CIVIL AERONAUTICS BOARD

AIRCRAFT ACCIDENT REPORT

ADOPTED: June 11, 1964 **RELEASED.** June 17, 1964

CONTINENTAL AIR LINES, INC.
VICKERS VISCOUNT 812, N242V
MUNICIPAL AIRPORT, KANSAS CITY, MISSOURI
JANUARY 29, 1963

SYNOPSIS

Continental Air Lines Flight 290, a Viscount 812, N242V, a regularly scheduled flight from Midland, Texas, crashed at the Kansas City Municipal Airport, Kansas City, Missouri, at 2244 c.s.t., January 29, 1963. All the occupants, three crew members and five passengers, received fatal injuries and the aircraft was destroyed by impact and subsequent fire.

After making a straight-in approach to land on runway 18, in visual flight conditions, the aircraft continued to fly over the runway in a nose-up attitude without touching down. Near the south end of the runway, from an altitude of approximately 90 feet, the aircraft nosed over sharply, wings level, and dived into the ground. The main wreckage came to rest 680 feet beyond the end of the runway.

The Board determines that the probable cause of this accident was an undetected accretion of ice on the horizontal stabilizer which, in conjunction with a specific airspeed and aircraft configuration, caused a loss of pitch control.

Investigation

Continental Air Lines Flight 290 (CAL 290) a Vickers Viscount 812 aircraft, N242V, crashed following an approach to landing at Kansas City Municipal Airport, Kansas City, Missouri. The accident occurred at 2244 1/ January 29, 1963. All the occupants, three crew members and five passengers, were fatally injured and the aircraft was destroyed by impact and subsequent fire.

The crew originated and flew CAL Flight 281 from Dallas to Midland, Texas, with an intermediate stop at Fort Worth. A Federal Aviation Agency operations inspector conducted an en route flight check during this trip and stated that the flight was normal and routine. The crew transferred to N242V and originated CAL Flight 290 from Midland, Texas.

Continental Air Lines Flight 290 was a regularly scheduled operation between Midland, Texas, and Kansas City, Missouri, with intermediate stops at Lubbock and Wichita Falls, Texas, and Lawton, Oklahoma City, and Tulsa, Oklahoma.

1/ All times herein are central standard time based on the 24-hour clock, unless otherwise identified.

The flight crew consisting of a captain and first officer, were properly certificated, currently qualified, and regularly employed by Continental Air Lines.

The preparation for flight from Midland to Kansas City was routine. The weath forecast issued the crew included the following significant information. The Continental Air Lines' Terminal Area Forecast transmitted at 1445 m.s.t., for Kansas City was: 2,000 feet scattered variable to broken, 3,500 feet overcast, visibility 10 miles with occasional very light snow, wind north to north-northwest at 10 knots gusting to 20 knots. At 1900, 3,500 feet scattered variable to broken, 10,000 fee broken; visibility 10 miles, wind north-nortnwest 15 knots gusting to 22 knots. At 2100; little change, wind northwest 15 knots, temperature range 25° to 5°F. The Continental Air Lines Conditions Aloft Forecast valid until 0200, January 30, 1963 predicted "moderate to heavy mixed icing below 5,000 feet in southern Kansas and Oklahoma."

The flight proceeded as scheduled with no reported difficulties to Tulsa, Okl homa, arriving at 2120.

After its arrival at Tulsa the aircraft was serviced with 1,391 pounds of fue No other maintenance was requested or performed Information furnished the pilot showed the takeoff weight to be 57,483 pounds which included 11,040 pounds of fuel and 9,030 pounds of payload. Both the gross weight and center of gravity (c.g.) w computed to be within allowable limits at takeoff.

CAL 290 departed Tulsa at 2154. The flight was cleared under Instrument Flig Rules (IFR) to the Butler, Missouri VOR, via Victor 161 (airway), to maintain 9,0C feet until reaching the Watova Intersection, then to climb to and maintain 11,000 feet. After takeoff CAL 290 was provided radar vectors to intercept Victor 161 ar was released to the control of the St. Louis Center after passing Watova.

The flight was routine until the landing approach. Approaching Kansas City, a radar handoff from St. Louis Center to Olathe radar approach control was accompl and the flight given further clearance to descend. The flight was directed to cr Pleasant Hill Intersection and maintain 5,000 feet. The altimeter setting was gi as 30.24. The crew reported leaving 9,500 feet at 2225. After reporting passing Pleasant Hill at 5,000 feet the flight was turned over to Kansas City Approach Co and instructed to maintain 5,000 feet, depart Blue Springs (VOR) on a heading of degrees, which was a radar vector to the Instrument Landing System (ILS) final ap course. The altimeter setting was given as 30.32, the wind 360 degrees at 9 knot and the flight was instructed to circle and land on runway 36. These instruction were acknowledged and tne crew requested the altimeter setting be repeated This was done and the crew ackrowledged with the correct setting. The flight was then cleared to 2,500 feet, vectored to a point one mile north of the outer marker on final approach, and transferred to the local controller who cleared the flight to land. The flight crew questioned the controller whether this landing clearance w for a straight-in landing. The controller advised them they could make a straigh in landing if they wished and gave the wind as 360 degrees at 6 knots The crew replied that they would land straight in on runway 18. This was the last transmi received from the aircraft.

Flight 290 was observed executing an approach from the ILS outer marker to runway 18. After passing the runway threshold, approximately 80 feet above the ground, the aircraft flew over the 7,000-foot long runway in what appeared to be a go-around. A climbing attitude was observed accompanied by engine sounds similar to those normally associated with a Viscount go-around or takeoff. The main landing gears were noted, by a number of witnesses, to be in the down position. According to the flight recorder the airspeed was approximately 132 knots as the aircraft crossed the runway threshold and was relatively constant until about 700 feet past the threshold when there was a deceleration to 118 knots with no loss of altitude.

The altitude remained nearly constant until about 3,000 feet down the runway, at which point the aircraft descended to about 50 feet. It then ascended to an altitude of 90 feet from which it nosed over into the ground.

