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14. Abstract About 0138 m.s.t. on December 18, 1977, a United Airlines, Inc., DC-8F-54 cargo aircraft, operating as Flight 2860, crashed into a mountain in the Wasatch Range near Kaysville, Utah. The three flightcrew members, the only persons aboard the aircraft, were killed, and the aircraft was destroyed.

Flight 2860 encountered electrical system problems during its descent and approach to the Salt Lake City Airport. The flight requested a holding clearance which was given by the approach controller and accepted by the flightcrew. The flight then requested and received clearance to leave the approach control frequency for a "little minute" to communicate with company maintenance.

Flight 2860 was absent from the approach control frequency for about 7 1/2 minutes. During that time, the flight entered an area near hazardous terrain. The approach controller recognized Flight 2860's predicament but was unable to contact the flight. When Flight 2860 returned to approach control frequency, the controller told the flight that it was too close to terrain on its right and to make a left turn. After the controller repeated the instructions, the flight began a left turn and about 15 seconds later the controller told the flight to climb immediately to 8,000 feet. Eleven seconds later, the flight reported that it was climbing from 6,000 feet to 8,000 feet. The flight crashed into a 7,665-foot mountain near the 7,200-foot level.

The National Transportation Safety Board determines that the probable cause of this accident was the approach controller's issuance and the flightcrew's acceptance of an incomplete and ambiguous holding clearance in combination with the flightcrew's failure to adhere to prescribed impairment-of-communications procedures and prescribed holding procedures. The controller's and flightcrew's actions are attributed to probable habits of imprecise communication and of imprecise adherence to procedures developed through years of exposure to operations in a radar environment.

Contributing to the accident was the failure of the aircraft's No. 1 electrical system for unknown reasons.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

Adopted: July 27, 1978

UNITED AIRLINES, INC.
DC-8F-54, N8047U
NEAR KAYSVILLE, UTAH
DECEMBER 18, 1977

SYNOPSIS

About 0138:28 m.s.t. on December 18, 1977, a United Airlines, Inc., DC-8F-54 cargo aircraft, operating as Flight 2860, crashed into a mountain in the Wasatch Range near Kaysville, Utah. The three flightcrew members, the only persons aboard the aircraft, were killed, and the aircraft was destroyed.

Flight 2860 encountered .electricalsystem problems during its descent and approach to the Salt Lake City Airport. The flight requested a holding clearance which was given by the approach controller and accepted by the flightcrew. The flight then requested and received clearance to leave the approach control frequency for a "little minute" to communicate with company maintenance.

Flight 2860 was absent from the approach control frequency for about 7 1/2 minutes. During that time, the flight entered an area near hazardous terrain. The approach controller recognized Flight 2860's predicament but was unable to contact the flight. When Flight 2860 returned to approach control frequency, the controller told the flight that it was too close to terrain on its right and to make a left turn. After the controller repeated the instructions, the flight began a left turn and about 15 seconds later the controller told the flight to climb immediately to 8,000 feet. Eleven seconds later, the flight reported that it was climbing from 6,000 feet to 8,000 feet. The flight crashed into a 7,665-foot mountain near the 7,200-foot level.

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Contributing to the accident was the failure of the aircraft's No. 1 electrical sygtem for unknown reasons.

1. FACTUAL INFORMATION

1.1 History of the Flight

On December 17, 1977, United Airlines, Inc., Flight 2860, a DC-8F-54 (N8047U), was a scheduled cargo flight from San Francisco, California, to Chicago, Illinois. About 2 1/2 hrs before Flight 2860's scheduled departure from San Francisco, an intermediate stop at Salt Lake City, Utah, was scheduled.

According to the flight dispatcher, the flightcrew reported for duty'at 2300. 1/ The captain and dispatcher discussed the weather situation at Salt Lake City, and the dispatcher informed the captain that the flight would be dispatched with the aircraft's No. 1 a.c. electrical generator inoperative. This conformed to company minimum-equipment-list procedures, and the dispatcher later stated that the lack of the generator seemed to present no problems to the captain. However, before the flightcrew left the dispatch office, the dispatcher received information that the generator had been repaired, and he passed this information to the captain.

On December 18, 1977, at 0017, Flight 2860 departed San Francisco on an instrument flight rules (IFR) flight plan for Salt Lake City. The flight's estimated time en route was 1 hr 12 min, and its planned cruise altitude was flight level (FL) 370.

Flight 2860's departure and en route portions of the flight were flown without reported difficulty, except the Salt Lake air route traffic control center (Salt Lake Center) sector 43 controller was unable to establish radio communications with the flight between 0105 and 0109 on frequency 133.45 MHz.' At 0111:41, Flight 2860 established radio comunication with the Salt Lake Center sector 41 controller on frequency 132.55 MHz and requested descent clearance for the approach to Salt Lake City Airport.

At 0111:52, the Salt Lake Center controller cleared the flight to descend to 15,000 ft 2/ and gave the altimeter setting as 29.58 in. At 0115:42, Flight 2860 requested landing and weather information for Salt Lake City Airport. The controller replied that the flight would soon be transferred to Salt Lake City approach control and the latter would provide the information requested. Flight 2860 said, "Okay, cause we're working with radio problems too it looks like."

At 0116:43 the controller cleared Flight 2860 to contact Salt Lake City approach control on frequency 126.8 MHz, and at 0116:58, Flight 2860 established radio communications with that facility. The

1/ All times herein are mountain standard, based on the 24-hour clock.
2/ All altitudes and elevations herein are mean sea level unless otherwise specified.

Salt Lake City approach controller gave Flight 2860 radar vectors for a VOR approach to runway 16R at Salt Lake City Airport 3/ and cleared the flight to descend to 8,000 ft. The controller also gave the weather information as: "...measured 1,700 overcast, visibility 15, light rain, temperature 41, altimeter 29.58."

The approach controller continued to vector Flight 2860 for alignment with the VOR approach to runway 16R, and at 0120:38, he cleared the flight to descend to 6,000 ft. The flight acknowledged the descent clearance and asked the controller, "What's the ceiling...?" The controller responded, "Measured 1,700 broken, the wind is 160 at 10."

At 0122:32, Flight 2860 advised, "Okay, we got. ..a few little problems here, we're trying to check our gear and stuff right now." The controller replied, "Okay, if...you need any help, I'll give you a vector back around to final, but you're 6 miles from the VOR." Flight 2860 said, "Okay...."

At 0124:18, the controller cleared Flight 2860 to land and gave the surface wind as 160° at 13 kns. Flight 2860 replied, "Roger, we got to check our gear first." At 0124:36, Flight 2860 indicated it would not land and the approach controller replied, "...fly runway heading, maintain 6,000, will vector you back around for an approach." Flight 2860 said, "Okay...."

The approach controller gave Flight 2860 instructions to turn right to a 330° heading and to maintain 6,000 ft. The flight acknowledged, and said, "Okay, we'd just as soon not get back in it if we can help it." The controller replied, "Okay, minimum vectoring altitude is 6,000, that's the best I can do for you to vector you back for the approach." Flight 2860 said, "Okay, we'll try that."

At 0127:31, Flight 2860 asked, "Take us out about 20 miles, can you do that?" The controller replied, "Affirmative", and Flight 2860 responded, "Okay 'cause we're gonna have to get the gear down and try to find out what the heck is going on." At 0128:08, the controller said, "United...2860 turn right heading 345," and Flight 2860 replied, "345, twenty eight sixty."

At 0129:01 Flight 2860 transmitted, "Ah tower, we're gonna have to, ah nuts, just a second." Fourteen seconds later, Flight 2860 asked, "You put us in a holding pattern at 6,000 here on the VOR for awhile?" The controller replied, "...roger, turn right, proceed direct to the Salt Lake VOR, hold on the, at the VOR, maintain 6,000." Flight 2860 said, "Okay, we'll hold north of the VOR, 6,000...right turns, Okay?" The controller said, "That's correct, northwest of the VOR at 6,000, right turns." Flight 2860 replied, "Okay."

3/ Airport elevation is 4,226 ft m.s.l.

At 0129:51 Flight 2860 asked, "Okay, now can we...leave you for a little minute, we wanna call San Francisco a minute?" The controller replied, "United 2860, frequency change approved," and at 0129:59 Flight 2860 said, "Thank you sir, we'll be back."

After the above transmission, Flight 2860 contacted United Airlines' system line maintenance control center in San Francisco. This contact was made through Aeronautical Radio, Inc. (ARINC) on frequency 130.6 **MHz.** Flight 2860 began this communication link at 0130:21 and terminated the link at 0137:11.

According to ARINC communications recordings, Flight 2860 established communications with the DC-8 maintenance controller at 0132:37. Flight 2860 informed the maintenance controller that the No. 1 electrical bus was inoperative, and the **No.** 3 generator would not parallel; also, the landing gear indicator lights did not present a "down" indication when the landing gear extended. The maintenance controller inquired whether the flightcrew had attempted to reset the **No.** 1 bus, and the crew replied that they had. The controller inquired whether the **No.** 1 generator was providing normal volts and frequency, and the crew replied that it was providing "nothing, it's dead."

At 0133:37, the maintenance controller told the flightcrew to standby while he checked the electrical power source for the landing gear indicating system, and at 0135:08, the controller informed the flightcrew "...the landing gear position indicating system comes off the No. 1 bus...." He then inquired whether the flightcrew could get another generator to power the No. 1 bus, and the crew responded, "The **No.** 1 bus is dead and that's it." At 0135:30, the maintenance controller said, "Okay, you can't get any other generator to pick up the dead bus, and that's why your landing gear warning system does not work--because you got to have power to the 28-volt d.c. bus, No. 1." Flight 2860 replied, "Okay, I've gonna kind of figure who the 28-volt d.c. No. 1--I can't find that landing gear warning circuit breaker **on** the dam thing. Ah, also, **I** assume the hydraulic quantity pressure gage is on the same circuit breaker, same generator." The controller said that he would "check **on** it if you like," but Flight 2860 said, "Oh, before you go.. .one thing, if that's the only way they can get gear indicators, we're gonna go ahead and land then." The controller confirmed that the **No.** 1 28-volt d.c. bus powered the landing gear warning system.

At 0136:28 Flight, 2860 terminated communications with the maintenance controller. **In** response to a querie from ARINC on whether to keep the line ***to*** maintenance control open, Flight 2860 replied, "Well no, **I** guess we're **...**only got one radio, ***so*** we're back to the. tower, we're going to land, we're going to call out the equipment." Flight 2860 terminated radio communications with ARINC at 0137:11.

While Flight 2860 was on the ARINC frequency, the Salt Lake City tower ground controller, at 0136:28, called the Salt Lake City flight service station (FSS) and told the specialist on duty there to transmit a message to United Flight 2860 on the Salt Lake City VOR frequency. The message to Flight 2860 was for the flight to contact Salt Lake City approach control on frequency 124.3 MHz. Between 0137:07 and 0137:22, the Salt Lake City approach controller attempted three times to establish radio communications with Flight 2860. At 0137:22, the ground controller asked the FSS specialist whether he had made the transmissions; the specialist replied that he had.

At 0137:26 Flight 2860 said, "...hello Salt Lake, United 2860 we're back." At 0137:31, the approach controller said, "United 2860, you're too close to terrain on the right side for a turn back to the VOR, make a left turn back to the VOR." Flight 2860 replied, "Say again," and at 0137:39, the controller said, "You're too close to terrain on the right side for the turn, make a left turn back to the VOR." At 0137:44, Flight 2860 said, "Okay."

At 0137:54 the approach controller asked, "United 2860, do you have light contact with the ground?" Flight 2860 replied, "Negative." At 0138:00 the controller said, "Okay, climb immediately to maintain 8,000." At 0138:07, the controller again transmitted, "United 2860, climb immediately, maintain 8,000," and 4 seconds later, Flight 2860 replied, "United 2860 is out of six for eight." At 0138:36, the controller asked, "United 2860, how do you hear?" Flight 2860 did not respond to that transmission or to succeeding transmissions from the approach controller.

Shortly after 0135, at least seven witnesses in Kaysville, Utah, and the nearby community of Fruit Heights heard what they described as a jet aircraft flying low overhead. One of the witnesses saw a red light on the airplane as it flew in an easterly direction over her location in Kaysville. She could see nothing more of the airplane because it was obscured by clouds, rain, and darkness. The airplane continued eastward and a short time later, she saw a bright orange glow appear to the east. The glow lasted 3 to 4 secs and disappeared. Four other witnesses saw the orange glow shortly after hearing the airplane pass overhead. All of the witnesses said that it was raining at the time--several described the rain as heavy.

The accident occurred at night (0138:28) at an elevation of about 7,200 ft, and at latitude 41°02'41"N and longitude 111°52'30"W.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Other
Fatal	3	0	0
Serious	0	0	0
Minor/none	0	0	0

1.3 Damage to Aircraft

1.4 Other Damage

Numerous trees and bushes were damaged and destroyed.

1.5. Personnel Information

The three crewmembers on Flight 2860 were qualified and certificated for the flight and had received the training required by current regulations. (See Appendix B.)

