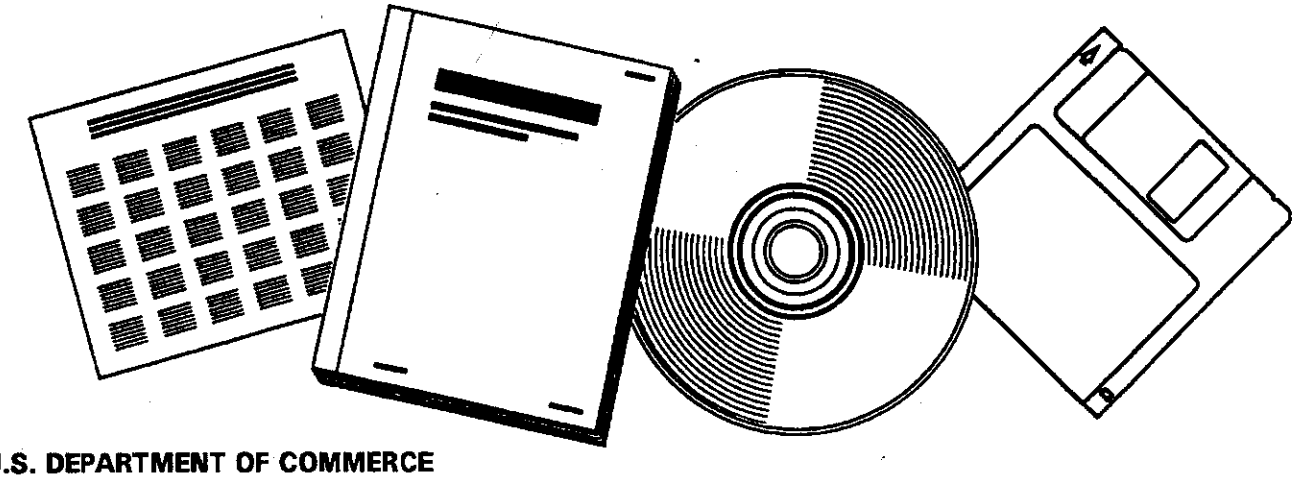
AIRCRAFT ACCIDENT REPORT. UNITED AIR LINES, INC. B-727, N7036U, IN LAKE MICHIGAN

NATIONAL TRANSPORTATION SAFETY BOARD,
WASHINGTON, D.C

16 AUG 1965



U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

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B-727, N7036U

In Lake Michigan

August 16, 1965

NATIONAL TRANSPORTATION SAFETY BOARD
DEPARTMENT OF TRANSPORTATION
WASHINGTON D.C. 20591

SA–None

File 1–0030

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Adopted: December 19, 1967

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TABLE OF CONTENTS

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SYNOPSIS

A United Air Lines, Inc., B-727-22, N7036U, Flight 389 crashed into Lake Michigan approximately 19.5 statute miles east of Lake Forest, Illinois, at approximately 2120 c.d.t., August 16, 1965. The 24 passengers and 6 crewmembers died in the crash and the aircraft was destroyed.

Flight 389, en route from LaGuardia Airport, New York to O'Hare International Airport, Chicago, Illinois, was descending from a cruising altitude of 35,000 feet to begin a landing approach when its radar target disappeared from the air traffic controller's radarscope. The weather at O'Hare at the time of the accident was: an estimated ceiling of 10,000 feet, visibility 7 miles. Ground witnesses observed a fire and explosion on the lake at approximately 2121. Search vessels discovered the first floating wreckage approximately five hours later.

The Board is unable to determine the reason for the aircraft not being leveled off at its assigned altitude of 6,000 feet.

1. INVESTIGATION

1.1 History of Flight

A United Air Lines, Inc., Boeing 727-22, N7036U, Flight 389 (UAL 389) was a regularly scheduled domestic passenger/cargo flight from LaGuardia Airport, New York to O'Hare International Airport, Chicago, Illinois. The aircraft had arrived at LaGuardia, on the date of the accident, following a trip from Los Angeles, California, with stops at Sacramento, California; Reno, Nevada; Denver, Colorado; and Chicago, Illinois. The flight crew of UAL 389 reported for duty at LaGuardia Airport one hour before scheduled departure where they prepared for the flight to Chicago. The stewardesses arrived with the aircraft from Chicago. Persons known to have been in contact with the crew prior to their departure from New York noticed nothing unusual about their behavior or appearance.

UAL 389 departed LaGuardia at 1952 [1/] on an Instrument Flight Rules (IFR) flight plan at FL 350 [2/] and estimated their arrival time at O'Hare to be 2127. The crew reported at FL 350 at 2011:35. At 2102 UAL 389 came under control of the Chicago Air Route Traffic Control Center (ARTCC) reporting its altitude as FL 350 and was cleared to the O'Hare Airport via Pullman VORTAC direct to the Northbrook VORTAC, direct O'Hare and to maintain FL 350. This clearance was acknowledged correctly and the crew was advised that radar contact had been established.