The airspeed reached its minimum value of 118 knots about 2,200 feet south of the approach end of runway 18 and then increased steadily until it reached 138 knots at the time of the nose-over.

From a position approximately 750 feet south of the approach end of runway 18 to the point at which the aircraft nosed over, there is little variation of the acceleration (G) trace.2/ However, at the time the nose-over occurred the trace shows a negative excursion which was terminated at -0.9G by the impact.

During the flight over the runway the aircraft's heading remained within 2 degrees of the published ILS localizer heading of 184 degrees magnetic

Shortly after passing beyond the south end of runway 18 the aircraft nosed down sharply, and crashed, and burned. (See Attachment #1.) A witness approximately 200 yards from the impact area stated that the aircraft nosed over very sharply into a steep dive but that the nose was rotating upwards just before impact. The aircraft struck a mound of dirt, (blast mound).3/ The point of initial contact of the nose gear was approximately 23 feet right of the extended runway centerline and 284 feet beyond the south end of runway 18 on a heading of about 184 degrees magnetic. The attitude of the aircraft at impact was more than 22 degrees below the horizon, wings level. The initial impact point was clearly shown, in the mound, by the imprint of the nose gear, all four engines, and the leading edge of the wing.

The aircraft slid over the crest of the blast mound, sailed over the perimeter road, struck the side of a river dike, and skidded over the top of the dike towards the Missouri River. The main fuselage and major portion of the wing came to rest

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2/ Acceleration "G" trace is the marking on the foil of the flight recorder tape that reflects the acceleration of the airplane in a direction perpendicular to its planform.

3/ The blast mound was a large mound of dirt that shelters the airport perimeter road from jet blast and propeller wash of aircraft taking off on runway 36.

680 feet beyond the south end of runway 18. The wreckage was distributed over an area approximately 600 feet long and 230 feet wide along a general line of 184 degrees magnetic. All major components of the aircraft were found in the wreckage area.

Examination of the recovered control surfaces showed that they were properly attached and operational. The available control linkage was examined and found to have been intact at impact with no evidence of binding or interference to normal movement. The elevator trim was established as near neutral at impact by measurement of the aft chain cable fastener. The gust lock control handle in the cockpit was found partially extended from the stowed position; however, the connections between the gust locks and the cockpit control were severly damaged by the crash and ensuing fire. The elevator gust lock assemblies were disassembled and inspected There was no evidence of fretting, binding, or malfunction.

Examination of the landing flaps, their slides, the gear box, and the flap selector components revealed that the flaps were at 32 degrees at impact, and furth that the last travel of the flaps had been from a more extended position. The emergency flap selector and emergency flap drive switch were safetied "off."

The nose landing gear, having separated from the aircraft, was found on the north side of the river dike. Damage to the surrounding structure showed the nose gear was just out of the down and locked position at impact. The main landing gears were found in the down position. The down locks of the right gear were in the locke position but the down locks in the left gear were 9/16 of an inch out of the locked position. The landing gear selector valve actuator shaft was found in the retracte or "up" position as was the landing gear selector valve slide. The manual bypass valve was found closed. The landing gear handle was in the "up" position.

Recovered components of the aircraft systems including the autopilot, fuel system, de-icing system, flight control, and the hydraulic system showed no evidence of other than impact damage, except the high pressure hydraulic filter cap retainin bolts. Three of the eighteen bolts in each filter cap were broken. Laboratory examination indicated that one and possibly two of these bolts showed evidence of fatigue failure. There was evidence of fire between the cap and the filter body ne the failed bolts. The engine drive hydraulic pumps were disassembled and both rotated freely with no signs of failure or lack of lubrication.

The autopilot controller, elevator main surface servo, rudder main surface ser and associated wiring aft of the pressure bulkhead were given a functional test whi indicated normal operation was available. The pitch control section of the pedesta controller had broken away from its mounting and could not be tested. The mechanic autopilot connections between the elevator and rudder were in place and secure. Al other components of the autopilot system were either destroyed or their indications could not be determined due to crash damage.

The elevator trim was set 1/4 unit nose up; rudder trim neutral; throttles were in intermediate positions; the No. 1 high pressure shut off lever was 1/2 inch aft of the open detent and all others were in the open detent; the low stop disengage lever was aft; and the emergency high stop disarm switch was safetied "off."

The aircraft radios were tuned to the appropriate frequencies for an approach to Kansas City.

The position of the jet-pipe hot air door actuators and heat exchanger bypass valve actuators indicate that the airfoil anti-icing heat was not being used at impact.

Examination of the engines showed no evidence of fire prior to impact. All mount tubes and fittings showed typical impact bending failures with no indication of fatigue failures. None of the engines showed evidence of operational distress, a lack of lubrication, abnormal wear, or in-service failure. All engines showed evidence of damage to rotating parts, caused by impact or ground fire.

Propeller blade angles were measured and all were found to be 34 degrees on impact. The propeller blades were bent forward in angles varying from 5 degrees to 45 degrees and there was no evidence of any fatigue or in-flight fracture of any propeller blade. The propeller control units showed no evidence of in-flight failure or operational distress. All damage was identified as having been caused by impact or ground fire. A series of four successive propeller blade slash marks made by the four rotating propellers were found near the point of initial impact These slash marks were equally spaced 36 inches apart, indicating that the four propellers were rotating at the same RPM. Computations based on the airspeed at impact of 138 knots, and a propeller blade angle of 34 degrees indicates that 15,000 engine r.p.m. was being maintained

No evidence was found of operational distress or pre-impact malfunction of any engine driven or electrical drive accessories

Three instruments were recovered from the cockpit The pilot's altimeter, set at 30.23, the copilot's altimeter, set at 30.37, and the copilot's flux gate compass indicator which read 170 degrees.

One piece of cargo, a power package assembly, which in normal use contained nitrogen under pressure, was examined for indications of inflight explosion, but none was found.

