

C I V I L   A E R O N A U T I C S   B O A R D  
ACCIDENT INVESTIGATION REPORT

Adopted: March 1, 1957

Released: March 11, 1957

TRANS-CANADA AIR LINES VISCOUNT, CF-TGR,  
FLAT ROCK, MICHIGAN, JULY 9, 1956The Accident

A Trans-Canada Air Lines Viscount, CF-TGR, lost No. 4 propeller and a portion of the forward part of the No. 4 engine about 1353, <sup>1/</sup> July 9, 1956, while in flight near Flat Rock, Michigan. One propeller blade passed through the fuselage, killing one and injuring 5 of the 31 passengers. Of the crew, one stewardess suffered a minor head injury. An emergency landing was made at Windsor, Ontario, at 1402.

History of the Flight

Trans-Canada Air Lines Flight 304 of July 9, 1956, was a scheduled passenger flight between Chicago, Illinois, and Montreal, Quebec, with intermediate stops at Toronto and Ottawa, Ontario. The crew consisted of Captain R. D. Smuck, pilot in command; Captain A. C. Adamson, first officer; and Stewardesses Rita Ann Tobin and Sheila Martha Thomsor. Captain Smuck occupied the right seat in the cockpit and was performing a route competency check of Captain Adamson. Earlier that day the aircraft had operated as Flight 303 from Montreal to Chicago without event except for a reported radio irregularity which was corrected at Toronto.

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

Flight 304 departed Chicago on an IFR flight plan at 1304 and climbed to its cruising altitude of 19,000 feet, in accordance with its ATC clearance. Gross weight of the aircraft at takeoff was 54,179 pounds, 3,221 pounds below the allowable, and the load was properly distributed.

At approximately 1345 in the vicinity of Flat Rock, Michigan, powerplant difficulty developed. During an emergency descent the No. 4 propeller broke loose and one blade passed through the fuselage, killing one person and injuring several others. The flight continued to Windsor, Ontario, where an emergency landing was made without further damage to the aircraft or injury to its occupants. Not until after landing did the pilots learn that a propeller blade had passed through the fuselage.

#### Investigation

According to the pilots the flight was routine until approximately 1345, at which time they noted a momentary drop in r. p. m. of No. 4 engine, 200 to 300 below the normal cruise r. p. m. of 13,600. Engine r. p. m. returned to and remained normal for about five minutes, then No. 4 engine r. p. m. was observed to increase rapidly to approximately 13,900 or 14,000. Shortly thereafter and concurrently with attempting to feather the propeller, the overspeed increased appreciably and feathering attempts, using both the manual and automatic systems, were unsuccessful.

During and following attempts to feather, the airspeed decreased, as did the sound of the No. 4 engine overspeed. The crew increased power on the remaining three engines and with the resultant increase in airspeed, the sound of No. 4 engine indicated its r. p. m. was rising. Because of this development an emergency was declared at approximately 1351 and clearance to descend was obtained from the Traffic Control Center at Detroit. Power was reduced on Nos. 1, 2, and 3 engines, then an emergency descent was started and was continued at nearly maximum airspeed. At some time during this phase of the descent the crew depressurized the cabin.

At approximately 1353, at an altitude of about 9,000 feet, the No. 4 propeller broke loose and all four blades separated from the hub. One of the blades struck No. 3 engine, then passed through the passenger-occupied portion of the fuselage. Descent was continued to about 3,000 feet, where power was again applied to Nos. 1, 2, and 3 engines. The r. p. m. of No. 3 engine did not go above 11,500 and the fire warning came on. Although no fire was observed, the engine fire procedure, which includes feathering of the propeller, was successfully accomplished.

Examination of the aircraft at Windsor revealed that the propeller and the front part of the No. 4 engine forward of the propeller reduction gear layshafts had broken away in flight. All of these parts were recovered in the vicinity of Flat Rock, Michigan.

The path of one propeller blade passed completely through the oil cooler of No. 3 engine and the forward portion of the passenger cabin. Major cabin damage occurred in the area of the two most forward rows of seats. A small piece of propeller blade that matched with the No. 2 blade was recovered from the cabin. The remaining propeller blades were found to be intact.

