

HQCAA/1901/262/SIB



**CIVIL AVIATION AUTHORITY
PAKISTAN**

ACCIDENT TO M/S PIAC

F-27 REG A-BAL

ON 8TH OCTOBER 2000

AT

LAHORE AIRPORT

FINAL REPORT

ACCIDENT TO PIA F-27 AIRCRAFT REGISTRATON NO AP-BAL WHICH OCCURRED ON 8TH OCTOBER 2000 AT LAHORE AIRPORT

Authority : Director General, Civil Aviation Authority
Memorandum No. HQCAA/1901/262/SIB
dated 12th October, 2000.

SYNOPSIS

Summary of the Incident: The initial incident information was conveyed by Airport Manager Lahore. The investigation was carried out by a CAA Pakistan team comprising Air Commodore Hashim Yamin, President SIB, as Investigator Incharge and Sqn. Ldr. (Retd) Ahmed Bilal, Operations Engineer, Flight Standards Directorate as the Technical Investigator. Representatives of the operator, M/s Pakistan International Airlines, were also involved in the investigation. This report is being released under the authority of Director General Civil Aviation Authority Pakistan.

Brief Resume of Circumstances Leading to the Incident. The aircraft was on a regular passenger flight from Bahawalpur to Lahore as PK 604. During the descent, before landing at Lahore, the cockpit crew heard a thud noise at 4500 ft. When landing gears were extended, a loud bang was heard. Indication of right main gear down did not appear on the instrument panel. On visual inspection from the cabin window, the lock strut of the right main gear was found disengaged from the shock strut. Emergency checklist was carried out. Landing on left main gear was made on runway 36L. Right main gear collapsed during the last part of the landing roll. All passengers and crew were evacuated safely from the aircraft.

1. FACTUAL INFORMATION

1.1 History of the Flight

1.1.1 PIA's aircraft, F-27 AP-BAL, departed Bahawalpur on 8th October at about 0900 UTC as a regular passenger transport Flight PK 604. The intended destination was Lahore.

1.1.2 The flight was normal till the aircraft descended to 4500ft. At this point the cockpit crew heard a thud noise. Then on extending the landing gears a loud bang was heard. There was no indication of right main gear on the instrument panel. On visual inspection the right main gear lock strut was found disengaged from the shock strut. A landing on left main gear was made and the right landing gear collapsed in the last part of the landing roll. The final flight path of the aircraft is depicted at Appendix-'A'.

1.1.3 Lahore airfield is at a geographical location of N31 30.0 E074 24.0 and at an elevation of 712 feet. The time of incident was 1054 UTC which was daytime.

1.2 **Injuries to Persons** Nil.

1.3 Damage to Aircraft

1.3.1. The right main landing gear trunnion linking shock strut to the drag strut was fractured and detached from the shock strut during the accident. There was post accident damage to the right propeller, wing tip, landing gear and under belly of the aircraft. A detailed report of the damage is given at Appendix-'B'.

1.4 **Other Damage** Nil.

1.5 **Personnel Information**

1.5.1 Refer Appendix-‘C’.

1.5.2 Also refer Appendix-‘B’.

1.5.3 The duty aircraft schedule of the post 72 hours indicated no overdue work.

1.6 **Aircraft Information**

1.6.1 The aircraft had a valid Airworthiness Certificate issued by CAA Pakistan (Appendix-‘D’).

1.6.2 The right main landing gear shock strut trunnion which failed in the accident had done 75214 landings against a life of 90000 landings. See Appendix-‘E’