A toxicological examination of flight crew members produced no evidence of carbon monoxide, alcohol, drugs, or food poisoning. No determination could be made as to the heart conditions of the pilot and copilot.

The flight recorder was recovered after approximately two hours exposure to ground fire. It did not appear to have received severe impact damage and the fasteners were locked and safetied. A readout of the recorder tape revealed that fifteen minutes before the crash there were nearly continuous excursions of the "G" trace ranging generally from a $\pm$ 0.2G from the normal mean of 1.0G. These excursions stop about six minutes before the crash The altitude trace showed a descent from 6,000 to 3,750 fe m s.l., and the airspeed indicated an erratic decrease from 255 to 198 knots during this period of time. The heading trace indicated a heading change from approximately 360 to about 295 degrees, 2-3 minutes before the crash the heading stabilized on the inbound, ILS localizer heading. Approximately 70 seconds before the crash the altitude trace shows a break in the descent approximately 100 feet above the runway elevation when the airspeed trace was indicating about 140 knots Following this both the altitude and airspeed decreased slowly. The altitude trace showed a descent to about 80 feet above the runway threshold and the airspeed trace indicated a decrease to 132 knots at that point. From the threshold on, the flight continued as previously described.

Runway 18 at Kansas City Municipal Airport is 7,000 feet long, 150 feet constructed of concrete. Airport lighting consists of a rotating green and beacon, approach, runway and taxi lights with a lighted wind tee. All light manually controlled with variable intensity of the approach and runway light available. All the airport lighting was on and operating satisfactorily dur the time of the arrival of CAL 290. The runway was clear and dry at the tim the accident and tower personnel on duty observed no animals or vehicles on runway that would have interferred with the landing of this flight. Three d sional photographs and a search of the approach zone showed no evidence of c with ground objects. There was no evidence of an in-flight collision with b

The airport was equipped with an Instrument Landing System for landings runway 18. The inbound heading of the ILS localizer is 184 degrees magnetic 3-degree glide slope intercepts the outer marker, which is 5.5 nautical mile the approach end of the runway, at 2,558 feet m.s.l. An FAA flight check pe on January 30, 1963, showed all components of the ILS operating properly.

A weather observation made at Kansas City Municipal Airport by the U. S Bureau 13 minutes prior to the accident showed the weather to be measured c 3,000 overcast; visibility 12 miles; temperature 17 degrees; dewpoint 8 degr wind north 10 knots, altimeter setting 30.32 Another observation made 3 mi after the accident was the same except that the wind was north-northwest at

A weather bureau witness testified that light rime ice 4/ was possible clouds along the route from Tulsa to Kansas City and a layer of moderate ic: tions might have existed in the Kansas City area. Heavier icing could be ex east of the Kansas City area.

Pilot statements indicated that an icing layer existed in the Kansas C from the cloud tops (6,000 feet m.s.l.) to their bases at approximately 3,5(m.s.l. CAL 290 was in this icing region 8 to 10 minutes. The temperature region ranged from -2 to -12 degrees C. These pilots operated other aircra the Kansas City area, shortly after the accident, and reported light to mod icing during letdowns and climbs.

The Continental Air Lines Viscount Aircraft Flight Manual prescribed t] ing procedures for use of the anti-icing systems.

1. Airfoil Anti-icing "ON" prior to entering icing conditions.

2. Do not operate Airfoil Anti-icing System on the ground

4/ The terms "light" and "moderate" icing are defined by the U. S. Wea Bureau as follows. Light icing is an accumulation of ice which can be disp of by operating de-icing equipment and presents no serious hazard to flight will cause no alteration of speed, altitude or track. Moderate icing is an mulation of ice for which de-icing procedures provide marginal protection ice continues to accumulate but not at a rate sufficiently serious to affec safety of flight unless it continues over an extended period of time. Rime is an opaque white ice of granular structure.

3. Do not operate continuously in flight at temperature above 10°C.

4 Wing (and tail) heat "OFF" for landing.

5. Windshield Anti-icing will be on "LOW" at all times for bird-proofing.

6 The powerplant anti-icing system may be turned on and left running in flight. It must be turned on prior to entering icing conditions

Two Continental Air Lines pilots testified regarding the use of the anti-icing system of the 812 model Viscount. They stated that the system is to be used before entering an icing condition, and they both indicated that they had encountered no icing problems with anti-icing system turned on.

One captain testified concerning an incident 5/ involving undetected structural icing of a Viscount 812 in the Colorado Springs area on February 20, 1963. When 40 degrees of landing flaps were selected, from the 32-degree position, at 145 knots, landing gear down, the aircraft became extremely nose heavy and he had to request that the first officer assist him in bringing the nose back to the desired descent angle. The nose steadied for a very short period of time and then went to an extreme nose high attitude, again requiring the efforts of both pilots on the controls to force the aircraft back to the approach attitude. A second series of similar oscillations occurred at approximately 130 to 135 knots and then the aircraft began to handle in a normal manner with no more control difficulties encountered during the remainder of the approach and landing

After landing, the aircraft was examined and light rime ice was found on the wings and radome, the propellers were clean and dry, and the horizontal stabilizer and vertical stabilizer had a concave, cup-shaped buildup of rough rime ice, approximately one-inch thick with horns extending diagonally upward and downward approximately one and one-half inches into the airstream. (See attachment #2.)

A review of the weather encountered by this flight showed that the flight operated in clouds for approximately 10 minutes. The temperature in the clouds varied from -3°C at 7,000 feet m.s.l to -5°C at cruising altitude, 10,000 feet. Propeller, windshield, and engine cowling anti-icing equipment was used but airfoil anti-icing was not turned on. The crew checked the aircraft visually when clear of the clouds at cruising altitude and saw no ice. The total time in clouds following this observation was estimated by the captain to be approximately 2 minutes The flight recorder tape from this trip was forwarded to the Civil Aeronautics Board for examination The readout showed that the aircraft lost approximately 200 feet during the approach oscillations and the acceleration reached a maximum of -.76G and ∱ 2.3G before control was regained.