The No. 4 engine r. p. m. indicating system and propeller feathering system up to the point of separation of the nose case were checked and both functioned satisfactorily. Subsequent checks at Winnipeg of the individual components which make up these systems showed them to be satisfactory.

The No. 4 engine revealed evidence of oil starvation throughout. Investigation disclosed that the driven bevel gear of the bevel box drive<sup>2/</sup> had suffered a fatigue failure and rotation of the drive was completely disrupted. Laboratory study revealed the fatigue failure started on the load side of one tooth. Other than the fatigue fracture, this tooth was relatively undamaged, whereas the teeth that remained in place on the gear exhibited gross damage.

There is no known history of failure of driven bevel gears and a laboratory study showed no manufacturing or metallurgical defects in this one. The bushing within which this gear rotates had turned and worn panel material away until its thrust face was .030" below the machined surface of the panel

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<sup>2/</sup> The engine fuel pump, propeller control unit, and oil pump are driven by the bevel box drive.

on which the bushing flange normally beds. Damage resulting from the bushing turning in its panel precluded a determination of why the bushing was initially allowed to spin. The bushing flange was cracked. Displacement of the bushing resulted in a partial disengagement of the driven and driving bevel gears and thus altered the stresses in these parts.

The teeth of the high-speed pinion of the propeller reduction gearing were stripped to the extent that the propeller had become uncoupled from the engine. Discoloration from overheat was evident on the high-speed pinion and thrust bearing, with some deterioration having occurred to this latter part also.

The forward edges of the teeth of the high-speed pinion were displaced forward as the pinion progressively failed. The propeller oil transfer housing, which is located just forward of the high-speed pinion, had a circular groove cut into its aft face. This groove mated with the deformed pinion teeth which, by measurement, interfered with the propeller oil transfer housing. The circular groove was of sufficient depth to intersect the internal oil passages. Three successive tests to determine the oil pressure available for feathering subsequent to the described damage resulted in 300 p. s. i., 250 p. s. i., and 215 p. s. i.

The hub, with the propeller shaft, and the four propeller blades fell in five separate units and were found separately but in relatively close proximity to each other where they had fallen from the aircraft. The blades had pulled radially out of the hub bores, as evidenced by the

shear pattern on the threads of the hub bore and on the blade retention nuts. All blades were intact except the previously reported tip portion of No. 2 which was found inside the fuselage. No irregularities of the propeller were evident except for impact damage.

The propeller control unit was functionally tested, disassembled, and examined. All was normal except that the pressure switch setting was 345 p. s. i. The specified setting is 460 plus or minus 20 p. s. i.

Weather conditions in the area of the accident were reported as ceiling estimated 3,500 feet, broken, 8,000 feet, overcast; visibility in excess of 15 miles; very light rain showers. The crew reported that although cruise flight was conducted above a cloud layer, breaks in the clouds permitted the entire descent to be made with visual reference to the ground.

#### Analysis

It was not possible to determine whether the momentary drop of 200 to 300 r. p. m. in No. 4 engine had any connection with events that followed. The initial overspeed of No. 4 engine to 13,900 or 14,000 r. p. m. undoubtedly occurred when the normally fixed bushing turned and failure of the driven bevel gear followed to the extent that rotation of the bevel box drive was completely stopped. At this stage of the engine difficulty the propeller could have been feathered.

The fuel pump, oil pump, and propeller control unit are driven by the bevel box drive. Following failure of the

driven bevel gear the engine was rotated with no pressure lubrication by the windmilling action of the propeller while the blades were at the inflight fine pitch angle. It was during this interval that the high-speed pinion progressively failed and was deformed so as to damage the propeller oil transfer housing, with the result that feathering oil at the required pressure could not be directed to the propeller; finally, the propeller became decoupled from the engine. No other reason for failure of the propeller to feather was revealed by the investigation. According to the crew the second overspeed occurred just as the first attempt was being made to feather the propeller. At this time, however, damage that precluded feathering had already occurred

The matter of an uncontrolled decoupled propeller such as occurred in this instance had not been anticipated with respect to Viscount aircraft and was not treated in Viscount training or manual material. However, the fact that the sound of overspeed decreased with decreased airspeed and increased with an increase in airspeed should have alerted the crew to the necessity for maintaining a moderate airspeed during the descent. Maintaining a low airspeed to reduce r. p. m. of an uncontrolled propeller has been for many years the basic procedure in use for reciprocating engine-propeller combinations and is widely known. Despite this, the captain ordered that an emergency descent be executed. The Board concludes that had a moderate airspeed

been maintained, failure of the propeller as subsequently happened would not have occurred.

