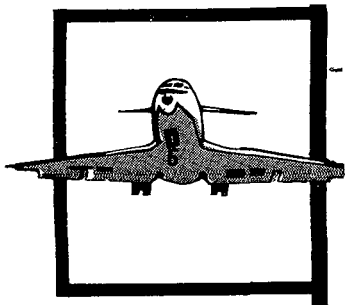

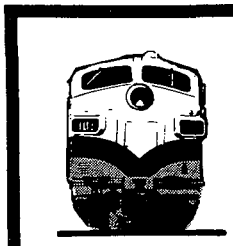

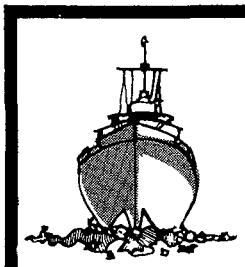

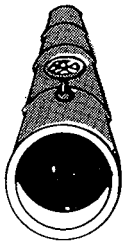

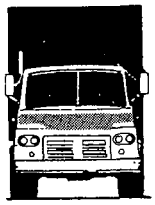

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

AIR CANADA
McDONNELL-DOUGLAS DC-9-32 (CF-TLU)
EAST OF BOSTON, MASSACHUSETTS
SEPTEMBER 17, 1979

NTSB-AAR-80-13

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-AAR-80-13	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Aircraft Accident Report-- Air Canada McDonnell Douglas DC-9-32 (CF-TLU), East of Boston, Massachusetts, September 17, 1979		5. Report Date January 30, 1981 6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		10. Work Unit No. 3119 11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Aircraft Accident Report September 17, 1979 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

At 1212 e.d.t., on September 17, 1979, Air Canada Flight 680, a scheduled passenger flight to Yarmouth, Nova Scotia, Canada, departed Logan International Airport, Boston, Massachusetts. About 14 min after takeoff, at an altitude of about 25,000 ft m.s.l., the tailcone along with the aft cabin pressure access door and a portion of the aft cabin pressure bulkhead separated from the aircraft causing rapid decompression of the passenger and flightcrew compartments. The aircraft was landed safely at Logan International Airport about 38 min after takeoff. Of the 45 persons aboard, one flight attendant received minor injuries during the decompression. The aircraft's oxygen system and its elevator control and engine control systems were damaged.

The National Transportation Safety Board determines that the probable cause of the accident was a fatigue fracture of the aft cabin pressure bulkhead which resulted in a rapid decompression of the aircraft's cabin area. This fracture initiated from a crack below the aft bulkhead access door which was discernible on the X-rays taken during the aircraft's last maintenance inspection but was not detected by the inspectors.

17. Key Words	18. Distribution Statement
Fatigue fracture, bulkhead, rapid decompression, X-ray, preexisting crack, access door area	This document is available to the public through the National Technical Information Service Springfield, Virginia 22161

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	21	

NTSB Form 1765.2 (Rev. 9/74)

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AIRCRAFT ACCIDENT REPORT

Adopted: January 30, 1981

AIR CANADA
McDONNELL DOUGLAS DC-9-32 (CF-TLU)
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SEPTEMBER 17, 1979

SYNOPSIS

At 1212 e.d.t., on September 17, 1979, Air Canada Flight 680, a scheduled passenger flight to Yarmouth, Nova Scotia, Canada, departed Logan International Airport, Boston, Massachusetts. About 14 min after takeoff, at an altitude of about 25,000 ft m.s.l., the tailcone along with the aft cabin pressure access door and a portion of the aft cabin pressure bulkhead separated from the aircraft causing rapid decompression of the passenger and flightcrew compartments. The aircraft was landed safely at Logan International Airport about 38 min after takeoff. Of the 45 persons aboard, one flight attendant received minor injuries during the decompression. The aircraft's oxygen system and its elevator control and engine control systems were damaged.

The National Transportation Safety Board determines that the probable cause of the accident was a fatigue fracture of the aft cabin pressure bulkhead which resulted in a rapid decompression of the aircraft's cabin area. This fracture initiated from a crack below the aft bulkhead access door which was discernible on the X-rays taken during the aircraft's last maintenance inspection but was not detected by the inspectors.

1. FACTUAL INFORMATION

1.1 History of the Flight

On September 17, 1979, Air Canada Flight 680, a McDonnell Douglas DC-9-32 (CF-TLU), operated as a scheduled passenger flight from Boston, Massachusetts, to Yarmouth, Nova Scotia, Canada. Flight 680 departed Logan International Airport at Boston at 1212, 1/ with 45 persons, including 5 crewmembers, aboard. The flight was cleared to Yarmouth in accordance with an instrument flight rules (IFR) flight plan and was issued climb-out instructions. The assigned en route flight level (FL) 2/ was 250. The flight was uneventful during the takeoff and most of the climb. All required checklist items were accomplished.

1/ All times herein are eastern daylight, based on the 24-hour clock.
2/ Altitude and terrain elevation referred to in this report are above mean sea level, and all flight levels (FL) are above the standard datum plane.

