FILE NO. 1-0008

AIRCRAFT ACCIDENT REPORT

SATURN AIRWAYS, INC.
LOCKHEED L-382, N14ST
SPRINGFIELD, ILLINOIS

MAY 23, 1974

ADOPTED: JANUARY 22, 1975

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D.C. 20591
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16. Abstract

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The outboard section of the left wing, including the No. 1 engine, separated in flight from the reminder of the wing.

The National Transportation Safety Board determines that the probable cause of the accident was the undiscovered, preexisting fatigue cracks, which reduced the strength of the left wing to the degree that it failed as a result of positive aerodynamic loads created by moderate turbulence.

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SYNOPSIS

About 1653 c.d.t., May 23, 1974, Saturn Airways Flight 14 crashed about 2.6 miles southeast of the Capitol VOR, near Springfield, Illinois. Three crewmembers and a route supervisor were killed, The aircraft was destroyed.

The outboard section of the left wing, including the No. 1 engine, separated in flight from the reminder of the wing.

The National Transportation Safety Board determines that the probable cause of the accident was the undiscovered, preexisting fatigue cracks, which reduced the strength of the left wing to the degree that it failed as a result of positive aerodynamic loads created by moderate turbulence.

1. INVESTIGATION

1.1 History of the Flight

On May 23, 1974, at 1000 P.d.t. 1/ Saturn Flight 14, a Lockheed 382, N14ST, departed the Alameda Naval Air—Station, Alameda, California. The flight was a scheduled cargo flight to Wilmington, Delaware, with an en route stop at Indianapolis, Indiana. On board were a crew of three and a route supervisor. The flight was uneventful before it reached Springfield, Illinois, except for a deviation to avoid weather over Colorado. Flight 14 did not report any airspeed changes or difficulties following the deviation.

About 1453, control of Flight 14 was transferred from Denver ARTCC to Kansas City ARTCC. The flight proceeded routinely until reaching the Springfield area where, at 1651:58, the controller approved Flight 14's request to deviate to the right. A short time later, the controller noticed on the radar alphanumeric data block 2/ that the target had gone

1/ Unless otherwise noted, all times hereafter are central daylight, based on the 24-hour clock.

2/ An electronic presentation on the radarscope which identifies data about the flight.

into a "coast mode." 3/ About 1658, the controller transmitted, "Saturn fourteen lost transponder, recycle one three zero four." This and subsequent attempts to establish radio contact were unsuccessful.

The last known radio transmission from the aircraft was acknowledgment of the clearance to deviate. The last intelligible words on the cockpit voice recorder (CVR) were, "Better tell our passenger to put his belt on."

Most witnesses said that they saw the aircraft fly from west to east, while several others said it proceeded north-northwest just before impact. Several other witnesses said that they saw the aircraft head southeasterly before impact.

Pieces of wreckage were seen falling from the aircraft just before impact, and some witnesses noticed that either a wing or a wing and engine were missing.

Persons in the area of the Rails Golf Club clubhouse saw the left wing and engine fall to the ground southwest of their position about 2 to 5 minutes after the impact of the main portion of the aircraft. About 1 minute after the left wing and engine came to rest, another piece of structure fell east of the golf course.

Nearly all witnesses said that the aircraft was on fire before impact. They said that flames came from the area of the fuselage near the wing leading edge, and engulfed the fuselage and tail. Several witnesses said that the aircraft exploded seconds before impact.

A house and *two* mobile homes near the main impact site were damaged by pieces of aircraft structure.

The crash of Flight 14 occurred in daylight, and the main wreckage was found at an elevation of 590 feet m.s.l. 4/ The coordinates of the accident site were latitude 39° 51' 46" north; longitude 89° 35' 52" west.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Other
Fatal	3	1	0
Nonfatal	0	0	0
None	0	0	

3/ An aircraft movement projected by the computer on the basis of the last known reliable speed and direction data.

4/ All altitudes herein are mean sea level, unless otherwise indicated.

1.3 Damage to Aircraft

The aircraft was destroyed.

1.4 Other Damage

A house and two mobile homes were damaged.

1.5 Crew Information

The crew was certificated and trained in accordance with existing regulations. (See Appendix B.)

1.6 Aircraft Information

The aircraft was maintained in accordance with Federal Aviation Administration (FAA) approved procedures.

Records indicate that all applicable airworthiness directives had been complied with.

When N14ST departed Alameda, its gross weight was 153,943 lbs. Its. maximum allowable takeoff weight was 155,000 lbs. At takeoff, the center of gravity (c.g.) was 28.1 percent MAC.

The gross weight included 40,500 lbs. of fuel and 39,302 lbs. of cargo. The fuel was a mixture of JP4 and JP5; 73 percent was JP5. (See Appendix C.)

1.7 Meteorological Information

The captain of Flight 14 was briefed at the **U. S.** Navy weather facility at the Alameda Naval Air Station. The forecaster said that the captain had no questions, and when told that he could expect scattered thunderstorms in the Kansas-Illinois area, he replied that he knew they were there because he had been flying the same trip all month.

The captain of Flight 14 received the following forecast information for FL 190.

1. Flight level winds - Light and variable to Lake Tahoe, 220° at 10 to 15 kn. to the Rocky Mountains, and 270° at **35** to *45* kn. to Indianapolis.

2. The flight was to be in and out of the clouds with no obstructions to visibility outside of the clouds.

3. The minimum ceiling en route was to be 2,000 feet above ground level at Dodge City, Kansas, with maximum tops at 35,000 feet near the thunderstorms forecast in the Kansas-Illinois area.

4. The minimum freezing level was at 9,000 feet at Kansas City.

5. No icing.

6. Moderate to occasionally severe turbulence near thunderstorms in the Kansas-Illinois area.

7. Moderate to heavy rain showers in the Kansas-Illinois area.

Between 1710 and 1730, three air carrier flights were operating in the vicinity of Capital VOR (CAP). They were at various altitudes between FL 190 and FL 230, en route from St. Louis to Chicago. None of the pilots saw severe thunderstorm cells visually or on radar. No lightning or hail was encountered, but light to moderate "chop" was experienced en route and in the Springfield area. All crews reported that at FL 230, they were on top, or nearly on top, of all clouds.

About 1630 one air carrier landed at Springfield. The crew reported seeing cloud to cloud lightning and heavy rain while approaching the airport. They were told during the approach that the winds were gusting to 35 kn.

The same flight took off from Springfield at 1646 bound for Chicago. The pilot stated that their radar ". . . painted cells to the northwest of V9." He said that they climbed out to the northeast to 7,000 feet, and experienced light "chop" but no hail. They were in the clouds until reaching Bloomington, where they climbed to 9,000 and were clear of the clouds.

The Springfield (Capital Airport) observation at 1655 was:

> Estimated ceiling 3,000 feet overcast, visibility-2 miles variable, thunderstorm, moderate rain showers, temperature-60%. , dewpoint-55°F. , wind-310° at 22 kn., altimeter setting-29.98 in., thunderstorm all quadrants moving eastward, peak wind-320' 32 kn. at 1641, thunderstorm began at 1625, visibility variable 1 to 3 miles.

The National Weather Service Office at Springfield reported a severe thunderstorm located just west of Springfield at 1628, moving eastward.

Radarscope photographs taken at Marseilles, Illinois, about 1648 and at St. Louis, Missouri, about 1651 showed weather echoes over the Springfield area. The Marseilles radar has iso-echo (contour) capability and depicted the maximum echo intensity as moderate.

Many witnesses stated that heavy winds were blowing from the west 10 to 20 minutes before the accident, and several said that hail, ranging from pea-size to golf-ball size, had fallen. Heavy rain had been reported. At the time of the accident, a moderate wind was blowing from the west,

light to moderate rain was falling, lightning was seen, and thunder was heard.

On radar, the Kansas City ARTCC controller saw weather cells ahead of Flight 14 when the crew requested to deviate to the right. Other cells were seen 25 to 30 miles southwest of CAP. According to the controller, the aircraft did not come closer than 15 miles to any of the weather cells.

1.8 Aids to Navigation

Not applicable.

1.9 Communications

No reported difficulties.

1.10 Aerodrome and Ground Facilities

Not applicable.

1.11 Flight Recorders

Flight Data Recorders. -- The flight data recorder (FDR), Lockheed Aircraft Service Company (LAS) Model 109-C, was severely crushed and the outer shell had separated. The cassette which contained the foil recording medium was deformed, and the foil was crumpled and torn.

All parameters had been recorded on the foil attached to the takeup spool, but none had been recorded on the foil attached to the supply spool. These facts, coupled with the discovery that the torn edges of the foil did not match, were evidence that the portion of the foil containing the recorded traces of the final seconds of flight were missing. A search for the missing piece was unsuccessful. The irregular edge of the torn foil and the offset characteristics of the recording styli allowed a portion of the final traces to be read.

The plot of the readout begins about 5 minutes before the start of the descent and covers 5 minutes 33 seconds of altitude trace with lesser times for indicated airspeed, vertical acceleration, and magnetic heading, respectively.

Using the start of the readout as a zero reference, descent began 5 minutes 13 seconds later from a pressure altitude of 21,050 feet and continued for 20 seconds to an altitude of 13,250 feet, an average descent rate of 23,400 fpm. At 4 minutes, the airspeed, which had been averaging 225 kn., increased to about 232 kn. The airspeed trace, which ended at 5 minutes 15 seconds, showed variations between 235 and 227 kn. at 4 minutes 42 seconds, and ended with a reading of 238 kn. 2 seconds after

start of descent. The vertical acceleration trace showed light turbulence beginning at 4 minutes 8 seconds and continuing to the end of the trace at 4 minutes 24 seconds. The magnetic heading trace ended at 4 minutes 1 second on 080° -- a heading which had been maintained for 1 minute 21 seconds. (See Appendix G.)

Another readout and plot were made of Flight 14's encounter with turbulence over Colorado, about 1 hour 40 minutes before the start of descent near Springfield, Illinois. The duration of the turbulence was about 1.5 minutes with a maximum vertical acceleration (g force) excursion of + 1.5 and 0.0 g, separated by about 18 seconds. The magnetic heading changed from 084° to 075°. The airspeed increased from 131 kn. to 152 kn., and decreased to 125 kn. The pressure altitude increased from 21,000 feet to 21,500 feet.

Cockpit Voice Recorder. -- The CVR assembly was crushed. The tape, although broken in several places, was readable after it was pieced together. All four tracks contained information. The entire recording was reviewed, but only the final 27:56.5 minutes contained pertinent information, part of which was transcribed. The crew made frequent use of the interphone system because of the high cockpit noise level of the Lockheed L-382.

