No. 23

The Flying Tiger Line Inc., L-1049H, N 6915C, accident at San Francisco International Airport, San Francisco, California, U.S.A., on 24 December 1964. Civil Aeronautics Board (U.S.A.) Aircraft Accident Report, File No. 1-0064, released 8 June 1966

1. - Investigation

1.1 History of the flight

Flight 282 was a scheduled domestic cargo flight from San Francisco International Airport, California, to John F. Kennedy International Airport, New York. It was originally scheduled to depart at 2100 hours, Pacific Standard Time, on 23 December, but the flight was delayed because of the non-availability of a flight engineer. An engineer obtained from Los Angeles arrived in San Francisco at 2315 hours and the flight departed at 0028 hours on 24 December.

At 0015 hours, while taxiing to runway 28L, the flight advised Ground Control that because of a heavy load, they would like to proceed out past the GAP Radio Beacon to the Golden Gate Intersection, and thence via Victor 150 to Sacramento instead of direct to Sacramento as originally filed. The request was co-ordinated with Oakland Air Route Traffic Control Centre and approval obtained. The crew was then advised that for take-off on runway 28L there would be a "heavy" left cross-wind from 210 degrees at 18 to 25 knots, which they acknowledged.

After having switched to clearance delivery frequency, the flight was cleared to Kennedy Airport via Victor one fifty Sacramento, Victor six north, and requested to climb out on the San Francisco two eight seven radial for a vector to Golden Gate Intersection to intercept Victor one fifty. This was acknowledged. The Clearance Delivery Controller then stated: "You can disregard the vector, climb outbound San Francisco 287-degree radial to Golden Gate Intersection, then Victor 150, and, depending on your altitude, they probably will give you a vector to intercept (Victor) 150 before you get to Golden Gate.* This was also acknowledged.

The Local Controller, who was also Tower Supervisor, noted the time of 0030 on his clock as the aircraft became airborne and passed the tower. An eyewitness observed the landing lights retracting as the aircraft crossed the end of the runway. However, several witnesses along the flight path, including some located at points just prior to the crash, saw both landing lights on. Landing lights of the L-1049H may be retracted flush with the lower wing surface and remain on until switched off.

After take-off, witnesses stated the aircraft made a slight turn to the right, then a steeper turn to the left, and then was observed returning to a wings-level attitude as it entered the clouds.

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* Radar vectoring could not be provided an aircraft departing runway 28 via the Golden Gate Standard Instrument Departure until the aircraft reached an altitude of 1 500 ft. This was because standard obstruction clearance from the terrain, both vertical and lateral, could not be achieved in so far as criteria, as existing on 24 December 1964, were concerned. Lateral clearance from obstructing terrain is so critical that there is no space available in which to vector an aircraft safely below 1 500 ft. (See Figure 23-1).

At 0030:22, the flight was advised to contact Departure Control and did so immediately. The Departure Controller advised the flight at 0300:57 that he had radar contact with it and requested it to report leaving thousand-foot altitudes.

At 0031:05, the crew asked how they were tracking toward the GAP. The Departure Controller switched his radar scope from the 30 to the 10-mile setting and requested the flight's altitude. The crew replied they were at 900 ft.

At 0031:20, the Departure Controller advised that they were left of the San Francisco 287° radial. As he received no acknowledgement he repeated his message. The Departure Controller stated that within seconds after the second transmission, the target stopped, bloomed, and disappeared from the radar scope. Repeated attempts to communicate with the flight after its disappearance from the scope were unsuccessful. At this time, 0032:30, the controller placed a time hack on the communications tape. Ground impact was computed to have occurred at approximately 0031:30. Main impact occurred 860 ft above sea level on Sweeney's Ridge, at approximately 4.3 miles on the 257° radial of the SFO TVOR. The co-ordinates of the impact area were 122°28'00" west longitude, 37°38'28" north latitude. (See Figure 23-2)

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	3		
Non-fatal			
None			

1.3 Damage to aircraft

The aircraft struck the east slope of a hill and disintegrated. Portions of the aircraft were partially or completely consumed in the intense ground fire which developed.

1.4 Other damage

The aircraft crashed on a Coast Guard Reservation. Impact damaged numerous antenna structures and fire consumed portions of the hillside foliage.