About 1226, shortly before Flight 680 leveled off at FL 250, a rapid decompression occurred. At 1226:08, the flight reported, "Boston Center, Air Canada 680 is doing a rapid emergency descent. Clearance back to Boston, we're out of twenty-three thousand, descending." The Boston Air Traffic Control Center cleared the flight to "turn right and proceed direct to Boston. Descend and maintain one four thousand. Boston altimeter three zero two four." The flight was then asked, "Are you going to need assistance?"

At 1226:34, the flight advised Boston Center that it had experienced an explosive decompression, that it was out of 20,000 ft, and that it was requesting 9,000 ft for level off. The flight was cleared to continue descent and maintain 10,000 ft.

At 1228:24, the flight responded, "Roger, we are just leveling now and the back end of our tail is blown completely off. If you could have some emergency crews standing by." The flight was then cleared to descend to 9,000 ft. At 1229, the flight cancelled the request for emergency crews and requested the closest runway for landing.

At 1231, the flight again requested the emergency equipment and Boston Center advised "they've got the equipment out and runway three three left." The flight acknowledged the clearance for landing on runway 33L.

At 1234:55, Boston center cleared the flight for descent to 4,000 ft.

At 1237:58, the flight was cleared to Boston, "altitudes at your discretion." At 1239:38, Logan Arrival Radar asked the flight if there were any control problems. The flight responded, "negative." A visual approach was flown and a landing was made on runway 33L, at 1250, without further incident.

During a postflight interview, the captain of Flight 680 reported that just before level-off at FL 250, an extremely loud bang was heard with complete loss of cabin pressurization. The first officer was flying the aircraft. "Rapid depressurization" was called and the first officer placed the aircraft on autopilot. The flightcrew donned their oxygen masks to make communication checks. The captain stated that he assumed control of the aircraft, started an emergency descent, and observed that the cockpit door was missing and that there was blue sky visible through the aft of the aircraft. He also observed that the passengers' oxygen masks had deployed, so he slowed the rate of descent. The purser advised that everybody was all right except for a flight attendant who had "a bump on her head." After level-off at 9,000 ft, the first officer went into the cabin to check on the passengers and crew. He reported that everyone was all right.

The captain stated that the right throttle would not advance beyond 1.25 exhaust pressure ratio (EPR); however, at that power setting all engine parameters were normal and the hydraulic system was normal. The first officer added that the right pneumatic crossfeed valve lever had opened and could not be closed.

The aircraft was purposely kept high during the approach for landing and the flaps and landing gear were used to reduce airspeed and altitude. The

captain stated that this was done because of the limited use of the right engine. He also stated that the landing was normal; however, the left engine could not be reversed after touchdown.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others	Total
Fatal	0	0	0	0
Serious	0	0	0	0
Minor/None	5	40	0	45
Total	5	40	0	45

1.3 Damage to Aircraft

The aircraft was damaged substantially.

1.4 Other Damage

None.

1.5 Personnel Information

The five crewmembers were trained and certificated in accordance with current regulations. (See appendix B.)

1.6 Aircraft Information

CF-TLU was certificated and maintained in accordance with current regulations. (See appendix C.)

The takeoff gross weight of the aircraft was 78,309 lbs with a center of gravity of 20.2 percent mean aerodynamic chord. The maximum allowable gross weight of the aircraft was 108,000 lbs and the maximum allowable landing weight was 87,000 lbs.

The aircraft had flown about 28,425 flight-hours and had completed 26,816 landings as of September 17, 1979. The C-check (C-10) of the maintenance progressive inspection program was performed on May 5, 1979. The aft bulkhead (flight station (FS) 996) was x-rayed during this inspection. About 1,006 flight-hours had been recorded since the C-10 inspection was performed. The aircraft total time at the inspection was 27,420 flight-hours and the total landings recorded at 25,879.

Under normal flight conditions, the aircraft's pressurization system maintains a maximum differential of 7.46 psi between the inside and the outside of the cabin.

1.7 Meteorological Information

The surface weather observations for Logan International Airport taken by National Weather Service personnel just before Flight 680 departed from and just after it landed at the airport were:

1154: sky clear; visibility--15 mi; temperature--73° F; dewpoint--55° F; wind--240° at 10 kn; altimeter setting--30.24 inHg.

1254: sky clear; visibility--15 mi; temperature--75° F; dewpoint--56° F; wind--220° at 10 kn; altimeter setting--30.22 inHg.

1.8 Aids to Navigation

Not applicable.

1.9 Communications

There were no reported communications difficulties.

1.10 Aerodrome Information

Runway 33L at Logan International Airport is hard-surfaced and is 10,081 ft long and 150 ft wide. The elevation of the runway's touchdown zone is 16 ft.