At 1651:53, the first officer transmitted to Kansas City ARTCC, "We'd like to deviate to the right sir, weather." The following dialogue took place sequentially:

ARTCC	1651:56	Fourteen, standby.
ARTCC	1652:00	Fourteen, deviation approved.
Flight 14	1652:02	Roger
Captain	1652:06.5	Better tell our passenger to put his belt on.
Cockpit Area Microphone	1652:12	(Sound of static type noise buildup similar to open microphone)
"	1652:17.5	Sound of loud noise.
"	1652:18.4	Sound similar to propeller pitch change noise.
"	1652:26.5	Sound of a click
"	1652:29.5	Sound of overspeed warning "clacker" begins and continues to end of recording.

Cockpit Area Microphone	1652:30.5	Sound similar to propeller pitch noise change.
"	1652:32.5	Unintelligible two syllable word or two short one syllable words.
"	1652:39.5	Sound of gear warning horn begins and continues to end of recording.
"	1652:39.75	Sound of heavy click.
"	1652:56.5	End of recording.

1.12 Wreckage

The main wreckage site is located about 2.6 statute miles on a true bearing of 145° from CAP. The wreckage site contained three clay pits. The aircraft impacted on a magnetic heading of 205° into the largest pit, which was about 15 feet deep, 40 feet in diameter, and partially filled with water.

Most of the identifiable pieces found in and near the largest pit were from the lower fuselage structure, and included the main and nose' landing gear components, vertical stabilizer, and fragments of the cabin floor structure. The flight data and cockpit voice recorders were found buried on the crest of the slope. The entire fuselage was fragmented. None of the recovered fuselage was damaged by fire.

The left outer wing panel separated from the aircraft in the vicinity of the inboard rib which supported the No. 1 engine (about outer wing station 162). The panel, including the No. 1 engine and propeller assembly, was found inverted about 1.2 statute miles on a true bearing of 182° from the CAP. Investigation disclosed that the wing panel had failed in an upward or positive direction. The laver front spar cap was severed by a fracture which was dirty, contained many crack arrest marks, and displayed evidence of rubbing deformation on the mating surfaces. A crack in the front spar web progressed from the spar fracture upward for 4.9 inches. (See Appendix H.) The crack contained about 116 crack-arrest marks, There was no fire damage.

The right wing panel fragmented and separated from the aircraft in flight near outer wing station 334 (OWS 334). Two main sections of the right outer wing panel were found about 4,900 feet north of the main wreckage. A number of right wing pieces, including leading edge structure, lower wing skin, upper wing skin, and the wing tip, were recovered as far as 2 miles northeast of the main wreckage.

The empennage was recovered in pieces from the main wreckage site. Numerous scrape marks and black deposits were found on the leading edge of the stabilizer tip.

No. 2 engine was recovered about 10 feet under the ground near the largest pit. The propeller and gearbox were found buried adjacent to the compressor and combustion section. The compressor blades were curled clockwise when viewed from the rear.

The No. 4 engine was recovered about 8 feet under the ground to the west of the largest pit. The propeller, propeller shaft and housing, and gearbox components were excavated separately from the compressor-turbine-burner sections. The compressor blades were curled clockwise when viewed from the rear.

Because of recovery difficulties in the impact area, the No. 3 engine and propeller were not examined.

The No. 1 propeller was attached to the engine except for one blade which had broken off and was lying nearby. The blades, which were still attached to the hub, were found at an angle of 84°. Later investigation determined that the blades had feathered from negative torque sequencing action.

The fuel shutoff valve on the fuel control of No. 1 engine had electrical continuity between pins A and C and no continuity between pins A and B. This condition exists when the valve is electrically open.

The magnetic plugs of No. 1 engine were free of metal accumulation, and the external oil filter, gearbox oil filter, power section oil filters, fuel filter, and fuel heater were clean.

The engine structure was separated at the inlet housing to compressor case split line for about 2 to 4 inches. The inlet housing was intact. The power section was undamaged except for the separation, fracture of the accessory housing, and local crushing of the rear turbine support. Fourteen 4th-stage turbine blades were bent where the case was deformed. (See Appendix E.)

1.13 Medical and Pathological Information

Insufficient tissue was found for autopsy. Toxicological tests on tissue received at the Civil Aeromedical Institute revealed no drugs or alcohol. Specimens were unsuitable for carbon monoxide analysis.

1.14 Fire

In-flight fire occurred and continued after impact. The fire was extinguished by No. 3 and No. 4 engine companies of the Springfield Fire

Department and the Williamsville Volunteer Fire Department, which were dispatched at 1656.

1.15 Survival Aspects

This was not a survivable accident.

1.16 Tests and Research

Metallurgical examination of the fractured surfaces of the left wing at outer station 162 revealed that the lower front spar cap fractured completely in fatigue. The spar cap was deformed at the primary origin area of the fatigue fracture. Hardness and electrical conductivity of the spar cap material were normal for 7075-T6511 aluminum alloy.

The lower portion of the front spar web contained an approximate 4.9-inch fatigue crack with intermittent tensile tearing.

The lower wing skin fracture stemmed from preexisting fatigue cracks at the first fastener hole which was located 3/4 inch outboard of the primary origin area at which the spar cap failed. Deformation and multiple cracks were noted at the origin of the skin fatigue fracture in the lower wing.

Further study showed that if the above cracks existed before the accident, a wing loading of about 60 percent of limit load would be required to make the 4.9-inch crack progress. When the crack progressed beyond the 4.9-inch mark, the stress intensity factor in the lower skin panel would approach the critical value and would trigger crack instability in the panel. From there on, the crack propagation in both the panel and the web would have been simultaneous. With this condition, total failure of the wing section would be expected.

1.17 Other Information

Classified Cargo. -- Two containers of water were on board and destined for testing for radioactive levels. Neither required a label and the contents were not dangerous. A radioactive check of the accident site by the U. S. Air Force and the State of Illinois revealed no hazardous radioactivity.

A pallet of corrosive battery electrolyte was on board and carried as a white label item.

Class C explosives on board were electric squibs of the type used to puncture the caps on remotely controlled fire extinguishers used on aircraft.

Automated Radar System. -- Kansas City ARTCC uses an automated radar system. The system involves a computer which can print a plot at 15-sec. intervals, using X and Y axes scaled in miles. The plot for Flight 14 covers an area of 30 sq. mi. with CAP in the center. The plotted information includes radar and position data on Flight 14, primary radar returns, transponder returns, and clutter returns, and is correlated in Greenwich mean time (G.m.t.). Radar data are recorded every 6 seconds. This information was charted to show the relationships between the radar returns, the CVR data, and the terrain, including the positions of the main wreckage, left wing, and the CAP. (See Appendix D.)

Appendix D shows a transponder return at 1652:17. At 1652:27, a primary target appeared followed by other primary targets shortly thereafter. Two more transponder targets appeared at 1652:29 and 1652:41. Flight check data indicate that the minimum altitude for usable radar returns is about 4,800 feet in the Springfield area.

Wing Crack History. -- All of Saturn's L-382 aircraft had been modified to a -30 configuration, which included the installation of a new center wing. However, only one of Saturn's L-382 fleet had Engineering Change Proposal (ECP) 954 modification. N14ST did not have this wing modification installed.

A review of the FAA Service Difficulty reports from July 1, 1973, to May 29, 1974, indicated that four L-382 aircraft had wing cracks. These reports included two ½-inch cracks in the forward spar cab at wing station (WS) 70, a 2-inch crack in the left front spar web, a 10-inch crack in the center wing dry bay area in No. 2 plank, and a 13-inch crack in the center wing plank at WS 61.

Lockheed participated in the United States Air Force Individual Aircraft Fatigue Tracking Program for the C-130 (L-382) aircraft. About 700 aircraft were surveyed which had accrued over 6,000,00 flight-hours. This program began in 1969 and is continuing. As a result of the program, Lockheed ECP 954 was developed and released on October 1, 1971. The Lockheed-Georgia Company Engineering Design Analysis -- Outer Wing Fatigue Improvements, was approved on October 17, 1970, and described the fatigue preventive modification kits for fatigue sensitive areas of the outer wing which had been identified by the tracking progrm. The record of cracking of the forward spar near Nos. 1 and 4 engines disclosed 36 cases, of which 11 were between OWS 156 and 162.

2. ANALYSIS AND CONCLUSIONS

2.1 Analysis

The aircraft was certified and maintained according to FAA procedures.

The aircraft was within the weight and balance limitations both at takeoff and at the time of the accident,

The judgment of the captain of Flight 14 in deviating to avoid turbulence was correct to assure a safe flight.

Only the No. 1 engine was found intact. Investigation revealed that it was capable of operating. The bent compressor blades of Nos. 2 and 4 engines prove that they were rotating at impact.

One significant event occurred before the aircraft reached the Springfield area. Over Colorado, the flight deviated to avoid turbulence. Nevertheless, weather was encountered and produced maximum vertical acceleration excursions of +1.5 and Og, separated by about 18 seconds. Applying the criteria from the Operations Manual of the National Weather Service, +1.5g excursion above the normal would be the upper limit of light turbulence.

The turbulence encountered over Colorado was relatively light, and since the crew made no comment to the contrary, the weather encounter was probably not significant.

Based on the forecast and his recent experience over the route, the pilot would have expected thunderstorms in the Springfield area. Apparently the captain saw weather on his radar and was granted a request to deviate. The airspeed was not reduced, although the recommended turbulence penetration speed is 180 kn. The fact that the pilot did not reduce the airspeed suggests that he expected to avoid any significant turbulence, even though he took the precaution of assuring that the route supervisor fastened his seatbelt. The flight's proximity to thunderstorm activity is supported by the Kansas City ARTCC controller's statement that the aircraft was about 15 miles from the nearest cell when radar contact was lost. Radarscope photographs taken about 1648 and 1651 shaved echoes over the Springfield area. The Marseilles radar depicted the maximum intensity as moderate. (See Appendix F.) Probably, Flight 14 encountered moderate turbulence which would have produced 1.5 to 2.0g vertical acceleration. Unless a preexisting weakness was present, the wings of the aircraft should have withstood g forces of this magnitude.

The initiating event of the accident was the separation of the outer portion of the left wing, including the No. 1 engine. The subsequent aerodynamic effect was a violent roll and yaw, which caused the right wing to fail. The fragmented right wing structure outboard of the No. 4 engine, and the wide scatter of the parts north and east of the main wreckage support this conclusion.

The final event was the steep, rapid descent which resulted from the loss of large portions of the wings and lateral control surfaces.

Investigation revealed that a wing loading of about 60 percent of limit load would begin to tear the web at the 4.9-inch point, after which crack propagation in both the panel and the web would be simultaneous and would be expected to result in total failure of the wing section. In terms of vertical acceleration, the force required would be about 1.62g.

The weather encountered over Springfield was capable of generating gusts which would produce at least 1.62g and probably as much as 2.0g.

