

## CIVIL AERONAUTICS BOARD

## ACCIDENT INVESTIGATION REPORT

Adopted: January 20, 1948

Released: January 21, 1948

## SLICK AIRWAYS, INC.—DENVER, COLORADO—FEBRUARY 14, 1947

## The Accident

A Slick Airways Curtiss C-46 all-cargo plane, NC-59486, en route from Omaha, Nebraska, to Denver, Colorado, crashed while making a practice approach on the Instrument Landing System (ILS) to Stapleton Airport, Denver, Colorado, at 0420,<sup>1</sup> February 14, 1947. The accident resulted in demolition of the aircraft and fatal injury to both pilots, the sole occupants.

## History of the Flight

NC-59486, hereinafter referred to as Aircraft 486, departed Chicago, Illinois, for Denver with a scheduled refueling stop at Omaha. Departure was made from Omaha at 0139 on a contact flight plan to the Denver Tower to cruise at 8,000 feet. At 0414, Aircraft 486 reported over the Watkins Fan Marker, 14 miles east of the Stapleton Airport, and requested permission to make a practice approach on the ILS. The Denver Tower approved the request and gave the surface wind as south-southwest ten miles per hour and an altimeter setting of 30.35 inches of mercury. The flight requested the frequency of the compass locators at the fan marker sites, and acknowledged after the tower advised that the frequency of the outer marker was 359 kilocycles and the middle marker 335 kilocycles. The last transmission from the aircraft was when it reported over the outer marker. In reply the tower cleared the aircraft to land and gave the surface wind as south-southwest ten miles per hour. The running lights of the aircraft were first observed by the Assistant Controller in the Denver Tower when the flight reported over the outer marker. The approach was continued, and appeared

normal, until the running lights were seen to disappear just short of Runway 21. Immediately afterwards the crash truck was alerted and directed to the scene of the accident.

## Investigation

The flight from Omaha to Denver had progressed in a normal manner. All en route position reports had been made and no malfunctioning of the aircraft or any of its components had been reported, nor were any revealed in the investigation.

The investigation disclosed that first contact with the ground was made by both wheels of the landing gear on the up-slope of a slight hill 218 feet past the middle marker antenna pole of the ILS and 3232 feet from the end of Runway 21. The wheels made straight tracks for a distance of 19 feet and the tracks progressed from slight impact marks to ruts that were about two feet wide and 9 inches deep at the ends. Approximately 8 feet beyond the ends of the wheel tracks were a series of propeller marks 2 to 4 inches deep and spaced approximately 4 feet apart. The tracks and propeller marks on each side were almost identical, indicating that the wings were approximately level at the time of first contact. About 6 feet beyond the last mark of the propellers the wheels struck the ground again leaving marks 4 to 8 feet long. Between the propeller marks and just before the crest of the hill was reached, which is 3 feet higher than the point of impact, the tail wheel struck the ground leaving a 32-foot track in the line of flight. Approximately 75 feet farther portions of the mud guard and engine cowling were found, with other parts of the aircraft having made a path along the ground up to the main portion of the wreckage located 840 feet beyond the first wheel marks. The main portion of the wreckage

<sup>1</sup>All times referred to herein are Mountain Standard and are based on the 24-hour clock.

was in an upright position and consisted of both wings, the tail group except for a portion of the left stabilizer, and the fuselage except the nose section, which, due to the forward movement of the cargo, was completely torn off just to the rear of the pilot's compartment. The aircraft did not catch on fire.

Examination disclosed that the engines were developing power on impact, that the flaps were 1/4 down, that the instrument flying hood was partially attached to the pilot's (left) side of the cockpit and that all trim tab settings appeared to be normal. Examination of the controls and aircraft structure failed to disclose any evidence of malfunctioning. The automatic direction finder was in the automatic position and was set to a frequency of 340 kilocycles. The range receiver was tuned to the tower frequency and the marker beacon receiver was set in the high position. The VHF transmitter was off and the other transmitter was set on 6210 kilocycles. The plane was equipped with a radio altimeter, but due to damage it was impossible to determine the setting of this instrument. The left altimeter was set at 30.29 inches of mercury and the right at 30.33 inches of mercury. Both landing lights were extended. The left landing light switch indicated that it was off; as the right landing light switch was broken, its position could not be determined. Investigation also disclosed that the cargo was securely lashed prior to departure from Chicago in accordance with company practice, but the lashings parted upon impact, being unable to withstand the severe load applied by the crash.

During the course of the investigation it was established that the aircraft passed over the 50.2 foot high middle marker antenna pole, approximately 12 feet inboard of the left wing tip, and that the course of the aircraft was one degree to the right of the course of the localizer, which is in line with Runway 21.