According to United Airlines' records, the captain's most recent trips into Salt Lake City were on January 7 and January 9, 1977. In the 6-month period preceding those trips, he had made seven trips into Salt Lake City in United Airlines' equipment. The first officer's most recent trip into Salt Lake City was on November 28, 1976. During 1976, he had made three other trips into Salt Lake City, all in the month of November. During 1976 and 1977, the second officer had made one trip into Salt Lake City; that trip was on February 26, 1977.

Before reporting for duty in Chicago about 2340 on December 16, the captain had been off duty for 44 hrs 15 min; the first officer had been off duty for 28 hrs 36 min; and the second officer had been off duty for 19 hrs 14 min. On December 17, the crew flew Flight 2892 to Detroit, Michigan, arriving there at 0330. The crew then flew Flight 2827 to San Francisco, arriving there at 0925. They were released from duty at 0955 on December 17, and they returned to duty at 2300 to prepare for Flight 2860. During the 26 hours preceding the accident, the flightcrew had been on duty 12 hrs 55 min and had received an intervening off-duty period of 13 hrs 5 min. During their duty period, they had flown 7 hrs 34 min.

A postaccident check of the flightcrew's activities during their off-duty period in San Francisco disclosed no evidence of anything unusual. The assistant manager of the hotel where the flightcrew stayed stated that all three crewmembers appeared normal when they left the hotel about 2245 .for the airport.

Two air traffic control specialists were on duty in the Salt Lake City control tower when Flight 2860 crashed. Both were working control positions and both were full performance level controllers. (See Appendix B.)

The approach control and local control functions were consolidated in the tower cab after 0030 on December 18, and the approach controller was functioning also as the local controller. The other controller, the controller-in-charge, was the ground controller and also was handling the flight data position. These functions were consolidated during the 2400 to 0800 duty period because traffic conditions were light and two controllers could provide the necessary services.

On December 17, the approach/local controller had worked the 0700 to 1500 shift. He was then off duty until reporting for duty at 2400. During the 9 hrs he was off duty, he slept about 2 to 2 1/2 hrs. He denied feeling any fatigue during duty on the 2400 shift.

1.6 Aircraft Information

N8047U was owned and operated by United Airlines, Inc. It was certificated, maintained, and equipped in accordance with current regulations and procedures. The aircraft had accumulated 29,832 flight-hours before the accident.

N8047U was configured as a cargo transport. Its maximum authorized takeoff gross weight and landing weight were 315,000 lbs and 240,000 lbs, respectively. Its gross weight on departure from San Francisco was 214,064 lbs, including the 38,800 lbs of fuel and 43,902 lbs of cargo aboard. At takeoff, N8047U's center of gravity was within prescribed limits at 27.5 percent mean aerodynamic chord. The aircraft's planned landing weight at Salt Lake City was 198,504 lbs.

On December 17, 1977, N8047U arrived in San Francisco about 1638 after completing a series of flights which began in New York that morning. According to the second officer on those flights, after the engines were started in New York the No. 1 generator indicated no voltage or frequency, so he left the generator control switch off. While en route to Cleveland, Ohio, the No. 3 generator unparallel light illuminated. He activated the generator parallel switch and the No. 3 generator returned to normal operation. During the stop in Cleveland, in response to the second officer's entry in the maintenance log, "No. 1 gen inop--no volts, no freq, CSD appears normal," maintenance personnel disconnected the No. 1 generator drive and deferred further maintenance on the generator. The flightcrew flew the aircraft from Cleveland to Denver, Colorado, and then to San Francisco with the No 1 generator drive disconnected. According to the second officer on those flights, all electrical systems were powered by 'the three remaining generators and no further difficulties were encountered during those flights.

According to maintenance personnel in San Francisco, on December 17, 1977, they removed the No. 1 generator control panel on N8047U and replaced it with a panel from serviceable supplies. They connected the No. 1 generator drive, started the Nos. 1 and 2 engines, and performed electrical system checks. These checks indicated that the No. 1 generator and the No. 1 electrical system were functioning properly. Subsequent tests on the generator control panel which had been removed indicated that no discrepancies existed in the panel which would justify its removal in response to the discrepancy, "no volts, no frequency."

The maintenance history of the generator control panel which was installed on N8047U on December 17, 1977, indicated that this panel (serial No. 105) was removed from aircraft N8007U in late October 1977 as the corrective action for a series of electrical problems involving that aircraft's No. 1 electrical system. N8007U continued to have problems with the No. 1 system until wiring defects in the No. 1 generator were repaired several days after panel No. 105 was removed. Generator control panel No. 105 was returned to the San Francisco maintenance shop where it was tested, found satisfactory, and returned to serviceable supplies; it remained there until it was installed on N8047U.

N8047U's maintenance records indicated that no other pertinent discrepancies existed during the 200 flight-hours which preceded the accident; except on December 13, 1977, the No. 3 generator unparalleled light came on in flight, and after about 1 hr of flight the generator was reset and returned to normal operation.

1.7 Meteorological Information

Synoptic Situation

The area forecast, issued at 1740 on December 17, 1977, by the NWS Forecast Office at Salt Lake City and valid from 1000 on December 17 to 1200 on December 18, was, in part as follows:

> Southern Idaho, Nevada, Utah--mountains generally obscured by clouds and precipitation. Clouds generally 6,000 ft to 8,000 ft broken to overcast with merging layers above to 18,000 ft to 20,000 ft except in eastern Utah and southern Nevada. The surface wind in southeast Idaho, western Utah, and Nevada, locally, 180° to 220° at 18 kns with gusts to 35 kns until 2000, and then decreasing. Occasional light rain and light snow, ahead of easterly moving cold front which extends from near the western border of Idaho southwestward into central California, with occasional ceilings 1,000 ft to 2,000 ft, and visibilities 1 to 4 mi. Occasional ceilings and visibilities along and west of the front at or about 800 ft and 1 mi. Freezing levels at 5,000 ft to 6,000 ft in northern Utah, lowering locally to the surface during the night. Occasional moderate icing in clouds and precipitation.

The terminal forecast, issued by the NWS Forecast Office at Salt Lake City at 1540 on December 17 and valid from 1600 on December 17 to 1600 on December 18, was, in part, as follows:

> Salt Lake City--Clouds 2,500 ft scattered, ceiling 4,000 ft broken, 8,000 ft overcast, winds 180° at 20 kns with gusts to 30 kns, occasionally, ceiling at 2,500 ft broken,

4,000 ft overcast with visibility 5 mi in light rain and snow. After 2300, clouds 1,000 ft scattered, ceiling 2,000 ft overcast, visibility 3 mi in light snow. Occasionally, ceiling 800 ft obscured, visibility 1/2 mi in moderate snow showers.

At 2318, United Airlines dispatch personnel in San Francisco provided the flightcrew of Flight 2860 with a weather briefing message for the flight's intended route which included the following information: "Valid 2131 December 17 to 1100 December 18; shallow low over southwestern Idaho at 2000 moving eastward into Wyoming by 1100. A cold front extending southwestward from the low through central Nevada and southern California moving southeast at 20 kns. Light rain, occasional moderate rain ahead of front except light snow showers and gusty southerly surface winds eastern Nevada and Utah." The message also contained the NWS's terminal forecast for Salt Lake City.

The surface weather observations at the following times and locations were, in part:

Salt Lake City

0054 - Clouds--ceiling measured 1,700 ft broken, 2,000 ft overcast; visibility--15 mi, light rain; temperature--41°F; dewpoint--36°F; wind--180° at 12 kns; altimeter--29.58 ins.; remarks--winds occasionally gusting to 24 kns.

0155 - Clouds--ceiling measured 1,600 ft broken, 2,800 ft overcast; visibility--12 mi, light rain; temperature--41°F; dewpoint--37°F; wind--220° at 11 kns; altimeter--29.58 ins.; remarks--rain ended at 0108 and rain began 0132.

Hill Air Force Base, Utah

0057 - Clouds--700 ft scattered, estimated 2,700 ft overcast; visibility--6 mi, light rain; temperature--38°F; dewpoint--31°F; wind--170 at 20 kns; altimeter--29.56 ins.

0158 - Clouds--600 ft scattered, estimated 1,500 ft overcast; visibility--3/4 mi, light snow; temperature--35°F; dewpoint--28°F; wind--190° at 12 kns; altimeter--29.58 ins.

The NWS's winds aloft observations at Salt Lake City at the times and altitudes indicated were as follows:

December 17, 1700

Height (Ft m.s.l.)	Direction (°True)	Speed (Kn)
4,226	170	16
4,971	170	29
5,762	176	29
6,970	190	22
7,884	212	19

December 18, 0500

Height (Ft m.s.l.)	Direction (°True)	Speed (Kn)
4,226	330	8
5,045	323	19
6,037	322	23
6,973	320	27
7,903	312	30

1.8 Aids to Navigation

The Salt Lake City VOR, which operates on 116.8 MHz, is located 2.9 mi north-northwest of the Salt Lake City Airport. No discrepancies in the operation of the VOR were reported before the accident, and postaccident ground and flight checks disclosed normal operation.

The Salt Lake City VOR is the initial approach fix for the VOR instrument approach to runway 16R at Salt Lake City Airport. (See Appendix C.) Also, the VOR is the navigational aid associated with numerous low-altitude airways that traverse the Salt Lake City area, including V-21-101 formed by the 331° radial of the VOR. According to Jeppesen and National Ocean Survey low-altitude navigation charts and the VOR instrument approach chart for runway 16R current at the time of the accident, there were no published holding patterns in the vicinity of the Salt Lake City VOR.

The Salt Lake City tower was equipped with an ASR 4 (modified 5) radar, ARTS III automation, a minimum safe altitude warning (MSAW) system, and an ATC BI-4 radar beacon system. The radar's antenna is located on the Salt Lake City Airport. The radar displays in the tower cab are closed circuit television pictures of the display in the tower equipment room. According to the tower controllers, all equipment was operational before the accident, and postaccident checks of the equipment disclosed normal operation.

The MSAW system provides the air traffic controller with a warning whenever the projected flightpath and reported altitude of an appropriately equipped aircraft under his control will put the aircraft in danger of collision with terrain or obstructions in his control area. The controller can then convey this warning to the pilot of the aircraft so that the latter can take corrective action.

The ARTS III computer compares the aircraft's altitude, as reported by its transponder, to terminal area terrain or obstruction elevation (m.s.l.) data which are stored in the computer. These data are established for a grid system composed of 2-mi squares, each with a 2,000-ft buffer zone. Based **on** computed groundspeed and rate of turn, the computer projects the aircraft's flightpath 30 seconds into the future. If the aircraft's projected flightpath will take it into a square where the highest terrain or obstruction elevation is within 300 ft or less of the aircraft's reported altitude, the MSAW will flash an alarm. Additionally, the ARTS III computer projects a 2-min flightpath based **on** the assumption that the aircraft will climb at **a** 5° angle. If the aircraft's projected flightpath and climb profile will place it within a square where the highest terrain or obstruction elevation is within 300 ft or less of the aircraft's reported altitude, the MSAW will alarm.

According to the Salt Lake City approach/local controller, the MSAW flashed a low-altitude warning on the tower cab radar display about the time (0137:31) or, shortly thereafter, that he made his first transmission to Flight 2860 after the flight had returned to the approach control frequency.

1.9 Communications

According to air traffic control transcripts, Flight 2860 reported a radio problem to the Salt Lake center R41 controller but did not specify the characteristics of the problem. Additionally, the flight told the ARINC controller, "...only got one radio.. .."

The tower controller testified that they were not aware that Flight 2860 had any radio problems. The approach/local controller stated that he believed the flight had two communications radios aboard the aircraft, but that the flight's request to leave approach control frequency did not alert him to possible communication problems. *Also,* he was not concerned about the flight's absence from his frequency for more than "a little minute" because the flight was in the holding pattern.

ARINC and air traffic control (ATC) tape recordings were reviewed by Safety Board and United Airlines personnel to determine which of the three members of the flightcrew made the radio transmissions from the aircraft.

With several exceptions, the first officer made all of the transmissions to ATC until 0110:11. After that time, the captain made the transmissions to Salt Lake Center except for transmissions the first officer made at 0115:40, 0115:42, and 0115:48. From 0116:58 until 0121:28, the first officer made the transmissions to Salt Lake City approach control. From 0122:33 to the end of the transmissions, the captain made all of the transmissions to Salt Lake City approach control except for transmissions the first officer made at 0125:31, 0128:15, and 0138:11.

With regard to the ARINC comunications, the captain made most of the transmissions until 0133:48. From that time until 0136:06, the second officer made all the transmissions but one which the captain probably made. From 0136:07 to the end of the communications, the captain made the transmissions.

1.10 Aerodrome and Ground Facilities

Salt Lake City International Airport is located about 3 mi west of downtown Salt Lake City. The airport has three hard-surfaced runways, 16R-34L, 16L-34R, and 14-32. Runway 16R is 9,902 ft long and 150 ft wide. It is not equipped with approach lights but is equipped with high intensity runway lights, runway end identifier lights, and a visual approach slope indicator. The airport elevation is 4,226 ft.