Assuming that the crack in the web (after the spar cap had cracked completely) had propagated as far as the top fastener hole and down as far as the edge of the web, considerably more force would be required to propagate the crack upward past the top fastener hole, which would act to arrest further cracking. Obviously, the vertical acceleration forces encountered over Colorado could not have produced sufficient forces. Therefore, the crack in the web up to the 5.9-inch point must have existed before the aircraft departed Alameda. When the web cracking reached the 4.9-inch point is not known. The presence of foreign material in the fracture, the rubbing deformation of the mating surfaces, and the number of fatigue striations indicate that the lower front spar cap had been cracked for a considerable time. The wing structure of the aircraft was weakened to the point that only moderate turbulence would have been required to fail it.

The USAF Individual Aircraft Fatigue Tracking Program for the C-130 shows many cases of cracking in the lower spar cap, web, and skin panel, in the same general area (outer wing station 162) as that of Flight 14. A military aircraft understandably may be subjected to more rigorous handling than its civilian counterpart, and tends to develop cracks more readily. Nevertheless, even if this accident had not occurred, the frequency of cracking in the area of OWS 162 indicates a potential danger to the civilian fleet. The military reinforced the wings in this area under Lockheed ECP 954, originally released on October 1, 1971, as T.C.T.O. IC-130-857.

The maintenance records show that, beginning July 5, 1972, N14ST was modified to the "stretch" version, and in September 1972, received check No. 12, which included inspection of the left wing. Subsequent maintenance checks were performed periodically through check No. 19 in April 1974. All of these checks included inspection of the left wing. The approved maintenance manual allows such inspections to be visual, Since the left wing of N14ST had been so inspected about a month before the accident, there is some doubt as to whether visual inspections are adequate for detecting cracks in the area of the failure. In fact, the cracks in question were probably present when the last inspection took place.

2.2 Conclusions

a. Findings

(1) The crewwascertificated and qualified to operate the flight.

(2) The aircraft was within the specified weight and balance limitations.

(3) Thunderstorms prevailed in the area of Springfield, Illinois.

(4) Shortly after a deviation to the right to avoid weather, the left wing separated from the aircraft at about outer wing station 162.

(5) Shortly after the left wing failed, the right wing failed outboard of the No. 4 engine.

(6) A fatigue fracture occurred in the lower front spar cap of the left wing, and preexisting cracks were found in the web and lower skin panel,

(7) The left wing failed because of positive aerodynamic loads in excess of the residual wing strength.

(8) The right wing failed because of the violent roll and yaw maneuver caused by the loss of the outer panel of the left wing.

(9) The aircraft descended at a steep angle and crashed about 2.6 miles southeast of the Capitol VOR. The aircraft was destroyed, and its four occupants were killed.

(10) Inspections had not revealed cracks in the areas where the left wing failed.

b. Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the undiscovered, preexisting fatigue cracks, which reduced the strength of the left wing to the degree that it failed as a result of positive aerodynamic loads created by moderate turbulence.

3. RECOMMENDATIONS

As a result of facts obtained by the Safety Board during its investigation of the crash of Flight 14, the FAA issued Air Worthiness Directive 74-12-06 LOCKHEED: Amendment 39-1867. The directive required that all applicable aircraft be inspected. If cracks were found in the designated inspection areas, repairs were required in accordance with Lockheed Service Bulletin 382-169A, or the later FAA-approved revision, or in an approved equivalent manner. Aircraft on which no cracks were found in the designated areas are required to be inspected at 1,000-hour intervals. Aircraft having the above repair are exempt from the periodic inspections.

The airworthiness directive also provides for preventive modification, which may be accomplished by the two methods mentioned above, or by ECP 954, or by Lockheed Drawing 3304406, or in an approved equivalent manner.

The inspection of all U.S. registered L-382 aircraft revealed one aircraft with the lower forward spar cap cracked through the entire cross section at OWS 160. The flight hours on the aircraft were 16,000 +.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JOHN H. REEL)
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

/s/ WILLIAM R. HALEY
Member

January 22, 1975

APPENDIX A

INVESTIGATION

1. Investigation

The National Transportation Safety Board was notified of the accident at 1905 e.d.t., May 23, 1974, by the Federal Aviation Administration. The investigation team departed Washington, D. C., the same day, and arrived at Springfield, Illinois, at 0015 e.d.t., May 24, 1974. Working groups were estabished for operations, witnesses, structures, systems and powerplants, weather, air traffic control, maintenance records, flight data recorder, and cockpit voice recorder. Parties to the investigation included: Saturn Airways, Inc., Federal Aviation Administration, the Division of Aeronautics of the State of Illinois, Lockheed-Georgia Co., Detroit Diesel Allison, Airline Pilots Association, and the U. S. Air Force Airlift Command.

2. Hearing

A public hearing was not held.

APPENDIX B

CREW INFORMATION

Captain Chapman Marston

Captain Marston, 58, held Airline Transport Certificate No. 168776 with type ratings in the Douglas DC-3/4/6/7, Curtis C-46, Lockheed L-382, and commercial privileges for airplane single engine land and multi-engine sea. He had 15,553 flight-hours of which 2,424 were in the L-382. His last line check was successfully completed on February 26, 1974. Since passing his captain's upgrade/type rating in the L-382 on March 2, 1973, Captain Marston successfully completed two 6-month proficiency checks, He possessed a current first-class medical certificate, dated January 3, 1974, with the limitation: Must wear glasses to correct near and distant vision.

First Officer Charles F. Moran

First Officer Moran, 35, held Airline Transport Certificate No. 1658157, with an airplane multi-engine land rating and commercial privileges for airplane, single engine land, and rotorcraft-helicopter. He also held Flight Engineer Certificate No. 1740607. His total flight time was 4,222 hours with an additional 420 as flight engineer, His total L-382 flight time was 1,060 hours. He successfully completed an annual proficiency flight check on May 22, 1973. His last recurrent training was completed September 8, 1973. His first-class medical certificate was dated March 1, 1974, with no limitations,

Flight Engineer Allan Collie

Flight Engineer Collie, 45, held Flight Engineer Certificate No. 1402602 for reciprocating and turbopropeller powered aircraft. His total flight time of 10,439 hours was as a flight engineer, and included 611 hours in the L-382. His last flight engineer's line check was completed on December 6, 1973, and his proficiency check and ground school (recurrent) requirements were completed during his initial training in August 1973. His second-class medical certificate was dated February 15, 1974, with the limitation: Must possess corrective glasses while exercising the privileges of his certificate.

APPENDIX C

AIRCRAFT INFORMATION

Make and Model	Lockheed L-382E
Registration	N14ST - formerly N959AL
Manufacturer's Serial Number	4225
Date of Manufacture	September 5, 1967
Total Flight-Hours	18,837 (Includes estimated time of 5.5 hours on 5/23/74 347 hours)

Engines - Allison 501-D22A

Number	S/N	Total Time	Since Overhaul
1	500893	17,446	1,500
2	550099	10,992	4,497
3	550181	12,322	6,739
4	550102	10,382	3,408

Propellers - Hamilton Standard 56H60-91/117

Number	S/N	Time Since Overhaul
1	230077	2,033
2	229193	369
3	231252	4,804
4	225626	2,570

On July 5, 1972, FAA Form 337 (7-67) was issued to Saturn Airways, Inc., as approval for the following modifications accomplished by the Lockheed Company to L-382E, S/N 4225:

1. Center Wing P/N 394037-1 replaced with new Center Wing P/N3304462-1, Reference Lockheed Dwg. 3304461. Left hand outer wing reinforcement and Mod Kits installed, Reference Lockheed Dwgs. 3302624, 3302625, 3302400, 3304391, R/H required only corner fitting replacement due to installation of a spare wing, S/N 4420.

2. Fuselage modified by removing 60" extension fwd and 40" extension aft and installing 100" extension fwd 80" aft. Reference Lockheed Drawings 3305200, 3305201, 3505203, and STC 446 SO amended March 22, 1972. The modification included the installation of a new wing to fuselage attach angles (Ref. Lockheed Dwg. 3305956), and the installation of auxiliary fuel tanks in the center wing.

The Maintenance Program

The following checks, inspections, and overhauls constitute the maintenance program for Saturn Airways. These data are incorporated in Saturn's Operations Specifications, Form FAA 1014 (5-47), as approved by FAA Air Carrier Inspectors.

This program made Saturn Airways responsible for performing all routine spections, including special and structural inspections, and line maintenance on its aircraft in accordance with procedures outlined in Saturn Airways Lockheed L-382 Maintenance Manual. These procedures were initiated from the Lockheed Document SMP 515, dated June **10, 1969.**

Special inspections and structural inspections, required by Lockheed Document SMP 515, are included on job cards in a manner to combine these inspections into Maintenance Check Periods applicable to each model and serial number of individual aircraft are controlled by the master job card listing in Saturn Airways Lockheed L-382 Maintenance Manual, resulting in a continuous inspection and progressive airframe overhaul.

Parts and subcomponents not listed were to be checked, inspected and overhauled at the time limitation specified for the component or assembly to which such components are related.

On Condition

Items listed as "On Condition" were to be maintained in a continuous condition of airworthiness by periodic inspection or checks and by means of overhaul and/or preventive maintenance in accordance with instructions in the Saturn Airways Maintenance Manual System for Lockheed Model L-382 aircraft.

Maintenance and Inspection

The maintenance record investigation covers the period from September 1972, through April 1974, and includes maintenance checks 12 through **19.** Each of these checks included the following inspections of the left wing.

A. Performance detailed inspection of upper exterior surfaces of wing for cracks, loose rivets, oil canning, and corrosion.

(1) Inspect fairings; access and inspection panels; associated latches, hinges, and fasteners for security and general condition.

(2) Inspect dry bay areas and components, lines, and connections for security and condition (SP-47)

(a) On #5 and #15 checks clean front beam stiffener and adjacent area around stiffener thoroughly.

(b) Visually inspect center wing front beam web stiffener that attaches CWS 178 bulkhead web to front beam. INTENSIFIED.

(c) Report any cracks found to STN engineering.

(3) Inspect fuel filler caps and seals for security and general condition.

B. Perform detailed inspection of lower exterior surfaces of wing for cracks, loose rivets, oii canning, and corrosion.

(1) Inspect fairings; access and inspection panels; and associated catches, hinges, and fasteners for security and general condition.

(2) Inspect wing drain holes, fuel drains, vents, and masks for obstructions and general condition.

(3) On #5 and 815 checks inspect outer wing laver surface skin panels externally for cracks between fastener holes for the pylon rib attachments at OWS 72 and 90. (SP-73) INTENSIFIED.

(4) Inspect accessible wing anti-Ice valves, lines, clamps, expansion joints, ducts, connections, thermocouples, temp bulbs, and attachments for security and general condition.

Other inspection of the wings included a detailed inspection of the interior structure for cracks, corrosion, loose fasteners, blistered or deteriorated sealant, and contamination. (#5 and 815 checks.) Special attention was given to the surge box bulkheads, where they contact the tank bottom, and phenolic tabs and "H" clibs between risers of the outboard end of the surge box. The forward and aft vertical beams were checked for condition and security. (#5 and 1/15 checks.)