1/ All times herein are central daylight time based on the 24-hour clock unless otherwise indicated.

2/ Altitudes above 17,000 feet are expressed as flight levels (FL) and reported in three digits i.e., FL 180. Flight levels are derived from a reference datum of 29.92 inches of mercury set in the altimeter as a barometric setting.

At 2103 the ARTCC controller cleared UAL 389 to descend to FL 240 and to "start descent now through 31" (FL 310). UAL 389 replied ". . . down to 240, leaving three five." At 2106 UAL 389 was cleared to continue its descent to 14,000 feet and given an altimeter setting of 29.90 inches for O'Hare. This message was acknowledged immediately and in reply to the controller's inquiry the crew reported they were leaving FL 280 "now." At 2109 the flight was instructed to change frequencies and within the same minute reported out of FL 260 descending to fourteen thousand. This was the last altitude information received from the crew. At 2111 the flight was cleared to descend to 6,000 feet and the clearance was immediately acknowledged correctly. At 2118:35 control of the flight was passed to Chicago Approach Control (ORD). The radar target of UAL 389 was in the vicinity of the Sturgeon Intersection (intersection of the 011 radial of Chicago Heights and 076 radial of Northbrook VORTAC, 28 miles east of Northbrook VORTAC). At 2118:38 the target was observed approximately 2 miles east of the intersection. At 2119:36 the crew contacted ORD and was advised that radar contact had been established. At this time the aircraft target was 2-3 miles west of Sturgeon. UAL 389 was cleared to maintain 6,000 feet and to depart the Northbrook VORTAC on a heading of 240 degrees. The flight was advised that instrument landing system approaches were in progress on runway 14R at O'Hare and that the current O'Hare altimeter setting was 29.93. The pilot [3/] read back the altimeter setting incorrectly, the controller corrected him, and the pilot repeated

3/ The voice was identified as that of the captain.

it correctly. This was the last communication received from the flight and ended at 2120:03.

The USAF Air Defense Command radar system and the SAGE [4] computer were monitoring and recording certain high altitude tracks by position, [5] altitude, [6] time, [7] heading, [8] and ground speed. [9] The SAGE data were reviewed and showed two tracks in the area of concern at the time UAL 389 was approaching O'Hare. The first track, identified by the computer as track A039, began at 0157.8Z (2057:48) at a point approximately 17 nautical miles west of the Salem, Michigan VORTAC (83°58' West - 42°22' North) and was dropped by the computer at 87°10' West - 42°17' North at 0217.3Z (2117:24). The second track, identified as K047, was initiated at 0218.6Z (2118:36) at 87°23' West - 42°15' North, and dropped at 0222.8Z (2222:48) at 87°52' West - 42°15' North. There was no other high altitude traffic observed by ARTCC or SAGE in the area of concern at the time UAL 389 passed through it. The track over the ground, ground speed and positions observed by SAGE were compatible with the intended flight path of UAL 389, and within the normal operating envelope of the B-727. In addition to the tracking

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4/ Semi-automatic ground environment.

5/ Positions are recorded in latitude and longitude of an intersection which is the southwest corner of a rectangle measuring one nautical mile on a north-south axis and approximately .74 nautical mile on an east-west axis. The target may be located anywhere within this rectangle.

6/ While there are potential errors in the height finding data experience has shown they are to a great extent self-cancelling.

7/ Time is expressed in hours, minutes and tenths of minutes and expressed as Greenwich Mean Time (Z).

8/ "Heading" is actually the magnetic track being made good by the target.

9/ Ground speed is derived by continuously averaging the time vs. location plot.

information obtained by SAGE, two height finder readings were obtained. The first, at 0214.6Z (2114:36) indicated the target was at 16,500 feet m.s.l. The second, at 0219.9Z (2119:54) indicated the target was at an altitude of 2,000 feet m.s.l. This latter altitude was considered by the Air Defense Command to be accurate within outside limits of +500 or -1,000 feet (1,000-2,500 feet m.s.l.). During the time of this latter altitude reading the aircraft was in voice communication with approach control and had an altitude clearance limit of 6,000 feet m.s.l.

Several witnesses on ships and along the western shore of Lake Michigan observed a ball of fire near the surface of the lake. These witnesses placed the time of their observation at 2120. Other witnesses reported the same general sightings but the time of their observations varied from 2100 to after 2130.

The accident location was determined by plotting the center of the wreckage distribution pattern and determined to be at a point 29.6 statute miles east-northeast of O'Hare Airport in 250 feet of water. The surface of the water is approximately 576.8 feet m.s.l. The coordinates were 87°27' 56" West - 42°15' 2" North.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	6	24	0
Non-fatal	0	0	0
None	0	0	

1.3 Damage to Aircraft

The aircraft was destroyed.

1.4 Other Damage

None

1.5 Crew Information

An examination of the company and FAA airman records of the flight personnel aboard UAL Flight 389 was conducted and the following summary of B-727 flight and ground school information on each crewmember prepared.