Wind tunnel tests by the manufacturer to investigate the effects of various ice formations on the handling characteristics of the aircraft disclosed that horn type ice formations can be developed on the leading edge of an unheated airfoil in an ambient temperature range of -5°C to -10°C.

5/ Reference Aircraft Incident Report DEN 63-65, Continental Air Lines, Inc., Vickers Viscount 812, N250V, February 20, 1963.

In this temperature range the tests indicated that the time required to produce 1-1/2 inch horn lengths was about 20 minutes with the continuous maximum liquid water concentration required by the British Civil Airworthiness Requirement (BCAR), or ten minutes with twice this concentration of water. This water concentration is 0.72 grams per cubic meter with a mean water droplet size of 20 microns.

The manufacturer's wind tunnel tests, indicated that horn type ice of the above magnitude on the horizontal stabilizer leading edge had a severe effect on the handling characteristics of the test vehicle under conditions where a large angle of attack was obtained on the horizontal stabilizer. The aircraft anti-icing system has demonstrated capability to prevent the formation of horn type ice or to shed the ice if it has been allowed to form before anti-icing is turned on 6/ These tests indicate that small isolated runback refreeze areas would occur on the tail if severe ice were allowed to accrue and then normal heat was applied. The amount of runback icing collected during the test, however, produced no significant lift distribution or hinge moment changes.

A study of the flight profile of CAL 290 revealed that the airspeed was higher than recommended on the final approach. Normal speed for this landing was 111 knots with 32 degrees of flaps and 108.5 knots with 40 degrees of flaps. Deceleration of this aircraft was compared to manufacturer's data to determine how the rapid decrease from 131 knots to 119 knots may have been accomplished. In level flight at constant power extending the flaps from zero to 47 degrees (maximum extension) gives deceleration of 0.86 knots per second. A sudden power reduction in level flight, from the power required to maintain altitude, to flight idle 7/ and 32 degrees of flaps extended, gives deceleration of 3.1 knots per second. The aircraft deceleration was 1.73 knots per second, approximately halfway between those two figures.

Previous Viscount accident and incidents that involved flight in icing conditions were reviewed during this investigation. One incident occurred when flaps were selected to 40 degrees on the final approach to Willow Run Airport, Michigan As the flaps extended, the nose of the aircraft went down and up elevator application did not stop the nose down movement, and in fact, seemed to accelerate the travel Flaps were immediately retracted to 32 degrees and pitch control was regained. The landing was accomplished without further difficulty. Examination of the aircraft showed an ice formation on the horizontal stabilizer leading edge described as a scave buildup.

Two other Viscount accidents were reviewed where icing was considered to be a factor. One was a result of a multiengine flame-out and in the other accident the type of icing was not identified

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6/ With the airframe anti-icing system operating normally, the complete heated areas on upper and lower surfaces can be maintained clear of ice. Small isolated runback ice accretions will occur behind the heated area. With one heat exchanger inoperative enough heat is available to keep the leading edge clear of ice, although a spanwise ridge of runback ice will form (on the heated area). If horn-like projections are allowed to build up they can be shed within one minute after application of heat to the tailplane.

7/ Flight idle is the minimum engine RPM (11,500)

The possibility of the propellers going into ground fine in flight was examined as a possible cause of the sudden nose-over of CAL 290.

Tests were conducted in a Viscount after this accident which revealed that with all protective devices removed, the propeller blade angle will not fine off 8/ to the critical range and cause a pitch down when aborting a landing and initiating a go-around under the conditions that existed in this accident.

At the accident hearing a Vickers representative testified regarding the possibility of any of the pitch control systems of the aircraft inducing a nose-over of this magnitude. His testimony indicated that with the elevator fixed and incapable of movement the elevator servo tab and elevator trim tab were each capable of providing the equivalent of one degree of elevator deflection nosedown. He said that this amount of deflection would be insufficient to force the aircraft into a 22-degree nosedown descent angle in the altitude available at the time of the accident.

The autopilot is limited to 2.5 degrees elevator angle at 136 knots and 3.5 degrees at 109 knots. To rotate the airplane to more than 22 degrees nosedown, utilizing autopilot input only, requires at least 350 feet of altitude.

Pilot application of full nosedown elevator, can rotate the airplane to more than 22 degrees nosedown from an altitude of 125-150 feet above the ground at an IAS of 136 knots.

Analysis

The investigation showed that the aircraft was properly loaded, dispatched, and in an airworthy condition. The crew was properly certificated, trained, and regularly employed by Continental Air Lines, Inc Crew rest requirements before this trip had been met and there is no evidence of any crew incapacitation.

No evidence could be found to indicate a collison with any object either airborne or ground installed

Air traffic control communications, transcripts, and witness statements indicate that the flight was normal until the aircraft reached a point at or near the outer marker. From the outer marker to the threshold of the runway the flight was operated in VFR conditions and did not conform to the recommended procedures for a straight-in ILS approach The airspeed was consistently high and the altitudes were maintained well below the glide path until just prior to reaching the runway, however, tower personnel indicated that the approach did not appear unusual to them

A go-around was not initiated at or near the runway threshold. The airspeed and altitude of the aircraft remained nearly constant for approximately the first 750 feet of travel over the runway. This was followed by a sharp reduction in airspeed with little change in altitude which continued to a point approximately 2,400 feet down the runway. This decrease in airspeed was probably accomplished by a reduction in power in conjunction with an extension of the flaps. Reviewing the deceleration available to the pilot by extension of the flaps it is noted that no flap extension,

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8/ "Fine Off" is a British term referring to propeller blade angle as it moves toward its minimum angle or flat pitch.

even zero to 47 degrees, will give a deceleration in excess of 0.86 knots per second. However, if the power is suddenly reduced to flight idle from that required for level flight, with the flaps extended to 20 degrees, there will be a deceleration of 2.8 knots per second. If this power reduction is accomplished with 32 degrees of flaps extended, a deceleration of 3.1 knots per second will occur. The aircraft decelerated at 1.73 knots per second. Therefore, the deceleration was not generated by a complete power reduction and could not have been generated solely by flap selection. At the same time the altitude remained nearly constant for approximately 3,000 feet down the runway then decreased to the minimum value of approximately 60 feet above the ground about 5,000 feet down the 7,000-foot runway. The Board relieves the crew initiated a go-around at this time, but the prescribed go-around procedures were not followed. The flaps were not retracted to the 20-degree position as required by the flight manual and the gear remained extended throughout the flight down the runway. The gear may have remained extended due to the previously mentioned failure of the hydraulic system. A normal go-around should have included full power, flaps retracted to 20 degrees, and landing gear retracted when a rate of climb was established. That these procedures were not followed indicates the crew had a problem, which in their opinion, made it unsafe to land the aircraft. Further, that problem, or an additional one, required deviations from the prescribed go-around procedures.