The weather forecast indicated contact conditions to exist the entire route of the flight with excellent conditions at Denver. The terminal conditions at the time of the crash were a clear sky, visibility 30 miles, a south-southwest wind of 12 miles per hour, and an altimeter setting of 30.35 inches of mercury. A United Air Lines' pilot,

operating over the route between Omaha and Denver at the same altitude as Aircraft 486, landed at Stapleton Airport less than an hour before the accident. He stated that the air en route was "glassy smooth," that a clear sky and unlimited visibility existed and that no turbulence was encountered while making the descent and landing.

The Instrument Landing System at Stapleton Airport included an outer marker beacon located 4.2 miles and a middle marker beacon located 3,450 feet from the northeast end of Runway 21. Compass locators were installed at each marker which enabled a pilot to use the automatic direction finder to supplement the marker beacon signal as a means of determining the aircraft's position. The height of the glide path above the elevation of the runway at the outer marker was 1,015 feet, at the middle marker 215 feet, and the angle of the glide path between the outer and middle marker was 23.4 to 1. The runway contact lights were on at the time of the accident. The neon approach lights, which extend to within 1,950 feet of the middle marker antenna pole, were also on.

The ILS had been flight-checked three days before the accident by the Civil Aeronautics Administration and its operation was found to be normal. Within six hours after the accident it was again checked and the airline pilot who conducted the check stated there was a slight dip in the glide path as the middle marker was approached and that the altitude of the glide path over the middle marker was 5,400 feet above sea level. The preponderance of opinion of other pilots also indicated that a slight dip existed and that the altitude of the glide path over the middle marker was at 5,400 feet rather than 5,500 feet, the established altitude.

The ground monitoring system indicated that the ILS was operating normally at the time of the accident. The glide path monitor is adjusted to detect any variation of the glide path greater than approximately 10 percent of the elevation of the glide path. At the outer marker this would amount to a tolerance of approximately 100 feet and at the middle marker approximately 20 feet below or above the normal glide path. If the tolerance allowed by the monitoring system is exceeded, the glide path

is automatically shut off and this non-operation is indicated to the tower and communication station by a separate warning device. Since the monitoring is accomplished at the transmitter, any dip or movement of the glide path beyond the monitor would not be detected; therefore, the dip that existed in the glide path and that extended through the middle marker would not be indicated by the monitoring system.

Since the glide path receiver in the aircraft was only slightly damaged and, when tested, was found to be operating normally, any non-operation of the glide path would be indicated to the pilot by the ILS indicator located on the instrument panel. The glide path needle would move to the top of the indicator, and since the needle indicates the direction of the glide path from the aircraft, the pilot would attempt to correct for the position of the needle by gaining altitude or remaining level and flying into the beam. Non-operation of the glide path would, therefore, very shortly be obvious to an experienced pilot as the glide path needle would remain at the top of the indicator regardless of the altitude gained or the forward motion of the aircraft. In any event, the non-operation of the glide path would not cause the pilot to fly into the ground. Also, a failure of the glide path receiver in the aircraft would be indicated to the pilot in the same manner as non-operation of the glide path.

Both pilots had made approximately 200 ILS approaches, with approximately 25 by Captain J. C. Hearn, Western Division Chief Pilot, and 50 by Captain W. S. Day, a check pilot, on the installation at Denver. Together they had prepared a chart showing the new ILS approach procedure for Stapleton Airport which they intended to place in the pilot's manual as standard company procedure superseding previous instructions. This revised chart was found at the scene of the accident. The investigation disclosed that Captain Hearn was occupying the pilot's seat and Captain Day the co-pilot's seat at the time of accident.

## Discussion

It has been determined that the engines were developing power on impact;

therefore, this would preclude the possibility of carburetor ice, lack of fuel or malfunctioning of the engines causing an involuntary landing. Examination of the controls, tab settings and aircraft structure failed to disclose any evidence of malfunctioning. Consideration was given to the possibility of the cargo shifting while in flight and changing the center of gravity, but since the cargo was securely fastened and the flight and approach was conducted in smooth air, it is improbable there was a cargo shift.

Since failure of the ILS installation or the ILS receiver in the airplane would have been indicated to the pilot by the ILS indicator on the instrument panel, it is unlikely that equipment failure was involved in this accident. Furthermore, the ground monitoring system of the ILS indicated no malfunctioning. The possibility of there being a difference between day and night operation of the glide path was explored, and it was found that no appreciable difference existed. Also, possibilities of train, truck, or automobile traffic deflecting the glide path of the ILS above the tracks and a highway running easterly and westerly approximately 1,848 feet northeast of the northeast end of Runway 21 were considered. As nearly as can be established by questioning witnesses, there existed no surface traffic on these lanes at the time of the accident.