1.11 Flight Recorders

N8047U was equipped with a Fairchild Industries Model 5424 flight data recorder (FDR), serial No. 6084. The recorder case was damaged mechanically, but the foil recording medium was not damaged. All recording traces were clear and active.

The FDR readout included 27 min of flight and indicated that before N8074U descended through 23,200 ft radio communication transmissions were made from the No. 1 VHF radio. After that time, all radio transmissions were made from the No. 2 VHF radio. The FDR altitude information was based on an altimeter setting of 29.58 in.Hg to convert pressure altitude to m.s.l. altitude below 18,000 ft. No other corrections were made to any parameters. The final 17 min of flight were plotted on a graph, and the last 5 min of the graph is part of this report. (See Appendix D.)

N8047U was equipped with a Sundstrand Data Control Model V-557 cockpit voice recorder (CVR), serial No. 1638. The recorder case was damaged slightly. However, the recording tape had bound and it contained none of the cockpit conversations related to Flight 2860. The portion of the tape that was recorded before the CVR malfunctioned was recorded on December 6, 1977.

A plot of Flight 2860's probable ground track in the Salt Lake City area was derived from NAS Stage-A D-log data from Salt Lake Center and FDR data. (See Appendix E.) The NAS Stage-A data were used for the first portions of the track. However, since the recording of these data ended at 0136:46 (probably because the aircraft was too close to and well below the radar beacon antenna), FDR data and pertinent meteorological data were used to complete the track.

Additionally, Flight 2860's altitude profile for its last 22 sec of flight was established. (See Appendix F.) This profile shows the aircraft's altitude in relation to the terrain beneath its probable ground track.

1.12 Wreckage Information

N8047U crashed on the southwest slope of Ed's Peak in the Wasatch Mountains about 2.85 nmi northeast of Kaysville, Utah. The crest of Ed's Peak is at 7,665 ft. Ground impact marks at an elevation of 7,200 ft indicate that the aircraft was in a near wings-level climb and on a magnetic heading of 040° at the time of impact. Most of the wreckage was scattered up the southwest slope but the cockpit section, parts of engines, some cargo containers, and other heavy parts were scattered down the northeast slope.

The wreckage area was about 1,300 ft long, horizontally, and 500 ft wide. From the 7,200-ft level to the 7,500-ft level, the slope of the mountain was 32°, and from the 7,500-ft level to the crest of the peak, the slope was about 26°. Much of the wreckage was covered with or buried in snow that ranged from 1 to 4 ft deep.

The horizontal stabilizer was the first large section of the aircraft above the initial impact level--it was at an elevation of about 7,300 ft. From there, numerous pieces and sections of the aircraft were scattered up the mountain, including fuselage structure, flight control surfaces, engine components, cargo containers, cargo, main landing gear, and wing structure. There was no evidence of ground fire; however, some papers and cardboard boxes showed evidence of scorching.

The wings trailing edge flaps and the landing gear were retracted. The horizontal stabilizer was at 4.2 units noseup. There was no evidence of preexisting structural damage or of flight control malfunction.

Both wings were separated from the fuselage and all four engines were separated from their wing attachments. The intact assemblies, consisting of high pressure compressors, combustion sections, and high pressure turbine modules of the Nos. 1, 2, and 3 engines, were in the main wreckage area. The fan sections, low pressure compressors, and low pressure turbine sections of these engines had separated from the above assemblies. The blades of the high pressure compressors and turbines of these engines were bent in the direction opposite to compressor/turbine rotation, were broken near the blade root platforms, or were missing from the root platform slots.

A portion of the fan, fan inlet case, and low pressure compressor of the No. 4 engine was in the wreckage area on the northeast slope of the mountain. The remainder of the engine was not located. The attached blades of the low pressure compressor were all bent in the direction opposite to compressor rotation and were flattened against their respective discs.

The snow in the area of the cockpit section was searched extensively for cockpit components of the aircraft. The readings or positions of the pertinent components recovered were as follows:

Pilots' Instruments/Controls

Course select--153
Attitude situation indicator--15° climb, 10° right bank
Radio magnetic indicator heading--035°
Altimeter barometric setting--29.57 in.
Altimeter altitude indication--6,820 ft
Standby altimeter--6,880 ft
Communications radio receivers--On
Transmitter selector--No. 2
Frequency selector switches--Both switches on VHF
No. 1 transceiver--132.55 MHz
No. 1 navigation receiver--116.8 MHz

Copilots' Instruments/Controls

Course select--000
To/From indicator--From
HSI heading--040°
Attitude situation indicator--15° climb, wings level
Instantaneous vertical speed indicator--5,500 ft/min climb
No. 2 transceiver--126.8 MHz
No. 2 navigation receiver--116.8 MHz

Cockpit Overhead Panel

GPWS Switch--Normal, cover guard broken

Second Officer's Station

Generator manual disconnect levers--all 4 levers in same relative position
Generator bus-tie circuit breakers

No. 1--broken	No. 2--broken
No. 3--open	No. 4--closed

Generator circuit breakers

No. 1--broken	No. 2--broken
No. 3--broken	No. 4--closed

The altitude module of the air data computer indicated an altitude of 7,261 ft, and the airspeed module motor was at the high stop, power-off position.

Three electrical relays were found and tested. The d.c. emergency monitor relay and the No. 1 load monitor relay operated properly. The No. 2 load monitor relay did not operate; impact forces had distorted the solenoid housing and the armature was bound.

The four generator protection control panels were examined. All four panels were damaged similarly by impact forces. The positions of the field relays and auxiliary field relays were as follows:

Panel No.	Field Relay	Aux Field Relay
105	closed	open
270	closed	damaged
213	damaged	open
241	open	open

The cockpit section of the aircraft was demolished; the largest piece consisted of the left side and roof of the cockpit, including six of the cockpit windows. The flightcrew's seats were separated from their supporting structure and were heavily damaged. Both the captain's and first officer's seatbelts and shoulder harnesses were intact, except the latter's right seatbelt anchorage was torn from the seat. Each of the three crewmembers was separated from his seat.

1.13 Medical and Pathological Information

All three members of the flightcrew died of extreme and extensive trauma. All suffered extensive craniocerebral trauma, multiple fractures of the extremities, and trauma to the chest and abdomen. None of the flightcrew displayed marks or injuries that could be attributable to seatbelt or shoulder harness restraints.

There was no evidence of preexisting disease or heart disorders in the captain and second officer. The first officer had some symptoms of slight preexisting heart damage, but medical authorities considered the damage insignificant.

Two laboratories, each using different specimens, performed toxicological examinations of the crewmembers. These tests disclosed no drugs or carbon monoxide in any of the crewmembers and no alcohol in the captain and first officer.

One laboratory's tests of tissue specimens from organs of the second officer disclosed ethyl alcohol in amounts which varied from 0.042 percent to 0.007 percent. Further culture tests of these specimens produced alcohol and a growth of mixed organisms. Therefore, lacking any corroborative evidence of alcohol ingestion, the laboratory considered the tissue specimens contaminated.

The other laboratory's tests disclosed that samples of the second officer's urine and bile contained 0.08 percent and 0.03 percent ethyl alcohol, respectively. Additionally, trace quantities of alcohol were found in the gastric contents of the stomach. The toxicologist who conducted these tests considered the tests valid and believed that the most likely source of alcohol was ingestion. He further stated that throughout the ingestion process, there is no established relationship between levels of alcohol in the urine and blood. However, in his opinion, since the gastric contents of the stomach contained only a trace *of* alcohol, absorption had ceased, equilibrium had been attained, and the alcohol was being metabolized at a rate of 0.012 to 0.015 percent per hour just before the second officer's death. At equilibrium, the 0.08 percent alcohol in the urine would equate to about 0.06 percent alcohol in the blood. Considering metabolization rates and assuming that no alcohol was ingested during the 3 hours before his death, the second officer would have to have had the equivalent of of 7 to 8 ounces of 80 proof alcohol in his body when he left the hotel to report for duty at 2300. The toxicologist thought it possible that, considering his weight of 200 lbs, the second officer might not have appeared intoxicated with that amount of alcohol in his body.

The results of the two toxicological tests were submitted to the Armed Forces Institute of Pathology (AFIP) for an additional opinion. AFIP considered both tests valid and considered the results of the urine tests more reliable because bacterial contamination of bladder urine would have been delayed under the low ambient temperatures to which the crewmembers were exposed after their deaths. Additionally, AFIP believed that significant weight must be given to the presence of ethyl alcohol in the tissues and fluids of only one of the three crewmembers even though all three were exposed to essentially the same postmortem conditions.

1.14 Fire

The evidence indicates that a flash fire occurred immediately after the crash but that the fire was of short duration.

1.15 Survival Aspects

At 0142 the Davis County Sheriff's Department at Farmington, Utah, was notified of the accident. The sheriff activated the county emergency plan, search parties were organized, and shortly after 0200 search activities were initiated. Rain, snow, darkness, and rugged terrain hampered the search. About 0755, a U.S. Air Force helicopter from Hill Air Force Base joined the search. Following improvement in the weather conditions, the wreckage was located about 0955 and paramedics were lowered from the helicopter. The paramedics searched the wreckage area but could not find the crewmembers. About 1245, members of the search parties arrived at the scene and secured the area. The remains of the flightcrew were found the afternoon of the following day.

The accident was not survivable because extreme impact forces destroyed the aircraft and caused severe traumatic injury to the flightcrew.

1.16 Tests and Research

N8047U was equipped with a Rockwell International, Collins Radio Group, FPC-75 ground proximity warning system (GPWS), which was powered by the No. 2 electrical system. This system was designed to provide flightcrews with both visual and aural warnings if the aircraft's flightpath between 50 ft and 2,450 ft above the ground places it in hazardous proximity to terrain. Because CVR information was not available, tests were conducted at the manufacturer's facility to determine whether N8047U's GPWS, if operative, could have provided the flightcrew with a timely warning about the aircraft's hazardous proximity to the terrain which it struck.

These tests were computerized simulations based on probable ground tracks of the last 10,000 ft of flight, FDR data, pertinent meteorological information, terrain profiles, and aircraft configuration (landing gear and flaps up). Five probable ground tracks were selected because of large variations in terrain elevations over a short distance and because of slight variations in three independently computed tracks. The track shown in Appendix E was one of the tracks. Additionally, the five tracks chosen insured radio altimeter illumination of all pertinent terrain features.

The simulations for all five tracks ended with radio altimeter altitude's (aircraft's altitude minus terrain elevation) reaching zero before the known impact point was reached. This could indicate one of three things: (1) An error in the barometric altimeter altitudes, (2) an error in topographical information, or (3) that Flight 2860 contacted the ground, or came very close to contacting the ground, before reaching the point where the evidence indicates that initial contact occurred. Since Flight 2860's altitude profile also appears to contact the ground before the established impact point, the FDR altitude trace is probably slightly in error but within recorder tolerances of ± 160 ft at 6,000 ft. Consequently, to determine more accurately what the warning time might have been, the times determined by the tests were increased by the amount of time required to traverse the distance, at the last simulated groundspeed, between the points where simulations terminated and the actual impact point.

The test results are shown in Table 1. If the GPWS was operable, it would have provided a mode 4 warning (unsafe landing configuration) from 7.7 sec to 10.2 sec before impact. Additionally, a mode 2 warning (terrain closure rate) would have been generated on three of the five probable tracks. However, on those three tracks, the mode 2 warnings were preceded by mode 4 warnings. The Collins FPC-75 system uses filter time constants and gains to eliminate nuisance warnings produced by high closure rates of short duration. Consequently, the mode 2 warning delays are attributed to Flight 2860's high groundspeed and low initial altitude, and the precipitous nature of the terrain.

Tests were also conducted on the MSAW system in the Salt Lake City control tower to determine more precisely when the MSAW system alert was triggered. The ARTS III expanded target generator was used to simulate the probable radar returns generated during the last minutes of N8047U's flight. Data from N8047U's probable ground track, the FDR, and

Track	Warning Time Before Simulation Termination		Warning Time Before Impact	
	Mode 2 (sec)	Mode 4 (sec)	Mode 2 (sec)	Mode 4 (sec)
1	6.6	7.9	8.6	9.9
2	7.3	8.2	8.9	9.8
3	0.9	8.3	2.5	9.9
4	-	8.7	-	10.2
5	-	6.3	-	7.7

TABLE 1.—
Simulation Result Summary

pertinent meteorological factors were entered into the generator computer and two simulated flights were monitored on a standard plan position indicator display in the radar room. All generated data were recorded on magnetic tape and later reduced to prints, which were used to plot the generated flight tracks.

These simulations, although not exact reproductions of Flight 2860's probable ground track, were sufficiently representative to determine that for an aircraft flying the track at *6,000* ft and 290 kns groundspeed, the MSAW system warning would activate as the aircraft's magnetic heading approached about 073° in its right turn toward Kaysville. (See Appendix E.)

1.17 Additional Information

1.17.1 Operational Information

United Airlines' Flight Operations Manual provided operational guidance to United's pilots. This manual specified that in accordance with Federal Aviation Administration (FAA) procedures the maximum holding airspeed from the surface through 6,000 ft is 200 KIAS, and from above 6,000 ft through 14,000 ft, 210 KIAS. Also, the pilot must advise ATC if any increased airpseed is necessary.

