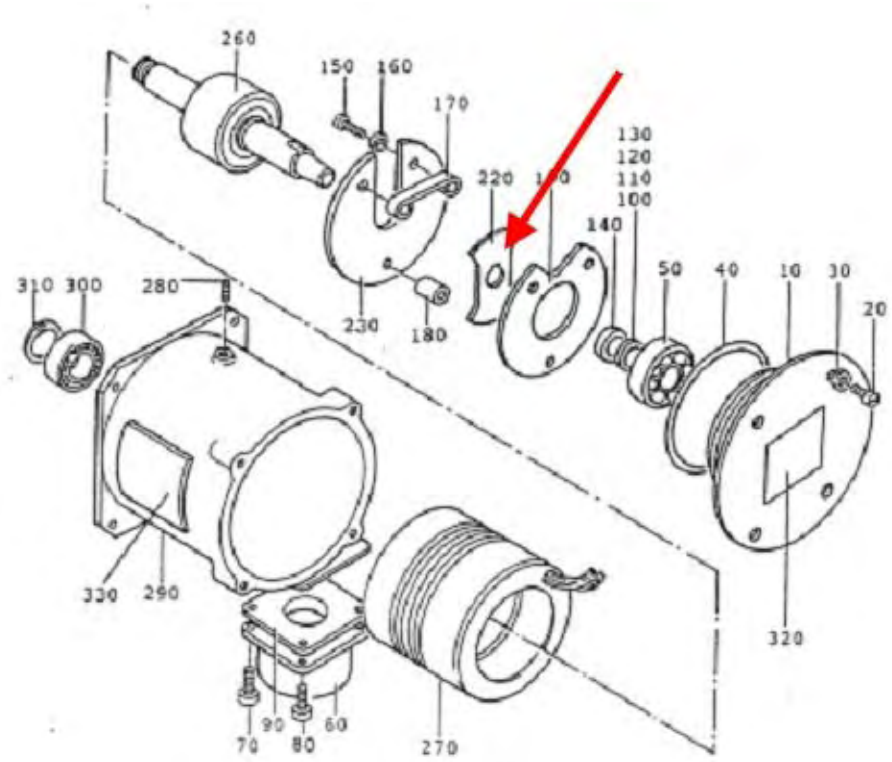


Figure 1.4-3 Motor drive components

The double motor drives the irreversible worm gear. This drives the ring gear and the sun gear remains stationary, the planet gear assembly rotates driving the output gear, which is connected to the butterfly valve by a linkage coupling. Should both automatic systems fail, operating the manual toggle switch located on the cockpit overhead panel activates the single motor drive. Manual control mode is backup by an electric system entirely independent of system 1 and 2 automatic modes. This motor drive a second irreversible worm gear, which drives the tangent gear that connected to the sun gear. Since the ring gear is now stationary, the sun gear drives the planet gear assembly producing the same function as in the automatic mode. Inputs to out flow valve from auto and manual modes are shown in Figure 1.4-4

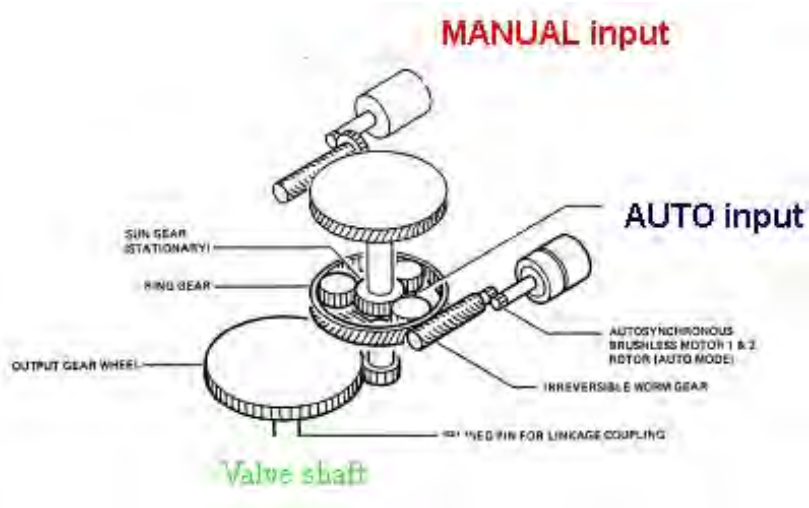


Figure 1.4-4 Out flow valve control modes

1.4.4.2 Cockpit Warning System

Cabin Altitude Warning

In accordance with A300-600 AMM dated on June 01, 2005:

"EXCESS CABIN ALT" message indicates cabin pressure altitude above 9,950 feet. According to the classfication, urgent correction action is

required. Excessive cabin altitude message is classified as level 3 warning[5].

This corresponds to an emergency configuration. Corrective or palliative action must be taken immediately by the crew.

These warnings are provided by a continuous repetitive chime (CRC) or by specific aural warnings and illuminates the MASTER WARNING lights. They lead to a display on the CRT.

1.4.4.3 Passenger Oxygen System

Each of passenger and cabin attendant's emergency oxygen are supplied by oxygen containers fitted above the passenger seats, in the lavatory ceiling and in the galley areas. The system is activated in two ways:

- By the altitude pressure switch, closing automatically at a cabin pressure corresponding to 14000+0/–500 ft.
- By pressing the MAN OVRD switch in the cockpit.

In accordance with A300-600 AMM dated on June 01, 2005:

If the cabin pressure corresponding to 14000+0/–500 ft. The altitude switch closes:

- *The oxygen container doors open.*
- *The oxygen mask fall out and hang by the lanyards within reach of the user passengers and cabin attendents.*

[5] Level 3 warning:

The warnings are classified in 4 levels according to the importance and urgency of the corrective action required. Level 3 has priority over level 2 which in turn has priority over level 1. Level 1 has priority over level 0.

- *When a mask is pulled towards the face of the user, the release pin is withdrawn from its housing by the lanyard attached to the mask. This release striker which ignites the percussion cap to start a chemical reaction in the generator core. Oxygen is produced and is delivered through the flexible hose to the mask.*

A chemical oxygen generator is used to give oxygen supply for at least 13 minutes. The oxygen generator is started mechanically when the oxygen mask is pulled towards the user's face.

1.4.4.4 Prerecorded Announcements

In the event of cabin depressurization condition, activation of passenger oxygen system starts the announcement reproducer. The emergency announcement is automatically broadcast and overrides all other prerecorded announcements, the passenger entertainment and boarding music.

In accordance with A300-600 AMM dated on March 01, 2003:

The number of times that the announcement is played back depends on the position of the DIP (Dual Inline Package)*switch in the announcement reproducer.*

The audio input control circuit provides the interface, priority switching logic and level control for the input singals from the filght crew and attendants handsets, inputs 1,2 and 2a, prerecorded annoucements/music and video reproducers input 3 and passenger entertailment reproducer, input 4. The control input lines are used to drive the logic control circuitry for priority switching. The order of priority from the highest to lowest is input 1, 2/2a, 3 and 4 respectively(Ref. Fig. 1.4-5)

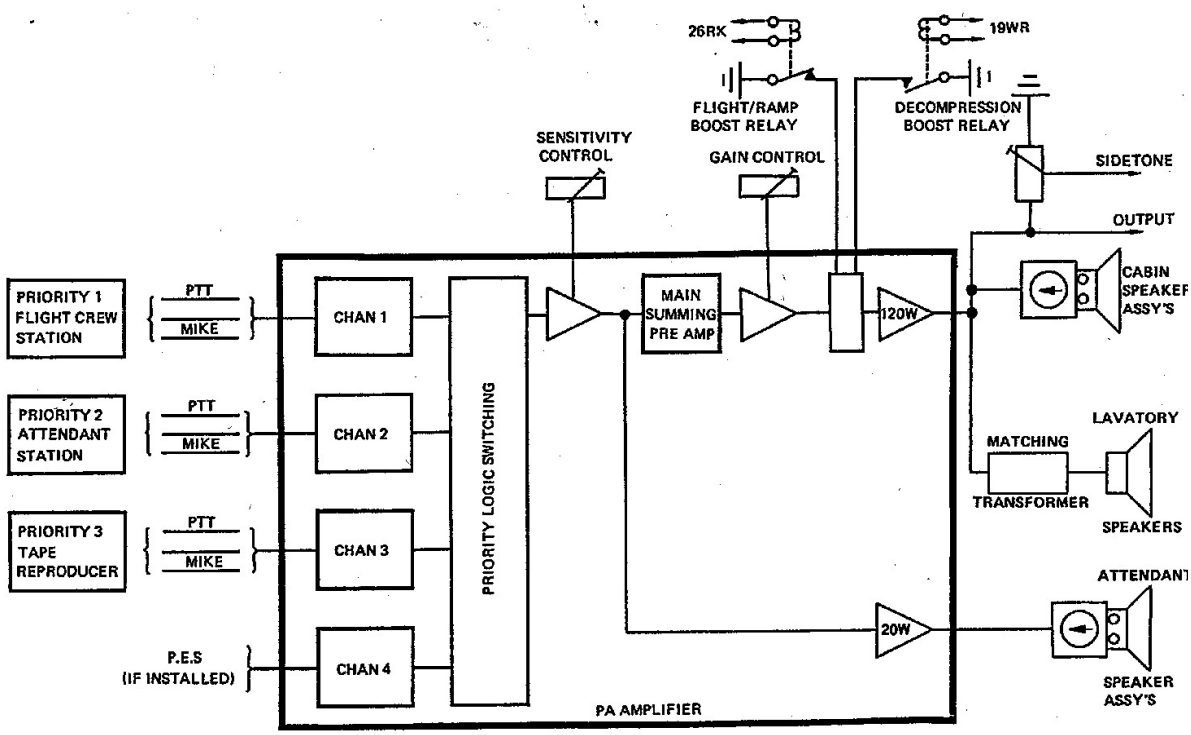


Figure 1.4-5 Priority Block Diagram

1.4.5 Weight and Balance

The maximum takeoff weight of this aircraft is 378,500 lbs, the maximum landing weight is 308,600 lbs, the maximum zero fuel weight is 286,600 lbs. The center gravity of takeoff is 25.4 MAC(Mean Aerodynamics Center). See Table 1.4-5 for weight and balance data.

Table 1.4-5 KE0691 Weight and Balance Data

Zero Fuel Weight	238,248 lbs
Takeoff Fuel	40,399 lbs
Takeoff Weight	278,648 lbs
Center of Gravity at Takeoff	25.4% M.A.C.
Consumed Fuel in Flight	24,400 lbs
Landing Weight	254,247 lbs

1.5 Meteorological Information

The weather in the area of occurrence was visual meteorological conditions and there was no any significant weather phenomenon nearby. According to the forecast of Washington World Area Forecast Center,the upper level wind and temperature were about 25 knots western and minus 40 degrees Celsius respectively at FL340,

1.6 Flight Recorders

1.6.1 Cockpit Voice Recorder

Not available

1.6.2 Flight Data Recorder

The aircraft was equipped with a magnetic tape-based Digital Flight Data Recorder (DFDR), manufactured by the AlliedSignal Inc, part number 980-4100-DXUS, serial number 11219, and with flight data record capacity of 25 hours.

