

INVESTIGATION REPORT ON INCIDENT TO M/S. PIAC'S
BOEING 747 AIRCRAFT AP-AYW ON 10-4-88 AT KARACHI AIRPORT.

Authority: Director General Civil Aviation Authority.

Memorandum No.HQ.CAA/1901/88.AIB DT:26-6-88
(Attached as Appendix-A to this Report)

1. AIRCRAFT INFORMATION:

1.1	Aircraft type and Serial Number	:	Boeing 747-200 S/NO. 21035
1.2	Classification of Aircraft	:	Regular Public Transport
1.3	Weight Category	:	"D"
1.4	Registration Marking	:	AP-AYW
1.5	Engine type installation Position and Serial Numbers	:	Pratt & Whitney JT-9D-7 Four installation in pods under wings #1 685993 #2 685908 #3 686019 #4 686026
1.6	Certificate of Airworthiness and	:	No.448 (Rev-1) valid
1.7	Certificate of Registration	:	No.495 (Rev-1) valid
1.8	Certificate of Maint	:	Duly certified and valid
1.9	Owner	:	PIAC
1.10	Weight of aircraft at time of release for flight PK766/100488	:	290567 KG
1.11	Maximum T.O.weight authorised as per C OF A	:	351500 KG.
1.12	Centre of Gravity	:	Within limits.
1.13	Fuel dumped before landing	:	15000 KG.
1.14	Fuel remaining on landing	:	43000 KG

Contd..P/2

1.15 Configuration of this flight : First Class - 20
: Economy - 384

1.16 Date and time of last major : 19-1-87 to 6-2-87
inspection carried out Hrs/Landings : Hours 32968-27
: Landings 10246

1.17 Date last F.A.Check carried out : 9-3 88

1.18 Next check was due on : 21-4-88 C-1 to C-9
(After 400 Hours)

1.19 Airframe History

1.19.1 Hours since new : 37687-50
Landing as on 19-6-88 : 11671

1.19.2 Hours at the time : 37157.28 Hrs.
of incident.(Return
of flight PK766)

1.19.3 Modification status : No outstanding mand-
atory modification.

1.20 Engine History

1.20.1 Hours since new : Position
#1.37548-58
#2. 36897-08
#3. 20672-35
#4. 25058-45

1.20.1 Modification status : No mandatory modifi-
cation outstanding.

1.12 Defects having a bearing : None
on the incident.

2. CREW INFORMATION:

2.1 Pilot-in-command

2.1.1 Name : Mahmood Ahmed

2.1.2 Position in the : Captain
cockpit

2.1.3 Date of Birth : 12-6-1932

2.1.4 Type of Licence and Number : ALTP NO.137

2.1.5 Medical date with status : 15-2-88 (subject to
use of corrective
glasses.

Contd...P/3

2.1.6	Types/Rating	
2.1.6.1	Type(s) held	: DC-3, F-27, TridentIE, B707/720, DC-10 & B747
2.1.6.2	Type current	: B-747
2.1.6.3	Flight Inst rating	: DC-10
2.1.6.5	Flight Engr Inst:rating	:
2.1.6.6	Check rating	: Simulator Instructor on B-747.
2.1.7	Flying Experience	
2.1.7.1	Grand Total	: 16331:20
2.1.7.2	Total in command	: 11928:00
2.1.7.3	Total in command Co-Pilot/flight Engr on the type accident/incident occurred.	: 3163:00 (B-747)
2.1.8	Where trained	: P.I.A.C.
2.1.9	Date of joining the Orgn:	: 15-9-59
2.2	Co-Pilot	
2.2.1	Name	: Adil bin Qamar
2.2.2	Position in the cockpit	: First Officer
2.2.3	Date of Birth	: 15-8-54
2.2.4	Type of Licence & NO.	: ALTP 551
2.2.5	Medical date with status	: 25-4-88
2.2.6	Rating	
2.2.6.1	Type(s) held	: F-27, Boeing 707/720, DC-10 & B-747
2.2.6.2	Type current	: B747 Group-II
2.2.6.3	Flight Inst Rating	: F-27
2.2.6.4	Flight Engr Inst rating	:

2.2.6.5	Check rating	:	
2.2.7	Flying Experience		
2.2.7.1	Grand total	:	7481.00
2.2.7.2	Total-in-command	:	3020.14
2.2.7.3	Total-in-command/ copilot/Flt Engr/ on the type accident/ incident occurred.	:	703:44 (P-2)
2.2.8	Where trained	:	P.I.A.C.
2.2.9	Date of joining the Orgn	:	13-2-76
2.3	Flight Engineer:		
2.3.1	Name	:	Syed Shabbir Hassan
2.3.2	Position in the cockpit	:	Flight Engineer
2.3.3.	Date of birth	:	13-7-1928
2.3.4	Type of licence & NO.	:	F/E Licence No.38
2.3.5	Medical date with status	:	14-4-88 (Fit for Renewal of F/E's licence subject to use of corrective glasses.
2.3.6	Rating:-		
2.3.6.1	Type(s) held	:	Constellation 1040 Series, Boeing 707/ 720B, DC-10-30 series.
2.3.6.3	Type current	:	B-747
2.3.6.3	Assist/Flight Inst Rating	:	
2.3.6.4	Flight Engr Inst rating	:	B-747 simulator Inst
2.3.6.5	Check rating	:	
2.3.7	Flying Experience:		
2.3.7.1	Grand total	:	17011.00

2.3.7 2 Total-in-command : 17011.00

2.3.7.3 Total in command : 5344.00
Flight Engr on/
the type accident/
incident occurred

2.3.8 Where trained : PIAC

2.3.9 Date of joining orgn: : 1-3-58

3. Summary of Incident:

3.1 On 10th April 1988, Boeing 747 aircraft bearing nationality and registration marks AP-AYW operated scheduled passenger flight PK766 Karachi Sector. Soon after take off and climb Pilot experienced an abnormally high degree of Aileron control movement, hence to maintain level flight he had to give 3 degree, Aileron trim to right, and 1.5 degree rudder trim to right, at engines power setting of 1.52 EPR at 33000 feet with speed of 280 Kts - mach 0.795. The Captain decided to return because of the unusual behavior of the aircraft.

3.2 After dumping 15000 KG of fuel aircraft landed back at Karachi airport.

3.3 Soon after arrival of aircraft, Investigation revealed, Right wing inboard Aileron cable AB10, out board of programmer at wing station 400 was broken. Also the cables AA10, AA8, AB8 had broken wires in the right hand wheel well areas.

3.4 Immediately Airworthiness Surveyors started their investigation, under instruction of Controller of Airworthiness, into the above discrepancy. Subsequently the matter was taken up with PIA Engineering Deptt: (Appendix - B) and a preliminary report put up to Director General by Chief of Airworthiness.

4. Injury to Person(s) : None
5. Damage to Aircraft : None
6. Other damages : None
7. Meteorological condition : Not a factor in this incident
8. Navigation & Landing aids : Not a factor in this incident
9. Communications : Not a factor in this incident
- 10 Aerodrome & Ground facilities : Not a factor in this incident.
11. i) Flight Recorder; and : Read out not required as control
ii) Cockpit voice Recorder cable failure was detected during investigation.
12. Wreckage & impact information : Not applicable.