With regard to holding pattern limits, the manual specified that inbound legs of the holding pattern are of 1 min duration (at or below 14.000 ft); the initial outbound leg should be flown for 1 min; and timing for subsequent outbound legs should be adjusted as necessary to achieve proper inbound leg time. Also, outbound timing begins over or abeam the holding fix, whichever occurs later.

With regard to communications procedures, the manual included the provisions of 14 CFR 91.129, which requires that the pilot report "immediately to Air Traffic Control any in-flight malfunction of navigation or air/ground communications equipment." The pilot must include in the report the "degree to which capability to operate IFR in ATC system is impaired", and the "nature and extent of assistance desired from ATC."

The Airman's Information Manual, Part I, July 1977, contained information on holding procedures for situations where the holding pattern was not published. The manual provided that an ATC clearance under such circumstances would include the following information:

"a. General Holding Instructions.

(1) The direction to hold from holding point; (The direction to hold with relation to the holding fix will be specified as one of eight general points of the compass; i.e., north, northeast, east, etc.).

(2) Holding fix;

(3) On (specified) radial, course, magnetic bearing, airway number or jet route;

(4) Outbound leg length in nautical miles if DME is to be used;

(5) Left turns, if nonstandard pattern is to be used;

(6) Time to expect further clearance, or time to expect approach clearance."

"b. Detailed holding instructions: Same as a.(1), (2), and (3) above with following additions to (4) and (5):

(4), or minute/s if DME is not to be used.

(5), or right turns if standard pattern is to be used."

United Airlines' Flight Handbook for DC-8 aircraft contained, in part, the following information pertinent to electrical system malfunctions:

"INOPERATIVE EQUIPMENT RESULTING FROM ELECTRICAL BUS FAILURE
(Critical items only. Some items which display a flag or evidence of power loss are not listed.)"

"If power cannot be restored to one or more buses, refer to the following list of systems important to the approach and landing phases of flight that will NOT be available. This list does not include all electrically controlled and/or powered systems, and is no substitute for a complete check of the circuit breaker panel to determine the affected systems."

"BUS SYSTEM NO. 1

Spoiler pump (and control on later airplanes).
Antiskid (Also main gear spoiler control with Mark II brakes).
Standby rudder pump.
JT4 outboard ejectors.
-62 reversing on No. 2 and No. 3 engines.

"BUS SYSTEM NO. 2

No. 1 Comm (except -62) and Nav Radios.
Hydraulic and spoiler pressure gages.

"BUS SYSTEM NO. 3

No. 2 Comm and Nav Radios.
-62 standby reverser pump (reversing available if buses 1 and 4 are powered).

"BUS SYSTEM NO. 4

Spoiler pump control (some early airplanes).
Spoiler selector valve (some later airplanes which also require right ground control relay power for spoiler operation).
Aux hydraulic pump.
Main gear spoiler control (with Mark II brakes).
JT4 inboard ejectors.
-62 reversing on No. 1 and No. 4 engines (no reversing on Nos. 1, 2, 3, or 4 if bus No. 3 is also lost).

"LEFT EMERGENCY BUS

Captain: horizon, compass, and pitot heat.
Spoiler selector valve (some early airplanes which also require right ground control relay power for spoiler operation).

"RIGHT EMERG BUS

F/O: horizon, compass, and pitot heat."

The Handbook also contained irregular procedures for: (1) Bus power failure light--On and (2) generator unparalleled light--On. The procedure for (1) above specified that if the volts and frequency were not normal and activation of the bus fault reset switch did not extinguish the failure light, the bus should be left unpowered (generator control switch--Off), and the inoperative equipment list consulted. If a generator unparalleled light could not be extinguished but generator operation was otherwise normal, the generator could be operated in an isolated condition; that is, with the generator powering only its own bus.

The Handbook did not contain a procedure that was sometimes recommended by maintenance controllers in circumstances where a generator was not producing any power and its associated bus could not be powered by the other generators. This procedure specified that the generator be disconnected from its constant speed drive (CSD) unit and was based on the theory that generator faults sensed by the generator's internal sensing circuit can prevent its associated bus-tie from closing, thereby preventing the other generators from powering the faulty generator's bus. 4/

The above procedure was used on N8047U's No. 1 generator on December 17, 1977, for flights from Cleveland to Denver and Denver to San Francisco before the No 1 generator control panel was replaced. The maintenance controller who communicated with the flightcrew of Flight 2860 through ARINC stated that he was not aware of N8047U's previous electrical problems but that he was aware of the disconnect procedure. He did not recommend the procedure to the flightcrew because they seemed to be concerned mainly with why the landing gear indicator system was inoperative and not with why the No. 1 bus could not be powered.

Most of the circuit breaker panels in N8047U were located on the aft wall of the cockpit. Some of the generator control circuit breakers were located in the flightcrew coatroom.

Numerous electrical components in N8047U were powered by the No. 1 electrical bus; pertinent components were:

No. 1 engine oil quantity indicator
No. 1 engine pressure ratio gage
No. 1 engine fuel flow indicator
Spoiler hydraulic pump control
Left wing landing light and light control
Left nose gear landing and taxi light
Captain's instrument lights (red)
No. 1 generator drive and engine oil temperature
No. 2 generator drive and engine oil temperature
Landing gear warning and interlock

4/ After the accident, United Airlines' included the procedure in the DC-8 Flight Handbook.

Hydraulic oil temperature
Hydraulic oil quantity
Main landing gear spoiler lockout
No. 1 VHF communication radio
No. 1 transponder

1.17.2 Air Traffic Control Information

The FAA's Air Traffic Control Handbook 7110.65 provided guidance for air traffic controllers. The Handbook, current at the time of the accident, specified that, with respect to holding aircraft, if the holding pattern is not charted, the controller issue both of the following:

"(1) General holding instructions or, if the pilot requests or you consider it necessary, detailed holding instructions....

"(2) The time at which the pilot can expect to receive approach clearance...or further clearance...."

According to paragraph 320 of the Handbook, general holding instructions consisted of:

"a. Direction of holding from the fix.
b. Holding fix
c. Radial, course, bearing, airway, or jet route on which the aircraft is to hold.
d. Outbound leg length in miles, if DME or RNAV is used.
e. Direction of holding pattern turns if left turns are to be made."

Paragraph 324 provided that for detailed holding instructions the controller "issue the same items as for general holding, but always specify leg length in minutes, miles RNAV, or miles DME, and direction of holding pattern turns."

The approach/local controller testified that according to the above provisions he should have issued general holding instructions to Flight 2860. He stated that he intended that the flight hold on the 331° radial, but he could not explain why he did not specify the radial. He stated that he had never worked in a nonradar control facility, and during his career at the Salt Lake City control tower facility he had few occasions to issue holding clearances to flightcrews of large aircraft.

The required obstacle clearance criteria, as specified in FAA TERPS Handbook 8260.38, could be met for an aircraft holding at 6,000 ft on the 331° radial of the Salt Lake City VOR if the aircraft was held in a righthand pattern, 1 min legs, at 200 KIAS or less.

According to video maps in the Salt Lake City control tower radar displays, the minimum vectoring altitudes (MVA) varied considerably within the facility's control area. The MVA for the area about 3 mi east of V-21 (331° radial) to 5 mi west of V-21 between the Salt Lake City and Ogden VOR's was 6,000 ft. The MVA's on both sides of this area were higher. On the east side, the MVA's extended to 9,000 ft and 10,500 ft.

2. ANALYSIS AND CONCLUSIONS

2.1 Analysis

The flightcrew was certificated properly, and all members were qualified for the flight. They had received the off-duty time required by regulation, and there was no evidence of medical factors that might have affected their performance.

There was evidence of ethyl alcohol in the second officer's body which according to the weight of medical opinion most likely occurred from his ingestion of alcohol within the 8-hr period preceding the flight. Since investigation of the second officer's activities before he departed San Francisco disclosed no evidence either of alcohol consumption or of the noticeable effects of consumption, the Safety Board is unable to determine the extent, if any, to which the second officer's physiological and mental faculties might have been impaired by alcohol nor could the Board determine whether the blood alcohol level of the second officer contributed to the accident. However, the consumption of alcohol by members of a flightcrew within 8 hrs of flight is prohibited by regulation for good reason, and should not be tolerated by anyone responsible for the operation of aircraft.

The aircraft was certificated, equipped, and maintained in accordance with regulations and approved procedures. Except for the electrical malfunction associated with the No. 1 electrical bus and the reported unparalleled state of the No. 3 generator, there was no evidence of a failure or malfunction of the aircraft's structure, powerplants, flight controls, or systems, including flight instrument and navigational systems. The postaccident condition of the engine components indicate that all four engines were running at high thrust selections when the aircraft crashed.

Based on the flightcrew's recorded conversation with United's system line maintenance controller, following the flight's descent for landing at Salt Lake City, the No. 1 electrical bus was not powered and all electrical components powered by the No. 1 bus were inoperative. The Safety Board was not able to determine why the No. 1 electrical bus could not be powered because many of the electrical components could not be recovered and because those recovered were too badly damaged to provide clues. However, we believe that the No. 1 generator probably was malfunctioning for the same reasons that it malfunctioned the day before. Also, although the generator control panel had been changed, the cause of the earlier malfunction apparently was intermittent and was not in the control panel as established by tests on the panel that was removed. Consequently, had the No. 1 generator drive been disconnected, as it had been the day before, the No. 1 bus-tie probably could have been closed and the No. 1 bus could have been powered by the Nos. 2 and 4 generators. The unparalleled state of the No. 3 generator appears to have been an unrelated malfunction which had no bearing on the problems associated with the No. 1 generator.

Notwithstanding Flight 2860's electrical systems problems, the Safety Board concludes that the failures associated with the No. 1 electrical system alone were not responsible for the accident. Although these failures precipitated a series of events which culminated in the accident, the aircraft's alternate electrical systems and the established procedures for dealing with electrical system failures were, for the most part, adequate to permit safe operation of the aircraft with the No. 1 electrical system inoperative. Further, although disconnection of the No. 1 generator drive might have permitted the flightcrew to restore power to the No. 1 electrical bus, the flightcrew should have been able to safely fly, navigate, and land the aircraft with the bus inoperative.

An analysis of the series of events which followed Flight 2860's electrical system problems discloses numerous acts of omission and commission, the slight alteration of which probably could have prevented the accident. The first of these events was the holding clearance that was issued by the Salt Lake City approach controller. The clearance clearly did not conform to established holding clearance requirements because the holding radial was omitted.

The controller was not able to explain why he omitted the radial from the clearance. Under the circumstances, with 2 to 2 1/2 hrs sleep in the 19 1/2-hr period preceding the accident, the controller might have been affected by fatigue. However, fatigue is a subjective physiological reaction since it affects each individual differently. Since the controller denied feeling fatigue, generalizations to the contrary would be speculative at best. It is believed more likely that since the controller intended that the flight hold northwest on the 331° radial and since the 331° radial was the only radial useful to the flightcrew in conducting a VOR approach to runway 16R, he probably thought that the holding radial was obvious and that, therefore, the direction of holding was sufficient. The flightcrew's response ("Okay") to the controller's correction of the holding direction from north to northwest would have tended to reassure him in this respect, as would the flight's subsequent return to the VOR via the 331° radial. Additionally, since the flight was apparently in visual flight conditions and under radar control and since there was no other traffic in the area, the controller probably did not consider the specific radial particularly important. As a practical matter, the omission of the holding radial would have been detected and corrected had communications with the flight not been interrupted.

Because of the lack of CVR information, the Safety Board is unable to determine why the captain and first officer might have failed to realize the omission of a specific holding radial from the holding clearance. Possibly, fatigue affected the flightcrew when the clearance was issued and throughout the remainder of the flight; but, there was no evidence that they did not make full use of the 13-hr rest period in San Francisco or of the rest periods afforded them before they reported for duty in Chicago on December 16. If the flightcrew made appropriate use of these rest periods, as the evidence indicates they did, fatigue should not have been a factor. Therefore, we believe it more likely that they probably failed to realize the omission, or the importance of the omission, because of distractions associated with the electrical system problems and because they were in visual flight conditions where the aircraft was just below the clouds and the visibility was good.

Flightcrew voice identification of ATC and ARINC tapes indicates that the captain originally was flying the aircraft and that the first, officer was managing the radio communications. Shortly after the flight established communications with Salt Lake City approach control, the captain began making the radio transmissions, which indicates that the first officer probably was flying the aircraft when the holding clearance was requested, because the nonflying pilot usually manages the radio comunications. Later transmissions on the ARINC frequency show that the captain was active in discussing the electrical system problems with United's maintenance controller. Therefore, before the flight left the approach control frequency, the captain probably was significantly involved in the diagnoses of the electrical problems and, consequently, his attention probably was divided between those problems and flying activities.