1.5 Crew information

The pilot-in-command, aged 49, held a valid airline transport pilot certificate with type ratings in C-46, DC-4, L-1049H, and CL-44 aircraft. He had a total of 14 911 flying hours, of which 3 942 hours were in L-1049H aircraft. He held a current first class medical certificate with the limitations: "Holder shall possess correcting glasses for near vision while exercising the privileges of this airman certificate." No eyeglass frames, lenses, or broken lenses were found at the accident site. A slip-in eyeglass case was found at the site, labelled with an east coast optometrist's name and address. It contained no traces of broken glass. The pilot-in-command was the only east coast crew member.

The pilot-in-command had risen some time before 1000 hours on 23 December, and had been on duty since 2030 of that date. He had not flown in the previous 24-hour period. He was based in Newark, New Jersey, and his last departure as a crew member from the San Francisco International Airport was on 14 December 1963, as a co-pilot.

The co-pilot, aged 33, held a valid airline transport pilot certificate with type rating in DC-3, and a flight instructor's rating. He had a total of 3 636 flying hours, of which 1 277 hours were in L-1049H aircraft. He held a current first-class medical certificate with no limitations. He had been on duty for 4.3 hours during the previous 24-hour period, of which 1.8 were flying hours.

The flight engineer, aged 37, held an airframe and powerplant certificate and a flight engineer's certificate. He had a total of 4 113 flying hours, of which 3 811 hours were in L-1049H aircraft. He held a current first class medical certificate with no limitations. He had 17 hours of rest during the previous 24-hour period and had been on duty for 7 hours but had not flown except for the deadhead flight from Los Angeles.

Blood specimens from each crew member were subjected to toxicological examination. Results were negative for the co-pilot and engineer and only a small amount of blood ethanol was indicated in the pilot-in-command's specimen. Since alcohol production may be associated with post-mortem changes, the concentration did not of itself constitute evidence of alcohol ingestion. There was no evidence to indicate the possible consumption of alcohol by the pilot-in-command prior to the flight.

Examination of the pilot-in-command's heart indicated extensive arteriosclerosis of the coronary arteries with considerable narrowing of the lumina of the vessels. However, there was no thrombus or plague haemorrhage found that would have acutely compromised the circulation within the arteries. There was also no anatomical evidence that the pilot-in-command had experienced an episode of anginal pain in the few seconds preceding the crash.

Review of the medical records of all the crew members failed to disclose any indications of significant pre-existing disease.

1.6 Aircraft information

When the aircraft taxied from the ramp, it weighed 142 073 lb, within 27 lb of the allowable take-off gross weight. The c.g. limits for maximum gross weight of this aircraft are 23 to 32% of MAC; it had a c.g. of 29.3%. The station agent certified on the flight clearance that the aircraft was loaded within limits.

The type of fuel being used was not stated in the report.

1.7 Meteorological information

Surface weather charts for the evening of 23 December and the early morning hours of 24 December indicated that San Francisco was under the influence of a cold frontal system moving onshore. At the time of the accident rain, low cloudiness, and considerable fog were shown along virtually the entire Pacific coast. The San Francisco terminal forecast issued at 2045 on 23 December, valid for a 12-hour period beginning at 2100, was in part as follows:

> 2100-0400: 700 ft scattered clouds, ceiling 1 800 ft overcast, visibility 6 miles in light rain, occasionally ceiling 600 ft broken clouds, 1 800 ft overcast, visibility 6 miles in light rain.

The 0028 San Francisco International Airport surface weather observation in part showed the following:

> Scattered clouds at 400 ft, measured 1 100 ft overcast, visibility 6 miles in light rain and fog, temperature 59°F, dew point 57°F, wind from 240 degrees at 22 kt, gusts to 28 kt.

The Flying Tiger Flight Operations Agents on duty prior to the departure of the flight indicated that the flight crew was provided with the 400-150 mb significant weather prognostic chart, the winds from the 500 mb prognostic chart, as well as terminal weather information.

There were five departures from San Francisco International Airport within approximately one half hour after the flight departed. Most of the pilots-in-command of these flights testified that the winds were strong and gusty on take-off; that there were low clouds and intermittent rain; and that the turbulence was light to moderate until reaching at least 1 000 ft altitude.

