B-80 Boeing

SA-243 File No. 1-0089

CIVIL AERONAUTICS BOARD

ACCIDENT INVESTIGATION REPORT

Adopted: June 11, 1952 Released: June 17, 1952

UNITED AIR LINES, INC. - NEAR REDWOOD CITY, CALIFORNIA, SEPTEMBER 12, 1951

The Accident

At approximately 1046[1/] on September 12, 1951, a United Air Lines' Boeing Model 377, N 31230, abruptly dived from low altitude and crashed just offshore in San Francisco Bay, near Redwood City, California. The three occupants - two pilots and a flight engineer - were killed, and the aircraft was demolished upon impact.

History of the Flight

The flight departed San Francisco at 0942, operating as "United Trainer 7030." Flight Manager Frederick S. Angstadt was captain and was being given his semi-annual instrument check by Assistant Flight Manager Hugh C. Worthington, who served as copilot. Flight Engineer Charles K. Brogden was the third crew member.

In addition to the foregoing instrument check, consideration had been given to investigating the feasibility of using the Oakland, California, Municipal Airport for certain phases of crew training in this type aircraft for a new class of pilots and flight engineers which was to convene that afternoon. Captains Angstadt and Worthington were to supervise this training. United Air Lines' officials stated that Captains Angstadt and Worthington intended to make this determination during the flight.

Captain Angstadt was given the 0828 sequence weather reports for the local area prior to completing a clearance form at the UAL dispatcher's office. Pertinent weather was as follows: stratus clouds in the Bay area with tops at approximately 1,600 feet; San Francisco and Oakland - 800 foot ceiling, overcast, visibility three miles, haze and smoke; ceiling and visibility at Fresno and Sacramento unlimited. The forecast for the Bay area indicated scattered clouds by 1000 PST.

Clearance was issued for local flight under Visual Flight Rules (VFR), confined to a 100-mile radius from San Francisco and under 10,000 feet. The load was properly distributed with respect to permissible center of gravity limits. Gross weight of the aircraft at takeoff was 114,886 pounds, with 4,700 gallons of fuel, well under the maximum permissible gross takeoff weight.

1/ All times referred to herein are Pacific Standard and based on the 24-hour clock.

After reporting on top of the broken scattered clouds to the San Francisco tower at 0946, the flight proceeded to Oakland. The Oakland tower approved a simulated Instrument Landing System approach; this and a missed approach procedure were performed.2/ The flight again reported on top at 1036. Another simulated ILS approach was requested of the Oakland tower but the flight was advised that there would be a delay due to other traffic. In view of this, the pilot decided to return to San Francisco. The flight changed frequency from the Oakland tower to San Francisco Approach Control at 1037.

At 1039, the flight was cleared for an ILS approach to the San Francisco Airport, but did not acknowledge the clearance on the 119.1 megacycle Approach Control frequency. Following two attempts to contact the flight, the controller heard the aircraft make an unreadable call on 121.9 megacycles, and instructed the flight to listen on 119.1. This transmission was followed by further instruction for the flight to hold VFR, and stand by. The frequency change was apparently accomplished by the flight and the pilot again requested permission to make a simulated ILS approach. The request was granted, with instructions to report upon leaving the ILS outer marker inbound. This message and one other were not acknowledged by the flight. No emergency call was received from the aircraft. The crash was reported to the U. S. Coast Guard Air Station at 1046 by the manager of a nearby airport.

Investigation

At takeoff, Captain Angstadt was seated on the left side and Captain Worthington on the right. Their positions at the time of the crash could not be ascertained.

A number of persons in the Redwood City area heard, but did not see, the aircraft. They reported hearing a great surge of power, and in some instances, the crash. Two eyewitnesses to the last few minutes of flight, James A. Bussell and Chester E. West, were working outdoors at the Kaiser Gypsum plant, about three miles from the impact site.3/ Both of these witnesses estimated visibility from 2½ to 3 miles, with haze and smog. Their attention was attracted to the aircraft by the "popping" of an engine, and the fact that the aircraft was lower than those usually observed in that vicinity. They also noted that the aircraft appeared to be flying rather slowly.

These witnesses first observed the aircraft in a left turn with about a 10-degree bank and almost east of their positions. It was quite low, but maintained a fairly constant altitude, though possibly in a slight descent. Their observation of the aircraft was momentarily interrupted as it passed behind some buildings. The turn was discontinued as the flight assumed a northerly heading at a point about a mile northeast of their positions. Shortly thereafter it passed behind some silos and was not further observed by Mr. West. He stated that the aircraft seemed to be losing altitude all the time, and there appeared to be no rotation of the No. 3 and 4 propellers. Mr. West did not recall whether the landing gear was extended or not.