1.6.3 See Appendix-‘F’ for flight planning and mass and balance data.

1.6.4 Fuel used was Jet A 1.

1.7 **Meteorological Information**

1.7.1 The meteorological information was available to the crew.

1.7.2 The incident took place in sunlight condition.

1.8 **Aids to Navigation**

1.8.1 ILS – Serviceable

1.8.2 Radar – Serviceable. For track, refer Appendix-‘G’.

1.9 **Communication**

1.9.1 The aircraft had satisfactory air to ground communication with control tower.

1.9.2 For tape extracts, refer Appendix-‘H’.

1.10 **Aerodrome Information**

1.10.1 See Appendix-‘J’.

1.11 **Flight Recorders**

1.11.1 See Appendix-‘K’.

1.12 **Wreckage and Impact Information**

1.12.1 Appendix-‘L’ shows top view of the failed trunnion after the accident. It has three attachment points. Point “A” is connected to the rear sub assembly of the lock strut and Points “B” and “C” are inboard and outboard eye ends respectively. They are connected to the main shock strut by stub pins, which pass through the eye end on the trunnion, and it’s counterpart on the shock strut. The downwind portion of inboard eye end of the trunnion was completely missing while its stub pin was found intact on the shock strut. The other stub pin was found attached to the trunnion eye end but it was bent in a pattern which suggests that after the fracture, a tensile load was applied between the trunnion and the shock strut and only outboard eye end was connected to the shock strut during application of the load.

1.12.2 The right side down lock was found to be in unlocked position and the electrical loom connected to the down lock switch was severed (see Appendix-‘M’). The down lock switch was also detached from it’s mounting but this is considered to be post accident damage.

1.13 **Medical and Pathological Information**

1.13.1 For Lab test results, refer Appendix-‘N’.

1.14 **Fire**

1.14.1 There was no fire during or after the impact.

1.15 **Survival Aspect**

1.15.1 N/A.

1.16 **Tests and Research**

1.16.1 The failed right main landing gear trunnion was subjected to a metallurgical examination at Pakistan Naval Dockyard Laboratory and the test report is attached as Appendix-‘O’.

1.16.2 Right main landing gear ram actuator was functionally tested and the test report is attached as Appendix-‘P’.

1.16.3 International Civil Aviation Organization (ICAO) was approached to provide data of similar occurrences on F 27 aircraft and their study report shows no incident of failure of subject trunnion.

1.17 **Organization and Management Information**

1.17.1 N/A.

1.18 **Additional Information**

1.18.1 Emergency Disaster Plan for Lahore Airport is available but was not situated.

1.18.2 SOP for removal of Disabled Aircraft available and also actioned.

1.18.3 The views of the incident was published by newspapers.

1.19 **Useful or Effective Investigation Techniques**

1.19.1 N/A.

2. **ANALYSIS**

2.1. The following aspects have been discussed:

2.1.1 Technical Aspects

2.1.2 Operational Aspects

2.2. **Technical Aspect**

2.2.1 **Main Landing Gear Kinematics** Figure at Appendix- 'Q' shows the retracted and extended positions of main landing gear of F 27 aircraft. Location of failed trunnion is marked on the figure. The landing gear retraction/extension system is pneumatically powered and the operation is carried out through the actuating ram. On "UP" selection the air is delivered to the "up" side of the ram which disengages the mechanical down lock in the lock strut and pulls the gear assembly to the retracted position. A pressure of 1000psi remains supplied to the "up" side of the actuating ram throughout the retracted phase. Therefore, the main load of the landing gear is carried by the retracted actuating ram and not by the up locks. This load is also partially transferred to the trunnion. When a "DOWN" selection is made, the air is delivered to the "down" side of the actuating ram and to the up lock rams. The

up locks are disengaged and the gear is extended by the action of the actuating ram. The extension is assisted by gravity and airflow and can be accomplished in case of loss of pneumatic pressure. The actuating ram also provides damping to the extension motion. The down lock is provided by the lock strut when it is fully extended.

2.2.2 **Landing Gear signaling** Theoretical diagram of landing gear signaling circuit is given at Appendix-‘R’. The down lock switch of right main landing gear is located on the lock strut. It has three terminals. One terminal is connected to the earth and the other two to green and red lights in the cockpit via an electrical loom running from lock strut to the aircraft structure. The up lock switch has two terminals. One terminal is connected to the red light in the cockpit and the other to the earth via the down lock.

2.2.3 **Evidence of Witnesses** The key witnesses i.e. the Captain and the first officer state that a thud was heard after passing through 4500 ft during the descent and once the landing gears were lowered, a loud bang was heard from the right side. There was neither green nor red indication for the right gear. On visual inspection from the cabin window, the right side lock strut was found separated from the shock strut. The Captain also stated that there was blinking of main landing gear green light that became steady during the holding pattern.