The meteorologist stationed at the San Francisco International Airport at the time of the accident testified that there would have been moderate to severe turbulence in the area of Sweeney's Ridge with moderate downdraughts as one approached the ridge.

1.8 Aids to navigation

All radar and NAVAID equipment operated within prescribed tolerances when checked following the accident. The pilot-in-command certified on the flight clearance that he considered conditions were satisfactory for flight in accordance with his analysis and current airline and Civil Air Regulations.

1.9 Communications

All communications between ATC and the flight were recorded. Communications were normal until 0031:20 hours, when the crew did not acknowledge the message of the Departure Controller advising them that they were left of the 287° radial. No further communication was received from the aircraft.

1.10 Aerodrome and ground facilities

There were no unusual aerodrome or ground facility activities or conditions at San Francisco International Airport during the departure of the flight. The runway and taxiways were wet from the light rain and fog conditions which existed at the time of take-off.

1.11 Flight recorders

No flight recorder was required or installed aboard this aircraft.

1.12 Wreckage

Initial impact was by the left wing tip at an elevation of 840 ft. The fuselage struck the hill at 860 ft, on a magnetic heading of 225 degrees, and spilled over the top of the hill and down the west side of the slope. The wreckage was scattered in an area approximately 300 ft wide and 600 ft long. Sweeney's Ridge runs from north-west to south-east, and the top is 925 ft at the accident site.

1.13 Fire

The fire that followed impact was extinguished by local fire-fighting apparatus.

1.14 Survival aspects

This was a non-survivable accident.

1.15 Tests and research

Following the accident, flights were conducted to correlate ground witnesses and traffic controller information. These flights pinpointed the probable speed and flight path of the flight, and established that the initial left turn immediately after take-off was in excess of 25 degrees of bank. Validation of times and rates of climb were also established by the flight tests.

Performance figures of the manufacturer indicated that this aircraft's rate of climb should have been in excess of 800 ft/min from lift-off. The chief pilot of the airline at San Francisco stated that in his experience similarly loaded L-1049H aircraft will normally climb between 400-500 ft/min on departures from runway 28 at SFO. While no minimum rate of climb per mile was established for runway 28 departures at the time of the accident, the FAA has since specified that 250 ft/mile is the minimum acceptable. (See Figure 23-3)

Tests were made to determine what effect, if any, an aircraft taxiing in the vicinity of the TVOR antenna on the airport would have on the 287° radial reception in flight. These tests revealed no appreciable effect on radial reception.

A review of previous L-1049 aircraft accidents indicated that a number of these involved navigation errors of some type on aircraft of the L-1049H series purchased by the airline.

After the accident a radio transfer switch assembly* containing loose wire-clipping contamination was removed from a sister aircraft (N6917C), as a result of extensive trouble-shooting for a VOR course deviation bar discrepancy. Examination of this switch and another one removed from another aircraft (N6919C) revealed short pieces of wire, varying from 1/16 to 1/4 inch in length, within the wafer switch mechanisms. Several wire-to-switch terminals had untrimmed wire strands extending up to 1/2 inch beyond the terminal lug. A review of the last available log sheet of N6915C, the accident aircraft, revealed that the VOR system had write-ups similar to N6917C. The log of N6915C indicated that the corrective action was removal of the VOR receiver which checked out normally during the subsequent bench check.

During the FTL campaign to examine all relay switches in the fleet, two switches were found to be contaminated and four were found to have a source of contamination present. Electrical shorts caused by relay switch contamination have been known to cause navigation bearing angle errors of as much as 60 degrees.

*Lockheed Part No. 319122. A multiple gang-type circular switch that switches navigation signals and allows the captain to view on his instrument information from the co-pilot's VOR system. There are three of these switches on each Lockheed 1049 aircraft. The type of switch here referred to is the deviation indicator transfer switch.

2.- Analysis and Conclusions

2.1 Analysis

An examination of the evidence indicated that there was no malfunction or failure of the structure, powerplants, and system components prior to initial impact. The landing gear was fully retracted and the flaps in a 25° setting at impact.

The medical records of all flight crew members failed to disclose any significant pre-existing diseases which would have disqualified any of the crew members from performing their duties for this flight.