2/ See attachment.

3/ See attachment for witness positions.

Mr. Bussell, a former private pilot, stated that after being momentarily lost to his sight behind the silos, he observed the aircraft proceed approximately another half mile. There appeared to be a pronounced falter in power, the aircraft seemed to hesitate while in level flight, and it then stalled at an altitude of about 300 feet. The nose dropped and it dived at an angle of about 30 degrees below horizontal. A stronge surge of power accompanied this sequence of events. Mr. Bussell was unable, however, to state whether power was applied immediately prior to or following the stall, due to the time required for sound to travel to his position. The aircraft seemed to strike the water with wings level. Mr. Bussell saw no indications of fire, nor did anything fall from the aircraft. He did not recall the position of the landing gear, nor whether any propellers were feathered. He stated that the "popping" which first attracted his attention sounded like backfiring and continued for five to ten seconds.

The flight path of N 31230 was simulated on September 26, 1951, with another UAL Boeing 377, flown by UAL pilots with CAB and CAA observers aboard. Eight patterns were flown over the Redwood City area, adjusting the flight path and altitude in accordance with instructions from mobile radio units stationed with Mr. Bussell and Mr. West, who were at their original locations. The landing gear was down on all of the passes and flaps were extended 10 degrees. The pattern most acceptable to the witnesses was one in which the aircraft crossed the road to the cement plant just east of the Redwood City Yacht Harbor on a heading of 110 degrees, whereupon a 10-degree left bank was made. The turn was continued to a heading of 340 degrees, and straight flight thereafter to the impact site. Approximately two minutes were required to fly from the San Francisco ILS outer marker to the start of the turn at the road. Altitudes necessary to satisfy the witnesses appeared to be not over 700 feet at the start of the turn and not under 450 feet at its completion. One minute was required from the start of the turn to the impact site. No unusual maneuvers were required in reconstructing the probable flight path of N 31230 and all turns were made with a shallow bank. Air speeds ranged from 150 to 175 miles per hour.

It is of interest to note that on one of the test flights over the area the No. 4 propeller was feathered with No. 3 windmilling, but the feathered propeller was not noticed by the two witnesses and the other ground observers. When operating with one propeller feathered and the other windmilling on the same side, full cruising power was required on the other two engines. Also, as No. 3 engine power was reduced to a windmilling condition, backfiring was noticeable for two or three seconds. This is a normal reaction, caused by sudden leaning of the fuel-air mixture. The backfiring was noted by Mr. Bussell and the sound was similar to that which he heard from N-31230.

Several other flight tests were made to investigate theories of aircraft or engine malfunctions which could have caused or contributed to the accident. During the course of these investigations, it was found that in addition to the usual method of increasing power through throttle advance, a power surge could be induced without advancing throttles by closing the master electrical power switch and overspeeding the propellers through use of the propeller controllers.

Company training procedures call for an engine to be throttled to zero thrust rather than feathering the propeller, though an actual feathering is also demonstrated to trainees. The aircraft is never stalled, but only brought to an approach to a stall. In making simulated or actual ILS approaches at San Francisco, company practice is to start interception of the glide path farther out and at a higher altitude than its 1,660 feet at the ILS outer marker. By passing over the Belmont fan marker southbound at 2,500 to 2,800 feet, then turning left, the pilot can intercept the glide path and localizer at an initially higher altitude, thus allowing him to place the aircraft in approach configuration prior to the time it passes over the ILS outer marker at 1,660 feet. As previously indicated, N 31230 was at considerably lower altitude.

Salvage operations resulted in recovery of approximately 75 per cent of the wreckage. The aircraft came to rest inverted. The wreckage was strewn along a path approximately 250 degrees magnetic, with the major portion within a radius of 100 feet, and the center of the area about 200 feet offshore. All four engines and their propellers were recovered. The structure was severely disintegrated, with the most intense damage having occurred to the right wing and forward part of the fuselage. The forward fuselage structure was crumpled to the rear, left, and upward. Other portions of the structure also indicated that impact forces acted rearward and to the left. Only two relatively large portions of the aircraft remained intact -- a portion of the left wing panel with most of the flap and part of the aileron, and the aft fuselage, with the empennage relatively intact.