Since the pattern of ground lights in the Salt Lake City-Ogden corridor are oriented in a true north-south direction and since, when the holding clearance was requested, the aircraft was about 7 to 8 mi west of those lights, the captain could have thought that holding north was more appropriate. His statement, "Okay, we'll hold north of the VOR...," tends to support such a train of thought. Whether the flightcrew discussed the matter is not known. However, the evidence indicates that the first officer accepted the 360° radial as the holding radial because the course selection in his horizontal situation indicator was found at 000. 5/ Additionally, the probable ground track shows that after the aircraft passed the VOR it flew the outbound leg of the holding pattern

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5/ This selection would keep the course deviation indicator (CDI) directional while the aircraft was outbound from the VOR. To keep the CDI directional after turning inbound, a course of 180 would have to be selected.

began about 10 nmi from the VOR which indicates that the first officer might have used 10 nmi on his DME as the measure of leg length even though the use of DME was not specified in the holding clearance. Since the controller had told the flight earlier that he could take it out 20 mi (north-northwest), the use of 10 nmi on the DME as the measure of leg length probably would have seemed reasonable to the first officer. On the other hand, the inbound turn was begun shortly after the discussion with United's maintenance controller ended, during the last portion of which the captain expressed his intention to "go ahead and land then." Consequently, it is possible that the first officer was monitoring the discussion and that he began the inbound turn shortly after the captain expressed his decision to land. Also, if the first officer's attention was partially directed toward the diagnoses of the electrical system problems, he might have lost track of the timing on the outbound leg. In any event, the holding pattern was not flown in conformity with prescribed procedures and, as a result, the aircraft was flown into an unsafe area when the air traffic controllers could not provide any assistance.

The final critical event which, if managed differently, might have prevented the accident was the exchange of communications between the controller and the flightcrew after the flight had returned to the approach control frequency. About 1 min elapsed between the time the flight reported back on the frequency and the time the aircraft struck the mountain. Considering the aircraft's speed and performance capability as demonstrated by the FDR traces, in about 30 secs or less the aircraft could have been flown safely above the mountains. Additionally, it is apparent from the probable ground track that had Flight 2860 continued its right turn, without climbing, and had it intercepted the 360° radial inbound, without overshoot, it would not have struck the mountains. On the other hand, had Flight 2860 begun the left turn immediately or had it begun the climb immediately after receipt of the controller's first instructions to turn and climb, it is likely that the aircraft would not have crashed.

Considering the alternatives which were possibly available to the controller, instructions for an immediate turn and climb with stress on the immediacy of the action would have been most appropriate. However, the controller's radar display did not, and cannot, portray sufficient details of the terrain or the aircraft's flight track to permit the controller to make fine distinctions about the aircraft's proximity to obstructing terrain. Additionally, the radar display that the controller was using in the tower cab did not portray these features with as high fidelity as the plan position indicator displays in the radar room. 7/ Consequently, under the circumstances, the controller's instructions to the flight must be considered a judgmental matter on his

7/ After the accident, the FAA discontinued the practice of using the radar display in the Salt Lake City control tower cab for approach control functions during weather conditions where the ceiling is below 5,000 ft or the visibility is less than 4 mi.

part. However, since the MSAW alert was flashing and since the aircraft was headed toward areas where the MVA's were 9,000 ft and higher, the controller should have placed more emphasis on the urgency of the action he told Flight 2860 to take, and he should have given the flight instructions to immediately turn and immediately climb.

The conditions in the cockpit of Flight 2860 after the flight reported back on approach control frequency are not known because of the lack of CVR information. However, based on weather reports and witness reports, the flight apparently entered instrument flight conditions during the inbound turn, if not before, and the flightcrew was not aware that a dangerous situation was developing. Consequently, the controller's instructions probably surprised them sufficiently to cause delays in their responses. Additionally, simulation tests indicate that the GPWS would not have provided a warning until 7.7 to 10.2 secs before impact, which because of the rapidly rising terrain was too late. 8/

Clearly. it was a preventable accident because so many independent events had to combine sequentially to produce the accident, and slight alterations in any of these events could have prevented it. However, we conclude that the most critical of the events was the manner in which understanding was reached on the holding clearance, because if the holding clearance had been properly given and properly understood the events that followed either would not have affected the safety of the aircraft or would not have occurred. We believe the major problem with the holding clearance was the lack of precision in the communications between the parties involved.

The captain knew that he had only one radio and that he would have to terminate ATC communications, and radar control, in order to communicate with United's maintenance controller. Further, from information available to him on the instrument approach chart and from his previous experience in the Salt Lake City area, he should have known that 6,000 ft was well below the elevations of surrounding mountains. Therefore, he should have insisted on absolute certainty about where the flight was to hold. When the approach controller issued the holding instructions, he was not aware that communications and, therefore, radar control, later would be interrupted. Consequently, the holding instructions were imprecise and contained an ambiguity which the flightcrew failed to detect.

8/ The GPWS probably functioned because the GPWS switch was found in the normal position. Additionally, the rapid increase in the FDR altitude trace and corresponding decrease in the airspeed trace during the final 4 to 5 secs of flight, and the impact attitude of about 15°, indicate that the pilot reacted sharply to such a stimulus.

The Board has noted this lack of precision in communication in other accidents 9/, and we believe that some of it is attributable to complacency while operating in the radar environment. When under radar control, flightcrew communications and adherence to prescribed procedures may tend toward imprecision because they know that the controller has the means to detect and correct mistakes. On the other hand, the controller may be less precise in his comunications and adherence to prescribed procedures because he has the means to correct any mistakes or misunderstandings that might occur. Consequently; after lengthy exposure to the pure radar environment, both flightcrews and air traffic controllers develop habits of imprecision in their communications with each other and in their adherence to prescribed procedures. Further, the exposure can lead to a loss of knowledge of procedures which, generally, were developed for use in the nonradar environment or for use in the event of lost communications and which may be used rarely with precision in the pure radar environment.

Flightcrews and controllers alike should consciously strive for precision in their comunications with each ocher and in their adherence to prescribed procedures, not only to avoid events similar to those which led to this accident, but also because the loss of communications between the flightcrew and controller always terminates radar control and prevents both parties from correcting mistakes or clarifying ambiguities.

Another problem inherent in situations involving malfunctions of aircraft systems in flight is the division of responsibilities among members of the flightcrew while the malfunction is being resolved. The Safety Board has addressed these responsibilities in a number of accident reports. 10/ In this instance, because of the lack of CVR information, the manner in which the captain coordinated and managed the activities of the first officer and the second officer is not explicitly known. However, it is known from the ATC and ARINC communications recordings that the captain was actively involved in resolution of the electrical

9/ NTSB-AAR-73-15, North Central Airlines, Inc., and Delta Air Lines, Inc., O'Hare International Airport, Chicago, Illinois, December 20, 1972.

NTSB-AAR-75-16, Trans World Airlines, Inc., Berryville, Virginia, December 1, 1974.

NTSB-AAR-77-8, Jet Avia, Ltd., Palm Springs, California, January 6, 1977.

10/ NTSB-AAR-70-14, Scandinavian Airlines System, near Los Angeles, California, January 13, 1969.

NTSB-AAR-73-8, Mohawk Airlines, Inc., Albany, New York, March 3, 1972.

NTSB-AAR-73-14, Eastern Air Lines, Inc., Miami, Florida, December 29, 1972.

problem and in obtaining a holding clearance. Consequently, the captain probably'was distracted by the electrical problem from supervision of the flying activities, including obtaining the holding clearance and the manner in which the first officer flew the holding pattern. Similarly, it is possible that the first officer was monitoring the resolution of the electricai problem and, therefore, was paying less than full attention to ATC comunications and to flying the aircraft.

Since this type of situation is dynamic because the aircraft must be flown while the malfunction is resolved, it follows that the captain must manage the flightcrew in a manner which will insure absolute safe operation of the aircraft during the interim. Therefore, although each situation will vary depending on the type of aircraft involved, the complexity and criticality of the malfunction, the composition of the flightcrew, and many other factors, it remains that the captain's first and foremost responsibility is to insure safe operation of the aircraft. To achieve this objective, he must relegate other activities accordingly.

3. CONCLUSIONS

3.1 Findings

1. The flightcrew were properly certificated and were qualified. for the flight.

2. There was toxicological evidence of alcohol in the second officer's body which according to the weight of medical opinion most likely resulted from his ingestion of alcohol during the 8-hr period preceding the flight; however, since there was no corroborative evidence of alcohol consumption or the effects thereof, the degree of impairment, if any, of the second officer's physiological and mental faculties could not be determined.

3. When initially dispatched, the aircraft's No. 1 a.c. electrical generator was inoperative, but repairs were completed and the dispatch release was revised accordingly before the flight departed San Francisco.

4. The aircraft's No. 1 electrical system malfunctioned during the flight's descent for the approach to Salt Lake City airport; the No. 1 electrical bus was inoperative and all of its associated electrical components were inoperative.

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5. Other than components that were powered through the No. 1 electrical bus, there was no evidence of malfunction or failure of the aircraft's other systems, including flight instrument and navigational systems, or its structure, powerplants, or flight controls.

6. Contrary to United's DC-8 Flight Handbook, the No. 1 communications radio was powered through the No. 1 electrical bus; the radio was inoperative after the loss of the No. 1 bus.

7. The flightcrew was unable to verify landing gear extension because the landing gear indicator system was powered through the No. 1 electrical bus.

8. Shortly after the flight established communications with Salt Lake City approach control, the first officer began flying the aircraft and the captain managed the radio communications.

9. Contrary to regulations, the flightcrew did not inform ATC of the loss of a communications radio, the extent to which the loss impaired the flight's capability to operate IFR in the ATC system, or the assistance desired from ATC.

10. Because the captain wanted to communicate with United's system line maintenance control in San Francisco, he requested a holding clearance from the Salt Lake City approach controller.

11. The holding clearance issued by the approach controller was incomplete and attempts to clarify the clearance resulted in an ambiguity.

12. The approach controller intended that Flight 2860 hold northwest on the 331" radial of the Salt Lake City VOR, but he did not specify the radial.

13. The captain apparently intended to hold north of the Salt Lake City VOR but did not request a complete holding clearance, including a holding radial.

14. Because the approach controller did not issue a holding radial, and because the captain did not request a holding radial, the first officer assumed the 360" radial to be holding radial.

15. The approach controller was misled by the captain's request to leave the frequency for a "little minute"; the flight was absent from the frequency for about 7 1/2 min.

16 During the flight's absence from the approach control frequency, the controllers recognized that the aircraft was entering a hazardous area but they were unable to communicate with the flight.

17. Flight 2860 was not monitoring the Salt Lake City VOR for voice transmissions even though both VOR receivers were tuned to the Salt Lake City VOR frequency.

18. The first officer did not fly the holding pattern in accordance with established procedures; as a result, the aircraft was unknowingly flown into an area near hazardous terrain.

19. When the flight returned to approach control frequency, the approach controller had determined that a left turn was required to prevent a collision with hazardous terrain.

20. The approach controller told Flight 2860 to turn left to avoid hazardous terrain on its right, but he did not stress the need for immediate action.

21. Because ATC radar displays cannot portray terrain features or an aircraft's track in fine detail, and because the display used by the controller had less fidelity than the usual approach control radar displays, the controller's instructions to Flight 2860 to turn and climb were judgmental.

22. When Flight 2860 received turn and climb instructions from the approach controller, it was in instrument flight conditions and the flightcrew was not able to make an independent assessment of their predicament.

23. The aircraft's GPWS probably functioned from 7.7 to 10.2 sec before impact but not in time for the flightcrew to prevent the aircraft's collision with terrain which rose at a 32° angle from the horizontal.

24. The accident was not survivable because severe impact forces destroyed the aircraft and subjected the flightcrew to extreme traumatic injury.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the approach controller's issuance and the flightcrew's acceptance of an incomplete and ambiguous holding clearance in combination with the flightcrew's failure to adhere to prescribed impairment-of-communications procedures and prescribed holding procedures. The controller's and flightcrew's actions are attributed to probable habits of imprecise communication and of imprecise adherence to procedures developed through years of exposure to operations in a radar environment.

Contributing to the accident was the failure of the aircraft's No. 1 electrical system for unknown reasons.

4. RECOMMENDATIONS

On April 3, 1978, the Safety Board issued Safety Recommendations A-78-21 and A-78-22 to the Federal Aviation Administration as follows:

> "Review the adequacy of current cockpit voice recorder preflight testing procedures to assure satisfactory system operation. (A-78-21)
>
> "Review the reliability of cockpit voice recorder units to assure that the mean time between failure is not excessive. (A-78-22)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PHILIP A. HOGUE
Member

/s/ ELWOOD T. DRIVER
Member

July 27, 1978

5. APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

The National Transportation Safety Board was notified of the accident about 0220 on December 18, 1977. The Safety Board immediately dispatched an investigative team to the scene. Investigative group were established for operations/witnesses, air traffic control, weather, human factors, structures, powerplants, systems, flight data recorder, maintenance records, and cockpit voice recorder.

Parties to the investigation were: The Federal Aviation Administration, United Airlines, Inc., Air Line Pilots Association, Professional Air Traffic Controllers Organization, Douglas Aircraft Company, International Association of Machinists, Pratt & Whitney Division of United Technologies Corporation.