2.2.4 **Maintenance Actions** The failed trunnion is a sub assembly of the right main landing gear shock strut. This trunnion is required to be inspected for cracks by penetrant flaw detection. This was done on 8th April

1999, see Appendix-‘S’. The shock strut along with the trunnion was installed on the mishap aircraft on 23rd November 1999, see Appendix-‘T’.

2.2.5 **Metallurgical Failure Analysis** The result of metallurgical failure analysis indicates that there were no signs of fatigue on the failed trunnion. The fracture was brittle in nature and without any appreciable plastic deformation. The mode of fracture is considered to be a result of formation of stress concentration points induced during manufacture/service or material deficiencies. This analysis has been carried out without having access to material composition and without determination of the load path within the landing gear structure. This information is normally available with the manufacturer only. The landing gear manufacturer M/s Dowty Rotor has however issued a service bulletin which recommends replacement of the existing trunnion part No 901843 with part # 200679312 when stocks of existing trunion are consumed see Appendix-‘U’. The reason given for the replacement is to improve resistance to stress corrosion.

2.2.6 **Hypotheses** Various hypotheses were considered for determination of the cause of the accident. They are discussed below:

- a) **Overweight / Hard Landing** An overweight or hard landing may transfer excessive tensile load to the trunnion to cause its failure. Since the failure was brittle in nature, this type of landing would have resulted in collapse of the landing gear after landing at Bahawalpur. As no such thing happened, this hypotheses is ruled out.

- b) **Failure of Actuating Ram** Failure of actuating ram, may cause the landing gear to extend without the damping and subsequently cause application of excessive load on the trunnion. The test report of the actuating ram shows no abnormality in its operation, therefore this hypotheses is also ruled out.
- c) **Maintenance Related Causes** The trunnion is a structural member and no particular maintenance other than inspection for cracks is performed on it. However, at the time of installation, rigging of various members of the landing gear frame is carried out to ensure proper dimensions. Any discrepancy in the rigging may cause excessive stress at a point and its effect would be the formation of fatigue cracks at the point. No signs of fatigue have been found on the fractured surface, therefore, possibility of miss rigging at the time of installation is ruled out.
- d) **Material Deficiency** This is considered to be the most likely hypothesis but it can only be confirmed after further analysis of the failure by using the manufacturer's data on material composition of the trunnion and load paths within the landing gear frame. The manufacturer has also recognized it to be a weak area as it recommends replacement of the existing trunnion with an improved material part number after consumption of existing stocks.

2.2.7 **Deduced Sequence of Failure** The trunnion is a critical member of the main landing gear frame and its failure on ground would result in collapse of the

landing gear. It is, therefore, concluded that the failure did not occur while the aircraft weight was on the landing gear. It can be seen from the failure of the trunnion that initially, the inboard eye end failed under tensile load. The most likely time of this failure is during retraction of gears after take off from Bahawalpur, when a tensile load was applied on the trunnion. This load also caused bending of the stub pin of its outboard eye end. Since there was a continuous load being applied at the pin during the flight, it ultimately got disengaged from the shock strut probably at the point of time when the crew heard the thud during the descent. With both eye ends disengaged the only link between the lock strut and shock strut was the electrical loom of down lock switch. No load was transferred to the loom at this stage as the assembly was locked in up position. When the gears were selected "down" the lock strut got pulled to its partially unfolded position by the electrical loom that subsequently got severed under load. Since there was no electrical link between right landing gear down lock switch and indicator panel in the cockpit, therefore, neither green nor red light came on. The broken end of electrical cables of green indicator light may have come in contact with aircraft body and made an earth connection resulting in the steady green light of right gear during holding pattern.

2.3. Operational Aspect

Sequence of events after touchdown

2.3.1 Evidence shows that at about 1000 feet down the runway, the aircraft touched down on left side wheels. This is based on eyewitness information. At 2600 feet down and about 25 feet left of the centre line, the first

nose tyre mark on the runway was located. At about 3200 feet down the runway and 33 feet left of the centre line the fuselage hit the runway surface. At the same time, No 2 engine propeller hit the runway surface. The aircraft started a gradual drift towards the right side. After 7 deep strike marks of the propeller, the pilot attempted to keep the aircraft right wing up with the help of left brake. This is evident from the strong left wheel impression on the runway surface during this period. After 55 feet 6 inches of the last propeller strike mark, more strike marks appeared on the runway. The aircraft continued to drift towards the right. At 3480 feet down the runway, a continuous dark mark of left tyre appeared for about 16 feet. Thereafter it continued in the shape of broken lines. At 3530 feet aircraft came to a stop at the right edge of the runway on a heading of about 043 degrees with the right gear collapsed.