The DFDR raw data and engineering parameters were provided by ARAIB(Aviation and Railway Accident Investigation Board), Korea, there are totally 117 parameters and the time format is synchronized to UTC[6]. The data parameters and the plots are shown as Appendix 1.

1.6.3 Radar Track

The secondary surveillance RADAR data was provided by Taipei Air Control Center of Civil Aviation Adminstration (TACC/CAA). The parameters of data includes RADAR time, longitude, latitude, and Mode-C altitude. The relevant data were in tabular and plots as in Appendix 2.

[6] The FDR were synchronized by VHF key. The time format for the transcript has been transferred to Taipei local time while the DFDR data were described in UTC format.

The time format of DFDR and RADAR were synchronized by pressure altitude and Mode-C altitude. The time synchronization formula is: DFDR UTC time + 16 sec = TACC/CAA Radar time.

1.7 Survival Aspects

According to the purser report and the questionnaire response of the cabin crew, the overall summary are shown as below:

During the occurrence happening, all cabin services were finished, some cabin crew were carrying out the walk around, and the other crew were seated at their jump seats. After seat belt sign illuminated and the oxygen masks dropped, the automatic emergency announcement in cabin began at 42 minutes before arrival. Cabin crew donned oxygen masks after sitting at the nearest seats and shouted on passengers to don their oxygen masks. After communicating with captain, the purser then made the PA announcement for asking passengers to don their oxygen masks and to fasten their seat belt. About 5 minutes later after descent, Captain gave permission to remove oxygen masks and announced the emergency descent was caused by the pressurization problem. All cabin crew informed the captain's illustration to all passengers. The captain made an announcement about the pressurization system failure and apologized to passengers at 30 minutes before arrival. The purser made an announcement with same contents about 5 minutes later. The cabin crew checked all lavatories immediately after the purser's announcement and check each passenger's condition.

A male passenger suffered from a headache and felt heavy in his chest. Cabin crew provided him oxygen from a portable oxygen bottle stored in R2 side. Cabin crew provided medical assistance information to him upon arrival. This passenger refused to be treated as illness passenger and insisted that he felt better. There was no other passenger with any pain

or anomalies other than the passenger mentioned above. Some cabin crew felt nauseous, heavy in chest, and headaches.

The automatic emergency announcement was activated totally three times. The first time occurred during the emergency descent, the second time occurred when the captain was making his announcement about 20 minutes before the arrival and overrode the captain's announcement, the last time occurred when the seat belt sign was turned off after engine shut down.

1.8 Test and Research

1.8.1 Inspection of FWD out flow valve assembly

On June 12, 2006, the FWD out flow valve assembly (S/N 0693) was sent to LIEBHERR-AEROSPACE in France for further examination. The detailed test results are shown in Appendix 3.

The following paragraphs summarized the results of the inspection:

- Operation in Manual mode was satisfactory,
- Operations in Auto modes (1 & 2) were failed. In both auto systems, the butterfly valve did not rotate correctly,
- During the test, an over consumption of the "AUTO" electrical motor that drives the butterfly valve was noted in both auto systems: around 1.5 Amp instead of 0.9 Amp.

After further dismantling of the motor (P/N S4090, S/N 815D), the flange was found free on the shaft(item 220 of Figure 1.8-1). The stop pin of the flange was broken. Figure 1.8-1 and 1.8-2 illustrate the differences.

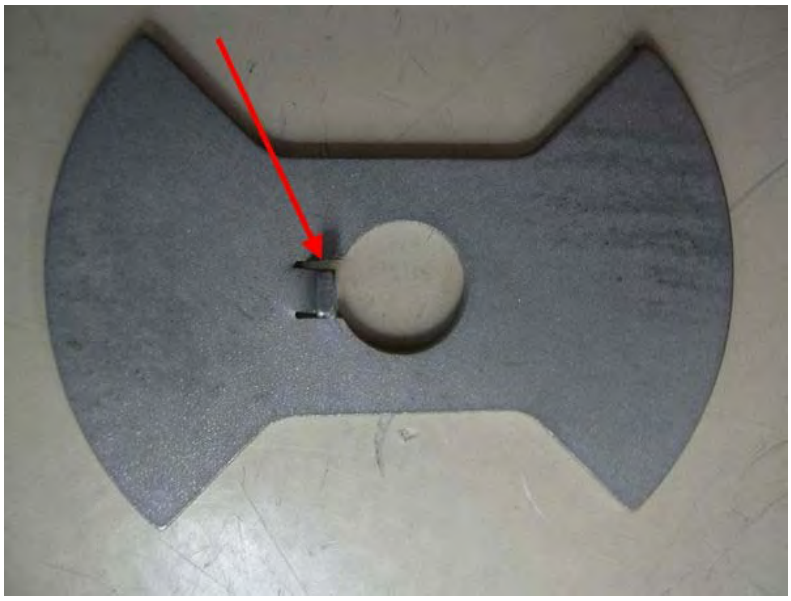


Figure 1.8-1 Normal flange

Figure 1.8-2 Damaged flange

The test report concluded that the broken pin on the flange explained the malfunction of the motor on both modes 1 & 2. It was randomly ordered by the variation of position of the flange.

1.9 Additional Information

1.9.1 Summary of Interview with Flight Crew

1.9.1.1 Flight crew

At 02:17(UTC), about an hour and half after take off, the aircraft was cruising at way point, 30NM south “SALMI” at an altitude of 32,000 feet, and a speed of 0.77M.

At that moment, "CAB PRESS REG 2 FAULT" message suddenly appeared on ECAM, accompanying chime signals. And the flight crew confirmed synoptic displayed automatically, which indicated cabin vertical speed +1,000 feet per minute, showing cabin pressure altitude continually increasing passed 9,000 feet.

In accordance with the pertaining procedure, the Captain (PF) instructed the First Officer (PM) to carry out "ECAM Action," and the First Officer switched off SYS 2, following the Captain's instruction.

As soon as SYS 2 was switched off, "CAB PRESS REG 1 FAULT" message appeared on ECAM, and upon verifying synoptic, it was shown that cabin vertical speed was increasing from +2,000 to +3,000 feet per minute, with cabin pressure altitude passing over 10,000 feet, and CRC (continuous repeated chime) warnings were activated.

The Captain instructed the First Officer to continually carry out "ECAM Action," and accordingly the First Officer switched off SYS 1.

When SYS 1 was switched off, an ECAM Message to manually control cabin pressure was displayed, however, when the flight crew noticed cabin pressure altitude was passing over 12,000 feet, they decided to execute an emergency descent rather than the manual control.

The flight crew remembered the circumstance and the actions taken as follows:

- Oxygen Masks – On
- Crew Communication – Established
- Emergency Descent - Executed.

The flight crew obtained a permission from the Taipei Air Control to execute an emergency descent, maintaining en-route Transponder code 7700 was set due to the sudden cabin decompression to the extent of suspecting of a structural damage (e.g.: door opened, etc) to the aircraft at first, the flight crew maintained the descending speed at 280 knots, and upon verification of no structural damage, they increased the speed to 315 knots. The items conducted by the flight crew during descent were as following:

- The flight crew used speed brake in air.
- The flight crew confirmed P.A broadcasting automatically in English and Korean.
- The flight crew confirmed cabin oxygen masks dropped automatically from overhead panels.
- The flight crew carried out checklist items following memory items.
- The cabin crew called, asking whether to don on oxygen masks in cabin, and the flight crew instructed to do so, as it was a real decompression situation.
- The flight crew confirmed cabin pressure altitude at 10,000 feet, taking off oxygen masks, and the Captain made a P.A. and the Captain instructed to check the cabin situation.

Upon confirmation that there was no problem with continuing the flight at an altitude of 10,000 feet to the destination with the remaining fuel (fuel remained after completion of the flight: 13,200 lbs), the flight was continued at an altitude of 10,000 feet and a speed of 315 knots (V_{MO} 335 knots).

When SYS 1 and 2 switches, which had been turned off, were on again for the confirmation of operation, cabin altimeter indicated normally at about 1,200 feet, and the landing was made with the systems on. The cockpit voice recorder C/B (Circuit Breaker) was not pulled out after landing.

Open/close status of outflow valves were not confirmed in the air, while it was shown after landing that forward valve was 1/4 open, with aft valve 3/4 open, and it was told by the Taipei ground engineer that according to the function check result, forward valve was stuck open.

About 6 hours after landing, FWD outflow valve was replaced, and the aircraft returned to Incheon International Airport as ferry flight

1.9.2 Summary of Operation Manuals

1.9.2.1 Flight Operations Manual

FOM(Flight Operations Manual)

Chapter 8, NON-NORMAL OPERATIONS

Loss of Cabin Pressure

A loss of cabin pressure can occur either slowly caused by leaks or malfunctioning systems, or rapidly through a breach of the aircraft structure. In case of in-flight decompression, descent will be made to the lowest safe altitude in accordance with POM/QRH or 10000feet. (14000feet for specific freighter: B-747, B-747-400) MSL whichever is higher. It is important for the flight crew to remember the asphyxiation due to lack of oxygen at 20000feet and above, immediately use the oxygen masks during descent.

Note) Turn on the exterior lights during the emergency descent, if possible.

• When cabin altitude exceeds 10000 feet, each crew member will don oxygen mask.

• Specific crew procedures are located in the POM/QRH.

• When oxygen is no longer required, the flight crew :

— Must notify the cabin crew that it is safe to move about the cabin.

— Will make an announcement in order to calm and reassure the passengers.

— Have cabin crews to report cockpit after cabin crews checked on the cabin and passenger status.

❑ Time of Useful Consciousness (TUC)

The time of useful consciousness shown below is the period during which a person is capable of coordinated action for self-preservation.

Cabin Altitude	Time of Useful Consciousness with Supplemental O_2	
	After Rapid Decompression	Un-pressurized Aircraft
15000feet	15~20 minutes	30 minutes
25000feet	2 1/2 minutes	5 minutes
30000feet	30 second ~ 1 minutes	1~2 minutes
40000feet and Above	18 second	18 second

Generally, a rapid decompression will reduce TUC by 50%. The time of useful consciousness is generally never less than 18 seconds because this is the shortest time required for oxygen starved blood from the lungs to reach the brain and depress brain functions. Recovery after administering oxygen requires nearly the same length of time.