An analysis of available meteorological information indicated that, at the time of the accident, Sweeney's Ridge would have been obscured by clouds and light rain. Winds would have been from the west-south-west at 30 to 35 kt, with occasional gusts to 45 kt. This would have created moderate to severe turbulence and a marked downdraught condition in the lee of Sweeney's Ridge. Turbulence would have been encountered throughout the flight path, increasing in intensity as the flight approached the ridge.

The ATC clearance and routing provided was in accordance with the crew's request and all ground electronic navigational aids were operating satisfactorily. The GAP homer and the Outer Marker compass locator frequencies were selected on the aircraft's ADF receivers and the loop bearing of the No. 2 ADF system validates electrical power at impact. Even assuming a malfunction of the aircraft's VOR course deviation needle, adequate guidance to a safe altitude was possible from the localizer course, the outer compass locator of the instrument landing system or the GAP low frequency homer. Also, three separate sources of heading information were available.

The term "radar contact" is used when radar identification of an aircraft is established. Critical obstruction clearance criteria for the Runway 28 departure at San Francisco, and limitations of the facility radar equipment, precluded radar vectoring service until the aircraft reached 1 500 ft. If the foregoing limitations were unknown to the crew, they may have believed the aircraft was under continuous radar surveillance from the time departure control reported radar contact. The crew may have disregarded their instruments believing their flight was monitored by the radar controller and, because of the turbulent weather conditions encountered, they may have concentrated their efforts on maintaining control of the aircraft. In those circumstances, the crew may have failed to detect errors in the instrument presentation to the extent that there were in fact erroneous indications portrayed.

A contaminated switch could cause intermittent large errors in navigational information displayed on the pilot's instrument. A review of log discrepancies on a number of L-1049 aircraft presently owned and flown by the airline revealed navigation errors in the VOR system that may have been caused by contamination of the radio relay switch, even though the VOR navigation selections had been properly made.

The flight made a left turn of approximately 55 degrees shortly after take-off. The reconstructed flight path indicated that this heading was maintained until impact. Since the relay switches in N6915C were destroyed by fire, it was impossible to determine whether contamination existed. However, the radio transmission before impact indicated the co-pilot's concern about the position of the aircraft. The turn after take-off and the subsequent concern of the co-pilot could be attributed to a malfunctioning VOR since it is the prime navigation aid. The straight track flown after the turn indicated that the pilot was using at least some of the aircraft's navigation instruments for guidance.

Immediately after take-off, the aircraft would have drifted to the right because of strong south-west winds. Moderate to severe turbulence would have been encountered and should have continued while the aircraft was in the lee of Sweeney's Ridge. Drift corrections would have been made to the left and high power settings were required to maintain a positive rate of climb. The aircraft was near maximum gross weight. It was considered that because of this, the crew would have been more concerned with flight and engine instruments than with navigational instruments and that, accordingly, the initial period of the flight was spent flying the aircraft, maintaining proper attitude, and a positive rate of climb. It was considered possible that the crew became aware that they were left of course and requested information on their position from the departure controller. At this point, 0031:05, they were considerably left of the course and 25 seconds from impact.

Under conditions of instrument flight, during a departure, if the crew were concerned with incorrect navigational readings combined with turbulence and marginal climb performances, the cumulative demands upon the pilot would have been very great.

Since no reason was apparent why the left turn would not have been displayed on the instrument panel, the Board concluded that the crew apparently failed to refer to the total instrument portrayal in the cockpit.

The investigation of this accident revealed that the lateral and horizontal terrain clearance for a runway 28 departure at San Francisco could be marginal for an aircraft operating in this environment. With respect to the radar procedures utilized, radar vectoring is not provided during this instrument departure until the aircraft reaches 1 500 ft. This is because standard vertical and lateral obstruction clearance from the adjacent terrain cannot be achieved in so far as present criteria are concerned. The lateral clearance from obstructing terrain is so critical that there is no available space in which to vector an aircraft safely until it has reached an altitude of 1 500 ft.

As far as can be determined the flight was initially climbing at approximately 250 ft per mile minimum rate of climb and would have undoubtedly made a safe climb-out had it remained on the appropriate standard instrument departure route. However, after the aircraft left the prescribed departure route, it entered an area of rising terrain where downdraught activity and moderate to severe turbulence affected the climb capability of the aircraft sufficiently to prevent terrain clearance. The deviation to the left was not detected in time to avert impact with the hill.