The flight over the runway as depicted by the flight recorder showed the aircraft accelerated at 0.9 knots per second to 138 knots and gained approximately 30 feet of altitude before pitching over. With all engines operating normally, excess thrust would have been available above and beyond that required to maintain a steady state, unaccelerated flight The aircraft should have been able to climb 960 feet per minute with the landing gear down and flaps extended 40 degrees. With 32 degrees of flaps and gear down the rate of climb should have been 1,160 feet per minute. Therefore, the fact that the aircraft did not climb appreciably indicates either that the crew did not apply full power or there was a drag factor which kept the aircraft from performing normally.

From the outer marker to the field the aircraft was making a VFR approach and the evidence indicates they were significantly below the ILS glide path until shortly before it crossed the runway threshold. This can best be described as a low, flat approach. If the crew was having any difficulty at this time they made no apparent attempt to execute a go-around. When they reached the runway threshold they were in a position to land. Even though the airspeed was 22 knots higher than prescribed, they were within 80 feet of the ground. With no obstructions on the runway the only reasons for the crew's failure to land must have been either an unsafe landing gear indication or a misjudged landing approach due to the relatively long, low, flat, high speed, down wind, final approach. An unsafe landing gear indication could have been the result of hydraulic leaks in the high pressure hydraulic filters at the points where the filter cap bolts failed. These same leaks may also provide one reason for the crew's apparent failure to retract the landing gear. The cockpit landing gear control indicated that the gear had been selected up, the nose gear was just out of the down and locked position, and the landing gear locks on the left main landing gear were slightly withdrawn from the locked position. It is possible that the crew had selected the gear up but the lack of hydraulic pressure had only removed the lock from the nose gear and partially removed the lock from the left main landing gear before the system failed. There is nothing in the evidence to indicate that, at this point, the crew was having a pitch control problem. There were no erratic maneuvers. The pilot increased his descent angle at approximately the time he intercepted the glide slope of the ILS from underneath and he

apparently had an adequate amount of control and power necessary to establish a constant altitude from the Bluff Fan Marker to the runway. During this time neither crew member made any radio transmission.

The flaps were found to have been at the 32-degree position at impact and they had reached that position by being retracted rather than by being extended. The nose landing gear had been knocked off the aircraft but the damage to the surrounding structure indicated that it was not locked down at the moment of impact. The left main landing gear was down with the locks withdrawn 9/16 of an inch and the right main gear was down and locked.

The testimony at the hearing indicates that it would not have been possible to cause a noseover rotation of the aircraft, of the magnitude required for this accident, through the use of the trim tab or the flying tab with the elevator in an immovable position. Further, the autopilot was not capable of creating such a noseover rotation within the altitude that is known to have existed at the time of this accident. The only ways the aircraft could pitch down to an attitude of more than 22 degrees below the horizontal, in the altitude available, was by a loss of down loading on the horizontal tail surfaces, or by pilot induced maneuver. There is no evidence to indicate that such a pilot induced maneuver did occur. The testimony at the hearing indicated that horn shaped or concave ice formations on the leading edge of the horizontal stabilizer can produce a strong nosedown pitching moment when flaps are lowered This type of ice was reproduced in tunnel tests by the manufacturer. It is known that a negative angle of attack of the horizontal tailplane increases with a given airspeed with an increase in flap angle; a given flap setting with an increase in airspeed, at a given airspeed and flap setting with a reduction in weight. Each of the above conditions requires more negative lift on the tailplane to maintain longitudinal trim. A stability test performed by the manufacturer showed conclusively that horn shaped ice formations can produce drastic reduction in the maximum negative lift obtained by the horizontal tailplane and the tailplane approaches a stall condition. Because of the criticality of the shape of the ice, the results of the test were necessarily qualitative. Little could be gained quantitatively. It was found, however, that for a particular shape of ice which could be trimmed against at a zero-degree flap setting at a constant speed, a serious nosedown pitching moment could occur at 20 degrees of flaps. Similarly, a shape which could be trimmed against at any flap angle could produce a lessening of tailplane lift at any higher flap angle. Also, a shape which could be trimmed at a given flap angle and speed could produce a nosedown pitching moment at some higher airspeed.

In addition, the tests revealed that with the reduction of negative lift there is a change in lift distribution such that elevator hinge moments (and therefore wheel force) are increased more than normal as up elevator is applied to counteract the pitch. Additionally, up elevator could increase the flow separation to the point of reducing tail load still further, resulting in a sharper nosedown pitching moment.

The fact that the aircraft was accelerating and climbing in a normal attitude negates the possibility of a wing stall

Furthermore, the evidence indicates that the powerplants were operating in a 15,000 r.p.m. range at impact and that the propellers were in the flight range The flight tests conducted by the manufacturer indicated that even if the low pitch stops had been removed the aircraft was still capable of executing the go-around maneuver without any loss of control and that the propellers would not go into flat pitch causing an abrupt nosedown.