Emergency Descent

○ Procedures/Callouts

Main points (If Rapid Decompression, Pressurization Problem or Structural Damage):

<table>
<tr><th>PF</th><th>PM</th></tr>
<tr><td colspan="2">• OXYGEN MASK -- ON
• CREW COMMUNICATION -------------------------- ESTABLISH
Announce --- "CM1" "CM2"
• EMERGENCY DESCENT ---------------------------- INITIATE</td></tr>
<tr><td><u>HDG</u>:
• Push to synchronize if NAV mode engaged.
• Pull to engage HDG/S
• Turn to initialize the turn (right if no altitude or navigation constrains)</td><td rowspan="3">IGNITION -------CONT RELIGHT
SIGNS (SEAT BELT) -------- ON
TRANSPONDER (ATC1) - Set 7700

EMERGENCY -- DECLARE (VHF1)
"MAY DAY, MAY DAY, MAY DAY, THIS IS KE 000, EMERGENCY DESCENT IN PROGRESS DUE TO RAPID DECOMPRESSION (or STRUCTURAL DAMAGE), POSITION 000 °R 00 NM FROM 000"</td></tr>
<tr><td><u>ALT</u>:
• Turn to decrease the altitude. (MEA or FL 100)
• LVL/CH push to initialize the descent and cancel profile mode.</td></tr>
<tr><td><u>SPEED</u>:
Revert speed mode
• If no damage :
- Speed ---------- Set MMO/VMO
• Structural damage:
- Speed ---Set present speed (IAS)</td></tr>
<tr><td>THROTTLE -------------- IDLE
SPEED BRAKE --- FULL EXTEND</td><td></td></tr>
<tr><td>Inform to CABIN (PURSER)
P.A. ------ Announce (as required)</td><td></td></tr>
<tr><td>Order ----- "EMER DESCENT CHECKLIST"</td><td>CHECKLIST--------- PERFORM</td></tr>
<tr><td>. FL 200:
Order --- "DESCENT CHECKLIST"</td><td>CHECKLIST -------- PERFORM</td></tr>
<tr><td>. At Transition Level:
Altimeter --- RESET QNH (or QFE)</td><td>Altimeter --- RESET QNH (or QFE)</td></tr>
</table>

PF	PM
2000 feet before MEA or FL100: SPEED - - - - - - - Reduce or Adjust to LRC or 250 SPEED BRAKE - - - - - - - RETRACT THRUST - - - - - - - - - - - - - ADJUST	
• If no damage: - Thrust adjusted to maintain the required speed (if A/THR was disengaged) • Structural damage: - Adjust thrust to maintain the more suitable speed due to the damage.	
Cabin altitude at or below 10,000 feet: OXY MASK - - - - - - - - - - - - - OFF	

※ See the QRH or FCOM 2.04.21 for procedure and more information.

1.9.2.2 Flight Crew Operating Manual

The related contents of Flight Crew Operating manual (FCOM) are summary as following:

GENERAL

Cabin pressure and rate of change control system is composed of :

- two independent automatic control systems,
- one manual control system.

They control two electrical regulating valves (outflow valves). Two pneumatically operated safety valves are provided to avoid over or under pressure.

The two automatic systems will alternately operate. Change over occurs automatically in case of failure of one system and before each flight.

AUTOMATIC CONTROLLER

Based upon information from the LANDING ELEVATION selector, the RATE LIMIT selector and the Captain or F/O altimeter setting, the automatic controller generates signals for positioning of outflow valves during all phases of flight. The other parameters used for signal computation are cabin pressure, aircraft static pressure, cabin pressure rate of change and static pressure rate of change.

The controller contains a computation circuit for determining theoretical cabin altitude relative to existing pressure altitude, taking into account the maximum performance of the aircraft (rate of climb, max. altitude). The control tendency is to adjust the actual cabin altitude towards either the theoretical cabin altitude or the landing elevation altitude selecting the higher of the two.

R **MANUAL OPERATION**

R The manual control of the aircraft pressurization is performed
R by selecting ON the MAN PRESS pushbutton switch and
R then action on the V/S CTL switch. When in manual mode
R the movement of the outflow valves is significantly slower
R than in automatic mode, and there is no automatic
R depressurization of the aircraft upon landing.

OUTFLOW VALVES

One of them is located forward of the air conditioning bay, the other one, aft of the bulk cargo compartment.

Each valve is operated by three electric motors, which are independently controlled by one of the two automatic systems or the manual system.

Each outflow valve can be closed from the overhead panel, where its position is displayed.

Note : In some ABNORMAL/EMERGENCY procedures where evacuation is requested, the RAM AIR is selected ON to open OUTFLOW valves. When the pressurization system is being operated in the manual mode, the RAM AIR switch does not control the OUTFLOW valves and does not depressurize the aircraft.

PRESSURE CONTROL

Preflight

Since the pressure control is fully automatic, the crew action is reduced to setting the LANDING ELEVATION selector and to checking the indications and switch settings on the CABIN PRESS panel.

Prepressurization

Before takeoff, in the following configuration :

- aircraft on the ground (landing gear shock absorbers compressed)
- two engines running (oil pressure normal)
- one throttle control lever beyond 22°.

The automatic system, operating the regulating valves ensure the cabin pressurization at a rate of - 500 ft/mn until the cabin △P reaches 0.22 PSI.

15 seconds after takeoff (shock absorbers extended), prepressurization signals are cancelled, normal pressure control is started through the active system.

Inflight Regulation

- Generally :

  The cabin altitude is regulated towards the theoretical cabin pressure altitude determined by the controller, or to the landing field elevation, whichever is the higher.

The △P increases with the increase of pressure altitude up to the operating ceiling.

When the theoritical altitude is higher than the landing elevation, the rate of change is the lowest of the two following values :

- RATE theoretical
- RATE limit (selected on the RATE LIMIT selector)

When the landing elevation is higher than the theoretical altitude the rate of change is the RATE limit.

In the particular case of :

- landing elevation selected before take-off is lower than T.O. elevation
- and the rate of climb of the aircraft is lower than 750 ft/mn for more than 1 min.

The cabin altitude starts decreasing in order to reach either the selected landing elevation or the theoretical cabin altitude (whichever is higher) with a rate of change of 500 ft/mn.

When this altitude is reached by the theoritical cabin altitude, the system works as in the general case. R

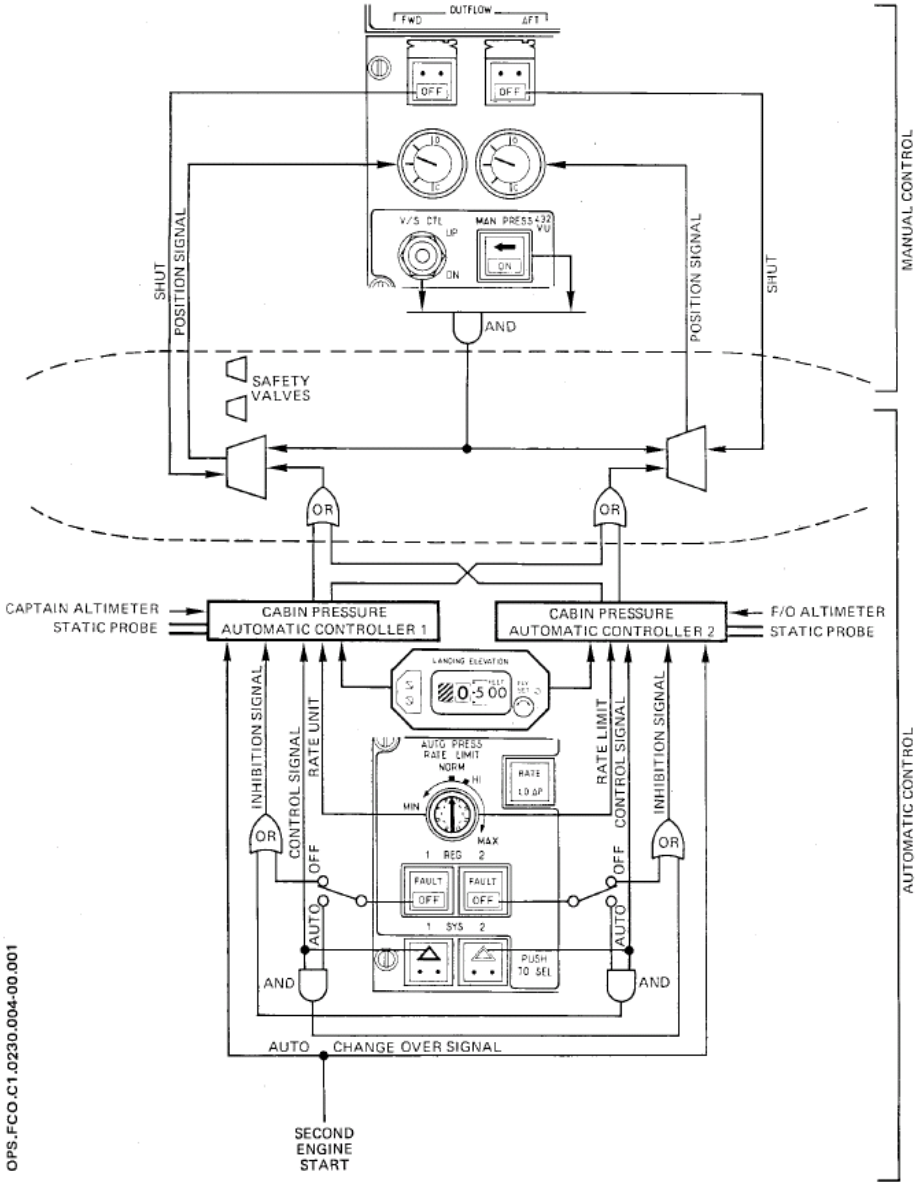
Depressurization

After touchdown, when the depressurization signal - L/G shock absorbers compressed, both throttle levers at idle - is received by the controllers, the cabin is depressurized by the active system at a rate of 500 ft/min. 45 seconds after touchdown both outflow valves will completely open for full depressurization.

RATE LIMIT SETTING

CABIN ALTITUDE	SELECTOR POSITION			
	MIN	**NORM**	HI	MAX
Increase	+ 170 ft/min	+ 850 ft/min	+ 1130 ft/min	+ 1670 ft/min
Decrease	– 70 ft/min	– 350 ft/min	– 470 ft/min	– 1170 ft/min

PRESSURIZATION CONTROL LOGIC



R
R
R

OPS.FCO.C1.0230.004-00.001

Vers. : All Eng. : All

EMER DESCENT

CREW OXY MASKS . . . . . ON
CREW COMMUNICATIONS (HEADSETS) . . ESTABLISH
TURN . . . . . INITIATE
DESCENT . . . . . INITIATE

- **It is recommended to descend with AP engaged :**
  - FCU ALT . . . . . DECREASE
  - LVL/CH . . . . . ENGAGE
  - SPD/MACH . . . . . SELECT SPD

THROTTLES . . . . . IDLE
SPD BRK . . . . . FULL
SPD . . . . . ADJUST AS REQUIRED

CAUTION : Descend at maximum appropriate speed or reduce speed if structural damage is suspected.

SEAT BELT . . . . . ON
NO SMOKING . . . . . ON
IGNITION . . . . . CONT RELIGHT
ATC (VHF 1) . . . . . NOTIFY
TRANSPONDER (ATC 1) . . . . . 7700 OR 77..
FCU ALT . . . . . MEA/MORA
LDG ELEVATION . . . . . SET

- **If CAB ALT above 14000 ft :**
  - OXYGEN PASSENGER . . . . . MAN OVRD
  - SYSTEM ACTUATED . . . . . CHECK ON

R

- **Below 20 000 ft and below 270 kt IAS :**
  - L/G LEVER DOWN . . . . . CONSIDER

CREW OXY MASKS . . . . . SET "N"

EMERGENCY DESCENT

- The descent is initiated in a turn, do not exceed a maximum bank angle of 30° and a maximum nose down pitch attitude of 5° in stabilized conditions.