2.2 Conclusions

Findings

The crew of the flight was properly certificated and there was no evidence of pre-impact incapacitation.

The aircraft was loaded to within the c.g. limits and was under the maximum gross take-off weight limitation.

Take-off was normal and the landing gear and landing lights were retracted after the aircraft became airborne. The landing lights were not turned off after retraction.

The aircraft made a slight right turn, then a left turn exceeding 25° of bank, rolled out and proceeded in an approximately straight line until it impacted Sweeney's Ridge.

The engines were functioning properly and were operating at a high rate of power at impact.

There were navigation instruments in the cockpit that were giving accurate heading and cross-check information at the time of the accident.

Cause or
Probable cause(s)

The pilot, for undetermined reasons, deviated from departure course into an area of rising terrain where downdraught activity and turbulence affected the climb capability of the aircraft sufficiently to prevent terrain clearance.

3. - Recommendations

The Civil Aeronautics Board (CAB) submitted the following recommendations to the Federal Aviation Agency (FAA).

3.1 On 22 April 1965 it recommended that all operators of Lockheed L 1049 aircraft equipped with radio transfer switch assembly (Lockheed part No. 319122) initiate a campaign to determine whether contamination of the switch assembly existed and take such steps as necessary to eliminate further contamination.

3.2 On 23 July 1965 it suggested to review the use of the term "radar contact" which could create a false impression of safety in the minds of the pilots, and to display prominently on aeronautical charts for departure limitations imposed by local features to radar vectoring.

3.3 On 24 September 1965 it recommended that the San Francisco departure controller be provided with an additional radar display, to be operated on a suggested 6 mile range setting.

4. - Action taken

4.1 On 14 May 1965 the FAA issued an Airworthiness Directive applicable to all L 1049 C, E, G and H series aircraft equipped with Lockheed radio transfer switch assembly (P/N 319122), requiring disassembly and checking of each switch assembly for wire clipping within 300 hours time in service.

4.2 New standard instrument departure (SID) procedures for San Francisco were issued and became effective on 22 July 1965. A note, to the effect that a minimum climb rate of 250 ft per mile up to 2 000 ft was required on certain SIDs, was included on the appropriate chart.

4.3 On 3 August 1965 the FAA advised the CAB that some of the terms in current use such as: "radar contact", "radar flight following", "radar hand-off", "radar service", radar surveillance", "radar target", "radar traffic information", "radar vector" and "radial" had been redefined and that their definition would be included in the Airman's Information Manual.

4.4 On 28 September 1965 approval was granted to the Western Region to proceed with the development of a common terminal radar control facility located at Oakland for the San Francisco/Oakland area.