2.3.1.1 Power and Speed at which Right Gear was Lowered

2.3.1.2 A question arose during the investigation as to whether the power was cut off after touch down and whether the right gear was held up long enough by the Captain, as required by the procedure 'keep unsupported wing up by use of aileron. As aileron control is lost, apply brakes to prevent a ground loop'.

2.3.1.3 The aircraft touched down at about 1000 feet from the beginning of the runway. The Captain claimed that the No 2 engine was switched off on touch down. No marks of the aircraft right side touching the runway appear upto 3200

feet, supporting Captain's claim that he kept the right wing off. The No 2 engine propeller tips were bent backwards indicating low/no power. The first officer and the Senior Flight Steward also support the Captain on this. From distance between the first two propeller marks on the runway and its RPM. The speed of the aircraft when these marks appeared on the runway is estimated to be about 50 knots.

2.3.1.4 All this evidence supports that the No 2 engine was switched off on touch down and that the Captain did hold off the right wing up as long as practical.

2.3.2 Role of the Captain

2.3.2.1 The Captain handled the emergency in a confident, composed and professional manner. He carried out the emergency check list actions prescribed for the emergency (Appendix-'V') meticulously. First of all, he burnt fuel. He also informed the various agencies i.e. ATC, PIA Ops and PIA Engg.

2.3.2.2 He verified the exact nature of the problem by visually inspecting the landing gear from the cabin. He also asked his First Officer to do the same. He discussed the emergency with the first officer and briefed him on the actions to be taken by him.

2.3.2.3 He displayed foresight and made a sensible decision of landing on the left runway, or else Lahore Airport would have had to be closed

down until removal of the aircraft from the runway.

2.3.2.4 He informed the passengers also of the emergency. He also briefed the senior Flight Steward on the role to be played by him. He even guided him on how the evacuation was to be conducted by him. After touch down on the left side of the runway, he kept the right wing up by use of aileron until about 50 kts. He also briefed the First Officer on the fuel shut off sequence.

2.3.2.5 Even though the aircraft drifted towards the right side after the collapse of the right gear, the aircraft came to a stop at the right edge of the runway. All passengers were evacuated safely, without undue alarm.

2.3.3 Role of the First Officer

2.3.3.1 Satisfactory performance.

2.3.4 Role of the Senior Flight Steward

2.3.4.1 He played his role confidently and well. While ensuring that safety precautions were taken in the cabin, he also ensured that no undue alarm was created. There was no reported panic among the passengers right up to the end of the emergency and evacuation. Part of the credit for this must go to the reassuring methodology adopted by him. He acted coolly even when the right side door did not open during evacuation. He also ensured that, despite a distance of 2-3

feet between the doorstep and the ground, no passenger was injured.))

2.3.5 Role of the Airhostess

2.3.5.1 Satisfactory performance.

2.3.6 Role of the CAA Airport Management, ATC & Fire Personnel

2.3.6.1 Satisfactory performance.

2.3.6.2 ATC did well to place an additional controller in the tower. However, it would have been better if the proposal for the use of left runway had been forwarded by ATC rather than the Captain of the aircraft.

2.4 Regulatory Aspect

2.4.1 N/A.

3. CONCLUSION

3.1 Findings

3.1.1 On 8th October 2000, Captain Nisar Dodhy and First Officer Mr Tauseef, were scheduled to operate PIA's F-27 AP-BAL as flight PK-604 from Bahawalpur to Lahore.