Additionally, all aircraft log sheets from January 1, 1974, through May 22, 1974, were examined as well as all routine checks and inspections performed during this period. All discrepancies listed during the maintenance checks, routine inspections, and log sheet items had been inspected, repaired, and signed off by authorized personnel or deferred in accordance with an authorized minimum equipment list published in Saturn Airways 382 operations.

Wing Crack Data

FAA Service Difficulty Reports, 7/1/73 to 5/29/74:

Oper.	N. No.	Wing	Date Reported	Condition
SPAX	4301	left	7/16/73	Two ½-inch cracks in wing forward spar web. Wing Sta. 70.
AIAX	4222	left	10/19/73	2-inch crack in left front spar web.
AIAX	4234	center	9/17/73	10-inch crack in center wing bay area. #2 plank.
AIAX	4234	left	10/24/73	13-inch crack in center wing plank at W.S. 61.

The following information regarding in-service crack experience of the outer wing in the dry bay area was obtained from Lockheed-Georgia Company. These data were primarily obtained through Lockheed's participation in the USAF Individual Aircraft Fatigue Tracking Program for the **C-130.** The information is based on a survey of approximately 700 aircraft which accrued in excess of 6,000 flight hours:

Crack Experience - FWD Spar At No. 1 and 4 Engines

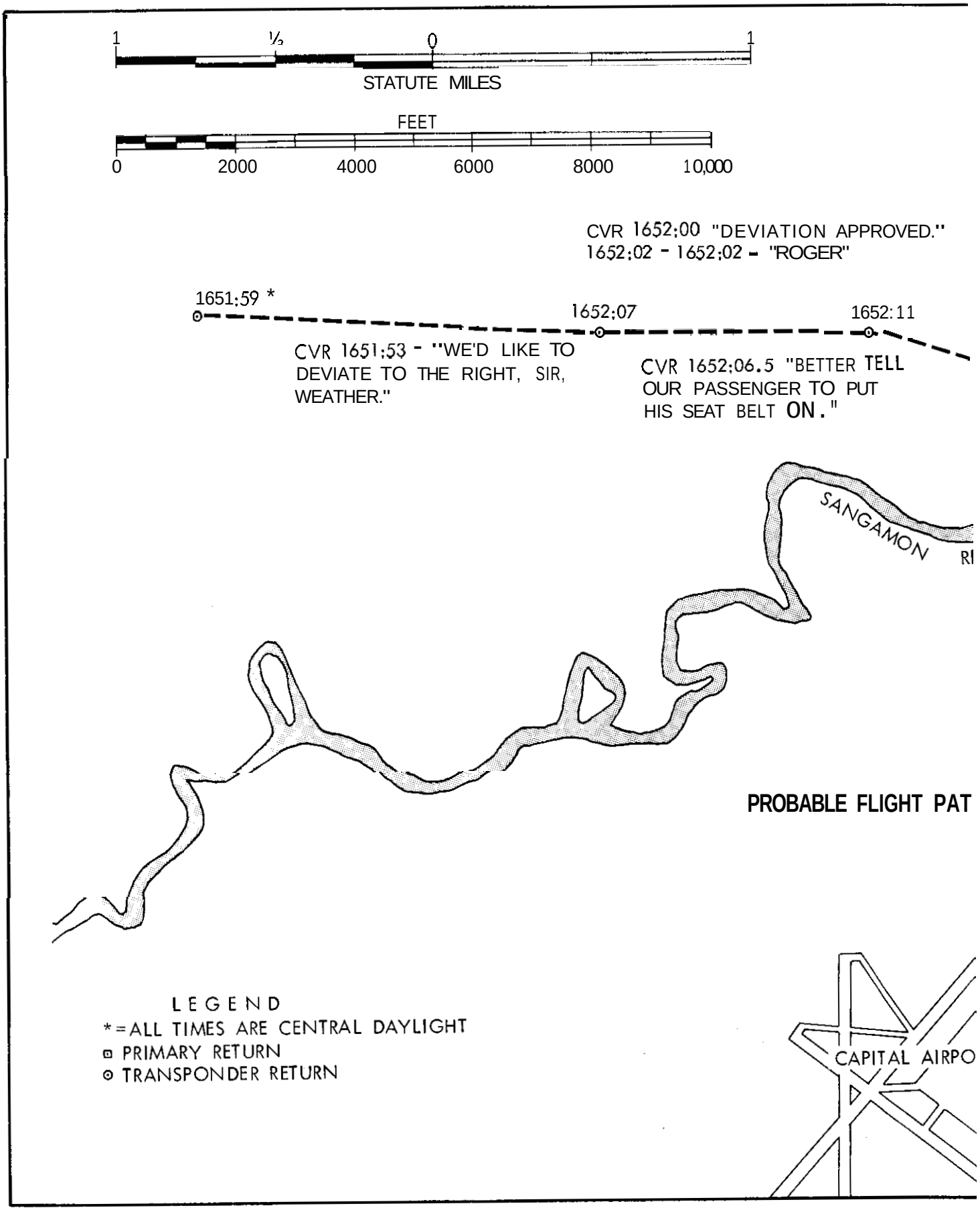
ACFT S.N.	Wing	Date Reported	Flt. Hrs.	Crack Description
6307769	R	Nov. 73	6901	OWS 160 Lower Fwd Spar Cap 2" Crack
6307773	R*	Unk.	8152	OWS 156 Lower Fdw Spar Cap Cracked
6307799	R*	Unk.	7468	OWS 159 Lower Fwd Spar Cap Cracked
6307803	L	April 74	7948	OWS 162 Lower Fwd Spar Cap - 2 - 1/4 inch Cracks
6307857	R	Sept. 73	6811	OWS 201 Lower Fwd Spar Cap Cracked Thru Entire Cross Section
	L	Sept. 73	6811	OWS 201 Lower Fwd Spar Cap Cracked Thru Entire Cross Section
6400538	L*	Unk.	7076	OWS 158 & 201 Lower Fwd Spar Cap Cracked
Delta 303	L	Dec. 70	12271	OWS 156 Lower Fwd Spar Cap - Aft Flange From Fastener to Edge
Saturn	L	June 74	16000+	OWS 160 Lower Fwd Spar Cap Cracked Thru Entire Cross Section Found After Inspection Required by AD No. 74-SO-59
6307764	L*	Unk.	6407	OWS 197 Fwd Spar Web 6" Crack
6307799	L	Oct. 73	7468	OWS 162 & 197 Fwd Spar Web 1" Cracks At Each Location Just Above Lwr Engine Truss Mount Tang
	R*	Oct. 73	7468	OWS 162-197 Fwd Spar Web Cracked
6307803	L	April 74	7948	OWS 197 Fwd Spar Web 1-1/2" Crack
6307815	R*	Unk.		Fwd Spar Web had 15" Crack
6307817	L	Jan. 74	12250	OWS 170 Fwd Spar Web Had Field Repair

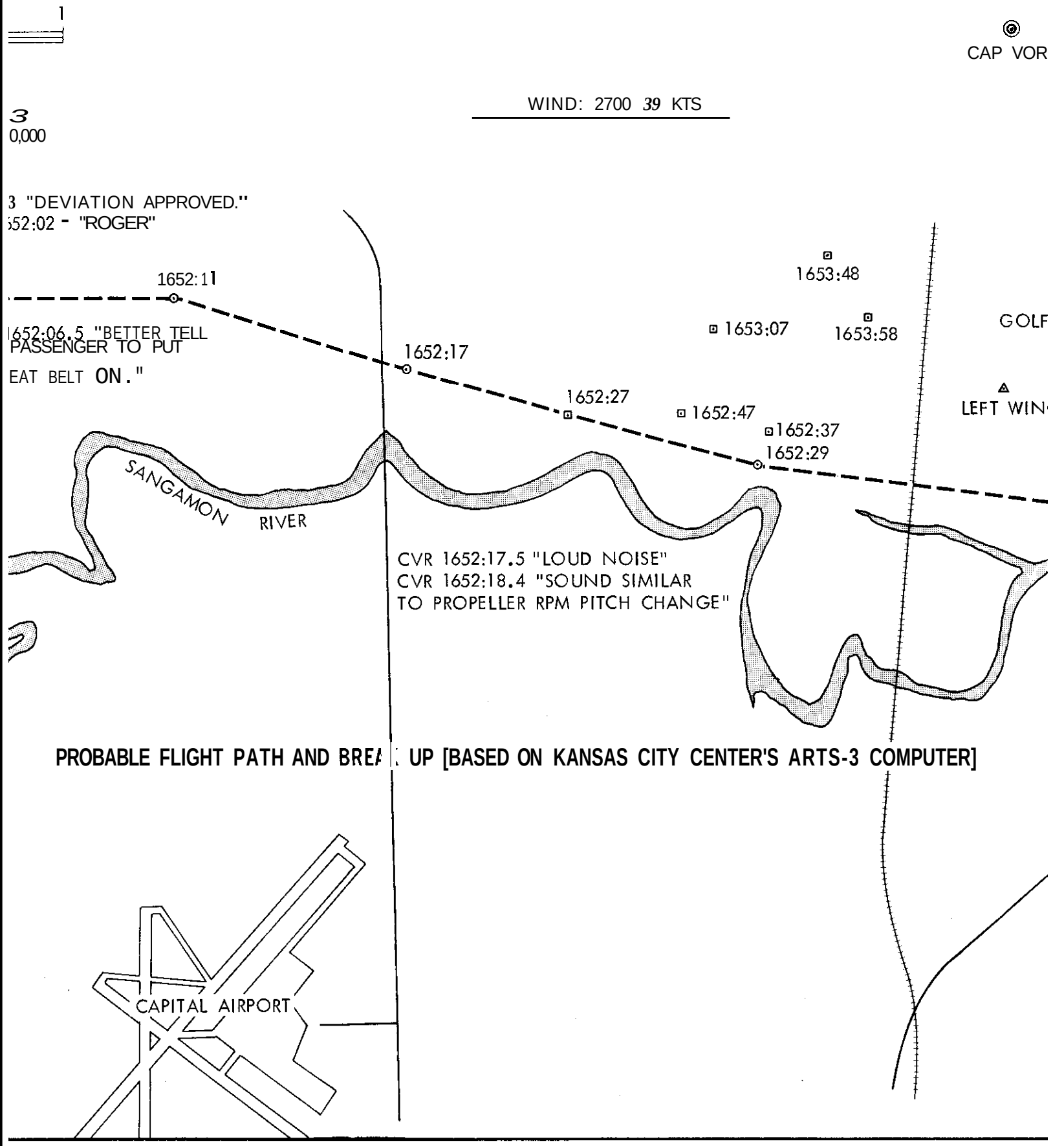
* Information received from Warner Robin ALC 30 May 1974