ICAO Ref: AR/907

ACCIDENT TO L-1049H, N 69150C
OF THE FLYING TIGER LINE INC.,
AT SAN FRANCISCO, U.S.A.
24 DECEMBER 1964

SAN FRANCISCO INTERNATIONAL SID's
STANDARD INSTRUMENT DEPARTURES

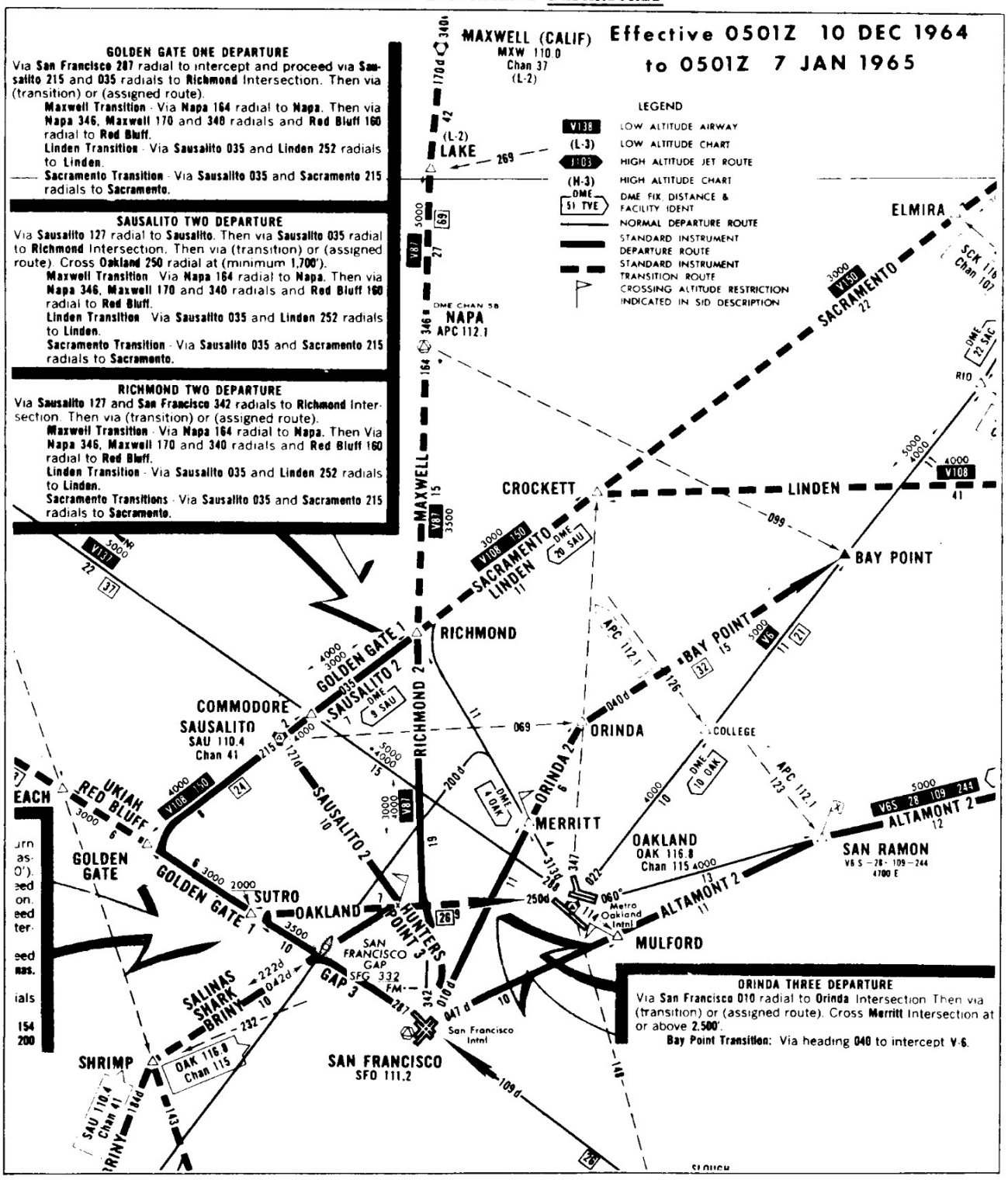

FIGURE 23-1

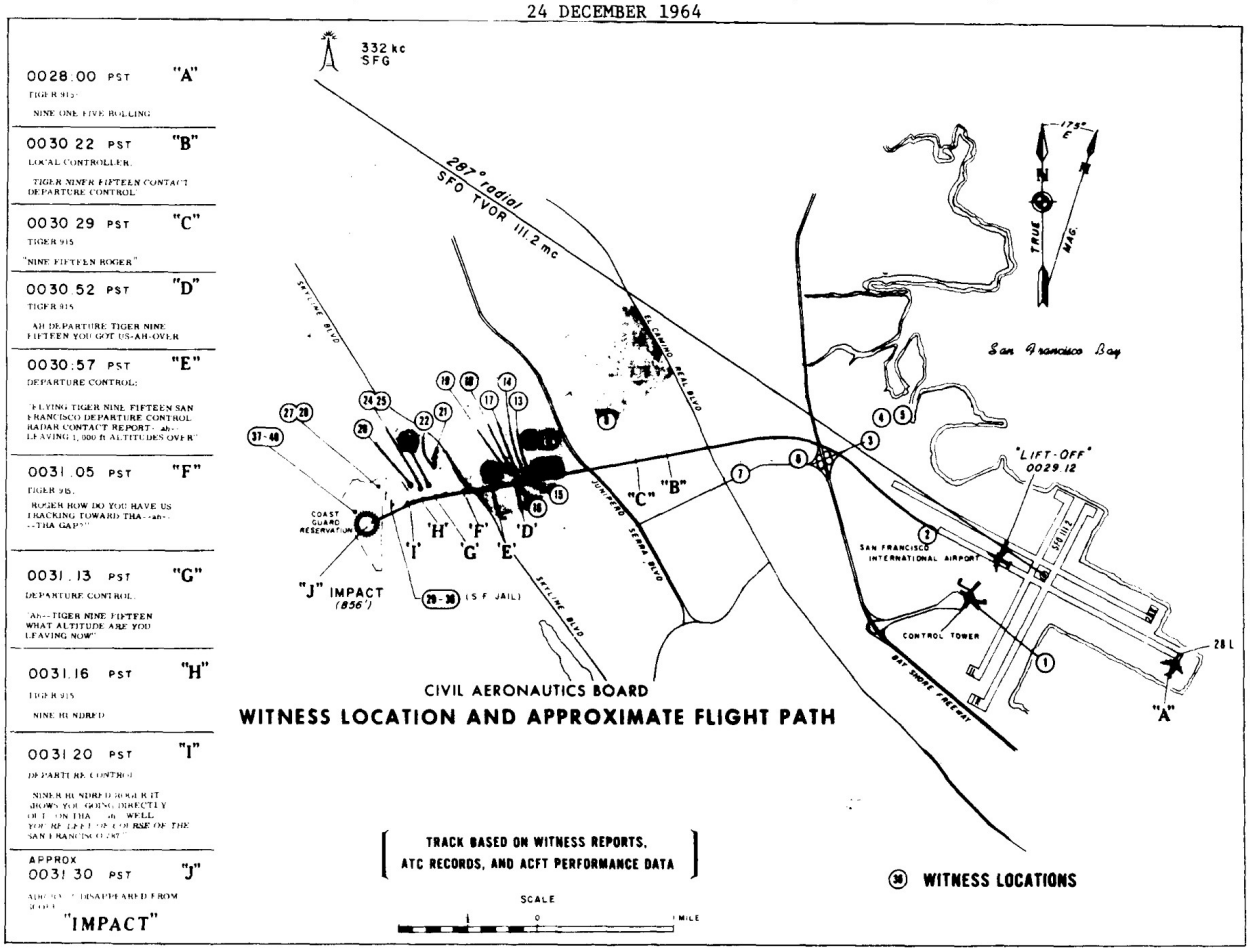
0028.00 PST "A"
TIGER 915:
NINE ONE FIVE ROGER
0030 22 PST "B"
LOCAL CONTROLLER:
TIGER NINER FIFTEEN CONTACT DEPARTURE CONTROL
0030 29 PST "C"
TIGER 915
"NINE FIFTEEN ROGER"
0030 52 PST "D"
TIGER 915
AH DEPARTURE TIGER NINE FIFTEEN YOU GOT US-AH-OVER
0030.57 PST "E"
DEPARTURE CONTROL:
"FLYING TIGER NINE FIFTEEN SAN FRANCISCO DEPARTURE CONTROL RADAR CONTACT REPORT--ah-- LEAVING 1,000 ft ALTITUDES OVER"
0031.05 PST "F"
TIGER 915:
ROGER HOW DO YOU HAVE US TRACKING TOWARD THA--ah-- --THA GAP?"
0031.13 PST "G"