2. Hearings

There was no public hearing. Depositions of material witnesses were taken in Salt Lake City, Utah, February 28, 1978, and San Francisco, California, March 2, 1978. Parties to the depositional proceedings were: The Federal Aviation Administration, United Airlines, Inc., Professional Air Traffic Controllers Organization, Douglas Aircraft Company, and International Association of Machinists.

APPENDIX B

PERSONNEL INFORMATION

Captain John R. Fender

Captain Fender, aged 49, was employed by United Airlines, Inc., December 10, 1954. He held Airline Transport Pilot Certificate No. 1240691 with an airplane multiengine land rating and type rating for CV-240, CV-340, CV-440. DC-6, DC-7, DC-8, S-210, and B-737 aircraft; he also had commercial privileges with an airplane single engine land rating. His first-class medical certificate was issued November 30, 1977, with the limitation that he wear corrective lenses while flying.

Captain Fender advanced to captain July 27, 1967, and he qualified in DC-8 aircraft April 4, 1973. He passed his last proficiency check October 9, 1977. During his flying career, Captain Fender accumulated 14,954 flight-hours, of which 4,148 were on DC-8 aircraft. In the 30-day, 7-day, and 24-hour periods preceding the accident, he flew 43.1, 17.4, and 7.7 hours, respectively, in DC-8 aircraft.

First Officer Phillip E. Modesitt

First Officer Modesitt, aged 46, was employed by United Airlines, Inc., June 13, 1966. He held Airline Transport Pilot Certificate No. 1447203 with an airplane multiengine land (centerline thrust) rating and B-727 type rating; he also had commercial privileges with airplane single engine land and multiengine land ratings. His first-class medical certificate was issued January 10, 1977, with no limitations, and had reverted to a second-class certificate.

First Officer Modesitt qualified in DC-8 aircraft April 5, 1977. He passed his last proficiency check November 1, 1977. During his flying career, First Officer Modesitt accumulated 9,905 flight-hours of which 366 were in DC-8 aircraft. In the 30-day, 7-day, and 24-hour periods preceding the accident, he flew 42.4, 14.3, and 7.7 hours, respectively, in DC-8 aircraft.

Second Officer Steve H. Simpson

Second Officer Simpson, aged 34, was employed by United Airlines, Inc., April 7, 1969. He held Flight Engineer Certificate No. 2114963 with turbo jet rating and Airline Transport Pilot Certificate No. 1582275 with airplane multiengine land rating and a type rating in Learjet aircraft; he also had commercial privileges with an airplane single engine land rating. His first-class medical certificate was issued August 12, 1977, with no limitations.

Second Officer Simpson qualified in DC-8 aircraft March 5, 1977. He passed his last proficiency check September 30, 1977. During his flying career, Second Officer Simpson accumulated 5,692 flight-hours of which 419 were in DC-8 aircraft. In the 30-day, 7-day, and 24-hour periods preceding the accident, he flew 63.8, 15.1, and 7.7 hours, respectively, in DC-8 aircraft.

Air Traffic Control Specialist Murray D. Hess

Mr. Hess served as an air traffic controller in the U.S. military forces from 1964 to 1968. He was employed by the FAA in 1968. Since then, he has served in the Oakland and San Francisco, California, air traffic control towers for 1 1/2 years each, the Bay Area terminal radar control facility for about 3 years, the Hill Air Force Base radar approach control facility for 1 1/2 years, and the Salt Lake City air traffic control tower for 1 1/2 years,

Mr. Hess holds an air traffic control tower operating certificate with qualifications in ARTS III equipment and air surveillance radar. At the time of the accident, he held a current second-class medical certificate.

Air Traffic Control Specialist Boyd R. Beazer

Mr. Beazer served as an air traffic controller in the U.S. Air Force from 1955 to 1959. He was employed by the FAA in 1959 and subsequently served in the Tucson, Arizona, air traffic control tower and radar approach control facility for about 3 years. He then served in the Casper, Wyoming, air traffic control tower for about 1 year followed by 11 years of service at the Hill Air Force Base radar approach control facility. At the time of the accident, he had served in the Salt Lake City air traffic control tower about 4 years.

Mr. Beazer holds an air traffic control tower operators certificate with qualifications in ARTS III equipment and air surveillance radar. At the time of the accident, he held a current second-class medical certificate with no limitations.

APPENDIX C

Jeppesen Approach Chart (United) AUG 5-77 (13-1) Eff Aug 11

SALT LAKE CITY, UTAH

SALT LAKE CITY INT'L

VOR Rwy 16R

VOR 116.8 SLC

Class ABVORTAC

Apt. Elev 4226'

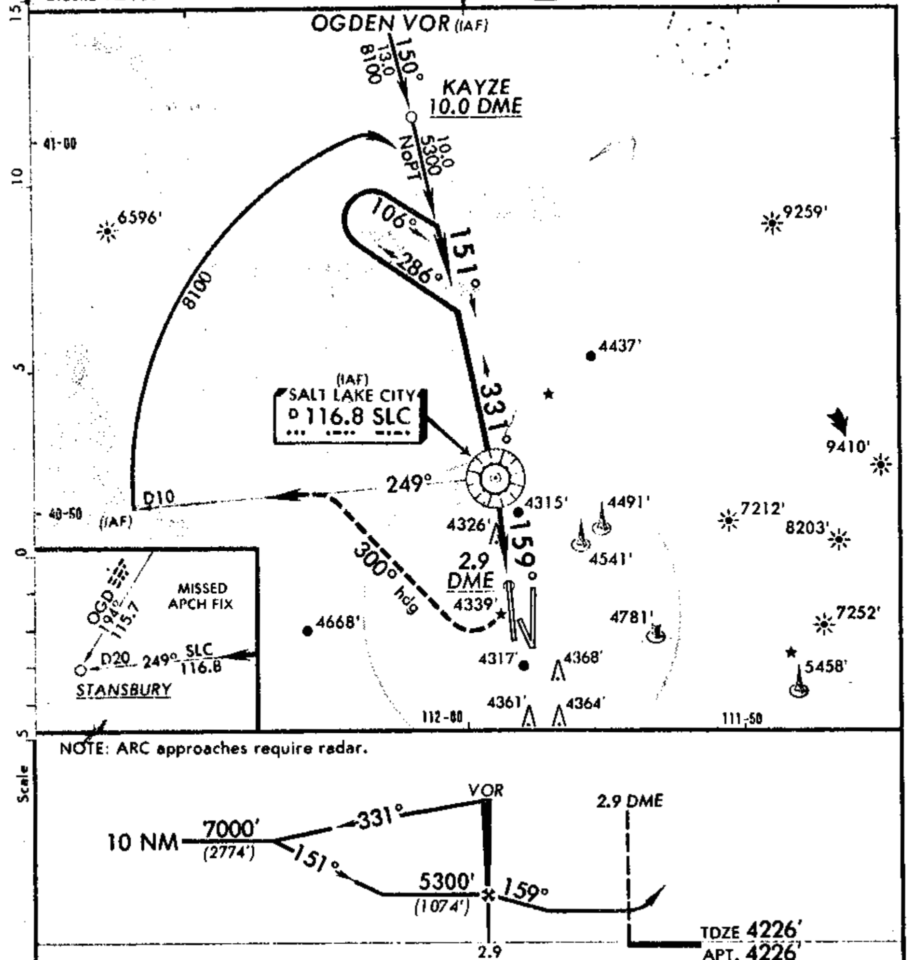
ATIS 125.6

SALT LAKE Approach (R) See apt. chart for freq.

SALT LAKE Tower 118.3

Ground 121.9

MSA SLC VOR: 10,800' (140°–230°), 7700', 12,500' (050°)



MISSED APPROACH: Climbing RIGHT turn heading 300° to 9000', intercept outbound SLC VOR R-249 to STANSBURY INT.

STRAIGHT-IN LANDING RWY 16R		CIRCLE-TO-LAND	
MDA 4580'(354')		MDA	
A	RVR 50 or 1	A	4640'(414')-1
B	RVR 50 or 1	B	4780'(554')-1
C	RVR 50 or 1	C	4860'(634')-1¾
D	RVR 60 or 1¼	D	4860'(634')-2¼

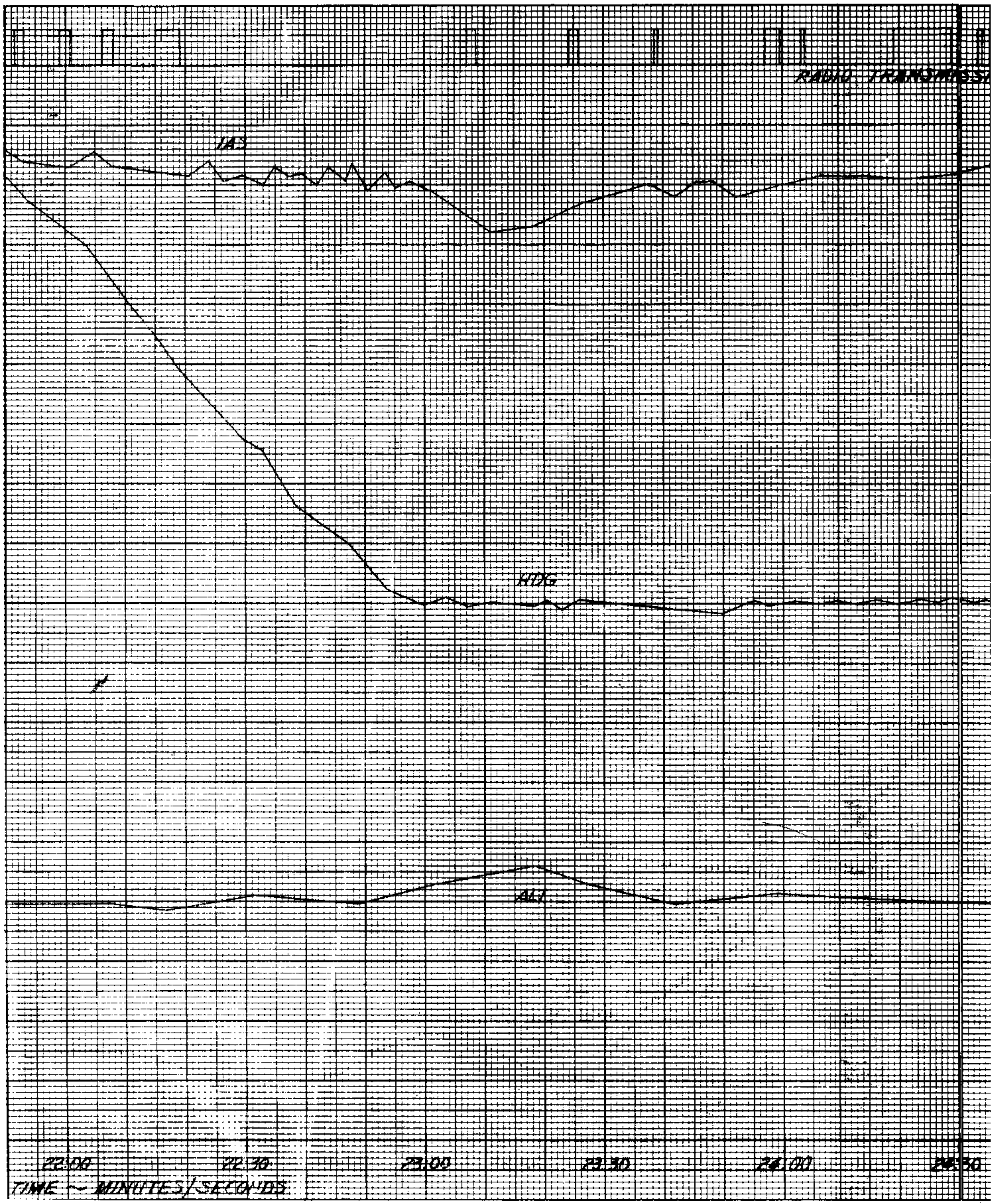
"NOT TO BE USED FOR NAVIGATIONAL PURPOSES"

Gnd speed-Kts	60	80	100	120	140	160
MAP at 2.9 DME or VOR to MAP 2.9	2:54	2:11	1:44	1:27	1:15	1:05

CHANGES: Procedure.