- The following applies, in case of rapid decompression :
  a) Ensure crew communication is established with oxygen masks. Set oxygen masks on normal (N) position.
  b) Avoid the use of interphone position to minimize interference from oxygen mask breathing noise.
  c) Passenger signs come on automatically when cabin altitude exceeds 11,300 ft except if MAN PRESS is selected.
  d) Passenger oxygen masks drop automatically and OXYGEN SYS ACTUATED light illuminates green when cabin altitude exceeds 14,000 ft.
     Confirm system activation by selecting the OXYGEN PASSENGER guarded switch to MAN OVRD.

- Maximum airspeed is MMO/VMO.
  If structural damage is suspected use the flight controls with care and reduce speed as appropriate.

- In the event ATC cannot be contacted select ATC code 7700 or declare an emergency on one of the following frequencies :
  (VHF) 121.5 MHz or (HF) 2182 KHz or 8364 KHz.

- Landing gear may be extended when below 20,000 ft at VLO/VLE 270 Kt to increase the rate of descent.
  (Above 20000 ft, descending at MMO/VMO with landing gear retracted provides the highest rate of descent).

EXCESS CAB ALT

OXY MASK . . . . . ON
DESCENT . . . . . AS RQRD
● **IF RAPID DECOMPRESSION :**
PROC : EMER DESCENT (2.01) . . . . . APPLY

● **If no REG FAULT illuminated or no automatic change-over :**
CABIN PRESS REG (affected system) . . . . . OFF
● **If CAB ALT control not recovered :**
DESCENT . . . . . INITIATE

EXCESS CAB ALT

Indications :
Continuous repetitive chime
ECAM activation with appropriate warning light
Left ECAM CRT : EXCESS CAB ALT procedure
Right ECAM CRT : CAB PRESS system page

– If decompression is rapid, apply EMER DESCENT procedure.
– Oxygen masks should be set to the normal (N) position.

1.9.3 Summary of Quick Reference Hand Book

The related contents of QRH are summary as following:

A300-600	CAB PRESS	REV 28 SEQ 001	2.01

EXCESS CAB ALT

OXY MASK ..... ON
DESCENT ..... AS RQRD

● **IF RAPID DECOMPRESSION :**
PROC : EMER DESCENT (below) ..... APPLY

● **If no REG FAULT illuminated or no automatic change-over :**
CABIN PRESS REG (affected system) ..... OFF

● **If CAB ALT control not recovered :**
DESCENT ..... INITIATE

EMER DESCENT

CREW OXY MASKS ..... ON
CREW COMMUNICATIONS (HEADSETS) ..... ESTABLISH

TURN ..... INITIATE
DESCENT ..... INITIATE
● **It is recommended to descend with AP engaged :**
FCU ALT ..... DECREASE
LVL/CH ..... ENGAGE
SPD/MACH ..... SELECT SPD

THROTTLES ..... IDLE
SPD BRK ..... FULL

SPD ..... ADJUST AS REQUIRED
CAUTION : Descend at maximum appropriate speed or reduce speed if structural damage is suspected.

SEAT BELT ..... ON
NO SMOKING ..... ON
IGNITION ..... CONT RELIGHT
ATC (VHF 1) ..... NOTIFY
TRANSPONDER ..... 7700 OR 77..
FCU ALT ..... MEA/MORA
LDG ELEVATION ..... SET

● **If CAB ALT above 14000 ft :**
OXYGEN PASSENGER ..... MAN OVRD
SYSTEM ACTUATED ..... CHECK ON

● **Below 20 000 ft and below 270 kt IAS :**
R L/G LEVER DOWN ..... CONSIDER
CREW OXY MASKS ..... SET "N"

KAL ALL

CABIN PRESS REG FAULT

CAB PRESS REG (affected) ..... OFF

- **If both REG affected :**
  MAN PRESS ..... ON
  PROC : CAB PRESS MAN CTL (below) ..... APPLY

CABIN PRESS LO △P

EXPECT HI CABIN RATE.
A/C V/S ..... REDUCE

CAB PRESS MAN CTL

CAUTION : When both CAB PRESS REGULATORS are selected OFF, the CAB ALT warning and the cabin pressure indications on ECAM are no longer provided.

MAN PRESS ..... ON
V/S CTL switch ..... AS RQRD

CLIMB or CRUISE

FL	400	350	300	250	200 and BELOW
TARGET CAB ALT (ft)	8500	6800	5000	2500	0

CAB V/S (until target CAB ALT) ..... 500 FT/MIN

BEFORE DESCENT

CAB V/S (until LDG ELEVATION) ..... 350 FT/MIN

- **If high aircraft V/S :**
  CAB V/S ..... ADJUST ACCORDINGLY

R **BEFORE LANDING, WHEN CAB ALT = LDG ELEVATION**

V/S CTL switch ..... UP (full open)

ON GROUND

PACKS 1 and 2 ..... OFF

- **Before doors opening :**
  △P (DIFF PRESS) ..... CHECK ZERO

KAL ALL

This Page Intentionally Left Blank

2 Analysis

2.1 General

The KE691 flight crew members were properly certificated and qualified in accordance with the applicable Korean Civil Aviation Regulations. The flight crew's duty and rest periods were normal within the 72 hours prior to the occurrence. There was no evidence indicating the crew had any physical or psychological problems, nor any use of alcohol or drugs. The aircraft was operated within allowable weight and balance limitations. Based on the meteorological information contained in Section 1.5, there was no adverse weather condition at the time of the occurrence.

2.2 Related factors

Based on the factual data collected during the investigation, the cabin pressure loss occurred at about FL 320 and the flight crew conducted an emergency descent. The cabin pressure loss resulted in the passenger oxygen masks dropped automatically, however there was no crew and passenger on board sustained injury. The related factors include cabin pressure control and the flight crew disposition procedures are presented as follows.

2.2.1 Cabin pressure control

The function of the cabin pressure system is dependent on pre-programmed cabin altitude, aircraft altitude and pre-selected landing altitude. The system is designed to ensure that during normal operation, the cabin altitude will not exceed 8,000 ft within the aircraft's maximum cruising altitude. Maintaining a constant cabin altitude is a balance between the entry of conditioned air from packs and the cabin air evacuation to the ambient via out flow valves. If any out flow valve failed

to operate properly during flight, the cabin altitude would not be maintained at the desired level.

The cabin pressure control system is composed of two independent automatic control systems and a manual control system. The aircraft maintenance manual (AMM) shows that there are two outflow valves (FWD and AFT) which are operated by three electric motors and controlled independently by one of the two automatic systems or the manual system.

In accordance with the inspection of the failed FWD outflow valve, it showed that a flange in the reduction gearbox which drived the FWD outflow valve was broken (Ref. Fig1.4-3 and 1.4-4). That damaged flange resulted in the malfunction of both auto modes input to drive the FWD outflow valve.

The maintenance records of the system were reviewed and no anomalies had been found. It was possible that the flange in the reduction gearbox probably was broken accidentally during cruise. The AMM and FCOM indicate that in this case even both of the auto modes failed to control the outflow valves; the manual mode still could properly control the outflow valves. The test result of that failed FWD outflow valve from LIEBHERR AEROSPACE confirmed that both of the auto modes were malfunctioned due to that broken flange, however, the manual mode to control the FWD outflow valve was still operated.

The test report has no further description and analysis about the causes of that failed flange. It would be better, for the operator’s privilege, to know the rationale of the flange failure if the LIEBHERR AEROSPACE could conduct more detailed exploration on that specific item.

2.2.2 Flight crew disposition procedures

In accordance with related flight operation manuals, there are three emergency procedures related to the “Loss of Cabin Pressure” in this event, which are “CABIN PRESS REG FAULT”, “EXCESS CAB ALT” and “EMER DESCENT” (Ref. 1.9.2).

The “CABIN PRESS REG FAULT” procedures define that the flight crew shall turn off the affected regulator and apply the manual control if both of the regulators failed. The “EXCESS CAB ALT” procedures define that flight crew shall turn off the affected regulator and conduct descent if the cabin pressure could not be recovered； The procedures also define the flight crew shall conduct emergency descent if a rapid decompression happened.

The flight crew interview records indicated: At the moment of the “CAB PRESS REG 2 FAULT” message appeared on ECAM in this occurrence, the CM2 switched off the system 2 by following the “CABIN PRESS REG FAULT” procedure provided on the QRH, as soon as the “CAB PRESS REG 1 FAULT” message appeared on ECAM, the CM2 switched off the system 1 by following the QRH action, but the flight crew found that the cabin altitude increased rapidly and decided to conduct the emergency descent procedure and neglected to complete the rest of the “CABIN PRESS REG FAULT” procedures of using manual mode to control the cabin pressure.

The flight crew dealt with this malfunction by following part of the QRH. In accordance with the test results of the FWD outflow valve assembly, the function of the manual mode of the system is normal. The emergency descent took about 5 minutes from FL 320 to 10,000 ft, if the flight crew continuously completed the rest of the “CABIN PRESS REG FAULT” procedure, which was applied the manual mode to control the cabin pressure simultaneously with the “EMERGENCY DESCENT” procedure,

the cabin pressure probably could be recovered before the aircraft reaching the altitude of 10,000 ft.

If there were an integrated procedure to remind the flight crew to continuously complete the “CABIN PRESS REG FAULT” procedures and the “EMERGENCY DESCENT” procedures, the cabin altitude might be controlled before the aircraft reaching the altitude of 10,000 ft..

2.3 Others

2.3.1 Emergency descent procedure

The “EMER DESCENT” procedure in A300-600 FCOM states that the decent is initiated in a turn maneuver after the flight crew put on the oxygen masks and established the communications. The maximum bank angle is limited to 30°(Ref. 1.9.2.2). The rationale for the flight crew to initiate the turning is trying to deviate the aircraft from the route to avoid interfering with other traffic; it also could increase the descent rate to arrive a safer altitude quicker and to diminish the negative G force during the descent push down maneuver for prevent the passenger from being injury.

The DFDR data shows that the aircraft initiated descent from FL320 at 02:17 UTC and leveled off at 10,000 ft at 02:22 UTC. It took about 5 minutes for the decent. The average decent rate was over 6,000 FPM. During this period, the aircraft constantly kept the heading at around 220 without turning. It revealed that the flight crew did not follow the standard procedure to conduct the emergency descent.

3 Conclusions

The Aviation Safety Council presents the findings derived from the factual information gathered during the investigation of the KE0691 occurrence. The findings are categorized as follows:

The findings related to the probable causes

The findings identify elements that have been shown to have operated in the occurrence, or almost certainly to have operated in the occurrence. These findings are associated with unsafe acts, unsafe conditions, or safety deficiencies that are associated with safety significant events that played a major role in the circumstances leading to the occurrence.

