

CIVIL AERONAUTICS BOARD

ACCIDENT INVESTIGATION REPORT

Adopted: May 19, 1958

Released: June 5, 1958

SCANDINAVIAN AIRLINES SYSTEM DC-7C, OY-KNB,
NEAR BOSTON, MASSACHUSETTS, OCTOBER 29, 1957

The Accident

No. 1 propeller of Scandinavian Airlines Flight 912, a DC-7C, Danish Registry OY-KNB, oversped about two hours after departure on a direct flight from New York, New York, to Copenhagen, Denmark. The flight, which had departed New York International Airport (Idlewild) at 1516¹/₂ on October 29, 1957, was diverted to Boston, Massachusetts, where the crew of 9 and 50 passengers deplaned safely. The aircraft received substantial damage.

History of the Flight

SAS Flight 912, a scheduled passenger operation, departed Idlewild, October 29, 1957, at 1516 on schedule. The crew consisted of Captain Kaare Herfjord, First Officer Erik Falkenberg-Nielsen, Navigators Henning Arthur Agerholm and Kurt Alborg Olsen, Flight Engineers Carl Emil Woehlke and Erling Halseth, Purser Poul Willy Kramath, Steward John Brandt, and Hostess Elli Rieneck. The gross weight at takeoff was approximately 138,000 pounds, 5,000 pounds under the maximum allowable. The load, including approximately 7,000 gallons of fuel, was properly distributed.

The IFR (Instrument Flight Rules) flight plan called for routing via Cod, Sable Island, Tarpon, Great Circle to Prestwick, Scotland, and airways to Copenhagen. The alternate was Oslo, Norway. Departure was made in accordance with ARTC (Air Route Traffic Control) clearance and the flight made routine reports while climbing to its cruising altitude of 21,000 feet, which it reached when passing Nantucket at 1606.

At approximately 1715, while about 200 miles off the Maine coast, engine roughness developed. Shortly thereafter, engine instruments indicated malfunctioning of the No. 1 powerplant. The BMEP (brake mean effective pressure) dropped rapidly to zero, manifold pressure dropped to 20-25 inches, the oil temperature increased, and the oil pressure dropped. Just as the crew was about to feather the propeller the engine oversped to nearly 4,000 r. p. m. Actuation of the propeller feathering system produced no results. Despite all efforts of the crew the propeller windmilled at high r. p. m. Sparks and flame appeared in the area of No. 1 engine exhaust and cowling.

At approximately 1728 the flight made an emergency radio transmission and was cleared by ARTC to descend to 8,000 feet, later to 6,000 feet, with routing for a return to Idlewild. At 1756 the flight crew reported they were about to dump fuel.

1/ All times herein are eastern standard and based on the 24-hour clock.

A Coast Guard aircraft departed Quonset Point, Rhode Island, at 1804 to intercept Flight 912. Communications between the Coast Guard and Flight 912 were established at 1836 and interception was made at 1942. At approximately 1905, SAS 912 requested ARTC clearance to Boston and this was granted immediately. During the Boston approach descent from 6,000 feet to 4,000 feet, the No. 1 propeller separated from the engine and dropped into the sea. Sparks and flame accompanied the separation and one bank of fire extinguishing agent was used at that time. The time of the propeller separation was between 2026 and 2030.

After a radar-controlled final approach the aircraft made a successful three-engine landing at 2044 on runway 22L, Logan Airport, Boston. At the end of the landing roll waiting airport fire equipment covered the No. 1 engine and left wing with foam as a precautionary measure.

It was not necessary to deplane the occupants by emergency means. Twenty minutes after the aircraft landed, all passengers, with the exception of four who had left earlier by the crew door, deplaned safely via a loading ramp taken to the aircraft.

Boston weather at 2045 was: Measured ceiling 8,000 broken; visibility 13 miles; wind south 2 knots; altimeter 30.09.

Investigation

Examination of the aircraft disclosed that except for a small puncture in the left wing leading edge all damage was forward of the No. 1 engine firewall. Accordingly, the Board's investigative activity was first directed to that area.

The engine was removed from the aircraft and transported to the SAS hangar at Idlewild Airport, New York. It was observed initially that a major portion of the propeller shaft had broken away from the engine.

The propeller governor, when removed and disassembled, was found to contain small metal particles. The pilot valve of this governor was stuck or seized in the "on speed" condition.

Operation of the feathering pump was normal. Fire or excessive heat damage was confined to the area where the nose case had broken away. The portion of the nose case remaining showed discoloration from heat. There was no fire damage around the cylinders, ignition wiring, or push rods.

The propeller shaft was broken off at the flange which is just rearward of the propeller oil transfer bearing. The most forward portion of the ring cowl (left side) was torn and flattened rearward.

After preliminary examination at Idlewild the engine was taken to the manufacturer's plant for complete disassembly. This revealed damage from overheating and heavy accessory drive gear damage throughout. The impeller drive system was completely destroyed as a unit; the various parts revealed damage consisting of gear tooth wear, breakage, and discoloration typical of excessive heat.