The discrepancy between the altimeter setting of 30.35 inches of mercury, as given to the flight when it was over the Watkins Fan Marker, and the settings of the pilot's and co-pilot's altimeters as observed at the scene of the crash, would make the indicated altitude of the aircraft approximately 60 and 20 feet respectively higher than the actual altitude, yet, as the aircraft's altimeters were damaged, it is possible that the altimeter settings had been jarred from the position set by the pilot. The flight had been given the latest altimeter setting when reporting over the Watkins Fan Marker and after having flown for three hours, it is not likely that an experienced pilot would attempt a letdown without setting the aircraft's altimeters to the altimeter setting of the field.

Testimony disclosed that the radio altimeter was reasonably accurate,

worked fairly well, and that it was the company policy to have it turned on for an ILS approach and normally set to indicate a minimum altitude of 200 feet above terrain. Since the altitude indicator lights of the radio altimeter are readily visible to both pilots, a definite warning would be given when the minimum altitude was reached and when below it, but as this altimeter was damaged, it was impossible to determine the altitude setting or whether it was "on" and being used.

The company's minimum approach r.p.m. is 1,900 and knowing the distance between the propeller marks on the ground, a speed of 126 miles per hour is computed. As the aircraft passed over the middle marker antenna pole, at a minimum altitude that would clear the pole, a minimum rate of descent of 1,140 feet per minute and an angle of glide of 11 to 1 is indicated in this instance. Had an r.p.m. higher than that authorized by the company been used, the computed speed would have been higher; therefore, any increase in r.p.m. would increase the speed which, in turn, would increase the rate of descent. The company recommends an ILS approach speed of 120 miles per hour. In a zero wind condition, the rate of descent required to stay on the glide path of the ILS at Stapleton Airport at 120 miles per hour is 507 feet per minute.

During an ILS approach the glide path indicator becomes more sensitive as the transmitter is approached. A small deviation from the glide path will result in a full scale deflection of the glide path needle, a ten-foot variation in altitude giving a decided "off-course" indication. Experience in ILS training program indicates a common tendency among pilots not experienced with this system to overcontrol the aircraft in attempting to keep the needle centered at a time when the glide path is becoming narrow and small deviations result in full scale deflections of the needle. In this instance, it appears that the pilot's experience should have enabled him to have avoided such a tendency.

During the course of the investigation of this accident, testimony was received which indicated a tendency among pilots during ILS approaches to reverse the sensing of glide path indicators when in proximity to the transmitter. This observation is confirmed in a

report by the Army Air Forces, Headquarters Air Transport Command treating the subject of pilot procedures on instrument low approach systems which also indicates a common tendency of pilots to make radical changes in attitude when close to the station and invariably to make these changes downward. As with the question of over-control, the possibility of either of the pilots having been troubled by reversed sensing appears remote in view of the actual experience of both pilots with ILS procedures and techniques in general and the Denver installation in particular. However, the investigation has not eliminated the possibility that the pilot actuated the aircraft controls in a manner not consistent with the ILS indication, either through excessive or opposite control movement.

Company ILS procedure directs the safety pilot to call out the air speed and altitude at 15-second intervals while on the final approach, and to notify the pilot over the middle marker when the minimum altitude of 5,500 feet is reached; 5,500 feet mean sea level is 225 feet over the terrain at the foot of the middle marker pole and 215 feet above the elevation of the runway. Company instructions furthermore direct that all flights be "contact" when over the middle marker, both for practice and actual instrument approaches. If a practice approach is being made, the hood is to be taken down and the rest of the landing completed with visual reference to the ground. If an actual instrument approach is being made, the aircraft must be "contact" when over the middle marker or a pull-up effected. In any event, 5,500 feet should have been the minimum altitude until the middle marker and its compass locator had been identified. Yet, it is apparent that the aircraft must have been below 5,500 feet and passed close to the top of the middle marker antenna pole in this instance.

Investigation disclosed that the hood was used in the approach, but as it was not completely fastened when the wreckage was examined, it cannot be determined whether the pilot was attempting to remove the hood or whether it was pulled loose in the crash.

When the instrument flying hood is installed, it covers the lower 15 inches of the windshield on the pilot's side

and extends from the middle of the windshield to the side window. This installation affords visibility to the pilot, if he desires to look out over it, and provides good visibility for the safety pilot; and in the event of an emergency, the hood can be removed from the four snap fasteners in a matter of one or two seconds.

Since there is no evidence of loss of power or structural failure, the minimum rate of descent and glide angle from the time of passing over the middle marker antenna pole to the point of impact, which is considerably greater than normal for a standard approach, indicates overcontrol or involuntary loss of control of the aircraft. Had the specified minimum altitude over the middle marker been observed, overcontrol or momentary loss of control would not have been so hazardous.