Since nearly one-quarter of the wreckage could not be recovered, conclusive examination for mechanical or electrical failure could not be made. Most of the wreckage was out of the water at low tide and had to be dug out of the mud and clamshells into which the heavier components, such as engines, had sunk several feet. Examination of recovered material, which included the pertinent parts of the major components of the aircraft, including the control system, revealed no indication of mechanical failure or malfunctioning, fire, malfunctioning of the fuel or electrical systems, or air collision with any object. Structural damage was found to be consistent with disintegration due to impact forces. Examination of the cowl flaps from more than two of the engines indicated that they were in the normal operating range. No evidence was found to indicate abnormal opening of any of the cowl flaps.

There were two propeller cuts on the left side of the fuselage approximately 30 and 60 inches forward of the plane of the inboard (No. 2) propeller. There were no breaks in the primary flight control cables in that area. There were no indications of fatigue failure of any blade, and evidence indicated that all propeller blades were secure in the hub barrels upon impact.

It was determined that the landing gear was extended, both wing flaps were 10 degrees down, and engines Nos. 1, 2, and 3 were developing power, with the propellers operating in the normal flight blade angle range. The propeller of No. 4 engine was feathered, but there was no indication that the engine had been shut down due to a malfunction. All recovered portions of the electrical system were carefully examined for any evidence of fire or overheating in addition to possible malfunction; none was found. The automatic pilot lever was in disengaged

position. Trim tab controls were nearly neutral; these settings would be normal for an approach configuration. There was no evidence of breakage, binding, or jamming in the flight control systems.

All flight instruments were badly damaged and their information could therefore be unreliable. The air speed indicator reflected a speed of 160 miles per hour, which is considered unreliable. The altimeter was set at 29.91 inches; the last setting given to the flight (but unacknowledged) was 29.78 inches. The directional gyroscope read 255 degrees.

Weather in the San Francisco Bay area on the morning of September 12 consisted of stratus clouds with considerable haze and smoke. Ceilings varied from 700 to 1,200 feet before 0900, with cloud tops near 1,600 feet. The stratus clouds dissipated during the morning, becoming scattered by 1025 and clear by 1100. The freezing level was at about 16,000 feet. On the basis of observations made during the morning, weather conditions in the vicinity of Redwood City at the time of the accident were: ceiling unlimited with only residual stratus clouds at about 1,000 feet in some sections of the Bay area, visibility from two to three miles, with haze and smoke.

Investigation revealed that all three crew members were in good physical condition and had fully adequate rest periods prior to the flight. Captains Angstadt and Worthington were pilots with extensive flight experience, and occupied highly responsible flight and executive positions with the company. Both were fully competent instrument pilots with several hundred hours time as captains of Boeing 377 equipment, and had adequate recent experience in the aircraft type. In connection with their duties, they often gave instrument and other flight checks to pilot personnel of the company.

The company, the crew, and the aircraft were properly certificated. A review of maintenance records revealed no evidence to indicate that the aircraft was not airworthy at takeoff.

Analysis

The flight path, both during and following the turn near Redwood City, shows that control was normal, since there were no erratic maneuvers prior to the dive. However, the stall could conceivably have resulted from a failure or malfunction in one of the control systems.

An analysis of the simulated flight path shows that there was not sufficient altitude for the aircraft to have made an abrupt turn, thus placing it on the 250-degree heading along which the wreckage was strewn. Both eyewitnesses agreed that the straight flight on a 340-degree heading was correct, and this heading took the test aircraft over the crash site. The pilot of the test aircraft, who is manager of Flight Engineering for United Air Lines, advised that such rotation about the vertical axis would be difficult, even should a wing tip have struck first. It is possible that there was some rotation not observed by Mr. Bussell due to the aircraft's beginning a spin just before striking the water.

The fact that No. 4 propeller was found feathered, with no indication of malfunctioning in No. 4 or other engines, gives good cause to believe that this configuration was the result of a simulated emergency given as part of the flight test.

It is evident that the aircraft struck at a sharp angle since the wreckage was confined to a very small area.

The surge of power at the time of the dive could be due to either propeller system malfunctioning or an attempt to increase thrust in order to effect recovery from a stall.

Regarding the propeller cuts on the left side of the fuselage, evidence definitely indicated that they were made at impact, since there was no indication of thrown propeller blades or fatigue failure of any blade. Any possible control system failure could not, therefore, be ascribed to thrown blades and as has been mentioned before, there were no breaks in the primary flight control cables in that area.