The findings related to risk

The findings identify elements of risk that have the potential to degrade aviation safety. Some of the findings in this category identify unsafe acts, unsafe conditions, and safety deficiencies that made this occurrence more likely; however, they can not be clearly shown to have operated in the occurrence. They also identify risks that increase the possibility of property damage and personnel injury and death. Further, some of the findings in this category identify risks that are unrelated to the occurrence, but nonetheless were safety deficiencies that may warrant future safety actions.

Other findings

Other findings identify elements that have the potential to enhance aviation safety, resolve an issue of controversy, or clarify an issue of unresolved ambiguity. Some of these findings are of general interest and are not necessarily analytical, but they are often included in ICAO format

occurrence reports for informational, safety awareness, education, and improvement purposes.

3.1 The findings related to the probable causes

1. A broken flange in the automatic mode motor drive component caused the FWD outflow valve failed and the subsequent failure of both auto modes in driving the FWD outflow valve. The failed valve in both auto modes caused the cabin pressure loss. (2.2.1)
2. The flight crew did not apply the manual mode to control the cabin pressure. (2.2.2)
3. There is no integrated procedures defined when both of cabin pressure regulators failed and rapid decompression happened, whether the flight crew shall continuously complete the “CABIN PRESS REG FAULT” procedure or direct to the “EMERGENCY DESCENT” procedure. (2.2.2)

3.2 The findings related to risk

1. The flight crew did not follow the standard procedures to initiate a turn when conducted the “EMER DESCENT” procedures. (2.3)

3.3 Other findings

1. The flight crew members were properly certified and qualified in accordance with the applicable Korean Civil Aviation Regulations. （2.1）
2. There was no evidence indicating the crew had any physical or psychological problems, nor any use of alcohol or drugs. （2.1）
3. The aircraft was operated within allowable weight and balance limitations. (2.1)
4. There were no adverse weather conditions at the time of the occurrence. (2.1)

5. The LIEBHERR AEROSPACE did not conduct more detailed exploration on that specific damaged flange of the motor drive component. (2.2.1)

This Page Intentionally Left Blank

4 Safety recommendations

4.1 Safety recommendations

To Korean Air

1. Ensure the flight crew to follow the specific emergency procedures and enhance the operating proficiency.（ASC-ASR-07-10-001）
2. Review and integrate the related emergency procedures to the loss of cabin pressure. (ASC-ASR-07-10-002)

To Korean Ministry of Construction & Transportation

1. Monitor and survey the safety recommendation #1 and #2 to Korean Air. （ASC-ASR-07-xx-003）

To LIEBHERR-AEROSPACE/France

1. Conduct more detailed exploration on the damaged flange of the motor drive component（ASC-ASR-07-10-004）

This Page Intentionally Left Blank

Appendix1 DFDR tabular data and plots

Appendix 1a KE691 DFDR recorded parameters List

Appendix 1b KE691 relevant DFDR parameters plot2

(1a) KE691 DFDR recorded parameters List

Korean Air (A300-600, HL7297) FDR Parameters

No.	Parameters	No.	Parameters
1	ACID DOC A/C TAILNO	61	PACK1 PACK MANUALSEL #1
2	AFTCG AFT CG WARN	62	PACK2 PACK MANUALSEL #2
3	AILL AILRON LH +=RWD	63	PITCH PITCH ANGLE +=N/UP
4	AILR AILRON RH +=RWD	64	PROG DFDAU PROG IDENT
5	ALT PRESS ALT	65	PTWS PITCH TRIM WHEEL
6	AOA ANG OFATTACK (IND)	66	RALT RADIO HEIGHT
7	AP1CM A/P CMD #1	67	ROLL ROLL ANGLE +=RWD
8	AP1CW A/P CWS #1	68	RUDD RUDDERPOSN +=N/RT
9	AP2CM A/P CMD #2	69	SLAT SLAT POS
10	AP2CW A/P CWS #2	70	SLATF SLATS FAULT ASSYM
11	APUBV APU BLDVLVNOOPEN	71	SPF14 SPOILR#1+#4 FAULT
12	BV1 BLEED VALVE ENG #1	72	SPF32 SPOILR#3+#2 FAULT
13	BV2 BLEED VALVE ENG #2	73	SPF5 SPOILR #5 FAULT
14	CAL DFDAU CAL	74	SPF6 SPOILR #6 FAULT
15	CAS COMP AIRSPD	75	SPF7 SPOILR #7 FAULT
16	CG CENTRE OF GRAVTY	76	SRL1 SPOILR LH #1
17	DAY DATE: DAY	77	SRL2 SPOILR LH #2
18	DBASE DATA BASE UPDATE	78	SRL3 SPOILR LH #3
19	DBASEC DATA BASE CYCLE	79	SRL4 SPOILR LH #4
20	DBITE DFDAU BITE	80	SRL5 SPOILR LH #5
21	EGT1 EGT ENG 1	81	SRL6 SPOILR LH #6
22	EGT2 EGT ENG 2	82	SRL7 SPOILR LH #7
23	ELEV ELEV POSN +=TED	83	SRR1 SPOILR RH #1
24	EPR1 EPR ACTUALENG 1	84	SRR2 SPOILR RH #2
25	EPR2 EPR ACTUALENG 2	85	SRR3 SPOILR RH #3
26	EVENT EVENT BUTTON	86	SRR4 SPOILR RH #4
27	FF1 FUEL FLOW ENG 1	87	SRR5 SPOILR RH #5
28	FF2 FUEL FLOW ENG 2	88	SRR6 SPOILR RH #6
29	FLAP FLAP POS	89	SRR7 SPOILR RH #7
30	FLAPF FLAPS FAULT ASSYM	90	STAB STAB POS
31	FLEET DOC FLEET ID	91	STV1 START VALVE ENG #1
32	FLT DOC FLIGHTNUMBER	92	STV2 START VALVE ENG #2
33	GSD1 GLIDE SLOPE +=FDN	93	SUP SUPER FRAME
34	HDGM MAG HEADNG	94	SYNC SYNCH WORD
35	HF1 HF 1 KEYED	95	TAT TOTAL AIR TEMP

36 HF2 HF 2 KEYED	96 TRA1 THROTLRESLVRANG #1
37 IAV1 INLET AI VLVENG #1	97 TRA2 THROTLRESLVRANG #2
38 IAV2 INLET AI VLVENG #2	98 TRP1 T/R IN POSENG #1
39 IM INNERMARKER	99 TRP2 T/R IN POSENG 2
40 K_PHA_03 ROLLINPOWER	100 TRU1 T/R UNLOCKENG #1
41 LAND1 A/P 1LAND TRACK	101 TRU2 T/R UNLOCKENG #2
42 LAND2 A/P 2LAND TRACK	102 TYPE DOC A/C TYPE
43 LATG LAT ACCEL	103 UTC UNIVER TIME CLOCK
44 LGDLL LDG LH DOWN LOCKED	104 VHF1 VHF 1 KEYED
45 LGDLN LDG NS DOWN LOCKED	105 VHF2 VHF 2 KEYED
46 LGDLR LDG RH DOWN LOCKED	106 VHF3 VHF 3 KEYED
47 LGSQL LDG SQUAT SW LH	107 VIBF1 EVM FAN ENG #1
48 LGSQN LDG SQUAT SW NOS	108 VIBF2 EVM FAN ENG #2
49 LGSQR LDG SQUAT SW RH	109 VIBT1 EVM TURBINENG #1
50 LOC1 LOC DEVN 1 +=RT	110 VIBT2 EVM TURBINENG #2
51 LONG LONG ACCEL	111 VMO VMO/ MMO OVRSPD
52 MACH MACH NUMBER	112 VRTG NORMALACCEL
53 MAIAS MAX ALLOW AIRSPD	113 WAIAL WING ANTICEALT L
54 MM MIDDLEMARKER	114 WAIAR WING ANTICEALT R
55 MON DATE: MONTH	115 WAINL WING ANTICENORM L
56 N21 N2 ENG 1	116 WAINR WING ANTICENORM R
57 N22 N2 ENG 2	117 XFV X-FEEDVALVE
58 OM OUTERMARKER	
59 OQ1 OIL QTY ENG #1	
60 OQ2 OIL QTY ENG #2	

(1b) KE691 relevant DFDR parameters plot

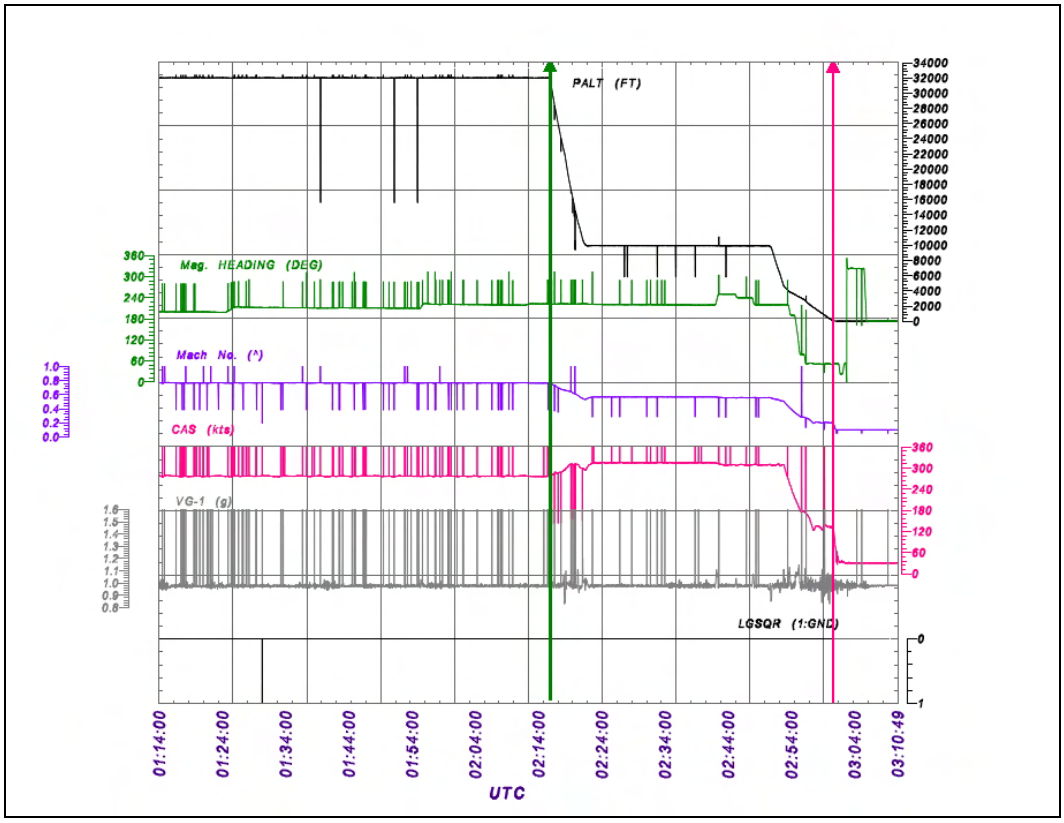


Fig. 1 KE691 relevant DFDR parameters plot (3,3000ft ~ landing roll)