The majority of this flight was made clear of all clouds However, the evidence indicates that moderate icing was possible in the clouds in the Kansas City area from 6,000 feet down to approximately 3,500 feet. While no determination can be made of water droplet size or water density in the cloud, the temperature ranges in the cloud were those which have been established by tunnel tests as having been conducive to the formation of horn type rime ice. The tunnel testing indicated that from 10 to 20 minutes was required to establish horn-like ice formations of the size described by witnesses However, a Continental Air Lines pilot's testimony indicates that this type of ice formation can occur within 2 or 3 minutes. CAL 290 was in icing conditions from 6-8 minutes, long enough to have accumulated ice as described by other Viscount crews and developed during the tunnel tests. The testing by the manufacturer indicates that the operation of either one of the two heat exchangers produces sufficient heat at the tailplane to prevent icing even under the extreme conditions tested. Heat applied following a buildup of horn type ice will remove the ice in one minute or less. Runback ice may form under certain conditions of de-icing (as opposed to anti-icing), and during the tests ridges of as much as 3/4 inch was produced. These tests did, however, show that there was no appreciable change in elevator hinge moment from this type formation. The weather information furnished to the crew indicated moderate to heavy icing over southern Kansas and Oklahoma, but did not call for icing in the Kansas City terminal area However, the terminal forecast did indicate cloudiness in the Kansas City area with sub-freezing temperature at the surface. Assuming that the captain followed the established company procedure for using the windshield heat in the low position throughout the flight it is possible that no ice would form on the windshield. This is normally the first indication the crew has that ice is forming on the aircraft. Testimony and testing have indicated that the only way a horn type of ice formation could occur on the horizontal stabilizer would be if the de-icing system were not used in flight through the clouds, or if the system had failed and no heat was provided to the tail surfaces. There is no evidence to substantiate a failure of the anti-icing system. The crew should have expected icing in the clouds However, as was the case with the Colorado Springs crew, if the windshield anti-icing system was on they may never have seen any indication of ice on the aircraft and therefore not turned on the airfoil anti-icing system.

The aircraft was subjected to an extremely rapid nosedown pitching moment that could only have been applied by nosedown elevator or by a loss of down loading on the tail. However, altitude was not sufficient to allow the required amount of pitch down by pilot actuated elevator control alone None of the other pitch control mechanisms on the aircraft could have provided sufficient rotation to force the aircraft into a 22-degree nosedown pitch attitude within the altitude available at the time of the noseover.

The Board believes that flaps were lowered to 20 degrees at some point during the approach; most probably at or near the outer marker. The ice shape was such that this amount of flap, at the airspeed involved was not detrimental to aircraft trim. The remainder of the approach was made at 20 degrees of flaps until over the runway. When over the runway the power was reduced and the flaps were further extended probably to 40 degrees. When the crew realized that a landing could not be made, power was applied for a go-around, the flaps were raised to 32 degrees, and the gear handle was actuated. As the airspeed increased the nosedown pitching moment increased to a point where it could no longer be counteracted This may have been due to either a progressive loss of negative lift or a tail stall induced by extreme up elevator. At this point the aircraft pitched over and crashed.

In summary, the Board believes that CAL 290 accumulated ice during its descent to Kansas City. The airfoil anti-icing system was not turned on and the crew was unaware of the icing accumulation because the windshield anti-icing system was used continuously. In this instance the aircraft did not reach the angle of attack critical for the horn type ice formation being carried on the horizontal stabilizer leading edge, until it passed over the south end of the runway and the airspeed increased to approximately 138 knots. At this point a combination of airspeed and flap position resulted in an angle of attack at which the tailplane down loading was lost and the aircraft pitched over. Although the evidence indicates the pilot was attempting recovery when the aircraft struck the blast mound, the pitch over started in an altitude too low to render such action effective.

Probable Cause

The Board determines that the probable cause of this accident was an undetected accretion of ice on the horizontal stabilizer which, in conjunction with a specific airspeed and configuration, caused a loss of pitch control.

Corrective Action Taken

As a result of this accident the Federal Aviation Agency has taken the following corrective actions.

1. Issued an alert bulletin to all domestic Viscount operators and FAA regional offices advising that both airframe anti-icing heat exchangers should be turned on whenever the indicated outside air temperature is 10°C or below, if there is any possibility of encountering airframe icing.

2. Proposed amending all Viscount airplane flight manuals as follows·

   a. Requirement to use both heat exchangers whenever OAT is 10°C or below.

   b. A recommendation to carry higher power on inboard engines during descent to increase hot air mass flow to wing and tail surfaces. (Airframe anti-icing heat exchanger on the inboard engine)

Additional corrective action taken by the manufacturer included a flight manual change that required both heat exchangers to be on at all times when the indicated outside air temperature is $\neq$ 10°C or below unless it is certain that no icing conditions will be encountered.

Board Action

The Board is presently reviewing the evidence in the record of the investigation of an aircraft accident involving a Capital Airlines, Inc. Viscount 745, N7437 which occurred at Freeland, Michigan, April 6, 1958, to determine whether a change of the probable cause is appropriate.

BY THE CIVIL AERONAUTICS BOARD:

/s/ ALAN S. BOYD
Chairman

/s/ ROBERT T. MURPHY
Vice Chairman

/s/ CHAN GURNEY
Member

/s/ G. JOSEPH MINETTI
Member

/s/ WHITNEY GILLILLAND
Member

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

Investigation

The Civil Aeronautics Board was notified of this accident on January 29, 1963, and an investigation was immediately initiated under the provisions of Title VII of the Federal Aviation Act of 1958 as amended. A public hearing was conducted at Kansas City, Missouri, March 13-14, 1963.

Air Carrier

Continental Air Lines Inc., is a Nevada corporation with headquarters at Los Angeles International Airport, Los Angeles, California.

The Company operates as a scheduled air carrier under a currently effective certificate of public convenience and necessity issued by the Civil Aeronautics Board, and an operating certificate issued by the Federal Aviation Agency.