The Boeing Model 377 was certificated with spoilers installed on the inboard leading edges of the wing between the inboard engines and the fuselage, in order to meet stall requirements for certification. The addition of spoilers results in certain problems in flying technique during takeoff and landing, but the aircraft gives adequate stall warning and its stall characteristics are normal. The spoilers present a problem in angle of attack: if unduly increased (as during flare-out prior to landing), the aircraft might stall at this critical altitude, or if kept too high during the takeoff run, maximum effective lift would not be obtained.

Although it could not be ascertained which pilot was flying at the time of the accident, in all probability they occupied the same positions as at takeoff; Captain Angstadt was being given a flight check, no landing was made, and the feathered propeller might suggest such a simulated emergency as is given on check flights. No emergency was anticipated prior to the stall, as evidenced by the absence of emergency radio transmissions.

Concurrent with the several phases of investigation, a group of United Air Lines' engineers and safety specialists was organized to study the problem under the direction of the General Manager of Engineering. These studies were fully coordinated with the CAB's Investigator-in-Charge. The primary question concerned the reason for the flight's descent from 1,700 feet, or above, to the approximately 300 feet reported by the witnesses, and subsequently, the crash.

All conditions which might reasonably have caused the crew to descend voluntarily were considered. Typical of these hypotheses were: flight control difficulty, buffeting, or a practice maneuver. Conditions causing involuntary descent were divided into three major categories, namely: major loss of net thrust, loss of flight control, or incapacitation of crew members. Over 30 hypotheses were investigated within the framework of the two principal categories, but, in most instances, vital information was lacking to complete the links in the speculative chain. In no case was it possible to prove any hypothesis. Examination for mechanical failure was of necessity inconclusive because all of the aircraft wreckage was not recovered.

Since the occurrence of the subject accident at Redwood City, an incident has been reported involving a B-377 in which certain aspects indicated the possibility of having been involved in the Redwood City accident. This incident indicated that a wide-open cowl flap setting in combination with a wind-milling propeller caused severe buffeting and vibration. However, it can be concluded from examination of the physical evidence in the subject accident that the cowl flaps on two or more engines were in their normal operating range and that nothing was found to indicate abnormal opening of any of the cowl flaps. The low altitude of the aircraft prior to the crash suggests the possibility of this difficulty. However, if the crew had experienced intense buffeting, it appears that they would have made an emergency call just as the flight that had experienced this difficulty did. None of the persons who heard the crash described the sound of very high power being developed during the time that the airplane was observed by two witnesses to maintain nearly constant altitude. This does not coincide with the above-reported incident since the Captain of that flight states he had to use rated power to maintain altitude.

The aircraft was in approach configuration, as has been shown, and air speed would have been relatively low. As previously pointed out, no evidence was found to substantiate any possibility of mechanical trouble. Study of the primary aircraft structure indicated that the aircraft was intact until impact. The flight path pattern and the observations of witnesses definitely indicate that the stall was the cause of the accident. The evidence available does not permit a definite determination of the cause of the stall.

Findings

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

1. The company, the aircraft, and the crew were properly certificated.

2. The gross weight of the aircraft was within approved limits, the load was properly distributed with relation to the center of gravity, and the aircraft was airworthy at takeoff.

3. The flight had been cleared for a simulated ILS approach to the San Francisco International Airport.

4. The aircraft, with No. 4 propeller feathered, stalled and abruptly dived from an altitude of approximately 300 feet and was demolished upon impact in San Francisco Bay.

5. Engines Nos. 1, 2, and 3 were developing power at the time of impact.

6. The No. 4 propeller was feathered; however, there was no evidence found of structural failure or malfunctioning of this engine or its propeller.

7. The landing gear was extended and wing flaps were down 10 degrees at time of impact.

8. About 75 per cent of the aircraft was recovered; no evidence of fire fuel or electrical system malfunction, or structural failure in flight wa

9. The cause of the stall was not definitely determined.

Probable Cause

The Board determines that the probable cause of this accident was an inadvertent stall at a low altitude from which recovery was not effected.

BY THE CIVIL AERONAUTICS BOARD:

/s/ DONALD W. NYROP

/s/ OSWALD RYAN

/s/ JOSEPH P. ADAMS

/s/ CHAN GURNEY

Josh Lee, Member, did not participate in the adoption of this report.

SUPPLEMENTAL DATA

The Civil Aeronautics Board was notified of this accident by the CAA Communications Station at Oakland, California, Municipal Airport at 1115, September 12, 1951. An investigation was immediately initiated in accordance with the provisions of Section 702 (a)(2) of the Civil Aeronautics Act of 1938, as amended. A public hearing was ordered by the Board, and was held in the Benjamin Franklin Hotel, 44 East Third Avenue, San Mateo, California, on November 6 and 7, 1951.