ACFT S.N.	wing	Date Reported	Flt. Hrs.	Crack Description
6307822	L	Nov. 73	7075	OWS 180 Fwd Spar Web Had Field Repair
6307836	L	May 74	11102	OWS 180 Fwd Spar Web Had 10" x 4" Field Repair
6307839	L	Sept. 73	7066	OWS 162-197 Fwd Spar Web Had Field Repair
6307844	L	Sept. 73	11812	OWS 180 Fwd Spar Web Had Field Repair
6307845	R*	Unk.		Fwd Spar Web had 12" Crack
6307857	R	Sept. 73	6811	OWS 197 Fwd Spar Web had 8" Crack
6307857	L	Sept. 73	6811	OWS 197 Fwd Spar Web 2" Crack at Truss Mount Tang
6307865	L	Sept. 73	8221	OWS 180 Fwd Spar Web Had Field Repair
6307868	L	June 73	10913	OWS 180 Fwd Spar Web Had Field Repair
6307880	R	Sept. 73	7271	OWS 158-201 Fwd Spar Web 4" Crack Extending Vertically Up Web
6307890	L	Sept. 73	12453	OWS 197 Fwd Spar Web 4" Crack OWS 197 Fwd Spar Web Cracked All the Way
6201811	L/R	Unk.	7906	OWS 162 Lwr No. 1 Skin Panel Cracked
6307766	R	Unk.	8054	OWS 162 Lwr No. 1 Skin Panel 2-1" Cracks
6307767	R	Unk.	6871	OWS 162 Lwr No. 1 Skin Panel Cracked
6307778	L	March 74	7451	OWS 159 Lwr No. 1 Skin Panel 1" Crack
6307781	L/R	May 73	6973	OWS 162 Lwr No. 1 Skin Panel 1/2" Crack
6307799	L/R	Oct. 73	7468	OWS 162 Lwr No. 1 Skin Panel Cracked At Forward Edge
6307803	L	April 74	7948	OWS 162 Lwr No. 1 Panel Cracked Beyond Repairable Limits
6307803	R	April 74	7948	OWS 162 Lwr No. 1 Panel Cracked
6307826	L	Jan. 73	6231	OWS 162 Lwr No. 1 Skin Panel 3/8" Crack at Aft Edge
	R	Jan. 73	6231	OWS 162 Lwr No. 1 Skin Panel 4" Crack
6307831	R	Oct. 72	11304	OWS 162 Lwr No. 1 Skin Panel Cracked
6307835	L	March 73	9506	OWS 162 Lwr No. 1 Skin Panel 1" Crack at Center of Panel
6307836	L	May 74	11102	OWS 162 Lwr No. 1 Skin Panel 2-1/2" Cracks

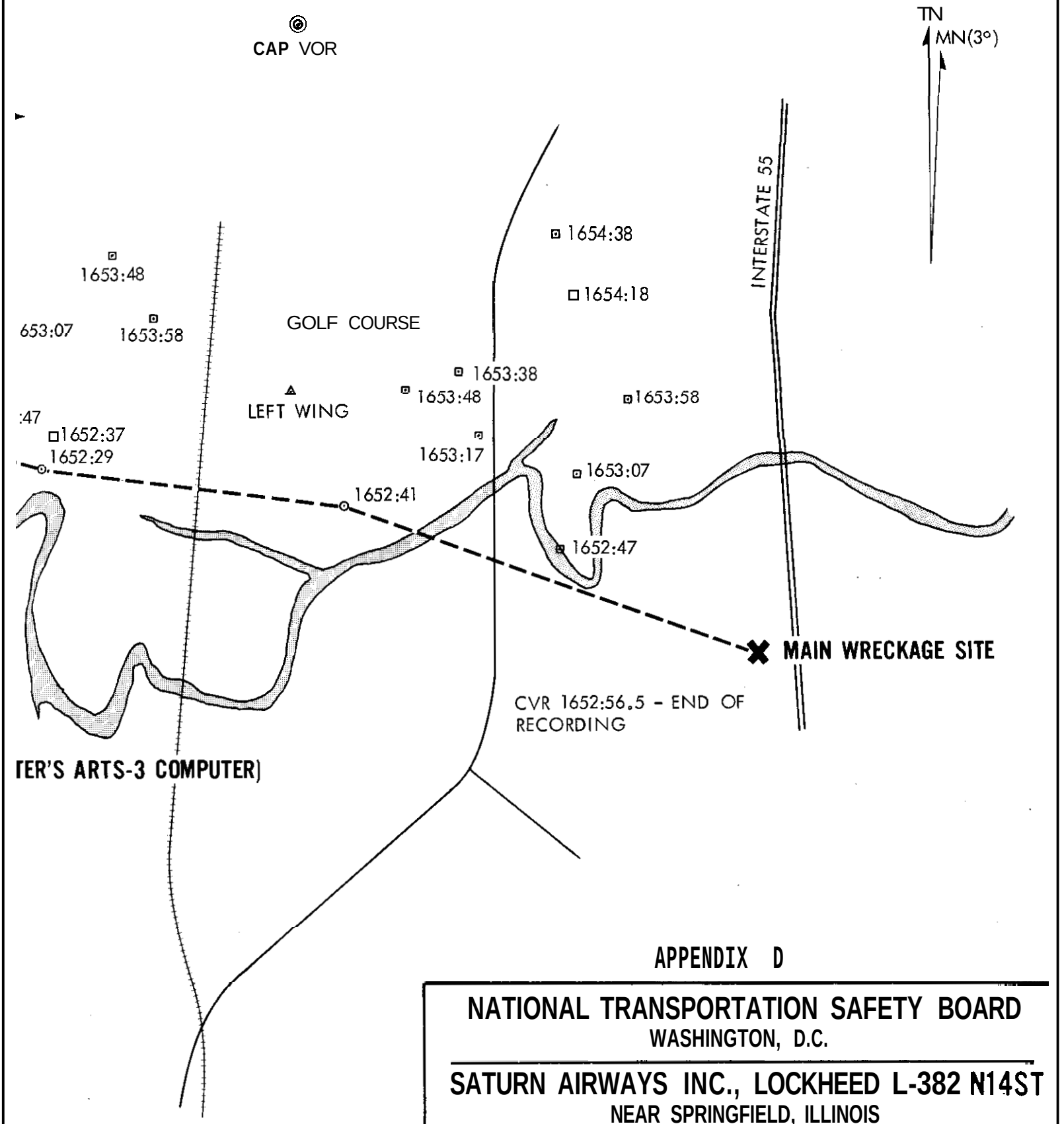
* Information received from Warner Robin ALC 30 May 1974

ACFT S.N.	wing	Date Reported	Flt. Hrs.	Crack Description
6307844	L	March 74	11812	OWS 162 No. 1 Lwr Skin Panel-2" Crack at Fwd Edge
6307857	L	March 73	6811	OWS 162 Lwr. No. 1 Skin Panel-5" Crack Aft From Fwd Edge Thru First Riser
	R	March 73	6811	OWS 162 Lwr No. 1 Skin Panel-3" Crack Aft From Fwd Edge
6307858	L	June 72	5482	OWS 162 Lwr No. 1 Skin Panel Crack
6307871	L	Sept. 73	9749	OWS 158 Lwr No. 1 Skin Panel-1" Crack
6400495	R	Unk.	6422	OWS 162 Lwr No. 1 Skin Panel-1/4" Crack
6400526	L	Dec. 72	7066	OWS 162 Lwr No. 1 Skin Panel-1" Crack
	R	Dec. 72	7066	OWS 162 Lwr No. 1 Skin Panel-3" Crack
6400528	L	Unk.	7188	OWS 162 Lwr No. 1 Skin Panel-2" Crack at Fwd Edge
6400533	L	Unk.	8093	OWS 162 Lwr No. 1 Skin Panel-1/4" Crack
	R	Unk.	8093	OWS 194 Lwr No. 1 Skin Panel-1" Crack
6400538	L	March 74	7703	OWS 162 Lwr No. 1 Skin panel-2 1/2" Crack at Fwd Edge
6417681	R	April 74	7834	OWS 162-190 Lwr No. 2 Skin Panel Had Field Repair


1
½
0
1
STATUTE MILES
FEET
0
2000
4000
6000
8000
10,000
CVR 1652:00 "DEVIATION APPROVED."
1652:02 - 1652:02 - "ROGER"
1651:59 *
1652:07
1652:11
CVR 1651:53 - "WE'D LIKE TO DEVIATE TO THE RIGHT, SIR, WEATHER."
CVR 1652:06.5 "BETTER TELL OUR PASSENGER TO PUT HIS SEAT BELT ON."
SANGAMON
PROBABLE FLIGHT PAT
CAPITAL AIRPO
LEGEND
* = ALL TIMES ARE CENTRAL DAYLIGHT
PRIMARY RETURN
TRANSPONDER RETURN



PROBABLE FLIGHT PATH AND BREA UP [BASED ON KANSAS CITY CENTER'S ARTS-3 COMPUTER]