3.1.2 Both the pilots were fit for this flight.

3.1.3 The weather enroute and a destination was clear.

3.1.4 The aircraft was declared serviceable.

- 3.1.5 The aircraft took off from Bahawalpur at 0900 UTC.
- 3.1.6 The flight was uneventful until decent for landing at Lahore.
- 3.1.7 During the decent, at 4500 feet, the cockpit crew heard a thud noise.
- 3.1.8 When landing gears were extended, a loud bang was heard.
- 3.1.9 Indication of right main gear down did not appear on the instrument panel.
- 3.1.10 On visual inspection from the cabin window, the lock strut of the right main gear was found disengaged from the shock strut.
- 3.1.11 Emergency checklist was carried out.
- 3.1.12 Landing on left main gear was made on runway 36L about 1000 feet down the runway.
- 3.1.13 At 2600 feet down and about 25 feet left of the centre line, the Captain lowered the nose gear.
- 3.1.14 At about 3200 feet down the runway and 33 feet left of the centre line the fuselage hit the runway surface. At the same time, No 2 engine propeller hit the runway surface. The aircraft started a gradual drift towards the right side despite the attempt of the pilot to keep the aircraft right wing up with the help of left brake.
- 3.1.15 At 3530 feet down the runway the aircraft came to a stop at the right edge of the runway on a heading of about 043 degrees with the right gear collapsed.

- 3.1.16 All passengers and crew were evacuated safely from the aircraft.
- 3.1.17 The Captain of the aircraft, Captain Nisar Dodhy, handled the emergency in a very professional manner.
- 3.1.18 Senior Flight Steward, Mr Imran Burki, displayed good performance during the emergency.
- 3.1.19 The First Officer and the Airhostess put up a satisfactory performance during the emergency.
- 3.1.20 CAA's airport management, ATC and Fire personnel displayed satisfactory performance. It was good to place an extra controller in the ATC. However, it would have been more appropriate if the suggestion to land on the left runway had come from the ATC rather than the Captain.
- 3.1.21 CAA's doctor was not immediately available at the time of incident.
- 3.1.22 There seems to be lack of coordination between CAA's Medical set up at Lahore and CMH Lahore as regards services to be provided by the CMH. (e.g. analysis of blood and urine samples).
- 3.1.23 Senior Flight Steward, Mr Imran Burki was tested positive for morphine.
- 3.1.24 He was taken through requisite tests before being subsequently cleared called back for flying. Self-medication was determined as the cause of the presence of morphine in his blood.

- 3.1.25 Presently there is no simulator for F-27 in Pakistan. As such all emergencies, e.g. landing with one gear up, can not be practiced by the pilots.
- 3.1.26 The aircraft had a valid certificate of airworthiness issued by CAA.
- 3.1.27 The right main landing gear shock strut trunnion was found fractured from its inboard eye end.
- 3.1.28 The fracture was brittle and there were no signs of fatigue on the failed trunnion.
- 3.1.29 No evidence of overweight or hard landing prior to the occurrence was found.
- 3.1.30 The actuating ram of the right landing gear was found to be serviceable.
- 3.1.31 No maintenance related discrepancy with respect to the landing gear or trunnion was found.
- 3.1.32 The manufacturer has recommended replacement of the trunnion with an improved material part number after existing stocks are consumed.
- 3.1.33 The trunnion installed on the mishap aircraft was of the older part number.

3.2 **Causes**

- 3.2.1. The cause of the accident was material failure of right main landing gear shock strut trunnion. The cause of the material failure can only be determined after a detailed analysis using manufacturer data.

4. SAFETY RECOMMENDATIONS

4.1 PIA to consider:

4.1.1 PIA to approach the manufacturers for detailed material analysis of the failed trunnion and their opinion on continuing with the older part number trunnions on F-27 fleet in light of this failure.

4.1.2 Arranging simulator training for F-27 pilots, where such training is available.

4.2 PIA to ensure that:

4.2.2 Regular thorough briefing are given to F-27 pilots on those emergencies which can not be practiced on aircraft and for which simulator is not available in Pakistan. The record of such briefings be properly documented.

4.2.3 Greater vigilance of landing gear trunnion assemblies is maintained till their replacement by the improved version.

4.3. CMO to ensure that:

4.3.1 At Lahore and our other international airports, CAA's duty doctor is available at the airport round the clock.

4.3.2 Comprehensive instructions are issued as to where blood and urine samples of relevant aircrew are to be tested at our various airports in case of an incident. These instructions should aim to eliminate delays.

4.3.3 The Aircrew be advised to refrain from self medication.

4.3.4 Captain Nisar Dodhy may be commended for handling the emergency in a professional manner.

4.3.5 Senior Flight Steward may be given a letter of appreciation for his good performance during the emergency.