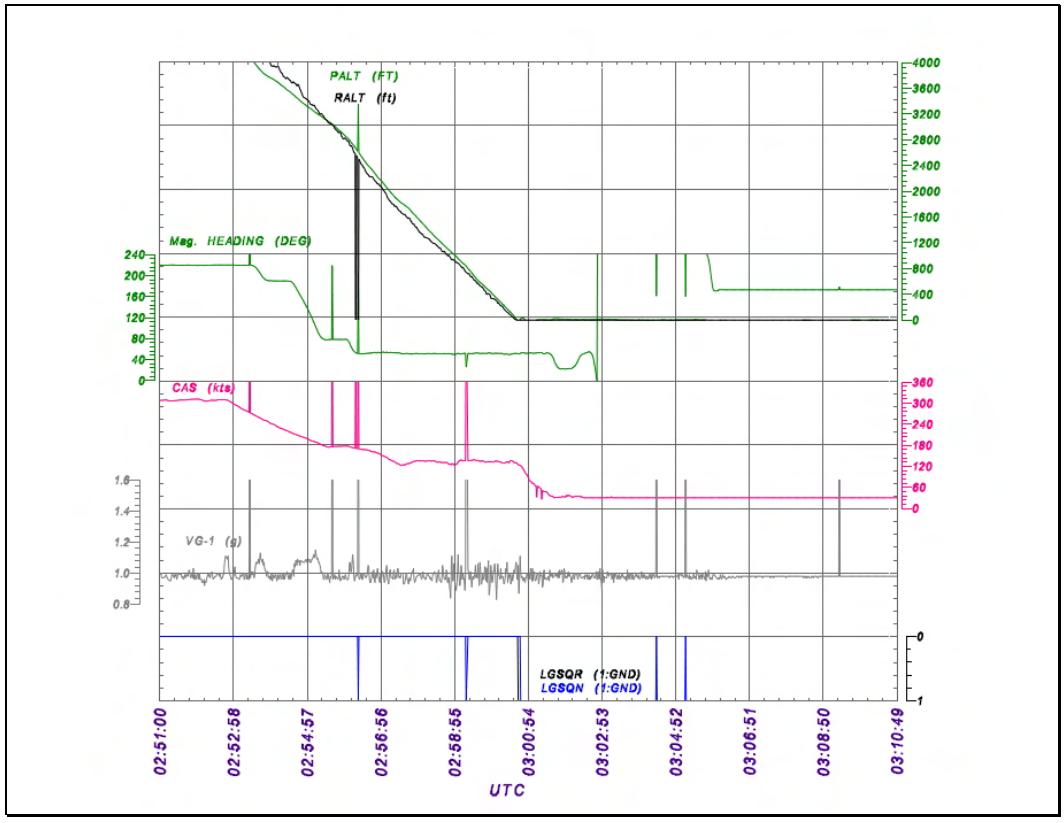


Fig. 2 KE691 relevant DFDR parameters plot (4,000ft ~ landing roll)

Appendix2 Radar track and plots

Appendix 2a KE691 radar track (tabular data)

FDR UTC	Mode-C	Long	Lat
	Alt	Pos.	Pos.
(Hh:mm:ss)	(Ft)	(Deg)	(Deg)
10:55:47.398	11500	121.802725	24.265129
10:55:52.268	11500	121.802217	24.271434
10:55:57.202	11500	121.806988	24.279314
10:56:02.073	11500	121.811641	24.287213
10:56:07.008	11500	121.815626	24.292522
10:56:12.008	11500	121.821376	24.300833
10:56:16.815	11500	121.824407	24.308405
10:56:21.750	11500	121.828679	24.316211
10:56:26.815	11600	121.832832	24.324041
10:56:31.657	11600	121.836812	24.332032
10:56:36.396	11600	121.840675	24.340034
10:56:41.396	11600	121.847758	24.346676
10:56:46.267	11500	121.851380	24.354703
10:56:51.138	11500	121.854881	24.362749
10:56:56.009	11500	121.859514	24.371076
10:57:00.944	11500	121.863672	24.377125
10:57:05.528	11500	121.867982	24.385640
10:57:10.396	11500	121.873166	24.392017
10:57:15.397	11500	121.877207	24.400564
10:57:20.203	11600	121.879979	24.408672
10:57:25.138	11500	121.883722	24.414628
10:57:30.009	11500	121.889416	24.421856
10:57:35.009	11500	121.895174	24.431253
10:57:39.879	11500	121.899586	24.437910
10:57:44.750	11500	121.902804	24.446522
10:57:49.654	11500	121.905963	24.454986
10:57:54.590	11500	121.907954	24.462949
10:57:59.461	11500	121.909744	24.471051
10:58:04.333	11600	121.909347	24.480408
10:58:09.202	11600	121.908935	24.487473
10:58:14.139	11600	121.908348	24.496771
10:58:19.073	11600	121.907880	24.503653

10:58:23.944	11600	121.906154	24.512403
10:58:28.879	11500	121.905283	24.521609
10:58:33.815	11600	121.904591	24.528442
10:58:38.525	11600	121.901716	24.536622
10:58:43.510	11600	121.898788	24.544781
10:58:48.332	11600	121.895809	24.552919
10:58:53.267	11500	121.893648	24.561502
10:58:58.141	11500	121.889704	24.569118
10:59:03.009	11600	121.886561	24.577204
10:59:07.879	11600	121.884541	24.583548
10:59:12.944	11600	121.879687	24.590658
10:59:17.750	11600	121.876432	24.598677
10:59:22.750	11500	121.872350	24.606210
10:59:27.750	11500	121.869410	24.612043
10:59:32.750	11500	121.865272	24.619567
10:59:37.526	11500	121.861109	24.627077
10:59:42.461	11500	121.856921	24.634576
10:59:47.332	11500	121.853995	24.640227
10:59:52.209	11600	121.849751	24.647717
10:59:57.203	11600	121.844788	24.654769
11:00:02.073	11600	121.841207	24.662631
11:00:06.944	11600	121.838198	24.668241
11:00:11.880	11600	121.833198	24.675274
11:00:16.815	11600	121.828856	24.682695
11:00:21.719	11600	121.824488	24.690104
11:00:26.591	11600	121.821305	24.695816
11:00:31.526	11600	121.816268	24.702830
11:00:36.461	11600	121.811842	24.710209
11:00:41.332	11600	121.806792	24.717217
11:00:46.202	11600	121.802954	24.722543
11:00:51.138	11600	121.797325	24.729208
11:00:56.008	11600	121.791719	24.735888
11:01:00.944	11600	121.786135	24.742584
11:01:05.879	11600	121.781327	24.747142
11:01:10.721	11600	121.775259	24.753561
11:01:15.655	11600	121.768709	24.759706
11:01:20.525	11600	121.762741	24.766197
11:01:25.527	11600	121.758090	24.770870
11:01:30.332	11600	121.751709	24.777139

11:01:35.203	11600	121.745395	24.783456
11:01:40.138	11600	121.740296	24.788099
11:01:45.137	11600	121.733639	24.794250
11:01:49.944	11600	121.727072	24.800468
11:01:54.944	11600	121.721707	24.805006
11:01:59.750	11600	121.715308	24.811345
11:02:04.668	11500	121.709015	24.817722
11:02:09.591	11500	121.703967	24.822276
11:02:14.396	11400	121.697435	24.828563
11:02:19.396	11400	121.692138	24.833029
11:02:24.332	11300	121.685819	24.839462
11:02:29.202	11300	121.680234	24.844025
11:02:34.073	11200	121.673770	24.850437
11:02:39.008	11200	121.668410	24.855157
11:02:43.944	11100	121.663253	24.859767
11:02:48.815	11100	121.657479	24.864178
11:02:53.526	11000	121.651438	24.868667
11:02:58.400	11000	121.645476	24.870890
11:03:03.396	10900	121.638150	24.874841
11:03:08.750	10800	121.630787	24.876908
11:03:13.461	10800	121.624103	24.876886
11:03:18.397	10700	121.616832	24.876826
11:03:23.203	10600	121.609578	24.877149
11:03:28.073	10600	121.603297	24.875669
11:03:33.007	10500	121.596148	24.876402
11:03:38.073	10500	121.589183	24.875170
11:03:42.798	10400	121.582528	24.876198
11:03:47.815	10300	121.575900	24.875362
11:03:52.750	10300	121.569242	24.874750
11:03:57.750	10200	121.562448	24.876309
11:04:02.750	10100	121.556161	24.876042
11:04:07.750	10100	121.549204	24.875983
11:04:12.750	10000	121.542829	24.874044
11:04:17.750	9900	121.536140	24.874319
11:04:22.592	9900	121.529799	24.874790
11:04:27.396	9800	121.523138	24.875430
11:04:32.396	9700	121.516153	24.874257
11:04:37.204	9700	121.509818	24.875258
11:04:42.203	9600	121.503330	24.874184

11:04:47.009	9500	121.496410	24.873365
11:04:52.008	9400	121.489784	24.872824
11:04:56.815	9300	121.483423	24.872373
11:05:01.815	9200	121.476598	24.872035
11:05:06.657	9100	121.469703	24.871891
11:05:11.590	8900	121.463475	24.871825
11:05:16.815	8800	121.457210	24.871948
11:05:21.657	8700	121.450486	24.872220
11:05:26.658	8600	121.444390	24.872379
11:05:31.461	8500	121.436985	24.871202
11:05:36.397	8400	121.430765	24.871695
11:05:41.332	8300	121.424848	24.872167
11:05:46.202	8300	121.417870	24.871219
11:05:51.073	8200	121.411857	24.871994
11:05:56.008	8100	121.404940	24.871029
11:06:01.073	8000	121.399285	24.872036
11:06:05.815	7900	121.392114	24.871260
11:06:10.655	7900	121.387086	24.872110
11:06:15.592	7800	121.379891	24.871786
11:06:20.463	7700	121.373297	24.871151
11:06:25.461	7600	121.368161	24.872340
11:06:30.461	7500	121.361340	24.871850
11:06:35.267	7400	121.354696	24.871765
11:06:40.202	7300	121.349703	24.872906
11:06:45.073	7200	121.343186	24.872678
11:06:50.008	7100	121.336616	24.872586
11:06:55.202	6900	121.331546	24.874038
11:07:00.073	6800	121.325369	24.874004
11:07:05.012	6600	121.318869	24.873847
11:07:09.815	6400	121.312594	24.874043
11:07:14.879	6300	121.306023	24.874150
11:07:19.662	6200	121.300022	24.874254
11:07:24.647	6100	121.293708	24.874246
11:07:29.461	6000	121.287641	24.874564
11:07:34.332	5900	121.281259	24.874779
11:07:39.268	5800	121.275133	24.875314
11:07:44.202	5700	121.269022	24.875359
11:07:49.073	5500	121.262502	24.876501
11:07:54.073	5400	121.256337	24.876757