1.11 Flight Recorders

CR-TLU was equipped with a Leigh Instruments Co., model VDR-2, digital flight data recorder (DFDR), serial No. 104. It is a 7-track serial binary DFDR with 1/2-in, continuous-loop recording tape (inside/outside loop). It is a non-ARINC 573 recorder with an 8-bit word plus one parity bit, and an 11-bit synchronization code. The signal is recorded using Harvard biphase code. A total of 33 1/2 hr of data are recorded.

The readout of the recording tape was accomplished under Safety Board supervision at the Playback Centre, Flight Research Laboratory, Canadian Aeronautical Establishment, Ottawa, Canada. There was no evidence of recorder malfunction or of recording abnormalities before the aft pressure bulkhead failed and disconnected the recorder. The DFDR showed that at the time of decompression, the cabin differential pressure was 7.2 psi.

CF-TLU was also equipped with a Fairchild model A100 cockpit voice recorder (CVR), serial No. 4034. The recorder was removed from the aircraft and the entire tape transcribed; however, since the aircraft flew for about 24 minutes after the rapid decompression and the CVR was running during the ground taxi time until power was turned off, very little information was revealed about activities immediately before, during, or immediately after the occurrence. 3/

1.12 Wreckage and Impact Information

The rear portion of the fuselage was damaged structurally. The fuselage tailcone, the aft cabin pressure bulkhead access door, the drink cart, and the lavatory water supply tank were missing.

3/ The capability of the CVR to store recorded information is limited to the last 30-min period before power is removed from the device.

1.12.1 Fuselage Examination

The aft bulkhead, vertical stabilizer front spar, center spar, and rear spar support bulkhead were not damaged. Most light frames were intact. One frame at FS 1076 was damaged. Connections to the flight data recorder were found severed. On the left side, there was foreign object damage (FOD) to the tail stub skin. The tailcone frame was intact.

An oxygen line was broken in the aft flight attendant's supply line. This line is routed along the aft pressure bulkhead. The crew oxygen supply cylinder gauge in the cockpit read zero psi when examined immediately after landing.

The inspection of the fuselage from the pressure bulkhead, FS 996, forward to the nose of the aircraft revealed that the window belt panels on both the left side and right side were free of any structural deformation. The door to the cockpit was damaged substantially. The internal sidewalls of the fuselage were displaced. The most notable sidewall displacement was at the overwing area.

The floor immediately forward of the aft pressure bulkhead was 5° to 10° low at the aft end. No other cabin floor damage was noted.

1.12.2 Flight and Engine Control Examination

The following flight controls were serviceable and operable: both elevators, the rudder control and hydraulic system, the left elevator trim control, and the rudder hydraulic shutoff system. The following flight controls were inoperable: the right elevator trim control, the rudder trim control, and the horizontal stabilizer indicating control system. The three systems were inoperable because a cable pulley support bracket located on the right aft side of the pressure bulkhead was torn off. The cables were loose in the tail section; however, no cables were broken.

The left engine reverser system was not operable on landing. Examination of the system revealed that the left thrust reverser control valve linkage was jammed against the displaced pressure bulkhead, thus restricting movement of the mechanism to the full reverse position.

The right throttle was restricted to 1.25 EPR when the captain applied power while leveling off at 9,000 ft. This condition could not be duplicated on the ground. The right throttle and reverser worked normally on landing. The right reverser control cable, No. 52, on the drum located on the forward face of the pressure bulkhead, was found off one side of the pulley.

The right pneumatic crossfeed shutoff valve jammed in the open position. The crossfeed operating pushrod aft of the pressure bulkhead was found broken off at the lower lever. The actuating drum crank through the pressure bulkhead was jammed in the open position due to bulkhead separation.

1.13 Medical and Pathological Information

The only known injury was to a flight attendant who was picking up trays in the back of the aircraft near row 18 when the rapid decompression

occurred. Her leg was caught in row 17 and she fell to the floor letting the trays go. She was unconscious for about 15 seconds and sustained minor leg, head, and hand injuries.

1.14 Fire

There was no fire.

1.15 Survival Aspects

This was a survivable accident.

1.16 Tests and Research

1.16.1 Metallurgical Examination

The aft cabin pressure bulkhead, P/N 5910163, was examined in Boston after the aircraft landed. (See figure 1.) Parts of the bulkhead were excised for more detailed metallurgical examination at the Safety Board's Metallurgical Laboratory in Washington, D.C.

Above the access door, a 0.03-in-long fatigue crack was found in the area of a rivet hole. The density of the fatigue striations in this area indicated the crack contained about 3,000 cycles. Other fractures found above the access door appeared typical of those produced by an overstress condition. Below the access door, a large crack was found in the P/N 5910163-9 jamb that originated in areas of mechanical damage in a lockbolt fastener hole. The examination determined that the crack had been caused by fatigue and that the mechanical damage existed before the accident. The P/N 5910163-182 web below the access door contained evidence of fatigue cracking originating at the upper rivet hole used in attaching the web to the jamb. The metallurgists determined that the majority of the crack extension down the web was probably caused by fatigue and/or intermittent tearing to a position approximately 10 in below the top of the web. Remaining fractures below this point appeared typical of fresh overload separations. Hardness and microstructural examination of the bulkhead jamb and web pieces were normal for the material specified for these members (alclad 2014-T6 sheet). Thickness measurements of the sheet material complied with that specified on the engineering drawing.

