

3 CONCLUSIONS

3.1 Findings

1. The airplane was inspected and maintained in accordance with EI Al and Boeing maintenance procedures.
2. The flight crew was trained and certificated in accordance with appropriate Israeli CAA, EI Al, and industry standard procedures.
3. At an altitude of about 6,500 feet the no. 3 pylon failed, this pylon and no. 3 engine separated from the right wing.
4. The no. 3 engine struck the no. 4 engine, causing the - no. 4 pylon and engine to separate from the wing.
5. The leading edge flaps and a portion of the fixed leading edge of the wing back to the front spar were extensively damaged. The no. 3 and 4 hydraulic systems were completely and the pneumatic system was partially disabled.
6. The flight crew reported a fire on the no. 3 engine to ATC. Given the system logic a fire warning may have been the result of a double fault indication of the system.
7. Due to the limited field of view from the cockpit to the wing area the flight crew was not able to observe the separation of the no. 3 engine nor the damage to the wing.
8. Performance and controllability were so severely limited that the airplane was marginally flyable.
9. Current standard industry training requirements and procedures do not cover complex emergencies like encountered by EI Al 1862.
10. After declaring an inflight emergency, the flight crew decided to return to Schiphol Airport immediately and land on runway 27, although runway 06 was in use for landing.
11. Because the airplane became too high and too close to the airport to accomplish a straight-in landing, the flight crew was vectored through an approximate 360 degree pattern of descending turns to intercept the final approach course.
12. During the vectoring to the final approach, the flight crew stated to air traffic control that they were experiencing problems with the aircraft's flaps. Shortly before intercepting the final approach they reported controlling problems.
13. During preparation for final approach speed reduction made the airplane exceed the limits of its remaining control capability. The airplane crashed into an apartment complex.
14. Exchange of information between EI Al 1862 and ATC was not always adequate.
15. The effectiveness of the fused pylon concept in protecting the wing structure and fuel tanks against the consequences of pylon overloads was based on the history of the similar fuse-pin design of the Boeing 707.

16. Certification of the B 747 pylon included a fail-safe analysis of the nacelle and pylon concept. At that time this analysis however did not address the specific fail-safe requirement assuming a fatigue failure or partial failure of a single structural element.
17. A then state-of-the-art fatigue analysis of the pylon structure was made to establish the maintenance requirements. In real life this did not turn out to be sufficiently reliable. From August 1979 on a large number of S.B.'s and A.D.'s were issued addressing numerous fatigue problems in the pylon structure including fuse-pins, lugs and fittings.
18. Inspection and analysis performed by specialists on recovered vital parts of the pylon construction revealed severe damage due to fatigue.
19. No firm conclusion could be drawn whether or not the fatigue crack in the outboard midspar fuse pin was detectable at the last ultrasonic inspection.
20. After analysing the possibilities it is assumed that the separation was initiated by a fatigue crack in the inboard shear face of the fuse-pin in the inboard midspar fitting.
21. Over a period of 15 months, three pylons have failed in flight, resulting in two fatal and one serious accident. The original type design together with the continuous airworthiness measures and associated inspection system did not guarantee the minimum required level of safety of the Boeing 747.

3.2 *Probable Causes*

The design and certification of the B 747 pylon was found to be inadequate to provide the required level of safety. Furthermore the system to ensure structural integrity by inspection failed. This ultimately caused - probably initiated by fatigue in the inboard midspar fuse-pin - the no. 3 pylon and engine to separate from the wing in such a way that the no. 4 pylon and engine were torn off, part of the leading edge of the wing was damaged and the use of several systems was lost or limited.

This subsequently left the flight crew with very limited control of the airplane. Because of the marginal controllability a safe landing became highly improbable, if not virtually impossible.