Flight Personnel

Captain Joseph W. Smith, age 47, held current airline transport rating No. 40606. He was qualified in DC-3, Martin 202/404, Convair 240/340/440, and Viscount 812 He possessed a current first-class medical certificate with no waivers or limitations. He had a total of 18,611 hours of flying time with 3,409 hours in the Viscount. His last proficiency check was given on October 5, 1962, and his last line check on the date of this accident

First Officer Sherl C. George, age 36, held a current airline transport rating No. 694251. He was qualified as a Captain in DC-3 aircraft and as a copilot in DC-3 and Viscount aircraft. He was issued a first-class medical certificate with no waiver or limitations on January 28, 1963 Mr. George had a total of 5,761 hours with 2,648 in Viscounts. His last proficiency check was accomplished October 5, 1962.

Both the captain and first officer had more than 24 hours rest before leaving Dallas, January 29, 1963.

The Aircraft

The aircraft, a Vickers-Armstrongs Viscount Model 812 N242V, manufacturing serial number 356 had a total of 12,860 hours flying time. The last major inspection was accomplished 3,317 hours before the accident, and the last line maintenance 58 hours before the crash

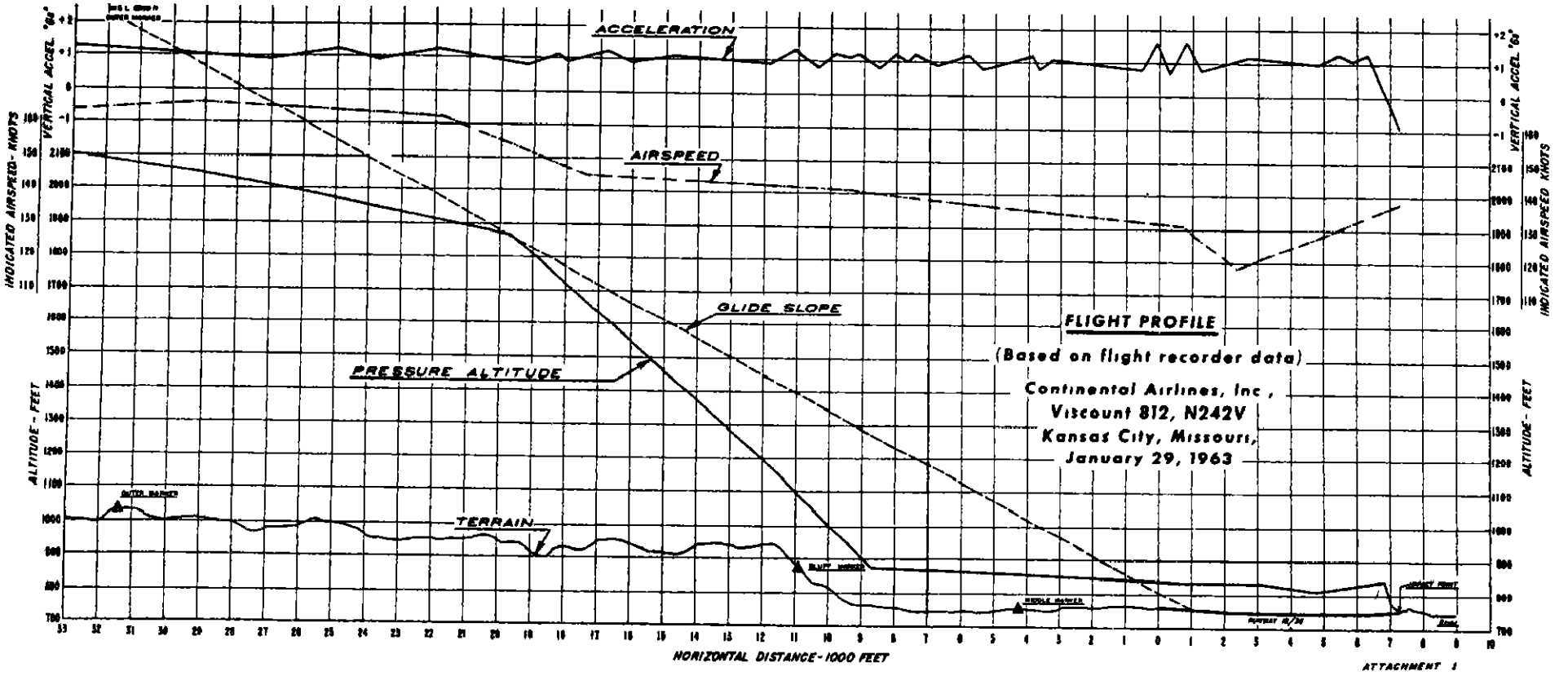
The Powerplants

The aircraft was powered by four Rolls-Royce Dart 525 engines with Rotol R/179/4-20-4/33 propellers. The engine total time and time since overhaul (TSO) were:

Engine No.	Total Time	TSO
1	9878·48	1146.11
2	9305 46	283.57
3	7592 18	1466:56
4	8964 41	2174:57