13. Fire : No fire occurred during or after the incident.
14. Survival Aspects : No injury or loss of life.
15. Test and Research : Failed Aileron flight control cable was sent to Boeing Factory. It was confirmed that an improper cable material was used in Aileron Control system. Report attached as Appendix - C to this report.
16. Observations : Failure of cable wires were also observed in other flight controls on this aircraft.
17. Investigation:-
- 17.1 Investigation of the incident under rule 329 was ordered through Memorandum No.HQCAA/1901/88/AIB dated June 26, 1988.
- 17.2 After take-off from Karachi and during climb the Pilot found difficulty in keeping the aircraft level after making a slight turn. He had to use almost full control wheel deflection to maintain level flight.
- 17.3 The pilot then contacted the Maintenance Base and sought advice. He checked the engines to see if the power settings were equal. The Flight Engineer has reported observing from the cabin that the right side spoilers were riding high. He tried disconnecting the auto pilots and various combinations of airspeed and power setting with no success. Finally it was decided to dump fuel and land back at Karachi.
- 17.4 On arrival at Karachi it was discovered that the right side inbd aileron cable had failed. The right inbd aileron cable AB10 outboard of the programmer at wing stn 400 was broken.
- 17.5 Further inspection disclosed that cables AA10, AA8 and AB8 had also broken strands in the right hand Wheel Well area.
- 17.6 During the earlier 'C' check on Jan 19/87 these cables were replaced. The subject cables were fabricated from material specifications MIL-W-83420 type-I composition B having release note number PIA 1066/200187.
- 17.7 Inspection of failed cables revealed initial failure due to breakage of the 7x19, 1/8" stainless steel cable at the fairleads in the right hand Wing Gear Wheel Well at Wing STN 400. Examination of the Fairleads indicate rub marks on the inner diameter.
- 17.8 Breakage of wires of the outer strands at this point caused 'Bird-Caging'. As the cable passed through the fairleads, this further diminished the cable integrity due to separation of strands over a period of time leading to this failure.

- 17.9 The Engineer responsible for replacement of this cable about a year back when drawing up the requisition, entered MIL-W-83420 without specifying composition "A" or "B". He was issued Composition "B" which were duly installed in the aircraft. Had the Engineer referred to the B747 Maintenance Manual, he would have become aware that Composition "B", a stainless steel cable, was not recommended for this aircraft, flight control system.
- 17.10 Order of preference of cable material as per Maintenance Manual 27-00-00 page 206 is given as under:
- 17.10.1 Carbon Steel per BMS-7-265 type 1 Comp "A" (T2) preferred.
 - 17.10.2 Carbon Steel per BMS-7-265 type 1 Comp "A" (1st option).
 - 17.10.3 Carbon Steel per MIL-W-83420 Type 1 Comp "A" (2nd option).
 - 17.10.4 Carbon Steel per MIL-W-1511 (3rd option).
- 17.11 Control cables under MIL-W-83420 Type 1 composition "A" is a carbon steel; and composition "B" is a stainless steel cable. But as per Boeing documents, only composition "A" cables are recommended on 747 Flight Controls. This cable has further been superseded since Sept 09/87 by Boeing Specification BACC2C4C for 1/8" which is Tin-over-zinc coated cables so as to reduce internal friction. This change was prompted due to a number of cables coated with zinc only were reported to have reduced tension on newly delivered aeroplanes; and there were also failures due to corrosion. Composition "B" is softer and yields more to stretch and wear.
- 17.12 Since the specifications carried a MIL number the Stores Deptt did not feel bound to obtain the Wire Rope (cable material) from Boeing approved vendors and procured them from US Army approved sources on competitive basis.
- 17.13 PIA was following the KLM Maintenance Schedule which requires inspection of these cables at every check "2C" which is 8800 hours. This particular cable failed at around 4000 hours. In the new maintenance schedule presently being followed after the induction of CP Air aircraft it has increased frequency of inspection to "C" check interval i.e; 4400 hours. However, in view of this incident this check period has now been further reduced to every 4A check which is 1700 hours.
- 17.14 The records of the cable change at the last check "C" were in the custody of Records Section. It appears that these records were sent for by CE(BM) immediately after this incident for scrutiny and returned to the Records Section. Subsequently the Record Office rearranged and relocated the documents, and reportedly in this process these documents were misplaced and are not traceable. The responsibility for this misplacement rests with the Records Section.

17.15 As far as can be determined the following lapses in procedure have been identified.

17.15.1 The Engineer drawing up the requisition for the issue of cable did not refer to the maintenance manual for the correct specifications. He followed a procedure which was out of date and had been superceded, with the result that incorrect cable was issued.

17.15.2 There was a general lack of awareness in the Engg Deptt regarding the latest recommendations of the Boeing Co pertaining to the use of cable materials on 747 flight controls. This resulted in incorrect specifications being drawn up and use of a wrong type of cable. The old practice continued until this failure was investigated and the matter highlighted sufficiently.