Air Carrier

United Air Lines, Inc., is a Delaware corporation, with its principal place of business at 5959 South Cicero Avenue, Chicago, Illinois. The company is engaged in the transportation of persons, property, and mail under certificates of public convenience and necessity issued by the Civil Aeronautics Board. It also possesses air carrier operating certificates issued by the Civil Aeronautics Administration for operations in the area involved in this accident.

Flight Personnel

Flight Manager Frederick S. Angstadt, age 46, was employed by United Air Lines in September 1932. He was the holder of a valid airman certificate with an air transport rating. Captain Angstadt had a total of 17,384 flying hours, of which nearly 572 were in Boeing 377 equipment. He received transition training to qualify on the Boeing 377 in June 1950. He had flown this type equipment 76 hours, 33 minutes in the past ninety days prior to the accident, and 16 hours, 46 minutes in the previous month. His last previous instrument check was accomplished on March 23, 1951. Captain Angstadt received a CAA physical examination on July 23, 1951, and his last company physical examination was accomplished on November 20, 1950. He was Flight Manager at Los Angeles, California.

Assistant Flight Manager Hugh C. Worthington, age 46, was acting as first officer and instrument check pilot on the subject flight. He was employed by United Air Lines in September 1933, and was the holder of a valid airman certificate with an air transport rating. Captain Worthington had a total of 16,390 flying hours, of which 346 were in Boeing 377 aircraft. He completed transition training to qualify on the Boeing 377 on September 18, 1950. During the last ninety days prior to the accident he had accumulated 145 hours, 26 minutes in the Boeing 377, and 2 hours and 19 minutes in the preceding 30 days. Captain Worthington's last instrument check was accomplished on August 8, 1951. his last CAA physical examination was accomplished on September 9, 1951, and his last company physical on December 18, 1950. Captain Worthington was Assistant Flight Manager at San Francisco, California.

Flight Engineer Charles K. Brogden had been employed by United Air Lines since December 1939, completed transition training for the Boeing 377 on July 3, 1950, and had over 1,451 hours in that equipment.

The Aircraft

N 31230, a Boeing Model 377, was owned and operated by United Air Lines, Inc. It had a total of 1,971 flying hours, and was currently certificated by the Civil Aeronautics Administration. It was equipped with four Pratt & Whitney Wasp Major R-4360 engines, and Curtiss Wright propellers.

SIMULATED FLIGHT PATH

MAP OF SAN FRANCISCO BAY AREA SHOWING OAKLAND AIRPORT, SAN FRANCISCO AIRPORT, AND RELATED RADIO NAVIGATION FACILITIES

1. ACCIDENT INVOLVING BOEING MODEL B-377, REGISTRATION NO. N31250, REDWOOD CITY, CALIFORNIA, ON SEPTEMBER 12, 1951.
2. ASSUMED FLIGHT PATH INDICATED BY DASH LINE.
3. POSITIONS OF AIRCRAFT ALONG FLIGHT PATH AT TIMES SHOWN ARE BASED ON ASSUMED GROUND SPEED OF 160 MPH.
4. TIMES SHOWN ARE PACIFIC STANDARD TIME.
5. *INDICATES TRANSMISSIONS FROM FLIGHT TO OAKLAND TOWER - NOT VERBATIM.
6. CIRCLED NUMBERS ALONG FLIGHT PATH REFER TO FOLLOWING TRANSMISSIONS FROM SAN FRANCISCO TOWER RADIO TRANSCRIPTION.

① UNITED TRAINER SEVEN ZERO THREE ZERO. THIS IS SAN FRANCISCO APPROACH CONTROL. CLEARED FOR AN ILS APPROACH TO THE AIRPORT DEPART THE OUTER MARKER INBOUND AT THREE SEVEN OR AFTER REPORT LEAVING THE OUTER MARKER INBOUND. RUNWAY TWO EIGHT RIGHT WIND NORTH SEVEN TO NINE. SCATTERED CLOUDS AT ONE THOUSAND (TWO HUNDRED) FEET. VISIBILITY THREE MILES. ALTIMETER TWO NINE SEVEN EIGHT. TIME THREE NINE AND THREE QUARTER.