X-ray radiographs from the C-10 inspection of the bulkhead on May 5, 1979, clearly showed crack indications from the lockbolt fastener hole in the jamb below the door, indicating that a substantial crack was present at this location at the time of the inspection. Nothing on the C-10 inspection record indicated that inspectors detected the crack when the X-rays were examined.

1.16.2 Test of the Oxygen System

The oxygen line that leads to the aft flight attendant's station was repaired and the oxygen system examined. The system operated normally and no other defects were noted.

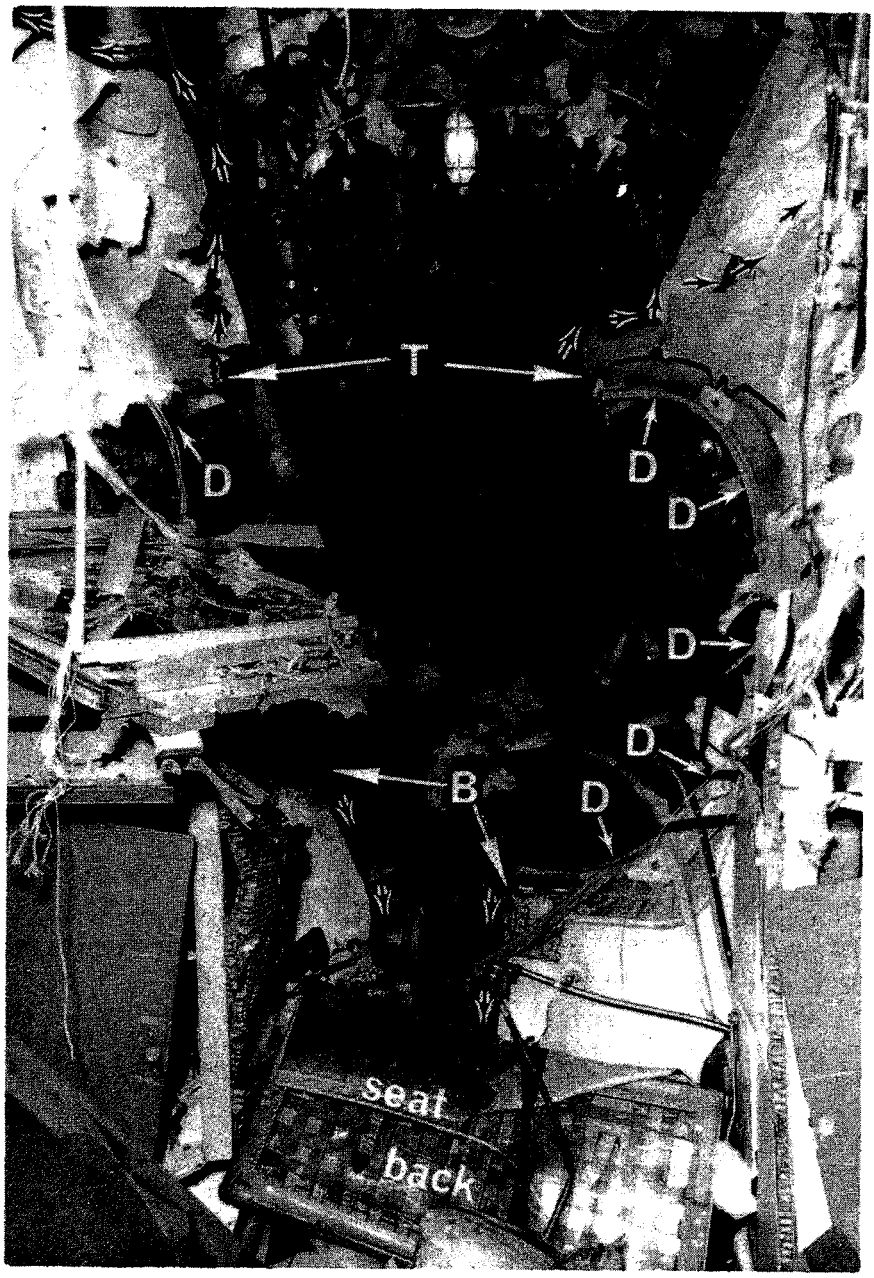

Figure 1.--Overall view looking aft on aft pressure bulkhead as first viewed in Boston. Arrows "D" outline the aft access door frame that is visible in this photograph. Mating areas at the top of the door jamb are denoted by arrows "T" and mating areas at the bottom of the door jamb are indicated by arrows "B". Unmarked arrows show principal fracture directions.

(Photograph courtesy of the Canadian Ministry of Transport.)