17.15.3 Adequate care was not exercised to ensure the security of records.

17.16.4 If PIA Engg had been fully aware of the difference in wear rate of composition "A" and/or composition "B", the inspection period would have been accordingly adjusted.

17.16 FA checks do not specifically require inspection on flight control cables and comprise only a general visual check (GVC) of the Wheel Well area. This particular failures was located in area which requires special access and cannot be noticed by just a visual check. FA Check on this aircraft, prior to this failure was done on March 7-9/88 i.e. approximately one month earlier.

18. WITNESSES

18.1 Statement of following witnesses is attached as appendices to this report:

18.1.1.	Captain M. Ahmed	: Appendix - D
18.1.2	First Officer Adil Bin Qamar	: Appendix - E
18.1.3	Flight Engineer S. S. Hasan	: Appendix - F
18.1.4	Chief Engineer (Quality Control) Layeequr Rahman	: Appendix - G
18.1.5	AME Iqbal Hassan	: Appendix - H

18.1.6	AME M. Aftab Iqbal	:	Appendix - J
18.1.7	AME M. S. Mirza	:	Appendix - K
18.1.8	Stores Inspector (QC Engg) Khadim Hussain	:	Appendix - L
18.1.9	General Manager Stores (Tech) S. M. Shah	:	Appendix - M

19. DISCUSSION OF EVIDENCE

- 19.1 From the investigation it emerges that in the year 1977 the Dev Engg made a slip when evaluating a Boeing Service Letter SIL 27-6 dated June 08/77 relating to the use of different types of control cables. Since two different cables were covered by the same specification number, it was presumed that they were interchangeable whereas the Service Letter emphasized the difference and areas for the use of these two types of cables. Subsequently Boeing brought out other Service Letters making it clear that the "B" Composition cable was not acceptable for B747 flight controls. Somehow, PIA Engineering failed to realise the importance of the subject and did not update specifications for cables to be used on flight controls with the result that they continued to use improper cables for 747 Flight Controls.
- 19.2 The check periods specified in the maintenance schedule were relevant for the composition "A" cables and therefore the condition of the cables in use could not be determined during maintenance prior to the failure.
- 19.3 Both these types of cables are acceptable for use on other aircraft in PIA fleet as permitted by the respective manufacturers. But, these are adequately safeguarded by appropriate frequency of inspection in the maintenance schedule.
- 19.4 Since these cables are only covered by general MIL specifications, they do not have to be procured from aircraft manufacturers' approved vendors, and the Stores Deptt considered it satisfactory to obtain these cables from US Defence Department approved stockists. This situation is now being corrected.
- 19.5 The Boeing Company have in their latest Service Letter (747-SL-20-23 dated Sept 29/87) recommended a newer type cable coated with Zinc over Tin which is highly resistant to corrosion and wear and has very little stretch and is now available under Boeing Material Specification (BMS) instead of MIL Specification.
- 19.6 Boeing have reported failures of flight control cables with other operators; the reasons being mainly due to corrosion and/or wear. The possibility of corrosion due to the presence of a black material on the failed cable has however, not been ruled out by Boeing.