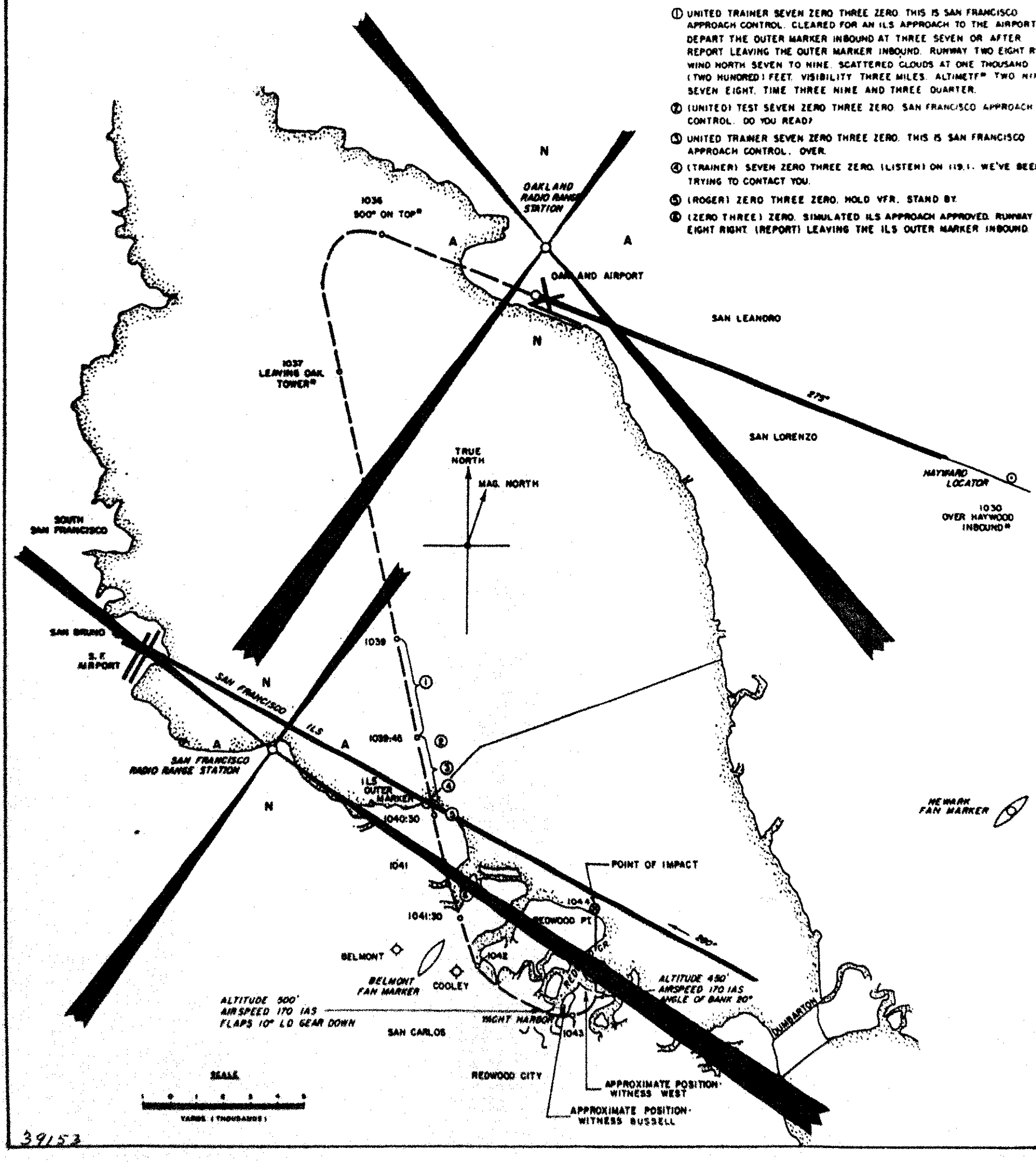
② (UNITED) TEST SEVEN ZERO THREE ZERO. SAN FRANCISCO APPROACH CONTROL. DO YOU READ?

③ UNITED TRAINER SEVEN ZERO THREE ZERO. THIS IS SAN FRANCISCO APPROACH CONTROL. OVER.

④ (TRAINER) SEVEN ZERO THREE ZERO. (LISTEN) ON 119.1. WE'VE BEEN TRYING TO CONTACT YOU.

⑤ (ROGER) ZERO THREE ZERO. HOLD VFR. STAND BY.

⑥ (ZERO THREE) ZERO. SIMULATED ILS APPROACH APPROVED. RUNWAY TWO EIGHT RIGHT. (REPORT) LEAVING THE ILS OUTER MARKER INBOUND.



39153