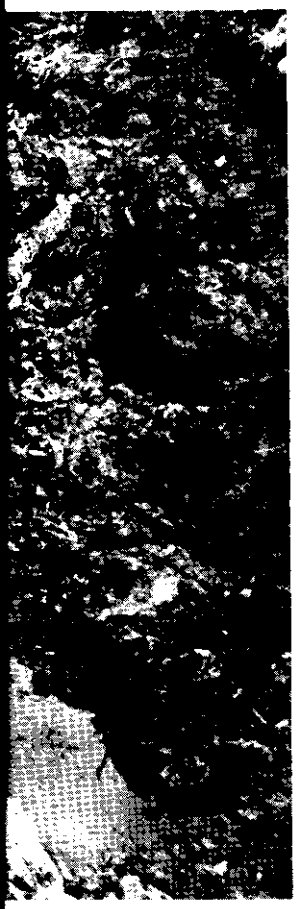
APPENDIX D

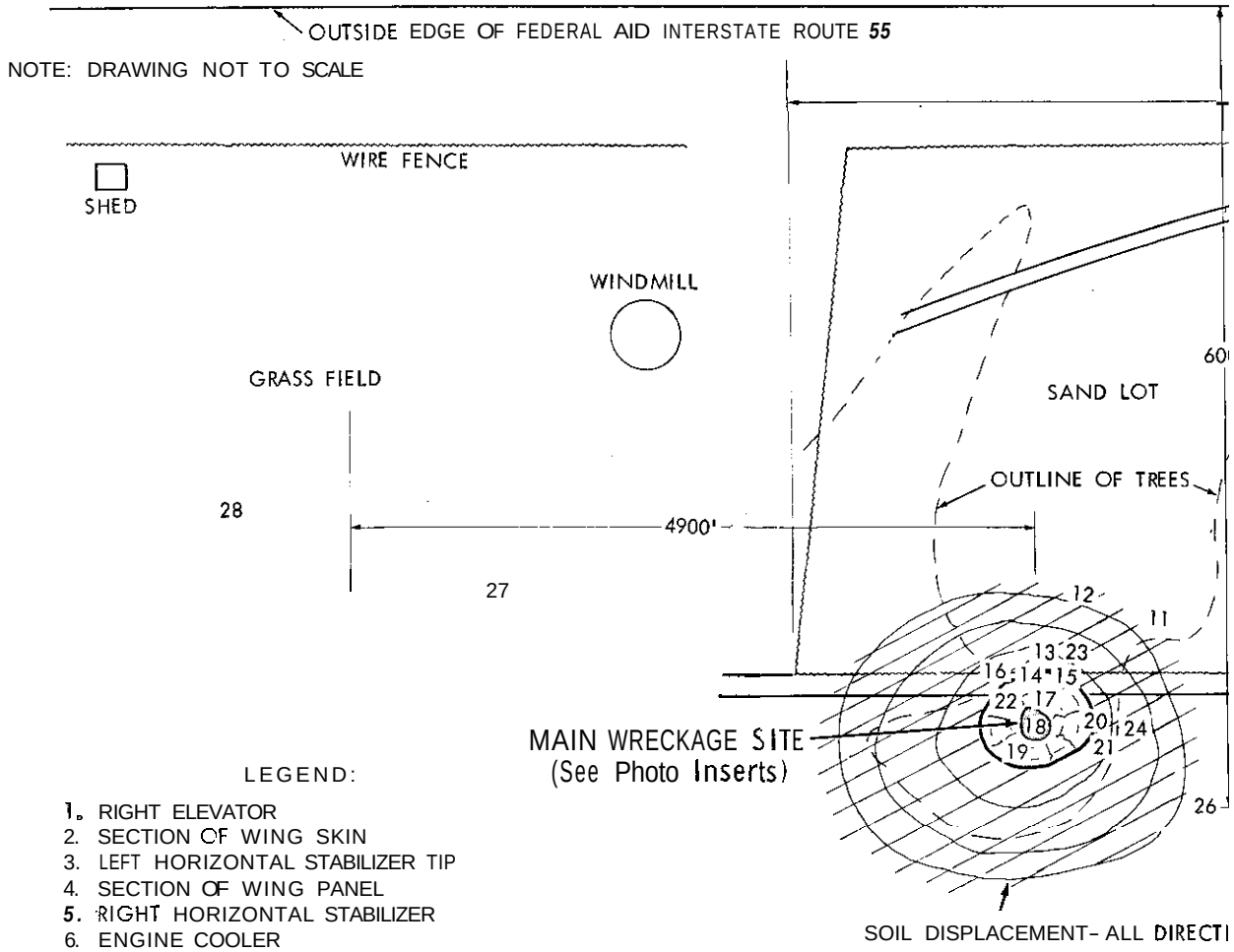
NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

SATURN AIRWAYS INC., LOCKHEED L-382 N14ST
NEAR SPRINGFIELD, ILLINOIS
MAY 23,1974

PHOTO 'A'

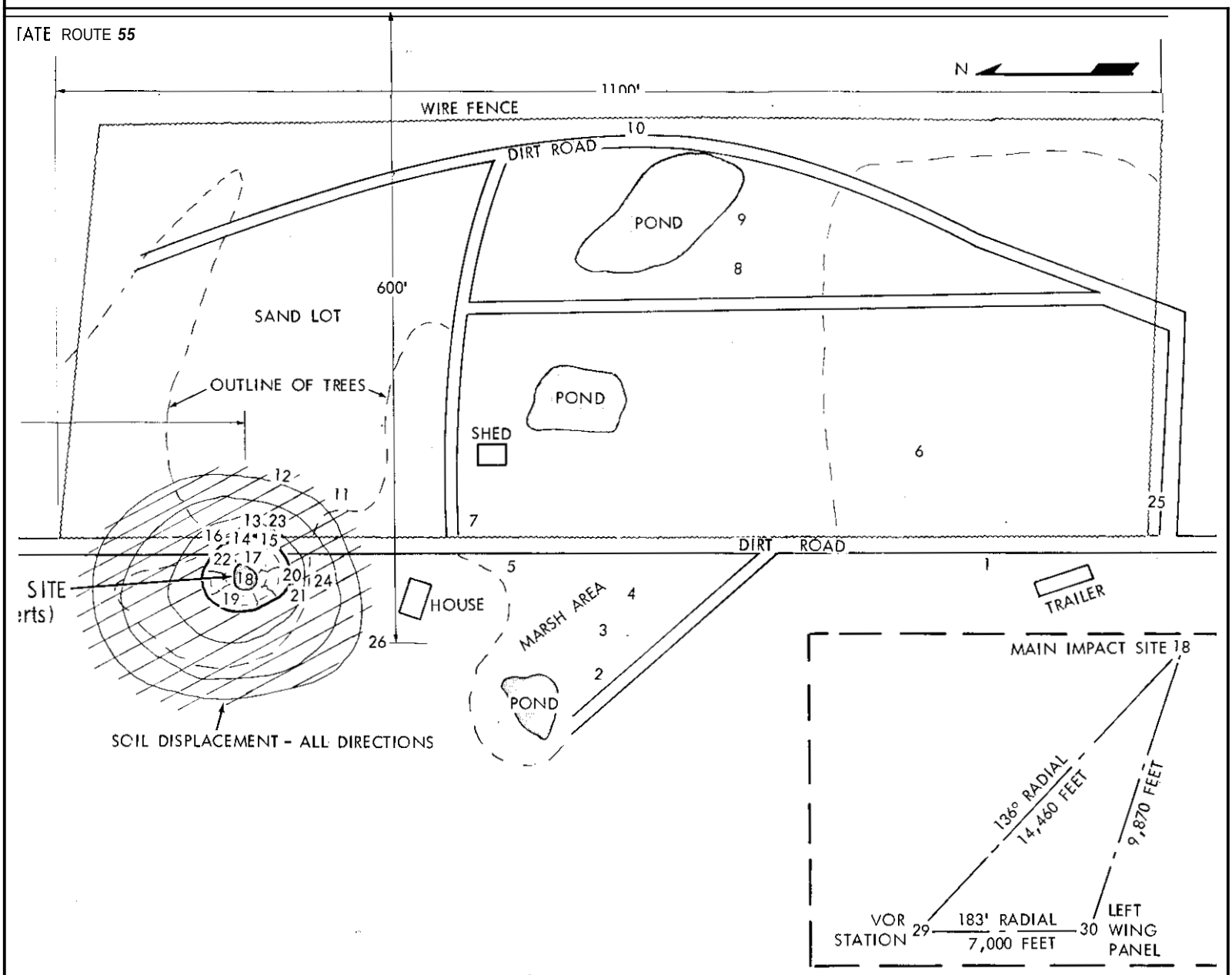
PHOTO 'B'





LEGEND:

1. RIGHT ELEVATOR
2. SECTION OF WING SKIN
3. LEFT HORIZONTAL STABILIZER TIP
4. SECTION OF WING PANEL
5. RIGHT HORIZONTAL STABILIZER
6. ENGINE COOLER
7. HORIZONTAL STABILIZER SKIN
8. LEFT HORIZONTAL STABILIZER SPAR SECTION
9. LEFT HORIZONTAL STABILIZER SECTION
10. LEFT HORIZONTAL STABILIZER SECTION
11. SECTION OF RUDDER
12. RUDDER TIP
13. VERTICAL STABILIZER STRUCTURE
14. VOICE RECORDER
15. FLIGHT RECORDER
16. VERTICAL STABILIZER SKIN
17. NO, 2 ENGINE AND PROPELLER CRATER
18. MAIN IMPACT CRATER
19. NO. 4 ENGINE AND PROPELLER CRATER
20. COCKPIT
21. PIECE OF RADOME
22. ITEMS FOUND IN AND ADJACENT TO MAIN CRATER
    a. MAIN GEAR
    b. NOSE GEAR
    c. CARGO FLOOR STRUCTURE
    d. FUSELAGE STRUCTURE
23. MAIN WHEEL ASSEMBLY MINUS TIRE
24. CONTROL QUADRENT
25. PIECE OF SKIN
26. PIECE OF SKIN
27. RIGHT WING SECTION
28. RIGHT WING FRONT SPAR
29. VOR
30. LEFT WING PANEL