A laboratory analysis revealed that the failure of the impeller intermediate drive gear was caused by fatigue fractures.

All of the cylinders remained on the crankcase. Cylinder skirts, in general, were distorted and broken. All connecting rods and the master rods were broken. The crankshaft counterweights were heavily peened and scored, and the leading edges were worn away. The rear counterweight was jammed against the rear crankcase. Two of the pistons were broken up completely and all others were damaged. The cylinder heads were gouged and peened consistent with damage to the tops of the pistons.

The center main bearing, discolored by heat, was in place. Both the front and rear main bearings were nearly destroyed. The shafts of all three PRT (power recovery turbine) units were broken and the drive assembly between the PRT and the crankshaft showed overheat discoloration. Crankshaft drive gear teeth were gone from approximately 230 degrees of the circumference.

Testimony of the flight crew was that the first indication of trouble was a sensing of engine roughness and that before the rough engine could be identified by the use of the ignition analyzer, the BMEP indicator of No. 1 engine dropped to zero and the No. 1 manifold pressure gauge dropped to 20-25 inches of mercury. This was followed by a rise in oil temperature to 90-95 degrees centigrade with a drop in oil pressure to 55-60 p. s. i. The engine r. p. m. increased to approximately 3,500-4,000. Throttle closing had no effect on the high r. p. m. Feathering was attempted without success. The captain and flight engineer stated that all these events and actions took place during approximately one or two minutes. Subsequent attempts to feather, using the feathering button and manual toggle switch, were equally unsuccessful. The loadmeter indicated that the feathering pump was functioning normally.

The mixture control was then placed in the idle cutoff position and the engine r. p. m. as indicated by the tachometer dropped to zero but the propeller continued to turn at a very high rate.

An emergency (MAYDAY) call was made as airspeed was reduced. The autopilot was turned off and the aircraft was thereafter flown manually. After descending to 8,000 feet altitude and dumping approximately 2,800 gallons of fuel, the aircraft was not able to maintain altitude; 6,000 feet was requested and granted and with the dumping of approximately 700 more gallons of fuel this altitude was maintained at an airspeed of 140 knots. At this speed the propeller r. p. m. and noise were noticeably reduced.

When the position of the aircraft was accurately determined the destination was changed to Boston, 120 miles nearer than New York. Captain Herfjord stated that although he had considered diverting to Halifax, Nova Scotia, he did not do so because of an overcast there and the short runways. He was able to remain clear of all clouds during his return to Boston.

As the flight approached Boston, about 3 hours and 15 minutes after the overspeeding occurred, the No. 1 propeller tore loose and fell into the sea. According to the captain flames and sparks were flying off the engine and one bank of Freon (fire extinguishing agent) was used. A three-engine landing was made at Logan Airport, Boston.

The captain decided not to use emergency evacuation after the landing since he was advised by ground personnel that there was no danger of fire. Use of a regular loading ramp for deplaning eliminated possible hazard to the passengers. The emergency deplaning chutes were ready for use had they been needed.

Testimony of the crew and investigation indicated that there had been no signs of engine difficulty prior to the engine roughness. The crew stated that engine starting and runups, takeoff, and climb were all made with normal indications. The previous flight crews reported no abnormal conditions. A review of maintenance records of OY-KNB disclosed no discrepancies or deferred items.

Analysis

The initial failure is believed to have been the fatigue fracture of the No. 1 engine impeller intermediate drive gear (P/N 145316N). All governor malfunction resulted from contamination by fine metal particles which were generated and introduced into the oil supply by the gear failure. The overspeed and inability to feather the propeller were caused by the governor pilot valve seizing in the "on speed" position.

Disruption of the gear train driving the fuel pump and tachometer occurred early in the failure sequence. This allowed the tachometer to register zero even though engine rotation causing extensive damage in the power section continued for approximately three hours.

The rear counterweight had partially separated during the continued rotation and the rear half was found jammed against the crankcase diaphragm. It is believed that sudden jamming occurred and caused the already heated propeller shaft to fail, permitting the propeller to separate from the engine.

There is no indication of operational discrepancies in the conduct of the flight. After the propeller overspeeding occurred the captain was able to maintain control of his aircraft while reducing speed and altitude. Feathering procedures were initiated promptly by the flight crew but were unsuccessful. Communications, traffic control requests, and navigation were properly handled. The cabin attendants continued to serve meals to the passengers who, according to testimony, remained calm during the return to Boston. The decision to delay evacuation after the landing seems reasonable in view of the extinguishing measures taken and the safer exit offered by the standard loading ramp.

The dumping of fuel, ordered by the captain, enabled the flight to maintain its assigned altitude of 6,000 feet, and reduced the gross weight of the aircraft below its authorized landing weight.

Windmilling of the propeller did present a definite hazard during the three-hour return flight. However, at the captain's request, a U. S. Coast Guard amphibian aircraft intercepted the flight and assistance was present had it been required. The Coast Guard aircraft escorted the DC-7 to the landing at Boston.