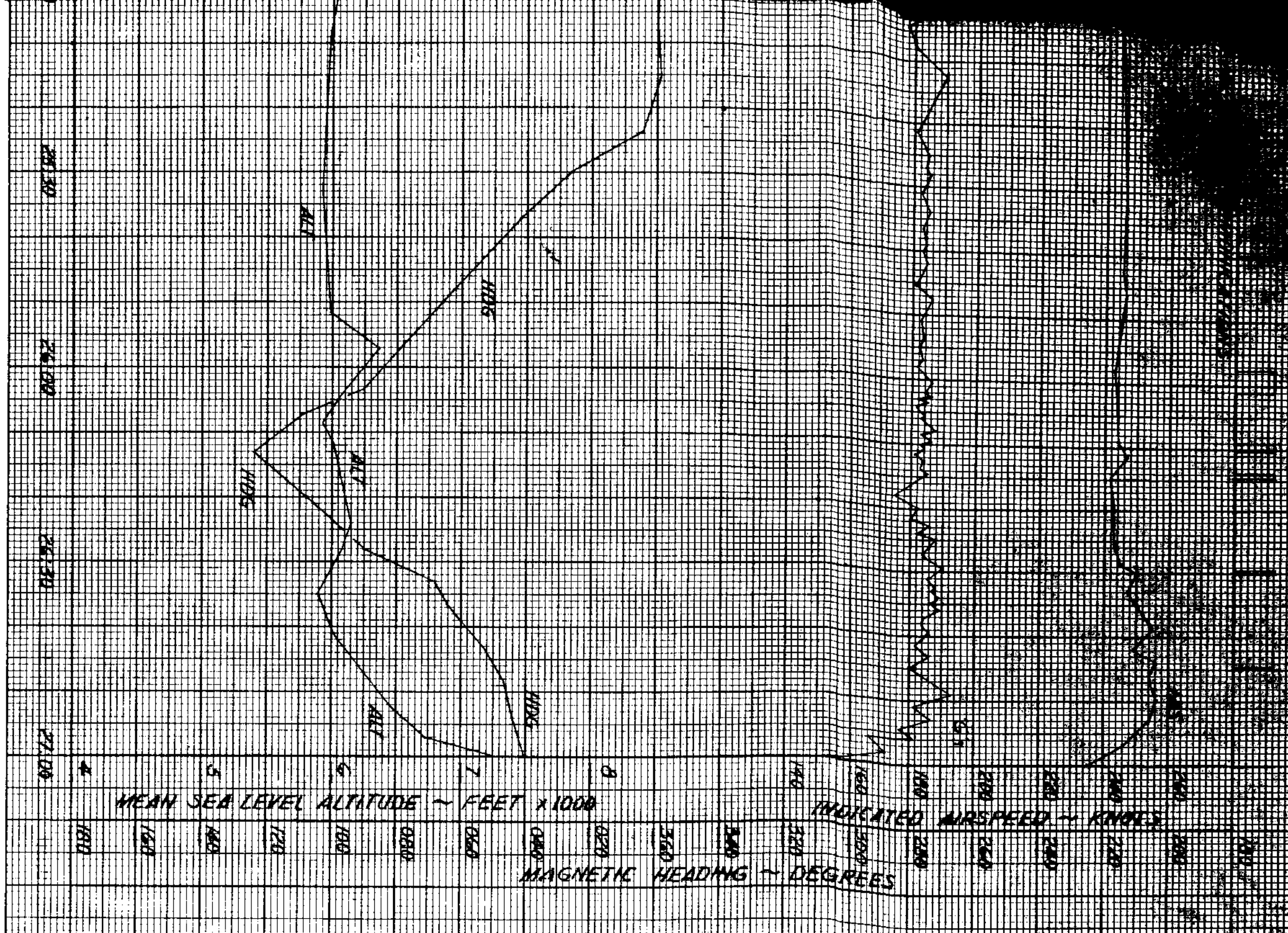
"REPRINTED FROM JEPPESEN APPROACH CHARTS BY PERMISSION OF JEPPESEN SANDERSON, DENVER, COLORADO 80207"

271-271 O - 78 (Face p. 38) No. 1

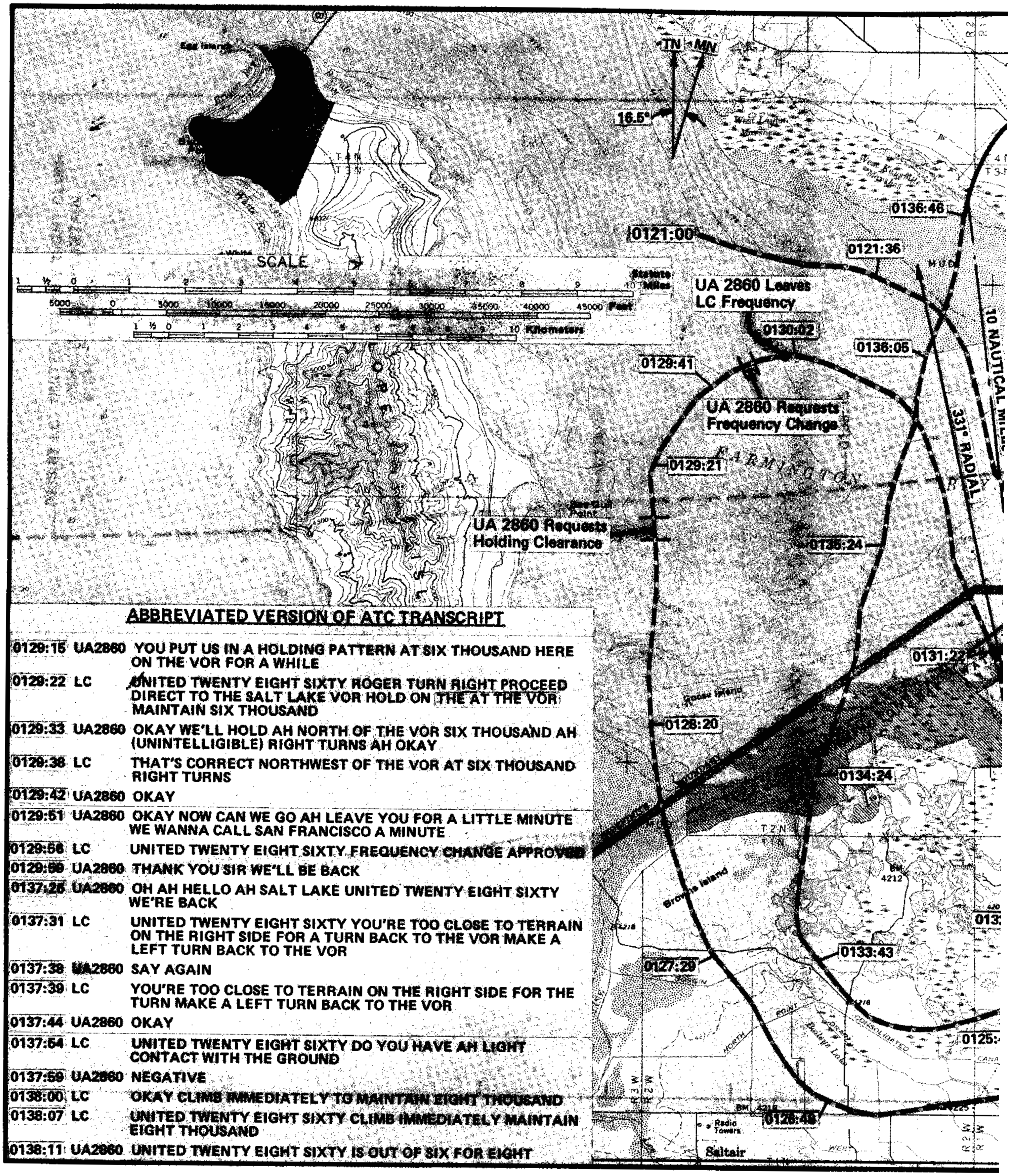


RADIO TRANSMISSI
IAS
HDG
ALT
22:00
22:30
23:00
23:30
24:00
24:30
TIME ~ MINUTES/SECONDS

APPENDIX D

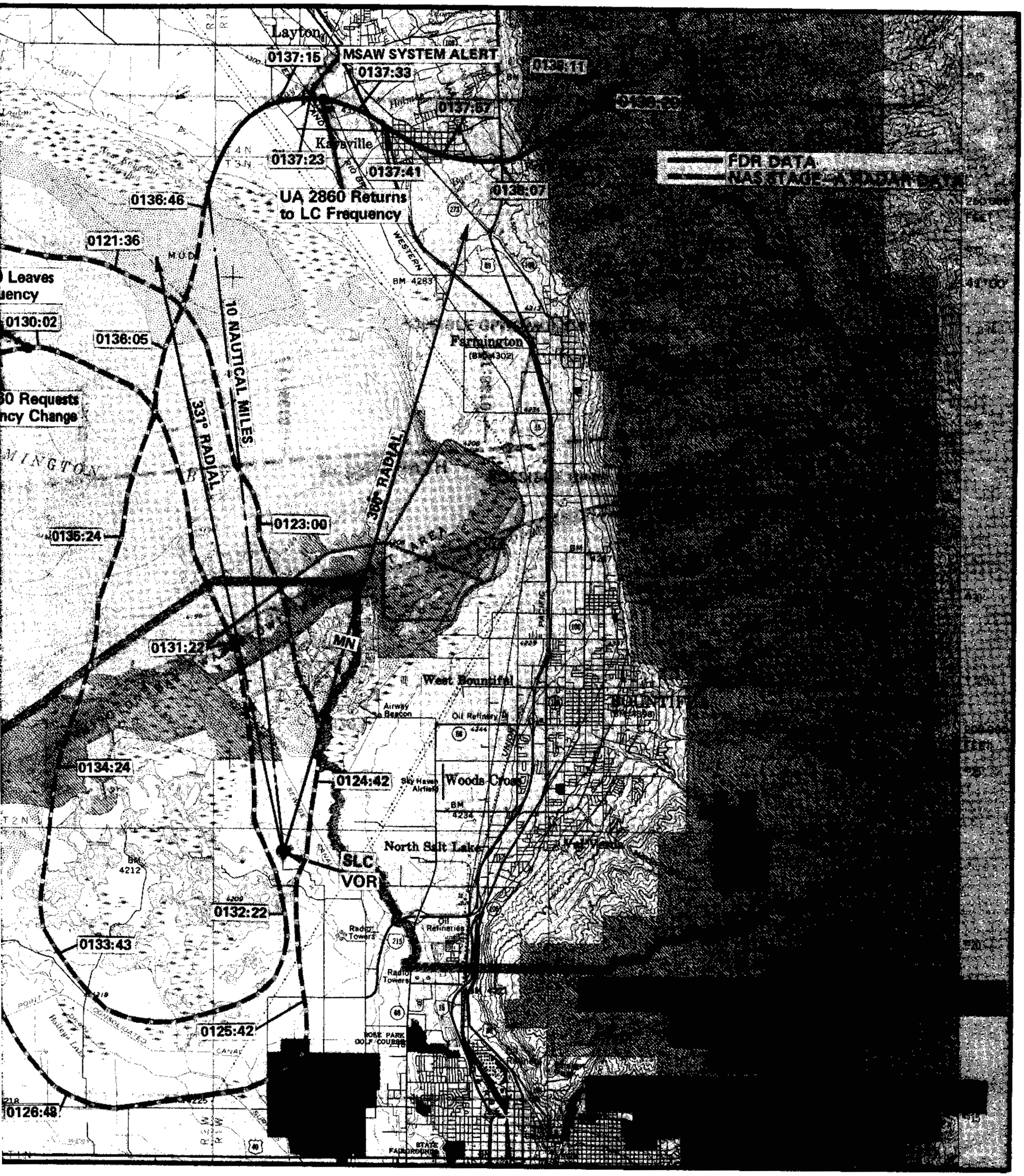


NATIONAL TRANSPORTATION SAFETY BOARD
BUREAU OF TECHNOLOGY
WASHINGTON, D.C.
UNITED AIR LINES, DOUGLAS DC-8F, N8047U
FLT 2860, SALT LAKE CITY, UTAH DEC. 18, 1977
CRASHED ON MOUNTAIN
FLIGHT DATA RECORDER GRAPH
FAIRCHILD 5424, S/N 6084
DCA 78-A-A005
RPT. NO. 78-11
DECEMBER 28, 1977
MEAN SEA LEVEL ALTITUDE ~ FEET x 1000
INDICATED AIRSPEED ~ KNOTS
MAGNETIC HEADING ~ DEGREES
ALT
HDG
IAS
25:30
26:00
26:30
27:00



ABBREVIATED VERSION OF ATC TRANSCRIPT

0129:15	UA2860	YOU PUT US IN A HOLDING PATTERN AT SIX THOUSAND HERE ON THE VOR FOR A WHILE
0129:22	LC	UNITED TWENTY EIGHT SIXTY ROGER TURN RIGHT PROCEED DIRECT TO THE SALT LAKE VOR HOLD ON THE AT THE VOR MAINTAIN SIX THOUSAND
0129:33	UA2860	OKAY WE'LL HOLD AH NORTH OF THE VOR SIX THOUSAND AH (UNINTELLIGIBLE) RIGHT TURNS AH OKAY
0129:38	LC	THAT'S CORRECT NORTHWEST OF THE VOR AT SIX THOUSAND RIGHT TURNS
0129:42	UA2860	OKAY
0129:51	UA2860	OKAY NOW CAN WE GO AH LEAVE YOU FOR A LITTLE MINUTE WE WANNA CALL SAN FRANCISCO A MINUTE
0129:56	LC	UNITED TWENTY EIGHT SIXTY FREQUENCY CHANGE APPROVED
0129:59	UA2860	THANK YOU SIR WE'LL BE BACK
0137:28	UA2860	OH AH HELLO AH SALT LAKE UNITED TWENTY EIGHT SIXTY WE'RE BACK
0137:31	LC	UNITED TWENTY EIGHT SIXTY YOU'RE TOO CLOSE TO TERRAIN ON THE RIGHT SIDE FOR A TURN BACK TO THE VOR MAKE A LEFT TURN BACK TO THE VOR
0137:38	UA2860	SAY AGAIN
0137:39	LC	YOU'RE TOO CLOSE TO TERRAIN ON THE RIGHT SIDE FOR THE TURN MAKE A LEFT TURN BACK TO THE VOR
0137:44	UA2860	OKAY
0137:54	LC	UNITED TWENTY EIGHT SIXTY DO YOU HAVE AH LIGHT CONTACT WITH THE GROUND
0137:59	UA2860	NEGATIVE
0138:00	LC	OKAY CLIMB IMMEDIATELY TO MAINTAIN EIGHT THOUSAND
0138:07	LC	UNITED TWENTY EIGHT SIXTY CLIMB IMMEDIATELY MAINTAIN EIGHT THOUSAND
0138:11	UA2860	UNITED TWENTY EIGHT SIXTY IS OUT OF SIX FOR EIGHT