DEPARTURE CONTROL:
"Ah--TIGER NINE FIFTEEN WHAT ALTITUDE ARE YOU LEAVING NOW?"
0031.16 PST "H"
TIGER 915
NINE HUNDRED
0031 20 PST "I"
DEPARTURE CONTROL:
"NINER HUNDRED ROGER IT SHOWS YOU GOING DIRECTLY OUT ON THA--ah-- WELL YOU'RE LEFT OF COURSE OF THE SAN FRANCISCO"
APPROX
0031 30 PST "J"
"IMPACT"
332 kc
SFG
297° radial
SFO TVOR 111.2 mc
SKYLINE BLVD
SKYLINE BLVD
SKYLINE BLVD
EL CAMINO REAL BLVD
JUNIPERO SERRA BLVD
COAST GUARD RESERVATION
"J" IMPACT
(856')
29-36 (S.F. JAIL)
"H" "F" "D"
"I" "G" "E"
"C" "B"
"LIFT-OFF"
0029.12
San Francisco Bay
SAN FRANCISCO INTERNATIONAL AIRPORT
CONTROL TOWER
28L
"A"
TRUE
MAG.
CIVIL AERONAUTICS BOARD
WITNESS LOCATION AND APPROXIMATE FLIGHT PATH
TRACK BASED ON WITNESS REPORTS, ATC RECORDS, AND ACFT PERFORMANCE DATA
WITNESS LOCATIONS
SCALE
MILE