Based on the investigation of this accident, and similar failures, the Board recommended to the Civil Aeronautics Administration that an Airworthiness Directive be issued requiring the earliest possible replacement of the P/N 145316N gear. Accordingly, AD-57-24-1 was issued on December 2, 1957, requiring replacement of this gear at the next overhaul and not later than July 31, 1958. In addition, the Board is currently preparing a notice of proposed rule making concerning means for preventing propeller overspeeding and inability to feather. The proposed regulation is intended to require the application of improved design principles to the propeller governing and feathering systems.

Findings

On the basis of all available evidence the Board finds that:

1. The crew, the aircraft, and the carrier were currently certificated.
2. The takeoff weight of the aircraft was less than the maximum allowable.
3. The flight was properly dispatched.
4. The flight was routine until the impeller drive gear failure and subsequent engine malfunction occurred.
5. The propeller speed could not be controlled nor could the propeller be feathered.
6. The propeller separated in flight without striking the aircraft.
7. The emergency was well handled by the flight crew.
8. Weather was not a factor in the accident.

Probable Cause

The Board finds that the probable cause of this accident was fatigue fractures in No. 1 engine impeller drive gear, resulting in an overspeeding propeller, loss of the propeller, and the subsequent emergency landing.

BY THE CIVIL AERONAUTICS BOARD:

/s/ JAMES R. DURFEE
/s/ CHAN GURNEY
/s/ HARMAR D. DENNY
/s/ G. JOSEPH MINETTI
/s/ LOUIS J. HECTOR

S U P P L E M E N T A L D A T A

Investigation and Taking of Depositions

The Civil Aeronautics Board was notified of the accident the night of October 29, 1957. An investigation was immediately initiated in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended. Depositions were taken at the Federal Building, New York International Airport, New York, on January 24, 1958.

Air Carrier

Scandinavian Airlines System is operated under a consortium between Danish Airlines, Norwegian Airlines, and Swedish International Airlines. The principal offices of the System are located in Stockholm, Sweden. The headquarters of the North American Division is New York, New York. Under the Bilateral Air Transport Agreements of 1945, Scandinavian Airlines System was granted two air routes to the United States November 24, 1947. These routes, including the one over the North Atlantic, are operated by SAS under a foreign air carrier permit issued by the Civil Aeronautics Board and an air carrier operating specification issued by the Civil Aeronautics Administration.

Flight Personnel

Captain Kaare Herfjord, age 38, was employed by SAS February 15, 1946. He held a currently effective airman certificate with rating of airline transport pilot. His flying hours total 8,324, of which 821 were in the type aircraft involved. His last line check was on March 23, 1957, and the last instrument check on September 4, 1957. The date of his last CAA physical examination was August 13, 1957. Time last 30 days, 79 hours; last 90 days, 229 hours.

First Officer Erick Falkenberg-Nielsen, age 29, was employed by SAS April 16, 1952. He held a currently effective airman certificate with rating of airline transport pilot. He had a total of 2,119 pilot hours, with 294 in the type aircraft involved. The date of his last CAA physical examination was July 11, 1957. His last instrument check was on March 14, 1957, and the last line check on September 20, 1957. Flying time in last 30 days, 75 hours; last 90 days, 256 hours.

Flight Engineer Carl Emil Woehlk, age 34, was employed by SAS January 2, 1947. He held a currently effective flight engineer certificate. Flying hours totaled 5,433 of which 151 were in the type aircraft involved. The date of his last physical examination was February 14, 1957.

Flight Engineer Erling Halseth, age 33, was employed by SAS January 16, 1947. He held a currently effective flight engineer certificate. Flying hours totaled 2,587, of which 291 were in the type aircraft involved. The date of his last physical examination was September 24, 1957.

Navigator Kurt Alborg Olsen, age 35, was employed by SAS November 29, 1946. He held a currently effective flight navigator certificate. Flying hours totaled 8,915, of which 759 were in the type aircraft involved. His last physical examination was November 25, 1956.

Navigator Trainee Henning Arthur Agerholm, age 31, was first employed by SAS April 16, 1953. He held a current radio operator license and had flown 170 hours as a navigator trainee. His last physical examination was February 23, 1957.

Purser Poul Willy Kramath, age 27, was employed by SAS March 1, 1956. Steward John Brandt, age 29, was employed by SAS February 1, 1957. Miss Elli Rieneck, hostess, was employed by SAS April 21, 1954.

The Aircraft

Douglas DC-7C, OY-KNB, manufacturer's serial number 44929, was delivered to Scandinavian Airlines System on September 19, 1956. Total flying time since manufacture was 3,815 hours. The aircraft was powered by four Wright model 98T18EA-1 engines. Time since overhaul of the four engines was 664, 928, 145, and 891 hours, respectively. The serial number of No. 1 engine was 704516; total time 1,514 hours. The engines were equipped with Hamilton Standard model 34E60 propellers and model 7019-2 blades. Time on the propellers since overhaul was 1,298, 1,760, 1,199, and 1,286 hours, Nos. 1 to 4, respectively. Total time on No. 1 propeller was 3,267 hours.