Layton
0137:15
MSAW SYSTEM ALERT
0137:33
0137:57
Kaysville
0137:23
0137:41
0138:07
FDR DATA
NAS STAGE A RADAR DATA
0136:46
UA 2860 Returns
to LC Frequency
0121:36
Leaves
uency
0130:02
0136:05
10 NAUTICAL MILES
331° RADIAL
360° RADIAL
Farmington
0 Requests
ncy Change
0123:00
0135:24
0131:22
MN
West Bountiful
0134:24
0124:42
Woods Cross
North Salt Lake
SLC
VOR
0132:22
0133:43
0125:42
0126:48

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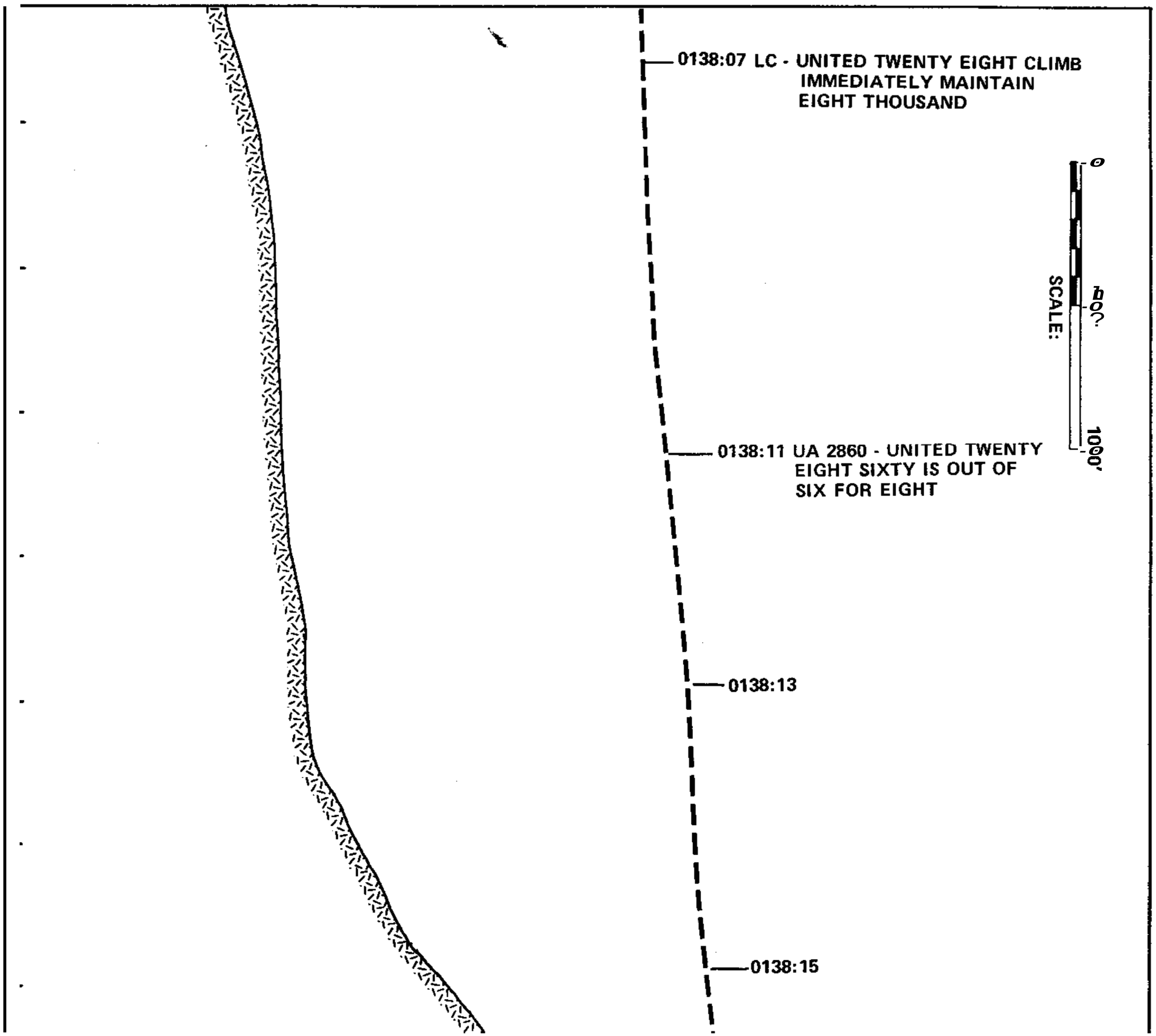
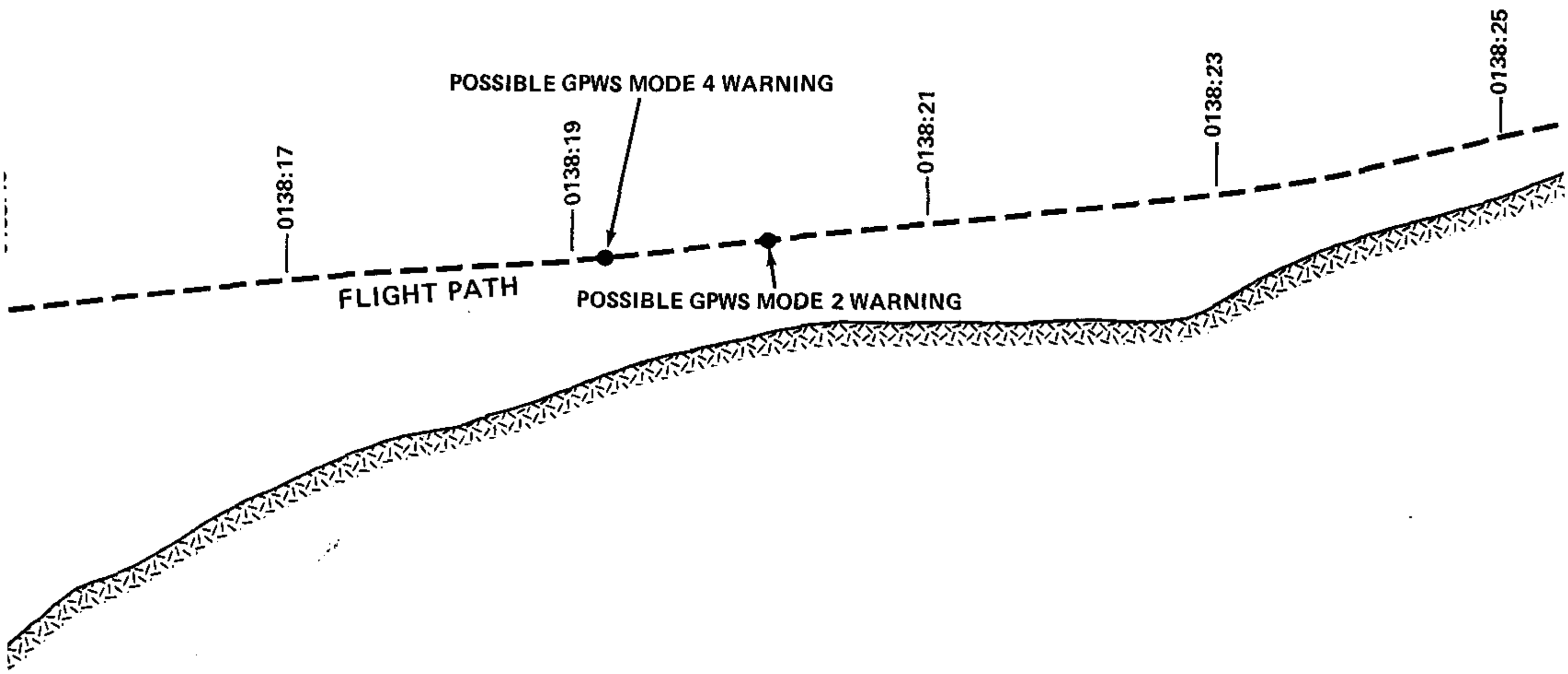
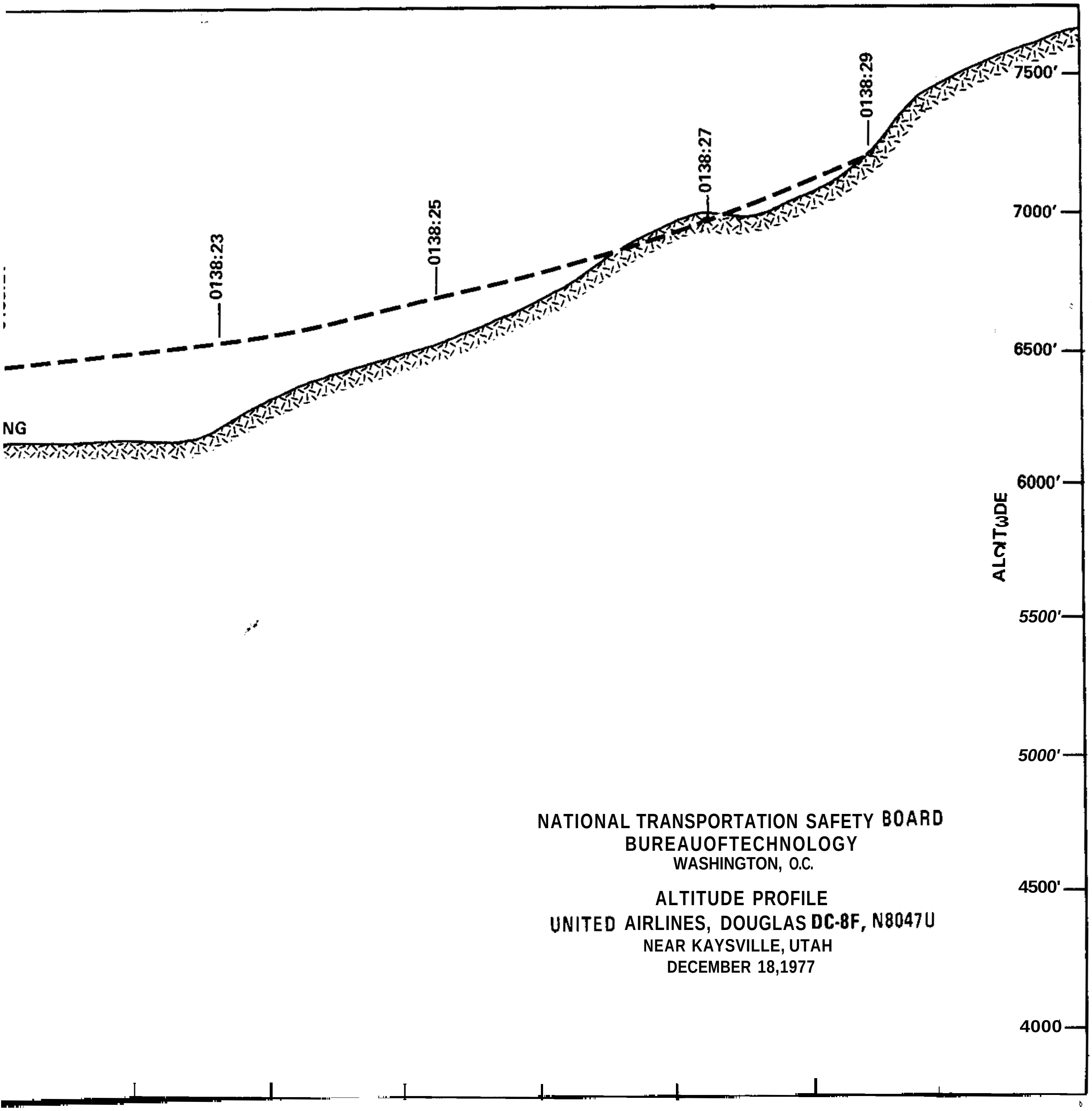



POSSIBLE GPWS MODE 4 WARNING
0138:17
0138:19
0138:21
0138:23
0138:25
FLIGHT PATH
POSSIBLE GPWS MODE 2 WARNING



NATIONAL TRANSPORTATION SAFETY BOARD
BUREAUOFTECHNOLOGY
WASHINGTON, O.C.

ALTITUDE PROFILE
UNITED AIRLINES, DOUGLAS DC-8F, N8047U
NEAR KAYSVILLE, UTAH
DECEMBER 18,1977