FIGURE 23-2

ACCIDENT TO L-1049H, N 69150C
OF THE FLYING TIGER LINE INC.,
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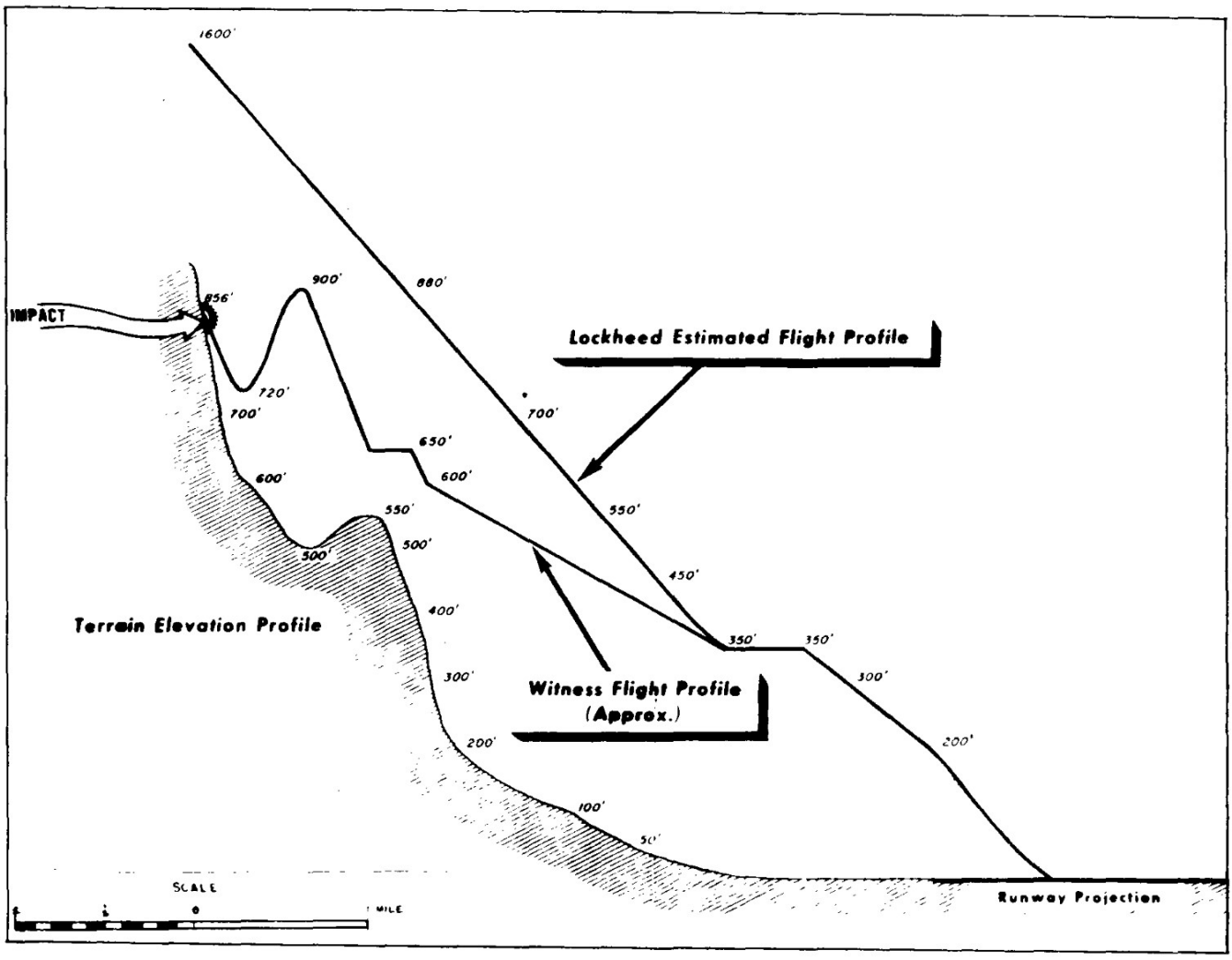

FIGURE 23-3