1.17 Other Information

1.17.1 Immediate Action of Air Canada

During the onscene investigation in Boston, Air Canada informed the investigating team that it had ordered an immediate examination of its fleet of 43 DC-9-32 aircraft to determine if others had similar cracks. One aircraft located in Regina, Saskatchewan, Canada, was found to have cracks in the same area and was immediately withdrawn from service. The aircraft was ferried, unpressurized, to the airline's principal maintenance base in Dorval, Quebec, Canada. After the onscene investigation, Air Canada informed the Safety Board that another DC-9-32 aircraft had been found with cracks in the same area. It was also immediately withdrawn from service and repaired before its next revenue flight.

1.17.2 Emergency Telegraphic Airworthiness Directive (AD) No. T79WE13

On September 18, 1979, as a result of the investigation, the Federal Aviation Administration (FAA) issued an emergency telegraphic AD No. T79WE13 which was effective upon receipt and applicable to all operators of the McDonnell-Douglas model DC-9 aircraft certificated in all categories which had made more than 15,000 landings, were not equipped with an aft ventral stairway, and had not been modified by an earlier DC-9 service bulletin. This emergency AD required each operator to:

> (A) Within 10 landings after receipt of this telegram, perform a visual inspection for cracks in the aft pressure bulkhead emergency exit door jamb and bulkhead skin in accordance with McDonnell Douglas DC-9 service bulletin 53-127 dated May 25, 1976. The area to be inspected shall be expanded to include the entire perimeter of the door opening and bulkhead assembly within twelve inches of the opening.
> Note: Preliminary examination of the suspect area prior to cleaning may reveal tar stains commonly associated with pressurization leaks. Following such preliminary examination, a thorough cleaning should be performed before proceeding with the prescribed visual inspection.
>
> (B) If cracks are found during the inspection which are limited to the emergency exit door jamb, repair before further flight as shown for condition 2, figure 2, in McDonnell-Douglas service bulletin 53-127 dated May 25, 1976.
>
> (C) If cracks are found during the inspection which extend through the emergency exit door jamb and into the pressure bulkhead skin, repair before further flight as shown by condition 3, figure 3 in McDonnell Douglas service bulletin 53-127 dated May 25, 1976.
>
> (D) If cracks are found during the inspection for which no repair is prescribed in McDonnell Douglas service bulletin

53-127 dated May 25, 1976, repair before further flight in accordance with FAA-approved data.

(E) Within 24 hours after the inspection, report the results of the inspection to the Chief, Aircraft Engineering Division, FAA Western Region.

(F) Special flight permits may be issued in accordance with FAR [14 CFR] 21.197 and 21.199 to operate the airplane unpressurized to a base where the inspection or crack repair can be performed.

1.17.3 Emergency Telegraphic Airworthiness Directive No. T79WE15

On September 28, 1979, the FAA issued emergency telegraphic AD No. T79WE15 which was effective upon receipt and superseded AD No. T79WE13. This emergency AD required each operator:

To detect fatigue cracks and prevent failure of the aft pressure bulkhead, accomplish the following:

(a) For aircraft not previously modified or repaired in accordance with McDonnell Douglas DC-9 Service Bulletin 53-127 dated May 25, 1976, accomplish the following:

(1) Within 10 landings after receipt of this telegram, unless already accomplished in accordance with telegraphic AD T79WE13, conduct an initial visual inspection per Step 1, Figure 1, of McDonnell Douglas DC-9 Alert Service Bulletin A53-127, Revision 1, dated September 26, 1979. The visual inspection shall encompass the entire periphery of the emergency exit doorjamb structure.

(2) Within 100 landings after receipt of this telegram, conduct both visual and X-ray inspections per Steps 3 through 10, Figure 1, of McDonnell Douglas DC-9 Alert Service Bulletin A53-127, Revision 1, dated September 26, 1979. The visual portion of the inspection shall encompass the entire periphery of the doorjamb structure.

(3) Within 2,000 landings from the inspection required by paragraph (a)(2) and thereafter at intervals not to exceed 2,000 landings, conduct X-ray inspections per Steps 8 through 10 and visual inspections per Step 1, Figure 1, of McDonnell Douglas DC-9 Alert Service Bulletin in A53-127, Revision 1, dated September 26, 1979. The visual inspection shall encompass the entire periphery of the emergency exit doorjamb structure.

(b) For aircraft previously modified or repaired per McDonnell Douglas DC-9 Service Bulletin 53-127 dated May 25, 1976, accomplish the following:

(1) Within 2,000 landings after receipt of this telegram and thereafter at intervals not to exceed 2,000 landings, conduct an X-ray inspection of the jamb structure per Steps 8 through through 10, Figure 1, of McDonnell Douglas DC9 Alert Service Bulletin A53-127, Revision 1, dated September 26, 1979, and a visual inspection of the entire periphery of the emergency exit doorjamb structure.

(c) If cracks are found during any of the inspections required by this AD, repair before further flight in accordance with the following:

(1) For cracks which are limited to the emergency exit doorjamb, repair as shown for Condition 2, Figure 2 of McDonnell Douglas DC-9 Alert Service Bulletin A53-127, Revision 1, dated September 26, 1979.