11:07:58.879	5300	121.251260	24.879726
11:08:03.879	5200	121.245896	24.883218
11:08:08.529	5200	121.240434	24.886734
11:08:13.464	5100	121.237023	24.891524
11:08:18.331	5000	121.233404	24.896808
11:08:23.333	4900	121.229893	24.902153
11:08:28.138	4800	121.228575	24.908617
11:08:33.138	4800	121.229466	24.915492
11:08:37.944	4700	121.228711	24.921444
11:08:42.815	4600	121.230305	24.927816
11:08:47.750	4500	121.234658	24.934160
11:08:52.750	4500	121.237036	24.938962
11:08:57.750	4400	121.241606	24.945097
11:09:02.750	0	121.246266	24.950592
11:09:07.525	4300	121.248934	24.955668
11:09:12.750	4300	121.253837	24.961468
11:09:17.750	4200	121.258839	24.967136
11:09:22.527	4200	121.261727	24.971439
11:09:27.526	4100	121.266758	24.977279
11:09:32.332	4000	121.269659	24.982248
11:09:37.269	4000	121.274755	24.987772
11:09:42.138	3900	121.277895	24.992963
11:09:47.138	3800	121.283077	24.998581
11:09:51.944	3800	121.286275	25.003484
11:09:56.944	3700	121.291761	25.009206
11:10:01.750	3700	121.294998	25.013816
11:10:06.750	3600	121.298583	25.018746
11:10:11.590	3600	121.304263	25.023942
11:10:16.526	3500	121.308038	25.027874
11:10:21.332	3500	121.314108	25.032767
11:10:26.333	3400	121.317860	25.036420
11:10:31.141	3400	121.324177	25.040653
11:10:36.138	3400	121.328120	25.045021
11:10:40.944	3400	121.332242	25.048636
11:10:45.879	3400	121.338775	25.052652
11:10:50.750	3400	121.342801	25.056549
11:10:55.815	3400	121.347279	25.060327
11:11:00.590	3400	121.351486	25.063654
11:11:05.597	3400	121.356106	25.067403

11:11:10.400	3400	121.360445	25.070711
11:11:15.590	3400	121.365216	25.073611
11:11:20.461	3400	121.369660	25.075865
11:11:25.332	3400	121.374479	25.077257
11:11:30.396	3400	121.378914	25.077862
11:11:35.202	3300	121.385872	25.077420
11:11:40.202	3200	121.390434	25.076839
11:11:45.008	3200	121.395011	25.076066
11:11:49.879	3100	121.399578	25.075543
11:11:54.815	3000	121.406354	25.075009
11:11:59.815	2900	121.411113	25.074736
11:12:04.599	2800	121.415504	25.074481
11:12:09.529	2700	121.420264	25.074234
11:12:14.396	2500	121.427028	25.073978
11:12:19.396	2400	121.431605	25.073762
11:12:24.202	2300	121.436184	25.073719
11:12:29.073	2200	121.440761	25.073522
11:12:33.398	2200	121.445358	25.073338
11:12:38.459	2100	121.449936	25.073167
11:12:43.277	2000	121.454515	25.073143
11:12:48.267	1900	121.459093	25.072991
11:12:53.269	1900	121.463691	25.072852
11:12:58.079	1800	121.466063	25.072609
11:13:02.944	1700	121.470458	25.072499
11:13:07.815	1700	121.475241	25.072402
11:13:12.884	1600	121.477429	25.072306
11:13:17.750	1600	121.482030	25.072135
11:13:22.750	1500	121.484401	25.072153
11:13:27.655	1500	121.486611	25.071990
11:13:32.532	1400	121.491194	25.071787
11:13:37.464	1400	121.493589	25.071661
11:13:42.269	1300	121.497987	25.071589
11:13:47.202	1300	121.500383	25.071496
11:13:52.138	1200	121.502759	25.071349
11:13:57.008	1200	121.507182	25.071285
11:14:01.944	1100	121.509560	25.071129
11:14:06.815	1100	121.514175	25.071043
11:14:11.815	1000	121.516373	25.070850
11:14:16.655	1000	121.518780	25.070752

11:14:21.525	900	121.523373	25.070755
11:14:26.461	0	121.525467	25.070544
11:14:31.460	800	121.528013	25.070372
11:14:36.267	0	121.532502	25.070407
11:14:41.138	700	121.534908	25.070183
11:14:46.073	600	121.537375	25.069929
11:14:51.075	600	121.542123	25.070149
11:14:55.882	0	121.543721	25.072490

Appendix 2b KE691 radar track (plots)

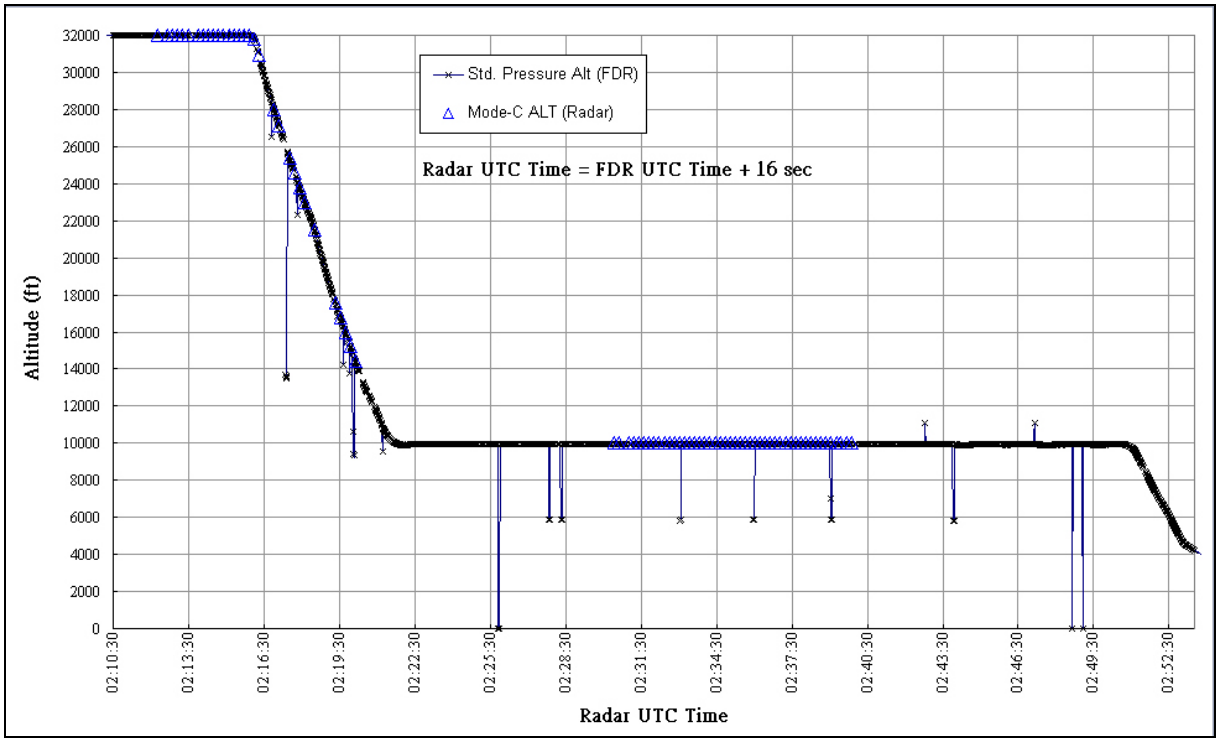


Fig. 3 KE691 relevant DFDR and radar data plot
(Altitude variation with UTC during descent from FL320)

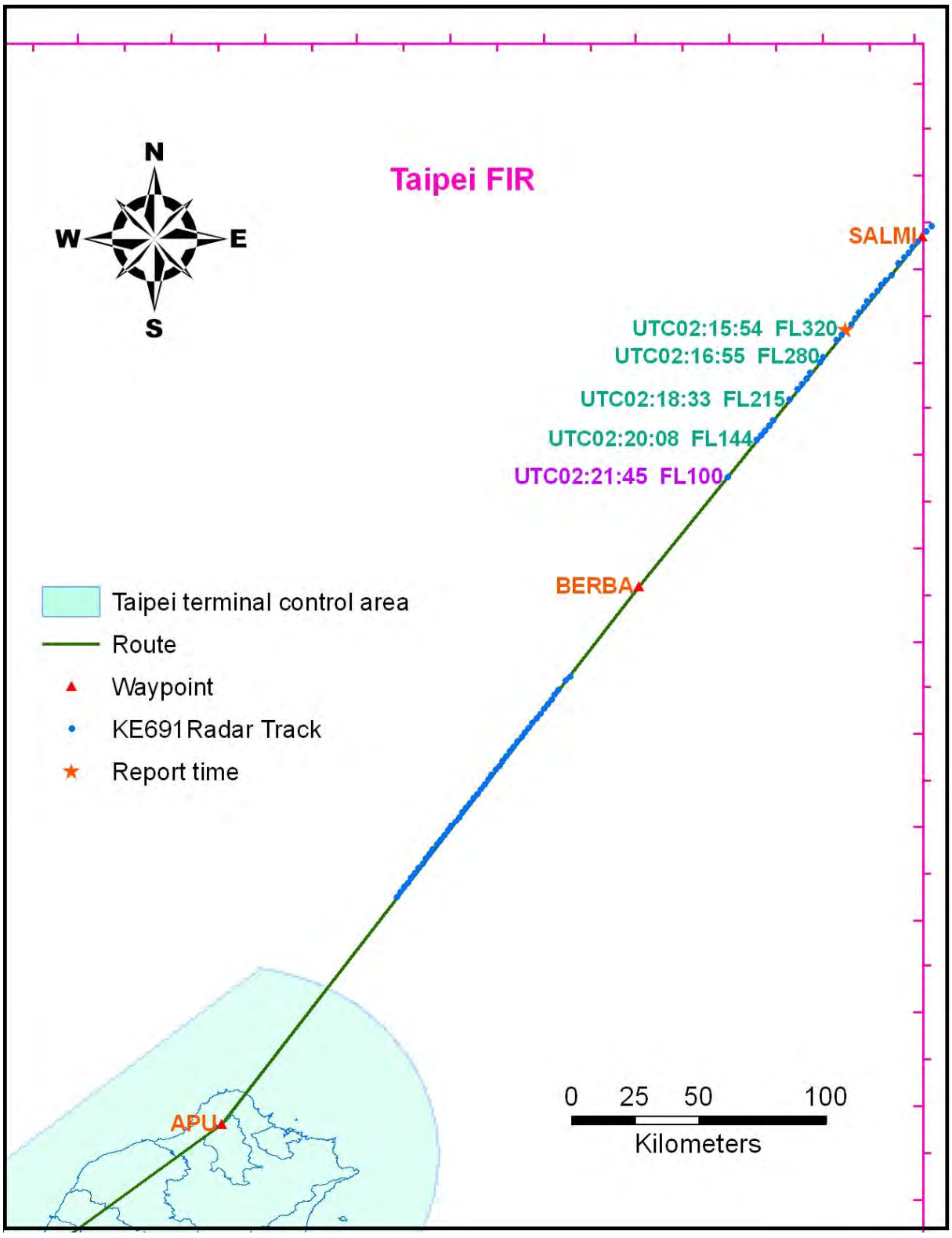


Fig. 4 Superposition of KE691 radar track and Taipei FIR chart
(UTC 1055~1114, descent from FL320, approach, and Landing)