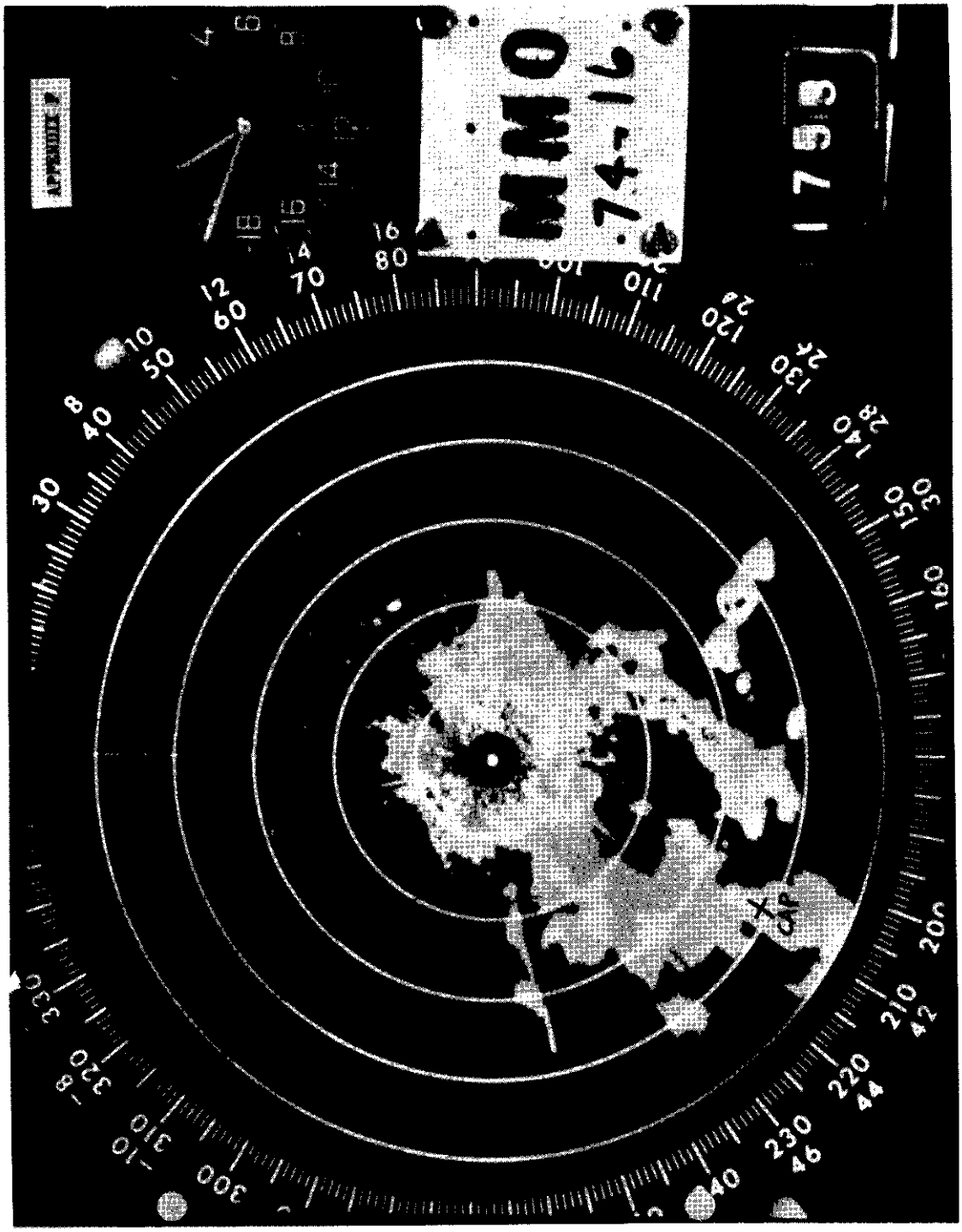


APPENDIX E

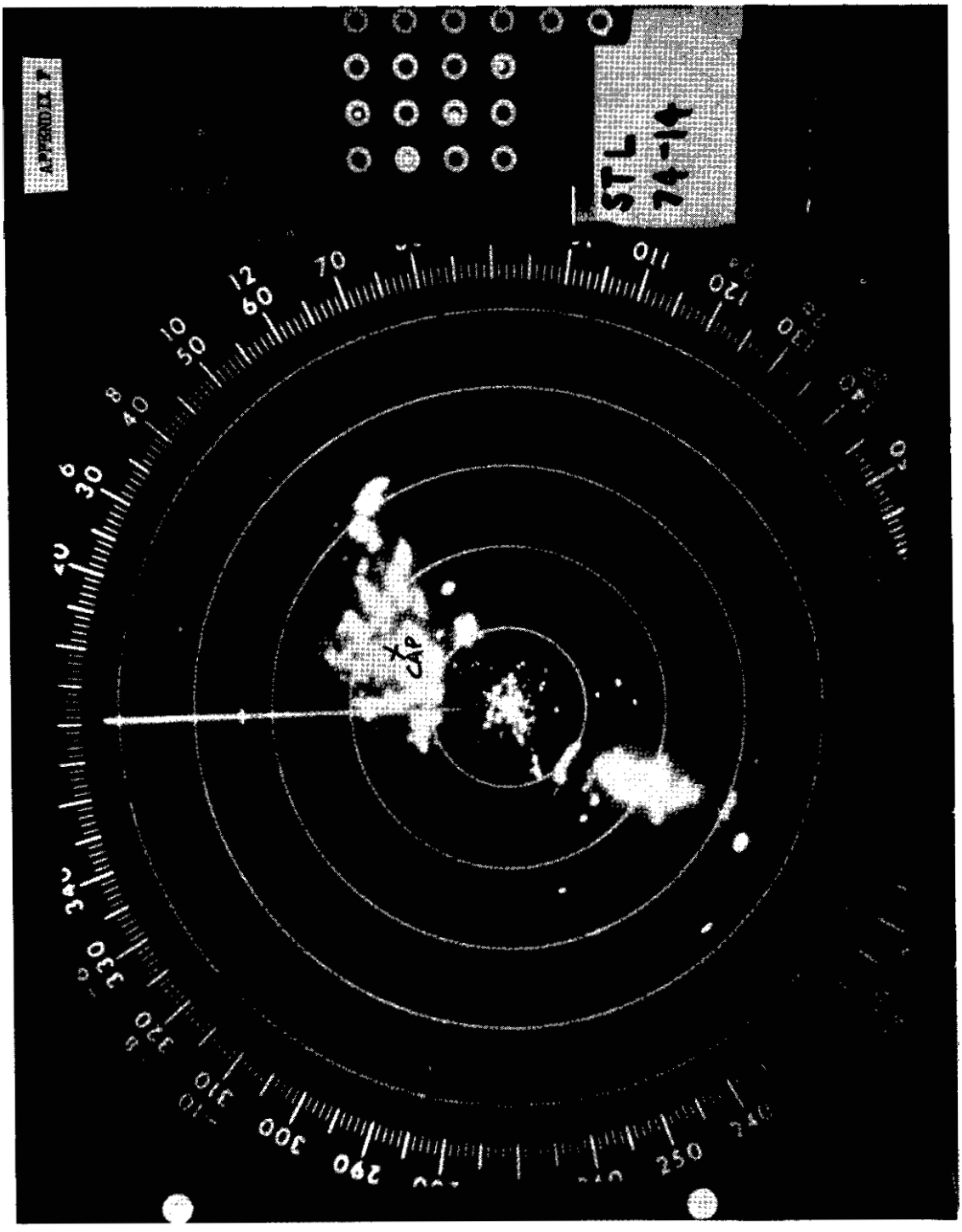
NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON D.C.

WRECKAGE DISTRIBUTION CHART
SATURN AIRWAYS INC.
LOCKHEED MODEL L-382
N14ST/S/N 4225 DCA 74-A-21
NEAR SPRINGFIELD ILLINOIS
MAY 23, 1974