(2) For cracks which extend through the emergency exit doorjamb and into the pressure bulkhead web, repair as shown for Condition 3, Figure 3 of McDonnell Douglas DC-9 Alert Service Bulletin A53-127, Revision 1, dated September 26, 1979.

(3) For cracks for which no repair is prescribed in McDonnell Douglas DC-9 Alert Service Bulletin A53-127, Revision 1, dated September 26, 1979, repair in accordance with FAA-approved data.

(d) Within 24 hours after inspections per paragraph (a) and paragraph (b), report the results of the inspections to Chief, Aircraft Engineering Division, FAA Western Region. Include in the reporting information the modification/repair status of the bulkhead.

(e) Special flight permits may be issued in accordance with FAR [14 CFR] 21.197 and 21.199 to operate the airplanes unpressurized to a base where the inspections or crack repair can be performed.

(f) For the purposes of complying with this AD, subject to acceptance by the assigned FAA maintenance inspector, the number of landings may be determined by dividing each airplane's hours time-in-service by the operator's fleet average time from takeoff to landing for the DC-9 airplane.

1.17.4 Airworthiness Directive 79-WE-30-AD; Amendment 39-3618

On December 24, 1979, the FAA issued a final AD which required the operators:

To detect fatigue cracks and prevent failure of the aft pressure bulkhead, accomplish the following:

(a) For aircraft not previously modified or repaired in accordance with McDonnell Douglas DC-9 Service Bulletin 53-127 dated May 25, 1976, accomplish the following:

(1) Within 10 landings after the effective date of this AD, unless already accomplished in accordance with telegraphic AD T79WE13 dated September 18, 1979 or telegraphic AD T79WE15 dated September 28, 1979, conduct an initial visual inspection per Step 1, Figure 1, of McDonnell Douglas DC-9 Alert Service Bulletin A53-127, Revision 1, dated September 26, 1979. The visual inspection shall encompass the entire periphery of the emergency exit doorjamb structure.

(2) Within 100 landings after the effective date of this AD, unless already accomplished in accordance with telegraphic AD T79WE15 dated September 28, 1979, conduct both visual and X-ray inspections per Steps 3 through 10, Figure 1, of McDonnell Douglas DC-9 Alert Service Bulletin A53-127, Revision 1, dated September 26, 1979. The visual portion of the inspection shall encompass the entire periphery of the doorjamb structure.

(3) Within 250 landings of the inspection required by paragraph (a)(2) of this AD and thereafter at intervals not to exceed 250 landings, conduct a visual inspection per Step 1, Figure 1, of McDonnell Douglas DC-9 Alert Service Bulletin A53-127, Revision 1, dated September 26, 1979. The visual inspection shall encompass the entire periphery of the emergency exit doorjamb structure.

(4) Within 1,000 landings from the inspection required by paragraph (a)(2) and thereafter at intervals not to exceed 1,000 landings, conduct X-ray inspections per Steps 8 through 10 and a visual inspection per Step 1, Figure 1, of McDonnell Douglas DC-9 Alert Service Bulletin A53-127, Revision 1, dated September 26, 1979. The visual inspection shall encompass the entire periphery of the emergency exit doorjamb structure.

(b) For aircraft previously modified or repaired per McDonnell Douglas DC-9 Service Bulletin 53-127 dated May 25, 1976, accomplish the following:

(1) Within 100 landings after the effective date of this AD, unless already accomplished subsequent to September 25, 1979, conduct X-ray inspections per Steps 8 through 10, Figure 1, of McDonnell Douglas DC-9 Alert Service Bulletin A53-127, Revision 1, dated September 26, 1979, and a visual inspection of the entire periphery of the emergency exit doorjamb structure.

(c) If cracks are found during any of the inspections required by this AD, repair before further flight in accordance with the following:

(1) For cracks which are limited to the emergency exit doorjamb, repair as shown for Condition 2, Figure 2, of McDonnell Douglas DC-9 Alert Service Bulletin A53-127, Revision 1, dated September 26, 1979.

(2) For cracks which extend through the emergency exit doorjamb and into the pressure bulkhead web, repair as shown for Condition 3, Figure 3, of McDonnell Douglas DC-9 Alert Service Bulletin A53-127, Revision 1, dated September 26, 1979.

(3) For cracks for which no repair is prescribed in McDonnell Douglas DC-9 Alert Service Bulletin A53-127, Revision 1, dated September 26, 1979, repair in accordance with FAA-approved data.

(d) Within 24 hours after the initial inspections per paragraph (a)(2) and paragraph (b)(1), report the results of the initial inspections by Telex to the Chief, Aircraft Engineering Division, FAA Western Region. Include in the reporting information the data and condition of modification or repair per DC-9 Service Bulletin 53-127 or A53-127, McDonnell Douglas fuselage number, factory serial number, and registration number.