Blade retention failure of the windmilling No. 4 propeller occurred when the aircraft was at approximately 9,000 feet altitude and at nearly the maximum permitted airspeed. According to information from the propeller manufacturer, based on the calculated blade retention strength and tests of the propeller, failure of this nature would be expected under approximately these circumstances. There were no indications of faulty material or workmanship.

Failure to obtain power from the No. 3 engine and the subsequent fire warning after leveling off at the lower altitude were the direct result of damage inflicted by the No. 2 blade of the No. 4 propeller when it became detached.

#### Findings

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

1. The aircraft and both pilots were properly certified for the flight involved.
2. The aircraft was loaded within allowable limits as to the amount and distribution of weight.
3. Weather was not a factor in this accident.
4. The driven bevel gear bushing of the bevel box drive turned and became displaced.
5. The driven bevel gear of the bevel box drive then failed from fatigue.



6. Failure of the bevel gear stopped rotation of the fuel pump, oil pump, and propeller control unit.

7. The engine, without pressure lubrication, was rotated by the propeller until the high-speed pinion failed, decoupling the propeller from the engine.

8. Failure of the high-speed pinion so damaged the propeller oil transfer housing that subsequent attempts to feather were ineffective.

9. An emergency descent was executed at nearly maximum airspeed.

10. During this high-speed descent r. p. m. of the windmilling propeller increased until loads imposed exceeded the designed blade retention strength and the propeller failed.

Probable Cause

The Board determines that the probable cause of this accident was the inflight separation of the No. 4 propeller as a result of excessive loads induced by a descent at too high an airspeed while the propeller was windmilling decoupled from the engine and its r. p. m. was known to be uncontrolled.

BY THE CIVIL AERONAUTICS BOARD:

/s/ JAMES R. DURFEE

/s/ CHLHN GURNEY

/s/ HARMAP D. DENNY

/s/ G. JOSEPH MINETTI

# S U P P L E M E N T A L   D A T A

## Investigation

Upon being notified of the accident on July 9, 1956, the Civil Aeronautics Board communicated with the Department of Transport of Canada and by mutual agreement between the Canadian and United States governments a joint board of inquiry was convened to investigate the accident in accordance with the separate requirements of the respective countries.

## Air Carrier

Trans-Canada Air Lines is a Canadian company engaged in scheduled air transportation in Canada and foreign countries, with authorization to operate as a scheduled air carrier over the route involved. Headquarters of the company are located in the International Aviation Building, Dorchester Street, Montreal, Quebec, Canada.

## Flight Personnel

Captain R. D. Smuck, age 40, held a valid Airline Transport Pilot License, No. AT 510, issued by the Canadian Government. He had a total of 9,714:38 flight hours since employed by TCA, of which 317:59 were in Viscounts, and was qualified to command Viscount aircraft.

Captain A. C. Adamson, age 34, held a valid Airline Transport Pilot License, No. AT 111, issued by the Canadian Government. He had a total of 9,975:59 flight hours since employed by TCA, of which 218:26 were in Viscounts, and was qualified to command Viscount aircraft.

Miss Rita Ann Tobin and Miss Sheila Martha Thomson were employed by TCA as stewardesses on August 4, 1954, and May 25, 1955, respectively. Both had received the usual training provided by TCA for cabin attendant personnel.

The Aircraft

Viscount aircraft CF-TGR, type 724, serial No. 55, was manufactured by Vickers-Armstrongs (Aircraft) Ltd., Weybridge, Surrey, England, and was delivered to Trans-Canada Air Lines on June 23, 1955. Its certificate of airworthiness, No. 4866, was currently effective. The aircraft had been flown a total of 2,586 hours. It was powered by four Rolls Royce Dart 506 engines, equipped with Rotol R 139/4/20-4/17E propellers.

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