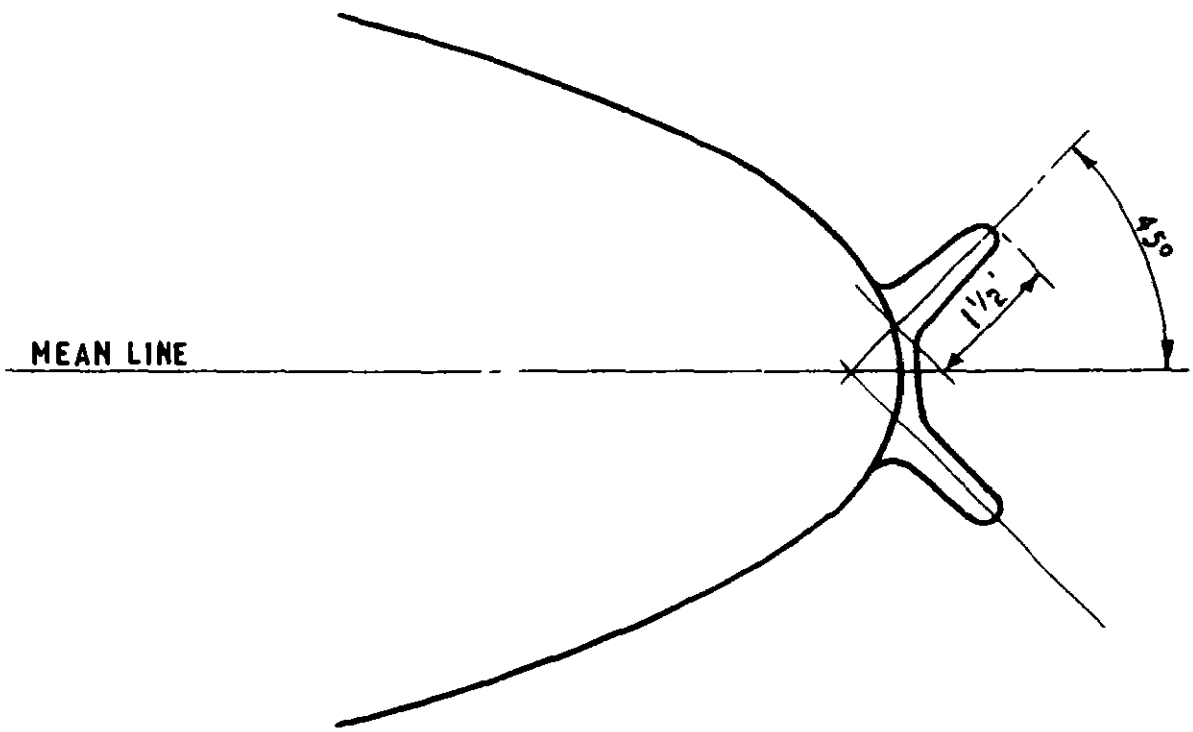
The propellers total time and TSO were:

Propeller No.	Total Time	TSO
1	10,695.40	1146 11
2	9880 24	2017 51
3	10,413 47	1483.49
4	8674 12	1960.03



ATTACHMENT 1

A TYPICAL PILOT SKETCH OF
HORN TYPE ICING

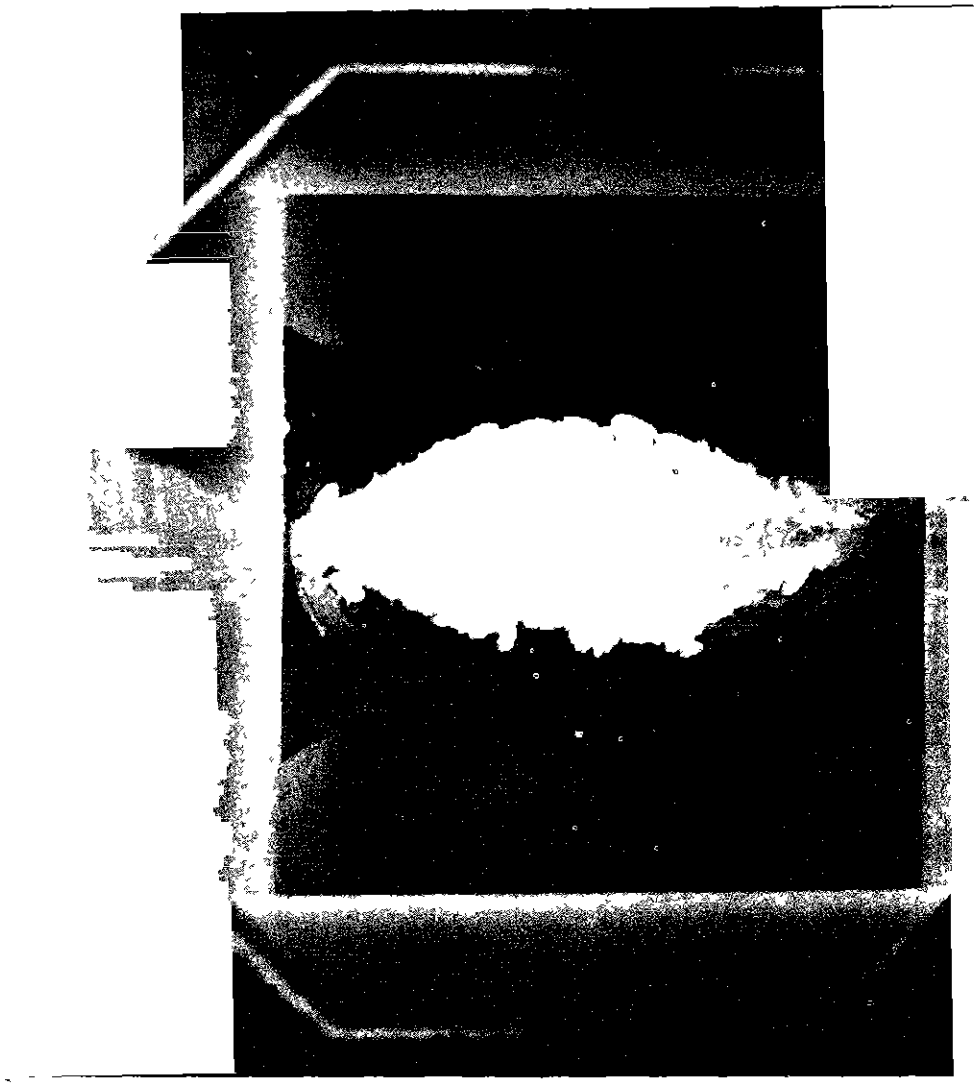


(b) PILOT'S SKETCH

SCALE ½

THE TAILPLANE AEROFOIL AT STN 76

FIG 1



Icing sample produced by Vickers-Armstrong wind tunnel test of 15 minutes duration with liquid water content of 1.5 grams per cubic meter, static tunnel air temperature - 8°C, tunnel airspeed 250 feet per second, with specimen air foil at 4° incidence (angle of attach), airfoil unheated.

A typical mid-span ice section from a wind tunnel test of 15 minutes duration with liquid water content 1.5 grams per cubic meter, static tunnel temperature -8°C, tunnel airspeed 250 feet per second, with airfoil at 4° incidence (angle of attach).