(e) Alternative inspections, modifications or other actions which provide an equivalent level of safety may be used when approved by the Chief, Aircraft Engineering Division, FAA Western Region.

(f) Special flight permits may be issued in accordance with FAR [14 CFR] 21.197 and 21.199 to operate the airplanes unpressurized to a base where the inspections or crack repair can be performed.

(g) For the purposes of complying with this AD, subject to acceptance by the assigned FAA maintenance inspector, the number of landings may be determined by dividing each airplane's hours time in service by the operator's fleet average time from takeoff to landing for the DC-9 airplane.

On July 17, 1980, AD 79-WE-30-AD was further amended by Amendment 39-3741 as follows: ". . . change paragraph (e) to read in pertinent part as follows:

'(e) Within the next 500 landings after April 14, 1980. . . .' "

1.17.15 Results of Fleetwide Inspection

As a result of inspections made after receipt of emergency AD No. T79WE13 on September 18, 1979, 7 air carriers with DC-9 aircraft that were within the requirements of the AD reported that out of 119 aircraft inspected, cracks were found in 33. Several of these aircraft were found to have more than one crack. All of the aircraft were removed immediately from service, repaired, and placed back in service.

1.18 Useful or Effective Investigation Techniques

No new or unusual investigation techniques were used during this investigation.

2. ANALYSIS

2.1 General

The flightcrew was properly certificated and qualified in accordance with company, Canadian, and FAA requirements and regulations.

Meteorological conditions did not affect the flight. Although the flight was being conducted on an IFR flight plan, visual flight conditions were maintained from takeoff until landing.

The aircraft was certificated and equipped according to applicable regulations. The gross weight and center of gravity were within prescribed limits.

The aircraft was maintained according to applicable regulations, except for the work which was accomplished during the aircraft's last maintenance check--the C-10 inspection on May 5, 1979. The aft pressure bulkhead was X-rayed during the C-10 inspection; however, no cracks were discernible in these X-rays and the aircraft was released for revenue service.

2.2 The Aft Pressure Bulkhead

Fracture of the aft pressure bulkhead initiated from a large preexisting crack below the access door area. Primary crack initiation was by low-load,

high-cycle fatigue originating at a mechanical gouge in the lockbolt fastener hole that most likely occurred during assembly of the bulkhead. Cyclic loading of the bulkhead was produced by cabin pressure fluctuations, each of which correlated to one complete cycle per flight. The density of fatigue striations in the access doorjamb and the magnitude of the fatigue crack extension suggests that the fatigue crack began upon initial pressurization of the aircraft. The aircraft had 26,816 landings recorded at the time of the accident, and it is possible that each of the service cycles (equated to landings) produced a striation or incremental crack extension. The loads producing fatigue crack extension in the doorjamb would have been distributed to the door web when the jamb cracks extended to the location corresponding to the top of the web. Low-load, high-cycle fatigue cracking in the web most likely was occurring simultaneously with that in the jamb as the crack extended downward below the web interface. The web most probably tore downward incrementally to about 10 in from the lower rivet hole used to attach the web to the jamb. From this point, the failure appeared to progress catastrophically without further stoppage.

The fatigue crack found in the jamb above the access door was extremely small and is not considered significant. Striation densities in this area indicated the crack contained about 3,000 cycles which is much less than the 26,816 landing cycles of the aircraft. Fatigue cracking in this area, however, may have influenced the location of breakage in the bulkhead above the access door area.

2.3 Inspection and Quality Control

During this investigation, the Safety Board became concerned that the crack in the bulkhead had gone undetected for more than 4 months. Radiographic inspection of the bulkhead on CF-TLU was accomplished on May 5, 1979, during a normal maintenance inspection. Examination of the X-ray plates taken during this inspection showed a fatigue crack which was clearly discernible and easily identifiable. Company inspection and quality control procedures allowed this discrepancy to go undetected. The Safety Board was not able to determine if earlier radiographic inspections of the bulkhead had shown any cracks.

Of equal concern to the Safety Board was the fact that, despite established inspection and quality control procedures, 33 other DC-9 aircraft belonging to 7 other air carriers were found to have similar cracks of varying lengths in the same area of the aft pressure bulkhead. Left undetected, and depending on time and circumstances, these cracks could have resulted in catastrophic accidents, the causes of which would have been extremely difficult to determine.

The Safety Board believes that the actions taken by Air Canada immediately after this accident as well as those taken by the FAA to insure more thorough and timely inspection and quality control practices throughout the affected DC-9 fleet were timely and effective. The Board concludes that the increased inspection criteria set forth in the FAA directives, coupled with FAA surveillance activity, should eliminate this type of fatigue failure.

*U.S. GOVERNMENT PRINTING OFFICE: 1981-0-341-828/2

3. CONCLUSIONS

3.1 Findings

1. The aircraft was certificated and equipped in accordance with approved procedures.

2. All crewmembers were certificated and qualified for flight.

3. The flight was on an IFR flight plan and visual meteorological conditions existed throughout the entire flight.

4. Separation of the aft bulkhead below the access door stemmed from a large fatigue crack in the doorjamb which originated in areas of preexisting mechanical damage in a lockbolt fastener hole.