The co-pilot in this instance was acting as the safety pilot and, as the night was clear and the visibility unlimited, the runway contact lights and neon approach lights were plainly visible and should have indicated to the safety pilot a low altitude had he been closely observing them. While the possibility no doubt exists that the safety pilot's dark adaptation was impaired as a result of use of cockpit lights, his ability to see the runway and approach lights would not be materially affected by such an occurrence.

The primary responsibility of the safety pilot is to prevent collision with objects on the ground or in the air while the pilot is under the hood, and under no circumstances should a safety pilot allow himself to be distracted from his primary responsibility and permit the aircraft to descend to a dangerously low altitude. In the event either pilot had determined that a dangerous condition existed, even at an extremely low altitude with flaps and landing gear down, a pull-up could have been made without loss of altitude, as proved by subsequent tests. It must be concluded, therefore, that the safety pilot was insufficiently alert to the altitude of the aircraft.

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## Findings

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

1. The air carrier, the aircraft and the crew were properly certificated.
2. There was no failure or malfunctioning of the aircraft, engines or radio. Power was being developed by both engines on impact.
3. The Instrument Landing System was operating normally and ideal conditions existed for an approach under the hood.
4. The glide path receiver in the aircraft was operating normally.
5. Adequate vision existed for the safety pilot when the instrument flying hood was used by the pilot.
6. The runway contact lights and neon approach lights were on and plainly visible.
7. A slight dip did exist in the glide path, but it was not hazardous.
8. The minimum possible glide angle of the aircraft, as it passed over the middle marker antenna pole, was 11 to 1 and the minimum rate of descent 1,140 feet per minute.
9. A minimum altitude of 5,500 feet over the middle marker was not maintained.
10. The co-pilot may have failed to alert the pilot to the altitude and air speed of the aircraft, but in any event, he failed to take over control of the aircraft when it descended to a dangerously low altitude.

## Probable Cause

The Board determines that the probable cause of this accident was the momentary loss of control or overcontrol by the pilot at a critically low altitude in the final stages of an IIS approach. A contributing factor was the failure of the safety pilot to remain alert to the altitude of the aircraft.

BY THE CIVIL AERONAUTICS BOARD.

/s/ OSWALD RYAN  
/s/ HARLEE BRANCH  
/s/ JOSH LEE

## Supplemental Data

### Investigation and Hearing

The Civil Aeronautics Board was notified of the accident at 0700, February 14, 1947, and an investigation was immediately initiated in accordance with the provisions of Section 702(a)(2) of the Civil Aeronautics Act of 1938, as amended. Air Safety Investigators of the Board's Kansas City and Denver Offices arrived at the scene of the accident at 1430 the same day. A public hearing was ordered by the Board and was held at Denver, Colorado, February 21, 1947.

### Air Carrier

Slick Airways, a non-certificated air carrier,<sup>2</sup> is incorporated under the laws of the State of Delaware and maintains its general offices at San Antonio, Texas. Pending action by the Civil Aeronautics Administration on an application for a non-scheduled air carrier operating certificate, the company was conducting its operations in accordance with the exemption provided in Part 42, Civil Air Regulations.

### Flight Personnel

Captain Joseph Charles Hearn, age 33, of Burbank, California, had been employed by the company since January 1, 1946. Until the date of the accident he had accumulated a total of 4,999 hours flying time, of which approximately 605

hours had been on the C-46 airplane. Captain Hearn possessed a valid air line transport pilot rating and was Chief Pilot, Western Division of Slick Airways. Captain William Shively Day, age 28, of Burbank, California, had been employed by the company since February 1, 1946. Until the date of the accident he had accumulated a total of 5,542 hours flying time, of which approximately 992 had been obtained on the C-46 airplane. Captain Day possessed a valid air line transport pilot rating and was a check pilot of the company. Captain Hearn and Captain Day had had approximately three and one-half years experience in the Army Air Force. Both Captains were properly certificated for their duties and qualified over the route.

### Aircraft

The Curtiss C-46E aircraft had been purchased from the War Assets Corporation in December, 1945, at which time a total of 24 hours had accumulated on the airplane since original manufacture. Up to the date of the accident it had accumulated 2,418 hours and was equipped with two Pratt & Whitney R-2800-75 engines, with Hamilton Standard Hydromatic propellers installed. The left engine had been operated a total of 717 hours since last major overhaul and the right engine 415 hours. Both engines had accumulated 86 hours since the last 100-hour check. At the time of departure from Omaha the weight of the aircraft was approximately 1,259 pounds less than the maximum allowable gross and the weight was distributed with respect to the center of gravity within approved limits.

<sup>2</sup> A non-certificated air carrier refers to a company operating in air commerce without a certificate of public convenience and necessity, and is commonly referred to as a non-scheduled operator.