This Page Intentionally Left Blank

Appendix3 Out Flow Valve Assembly Test Result

LIEBHERR - AEROSPACE TOULOUSE SAS

COMPTE-RENDU / MINUTES OF MEETING

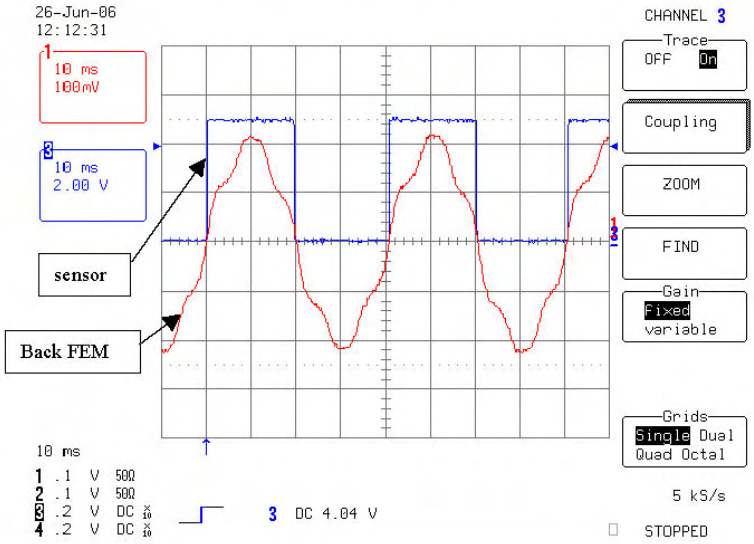
REF. : CRR47990-001 DATE : 27/06/2006 PAGE : 1/3

NOM (Name) ..... : FOUQUET GILBERT DÉPT. ..... : DTP/CSS	OBJET : (Subject) **INVESTIGATION REPORT P/N 47990 S/N 815 DATE :03/89 RGE: 09/03**
PARTICIPANTS : (Attendants) ZULIANI PHILIPPE	DIFFUSION : (Distribution)

1. The aim of this report is to find the reason of non-functionment of this motor with was equipped on the OFV 88005B0306 S/N 693

2. Test devices used for the investigation:
   - Test bench p/n LEM69 to visualise sensor signals and back FEM of motor winding
   - Power supply SODILEC (40V/2A) p/n SDL/GA-R40.2 s/n 384919
   - Driving motor PORTESCAP p/n 35NT2R 82-426E7
   - Scope LE CROY LT224 (220Mhz-200Ms/s) s/n 01230
   - Voltage isolator TEKTRONIX p/nA6909 s/n J310159

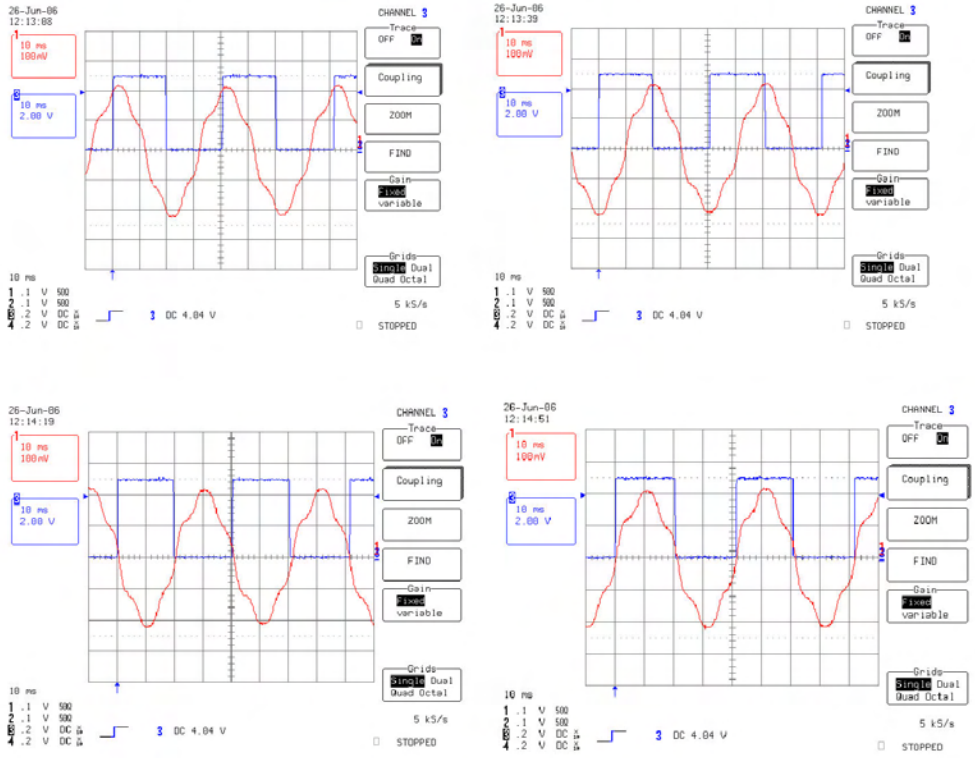
3 Test procedure:
   - Drive motor in test with PORTESCAP unit and measure sensor signal in proportion to back FEM. See standard view below (only 1 phase/sensor)



APPROBATION (Agreement) :

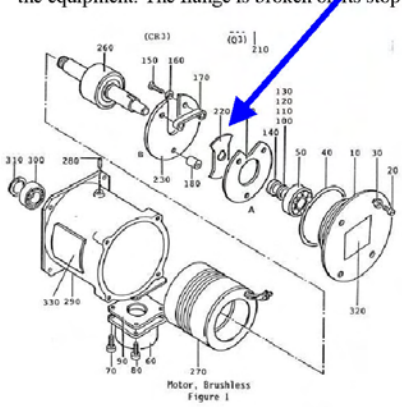
LTS - 408 avenue des Etats-Unis - Boîte Postale 2010 - F-31016 TOULOUSE CEDEX 2 - France
Télex LTS 531634F - Téléphone +33 (0)5 61 35 28 28 - Téléfax +33 (0)5 61 35 28 00

- During manipulation of the motor in investigation, failure appears instantaneously. We can see an increasing shift of sensor signal in proportion of FEM



- Dismantling of the motor: the flange (rep 220) is free on the shaft. That explains the random running of the equipment. The flange is broken on its stop pin.

-



Motor, Brushless
Figure 1

MODCR/06-2002

View of broken flange

CONCLUSION:
The broken flange explains the malfunction of the motor on both modes 1&2 . It was randomly ordered by the variation of position of the flange. So, windings were not in accordance with sensors. This failure is considered as an isolated case.

LIEBHERR-AEROSPACE TOULOUSE S.A.

B.P. 2010 - 408 av.des Etats-Unis
F-31016 Toulouse Cedex - France

COMPTE RENDU D'EXPERTISE / INVESTIGATION REPORT

EMETTEUR / SENDER	Rédigé par / Issued by	Approuvé par / Approved by
Nom / Name **Département** **Téléphone / Phone** **Fax** **Date** **Visa**	Philippe Zuliani Technical Support 05-61-35-22-41 05-61-35-29-29 09/05/2006	

PARTICIPANTS / MEMBERS		DIFFUSION / ISSUING	
Airbus : NIGEL DADSWELL LAURENT MOISSET MARC REVEL	SEE23	Participants + : Airbus : GILLES JUAN	SEE23
F CEPAS D GAILLARD P BRODEAU G FOUQUET	LTS	T LLOYD C BLAL DEREK NEO	LTS LTS LSI

OBJET DE L'EXPERTISE / SUBJECT

Désignation / Description	**OFV**
Référence / Part Number	88005B0306
N°série / Sérial Number	S/N 0693
Operator	KAL
Support / Aircraft	MSN 609
Date de fabrication / Assembly Date	A4T89
Temps de fonctionnement / Flight hours	TSI :1870 FH TSN : 28175 FH
Date de dépose / Removal Date	06/05/2006

SUB ASSEMBLY

Description	P/N	Amdt	SN	DATE FAB
Gear reducer	9220A02	ABC	1263	A3T97
Electronic control box	2058A0601	AB	155	04/84
DC Elect motor	S4019		204490	11/88
Brushless elec motor	S4090		815D	03/89

MOTIF DE L'EXPERTISE / PROBLEM DESCRIPTION

The purpose was to investigate an Out Flow Valve involved in a cabin decompression event of MSN 609 .

Reason for removal : FWD OUTFLOW VLV IS OUT OF ORDER

matrice/0992crex

➢ **Visual inspection and investigation .**

A complete acceptance repair test data sheet has been performed with the test results as follows:

- Operation in Manual mode was satisfactory
- Operation in Auto mode 1 and Auto mode 2 were failed . In both auto systems the butterfly did not rotate correctly. During the test an over consumption of the "AUTO" electrical motor which drives the butterfly was noted in both auto systems: around 1.5 A instead of 0.9 A

The OFV electronic controller (BCV) was replaced to determine if the controller was a contributor, but changing the controller did not change OFV operation. Therefore this test has confirmed the BCV is well serviceable and hence not involved by the OFV failure.

The next step of the OFV trouble shooting, was located on the "AUTO" electrical motor. This sub assembly (S/A containing both auto motors) was also removed and replaced by a new serviceable one.
This time, by changing this S/A, the OFV operated fully satisfactory in both auto modes.

❖ Investigation of the "AUTO" electrical motor S/A:

The review of the documentation has confirmed that the SN 815D of the "AUTO "electrical motor S/A was the same as that recorded as fitted to OFV SN 693 during the last shop visit to Liebherr of the OFV in 2003.

The S/A SN 815D was tested alone on the bench and it was found that the output shaft from the unit (which is driven by both auto motors) did not rotate correctly when power was applied to either auto motor.
The test of the S/A did not allow to easily determine the root cause of the failure.

In order to fully investigate the failure within the "AUTO" electrical motor S/A, a separate in depth investigation by the specialist of the LTS electronic laboratory has been decided.

➢ **Conclusion**

Based on these above tests results, the removal of the OFV is confirmed.
The removal is due to a failure of both auto systems which has contributed to affect the correct closing and opening of the butterfly leading to a cabin decompression.
The raison of the failed both auto systems is explained by a failed "AUTO" electrical motor S/A.

Moreover, the test of the LRU has also highlighted that the "safety mode" by using "MANUAL" electrical motor was well operating and available on the OFV despite that both automatic mode were breakdown.

LTS action : in depth investigation of the "AUTO" electrical motor S/A by electronic laboratory

➔ target date: by 16th June 2006