20. FINDINGS

- 20.1 The failure of the R.H. Inbd Aileron cable was determined to have been due to an incorrect type of control cable used on the flight control.
- 20.2 The Engineer instead of referring to the maintenance manual requisitioned an incorrect type of cable in accordance with the prevailing incorrect practice. The Engg Deptt had not taken the required action on the latest Boeing recommendations to up date their cable specifications for flight control.
- 20.3 PIA Maintenance Schedule inspection periods on flight control cables are related to correct type of cables and did not cater for softer material. The FA Checks only call for general visual inspection and does not include the area of failure of this cables.
- 20.4 According to the CE(QC), the relevant Aircraft Repair Orders (ARO's) were available immediately after the incident. However, they were moved for scrutiny by another section in the Engg Deptt and returned. Subsequent to some rearrangements carried out in the Record Office, these documents were no longer traceable. The record office is entirely resonsible for this loss. (Appendix - N attached to this report.
- 20.5 Procedural lapses are:
 - 20.5.1 The PIA Dev Engg Section failed to evaluate Boeing company's Service Letters in respect of cables to be used on flight controls. This failure resulted in cables of incorrect specifications continuing to be used on B747 Flight Controls.
 - 20.5.2 Adequate procedure does not seem to exist for disseminating of such informations to Engineers on the floor.
 - 20.5.3 The Engineer responsible for requisitioning the cables from Stores used an incorrect specification without referring to the aircraft maintenance manual.
- 20.6 Comments:
 - 20.6.1 The primary responsibility rests with the Engineer who fabricated the cable without ensuring that the correct type of cable specified in the manual was used.
 - 20.6.2 The Dev Engg Section failed to take adequate notice of various Boeing Service Letters pertaining to the use of cables on B747 flight controls and thus did not update their specifications. As a result the following occurred.

- a) Failure to update clarification on Composition "A" & "B".
- b) Frequency of inspection and lubrication was not adjusted according to Boeing recommendations.
- c) Failure to disseminate information on the floor.

20.6.3 The record section failed to ensure security of records resulting in the loss of important documents.

20.6.4 Due to the loss of records positive evidence could not be established as to which Engineer carried out the installation and certification of these cables.

20.6.5 There was no reported defect on these cables on aileron controls since the installation of these cables and the last check 'C'.

21 CAUSE(S)

USE OF IMPROPER CABLE MATERIAL FOR FABRICATION OF FLIGHT CONTROL CABLES AND INSTITUTION OF CHECKS AT AN INAPPROPRIATE INTERVAL FOR "B" COMPOSITION MATERIAL.

22. RECOMMENDATIONS:

- 22.1 Boeing Specifications (BMS) should be introduced immediately as per Service Letter 747-SL-27-23 dated Sept/87 as against MIL specifications in the current practice.
- 22.2 Action may be taken against the Engineer responsible for not referring to the maintenance manual for correct specification.
- 22.3 Action to be taken against the person in Record Office responsible for custody of these documents.
- 22.4 Action to be taken to ensure that Dev Engg is more vigilant and prompt in evaluating manufacturers' recommendations.
- 22.5 Action to be taken to ensure that all important Technical information is disseminated in all areas of the Engg Deptt.
- 22.6 A system of double check in Dev Engg to be instituted to ensure that material specifications are correctly drawn up. Quality Control to review all specifications and evaluation of Service Bulletins drawn up by Dev Engg.
- 22.7 The Quality Control Inspectors in Stores should also review material specifications to ensure that they comply with - manufacturers recommendations. If necessary re-organisation of the functions and responsibilities of the Inspectors be carried out and approved accordingly.

- 22.8 After installation of new cables, a check for correct tension should be carried out at the following Check "A".
- 22.9 Cable tensions on flight controls and condition of cables to be determined at every 4 FA check.
- 22.10 All installations, tensions and condition checks to be done in a manner recommended by the manufacturers or as per Maintenance Schedule.
- 22.11 The retention of records may now be made mandatory from one major check to the subsequent, irrespective of time period.

23. REMARKS

Immediately following the incident under investigation, the following actions have already been taken:

- 23.1 The Chief of Airworthiness wrote a strong letter to the Director of Engineering PIA to revise and re-organise the Sections involved so as to ensure such discrepancies are detected and precluded in future and take other corrective actions as necessary such as carrying out a fleet wise check.
- 23.2 The entire B747 fleet was checked and all composition "B" cables were replaced.
- 23.3 Inspection cleaning and lubricationn of cables on 747 have been instituted at check 4A intervals.
- 23.4 All types of aircraft in PIA have been standardised on composition "A". Even though composition "B" is permitted by some manufacturers, PIA have completely discontinued its use.
- A review has been undertaken to assess the authenticity of all aircraft material specifications in the Stores.
- 23.6 The Stores Deptt has been instructed that aircraft parts and materials must be procured from approved sources only.