5. Postaccident review of X-rays of the aft pressure bulkhead taken on May 5, 1979, disclosed a crack which was not detected.

6. The maximum cabin pressure differential under normal operations with an uncracked aft pressure bulkhead was 7.46 psi. At the time of the failure of the aft pressure bulkhead, the cabin pressure differential was 7.2 psi.

7. The DFDR functioned normally during the flight until the aft pressure bulkhead failed.

8. The DFDR shows that the flight was at 25,000 ft when the DFDR stopped functioning normally.

9. The pilot could not advance the right throttle past 1.25 EPR when the flight leveled off at 9,000 ft. This condition could not be duplicated on the ground.

10. The left engine reverser system could not be placed into reverse after landing.

11. The right elevator trim control, the rudder trim control, and the horizontal stabilizer indicating control system were not operational because the cable pulley support bracket attached to the upper right side of the aft pressure bulkhead was torn off and the cables were loose.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was a fatigue fracture of the aft cabin pressure bulkhead which resulted in a rapid decompression of the aircraft's cabin area. This fracture initiated from a crack below the aft bulkhead access door which was discernible on the X-rays taken during the aircraft's last maintenance inspection but was not detected by the inspectors.

4. RECOMMENDATIONS

As a result of this accident investigation and timely information developed and forwarded by the Safety Board's metallurgist, the FAA issued emergency telegraphic AD No. T79WE13 for inspection of all other DC-9 aircraft.

The Safety Board considered the immediate action taken by the FAA, the manufacturer, and the airlines involved to be satisfactory and no recommendations were issued.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ ELWOOD T. DRIVER
Vice Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PATRICIA A. GOLDMAN
Member

/s/ G. H. PATRICK BURSLEY
Member

JAMES B. KING, Chairman, did not participate.

January 30, 1981

5. APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

Investigation

The Safety Board was notified about 1330 on September 17, 1980, that Air Canada Flight 680 had experienced a rapid decompression. The Safety Board immediately dispatched investigative personnel from the New York field office and Washington, D.C. Headquarters to the scene. Working groups were established for operations, air traffic control, structures, and maintenance records. Working groups for CVR, DFDR, and metallurgy were established in Washington, D.C.

Participants in the onscene investigation included representatives of the Federal Aviation Administration, the Canadian Ministry of Transport, Air Canada, and the McDonnell Douglas Aircraft Corporation.

Public Hearing

There was no public hearing held in conjunction with this accident.

APPENDIX B

PERSONNEL INFORMATION

Captain George D. Gill

Captain George D. Gill, 44, held Airline Transport Pilot Certificate No. WGA785, with a Class I instrument rating valid to April 1, 1980, and a DC-9 endorsement. As of September 17, 1979, Captain Gill had accumulated about 13,864 total flight-hours, 1,213 of which were in the DC-9. He held a category 1 medical certificate with no limitations valid to November 1, 1979.

Captain Gill began his flying career with the Royal Canadian Air Force in August 1954 and flew Harvard, C45, DC-3, and T-33 aircraft. In November 1966, he joined Air Canada and flew Vickers Viscount, DC-8, and DC-9 aircraft.

Captain Gill was promoted to Captain in May 1979 and his last proficiency check was in a DC-9 visual simulator at Toronto, Ontario, on September 11, 1979.

First Officer E. Michael Lang

First officer E. Michael Lang, 31, held Airline Transport Pilot Certificate No. WGA1137, with a Class I instrument rating valid to November 1, 1979, and a DC-9 endorsement. As of September 17, 1979, First officer Lang had accumulated 6,434 total flight-hours, 753 of which were in the DC-9. He held a category 1 medical certificate requiring glasses valid to January 1, 1980.

First officer Lang began his flying at Fort St. John Air Services, British Columbia, and flew various light aircraft. He then worked for several business firms and flew DC-3, DC-4, DHC-4, DHC-6, and L-188 aircraft. In January 1974, he joined Air Canada and flew DC-8 and DC-9 aircraft. His last proficiency check was in a DC-9 visual simulator at Toronto, Ontario, on July 6, 1979.

Flight Attendants and Purser

The two flight attendants and the purser were qualified in DC-9 aircraft in accordance with applicable regulations and had received the required emergency evacuation training.

APPENDIX C

AIRCRAFT INFORMATION

The aircraft, Canadian Registration CF-TLU, is a McDonnell Douglas Corporation DC-9 series 32 aircraft, serial No. 47196, Air Canada identification No. 720. It was manufactured on March 22, 1968. The aircraft was maintained under a progressive maintenance program. On September 17, 1979, the aircraft had accrued the following times since the last scheduled inspection:

Inspection	Hours
A	146
B	58
C	1,005
D	10,636