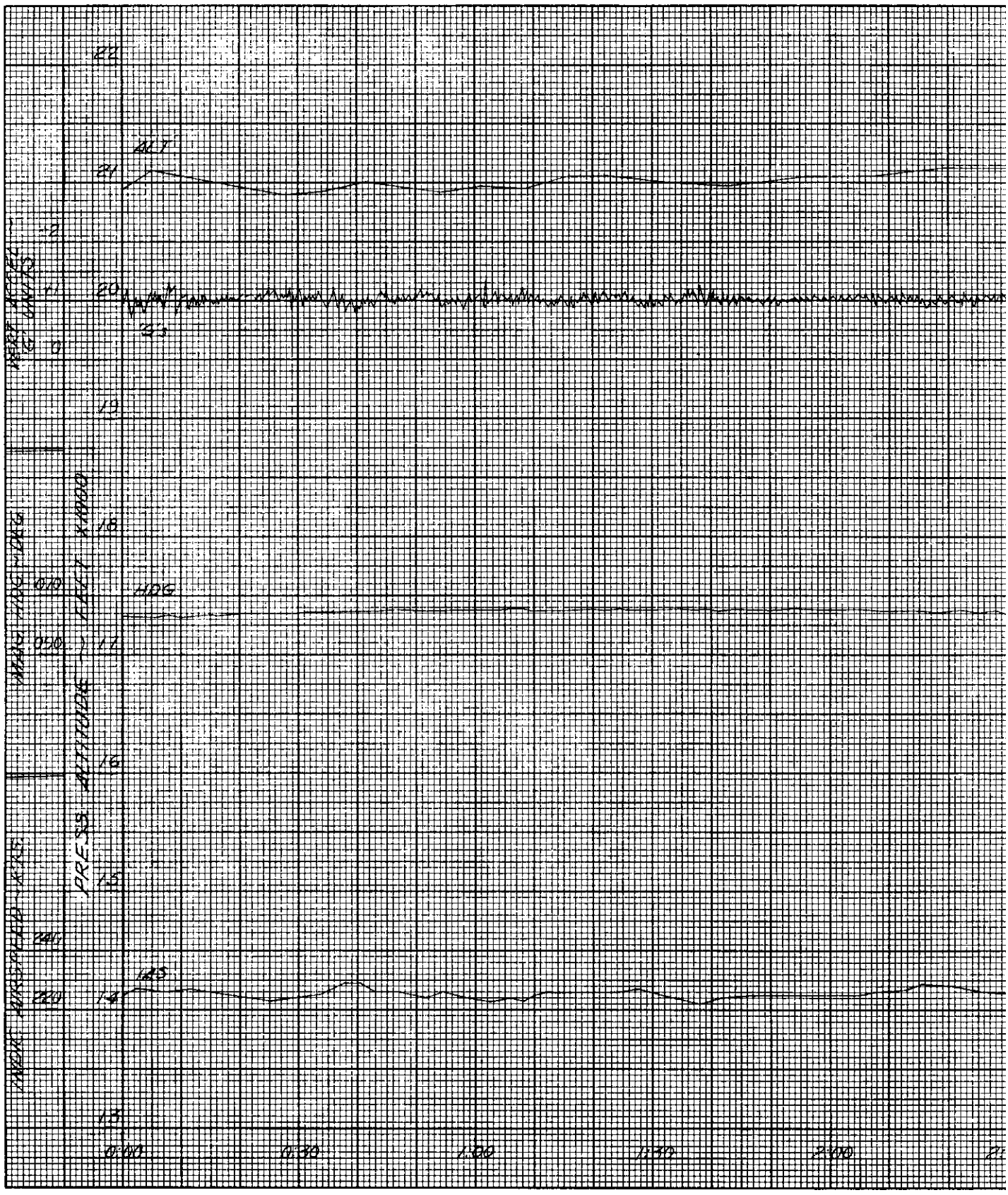
APPENDIX F

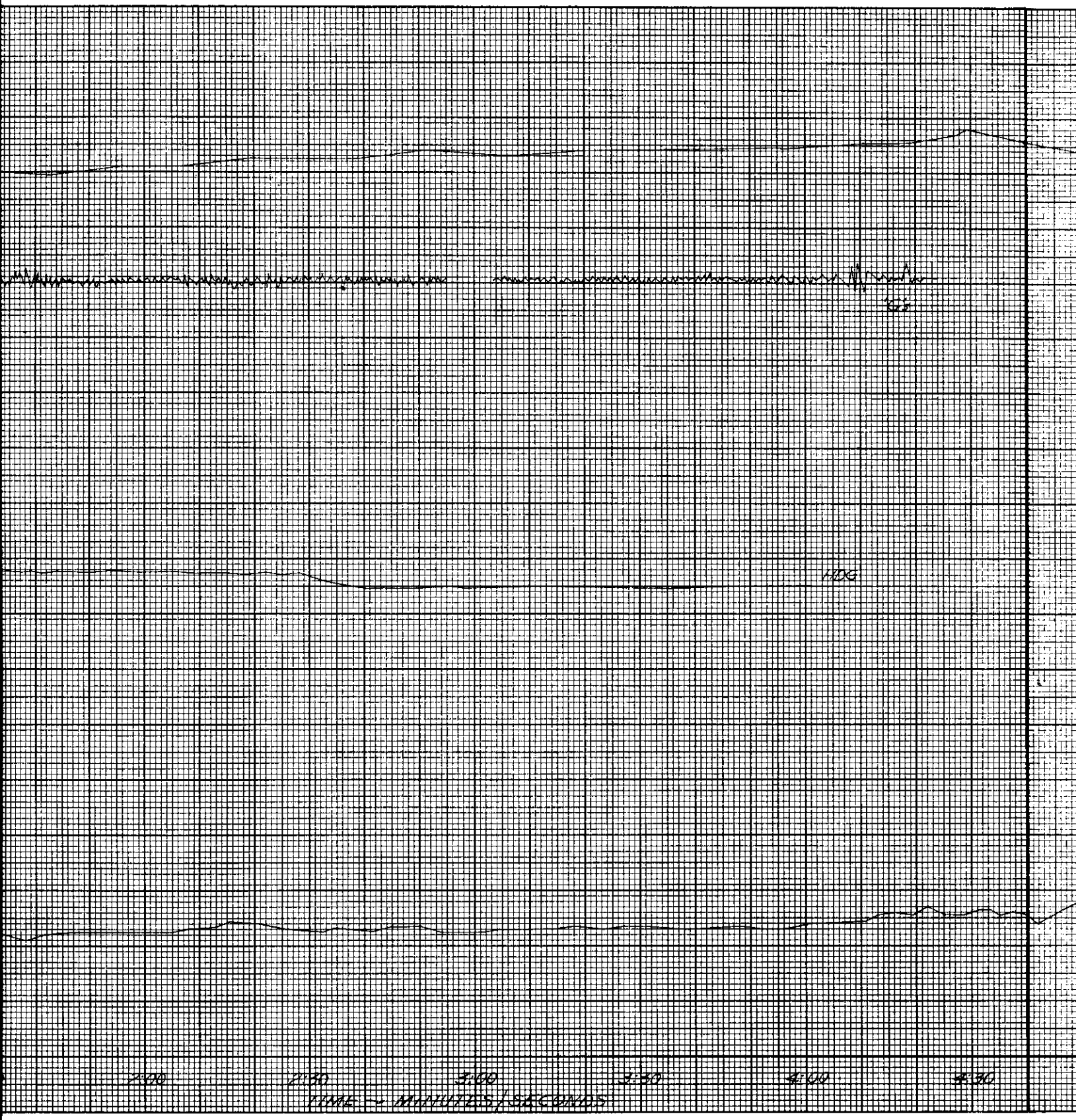


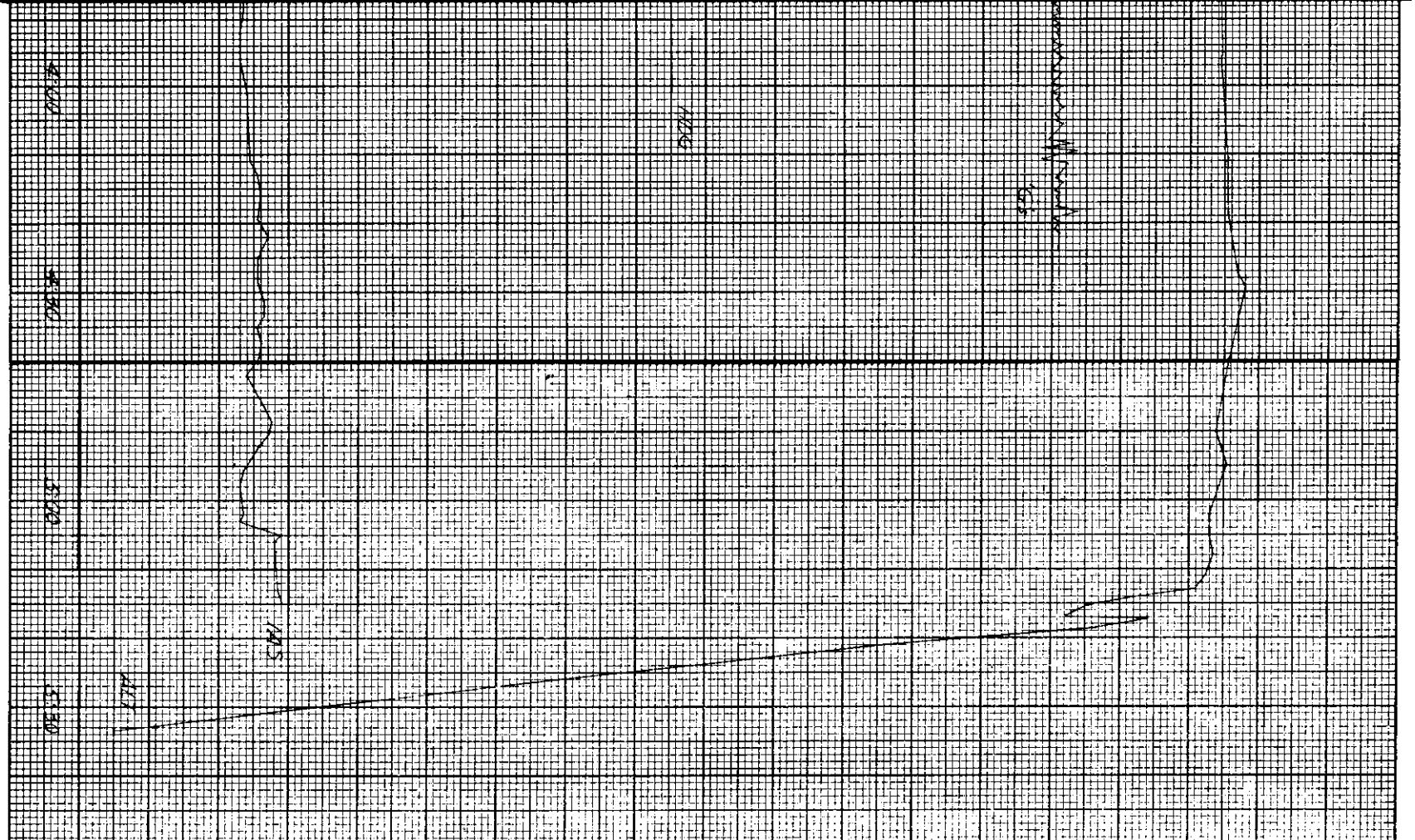
Photograph taken from National Weather Station at Marseilles, Illinois (Range 125 nautical miles)



Photograph taken from National Weather Station at St. Louis, Missouri (Range 250 nautical miles)


22
21
20
19
18
17
16
15
14
13
ACT
PERF
PRESS ALTITUDE FEET X1000
0:00
0:30
1:00
1:30
2:00


HDG
2:00
2:30
3:00
3:30
4:00
4:30
TIME - MINUTES/SECONDS

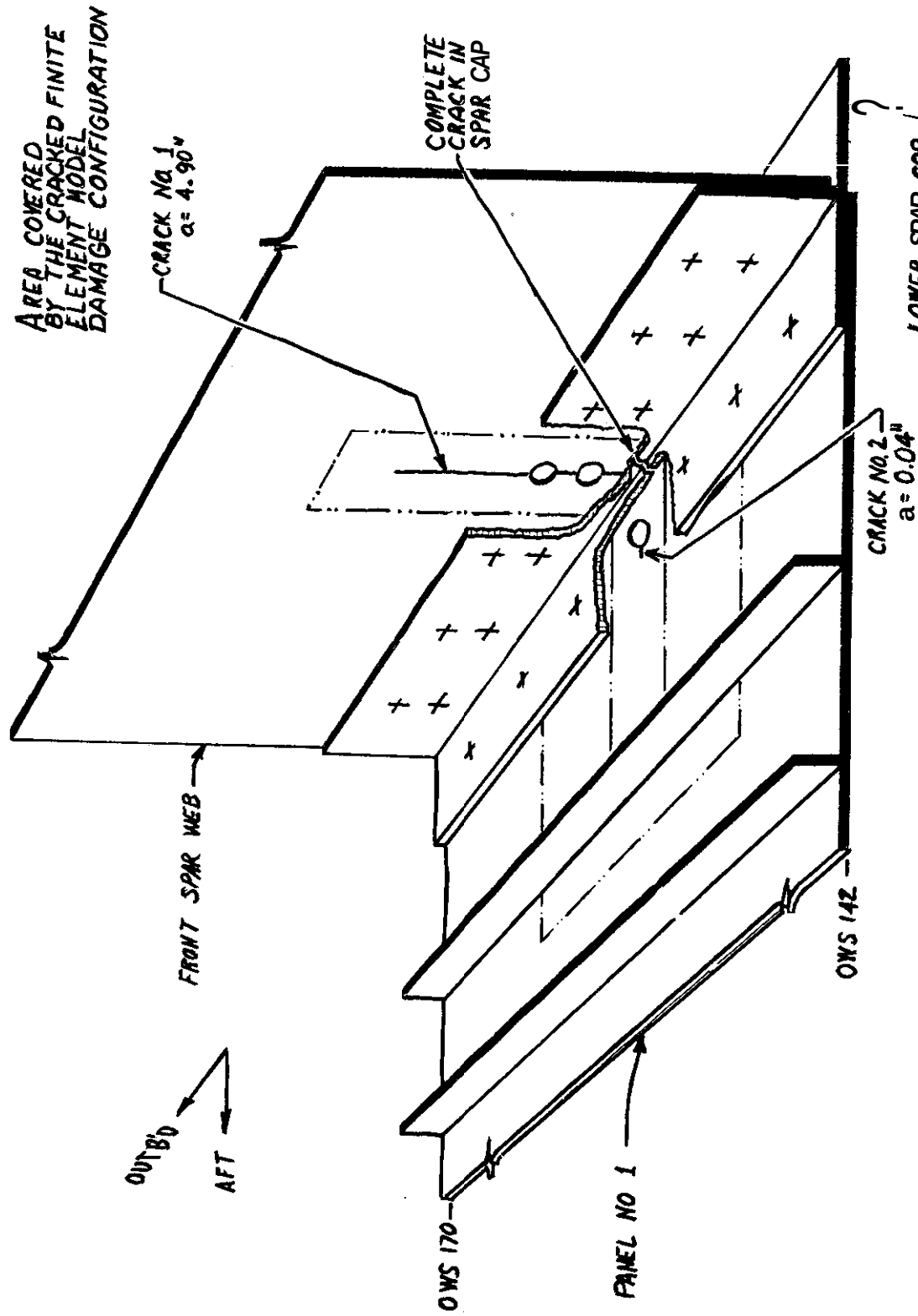


NATIONAL TRANSPORTATION SAFETY BOARD
BUREAU OF AVIATION SAFETY
WASHINGTON, D.C.

SATURN AIRWAYS, LOCKHEED MODEL L-382
N145T, SPRINGFIELD, ILLINOIS, MAY 23, 1974
INFLIGHT STRUCTURAL FAILURE
FLIGHT DATA RECORDER GRAPH
LAS MODEL 109-C, S/N 1133

GRAPH 2

APPENDIX H


AREA COVERED BY THE CRACKED FINITE ELEMENT MODEL DAMAGE CONFIGURATION
CRACK No. 1 a= 4.90"
COMPLETE CRACK IN SPAR CAP
LOWER SPAR CAP
CRACK No. 2 a= 0.04"
FRONT SPAR WEB
OUTBD
AFT
OWS 170
PANEL NO 1
OWS 142