Captain Melville W. Towle held an airline transport certificate #308952 with type ratings in the Douglas DC-3, DC-4, Vickers Viscount and Boeing 727 aircraft with commercial privileges in airplane multi-engine land. His first-class medical certificate was dated July 26, 1965, with no waivers noted.

Date of birth	9/11/22
Duty time since last rest period	Approx. 2 hours and 30 minutes
Date of employment (UAL)	2/12/46
Total pilot time	17,142 hours
Total pilot-in-command in Boeing 727 equip	59 hours
Total time flight training in Boeing 727 equip	22 hours & 39 minutes
Satisfactorily completed ground training on B-727	6/7/65
Unsatisfactory on type rating check on B-727	7/7/65
Satisfactorily passed type rating check on B-727	7/12/65
Satisfactorily passed en route check B-727	7/19/65
Satisfactorily passed en route check B-727	7/21/65

First Officer Roger Marshall Whitezell possessed airline transport certificate #1275469 with a type rating in Douglas DC-6/7 and commercial privileges in airplane single-engine and multi-engine land. His first-class medical certificate was dated November 13, 1964, with no waivers noted.

Date of birth	9/6/30
Duty time since last rest period	Approx. 2 hours and 30 minutes
Date of employment (UAL)	2/27/56
Total pilot time	8,466 hours
Total First Officer time on Boeing 727 equipment	363 hours
Satisfactorily completed ground training Boeing 727	10/21/64
Satisfactorily completed Boeing 727 transition flight training - pilot second in command	11/1/64
Satisfactorily passed First Officer en route check B-727	3/8/65
Satisfactorily passed First Officer en route check B-727	4/1/65
Satisfactorily passed First Officer proficiency check B-727.	4/7/65

Second Officer Maurice L. Femmer held a commerical pilot certificate #1367502 and flight engineer certificate #1599415. He had commerical privileges in airplane single-engine land and an instrument rating. His second-class medical certificate was dated September 18, 1964, with no waivers noted.

Date of birth	3/26/39
Duty time since last rest period	Approx. 2 hours and 30 minutes

Date of employment 4/6/64

Satisfactorily completed ground training Boeing 727 . . . . . .12/3/64

Satisfactorily passed Second Officer en route check B-727 . . . 4/19/65

Total Second Officer time on Boeing 727 equipment . . . . . 303 hours

Total flight time with UAL . . . . . 649 hours

Stewardess Phyllis M. Rickert

Date of birth 11/2/42

Date of seniority 11/25/64

Completed Boeing 727 training

Emergency 11/13/64

Procedural 11/13/64

Flight 4/5/65

Stewardess Sandra H. Fuhrer

Date of birth 11/1/44

Date of seniority 11/25/64

Completed Boeing 727 training

Emergency 11/13/64

Procedural 11/13/64

Flight 12/30/64

Date of last recurrent training 4/5/65

Stewardess Jeneal G. Beaver

Date of birth 12/10/44

Date of seniority 3/31/65

Completed Boeing 727 training

Emergency	3/26/65
Procedural	3/26/65
Flight	8/1/65

1.6 Aircraft Information

N7036U, a Boeing 727-22, serial number 18328 manufactured June 3, 1965, had accumulated a total of 611 hours [10] flying time when the accident occurred. A numbered maintenance check [11] was performed 125 hours before the accident and a service check [12] was completed 16 hours before the accident. An en route service inspection was conducted before takeoff from LaGuardia. During the en route inspection a check was made for lightning damage and the No. 1 tire was inspected to insure it was suitable for service. These items were checked because of verbal comments received from the deplaning crew. No lightning damage was found and the tire was found suitable for service.

There were no discrepancies written up in the log sheet by the inbound crew but there were three deferred discrepancies on the log. These involved an inoperative circuit breaker panel light, the passenger cabin air mixing valve, and reset button in the buffet. The inbound crew stated that aside from the deferred items there was nothing wrong with the aircraft. According to the aircraft logs and the inbound crew's statements the aircraft was airworthy at the time of departure from LaGuardia.

10/ All aircraft and pilot times are reported to the nearest whole hour.

11/ Inspections performed at no more than 525 hour intervals.

12/ Conducted every 125 hours.

A review of the aircraft records revealed a number of pilot writeups regarding the autopilot. In summation, the complaints were that the autopilot was trimming for pitch attitude, but the stabilizer did not trim to make a correction. The out-of-trim light on early B-727 aircraft had a delay relay which was set for two seconds, in the circuit. If the elevator held a pitch correction signal for more than two seconds, the out-of-trim light illuminated until the stabilizer corrected for trim. None of the writeups reflected any difficulty with control of the aircraft. A total of seven pitch channel assemblies were removed to answer these pilot complaints and five of them were bench checked and found to be satisfactory. The last writeup on the autopilot was cleared at Los Angeles on August 15, 1965 and no further entries regarding it were found in the aircraft records.

The aircraft was serviced with 2,443 gallons of aviation kerosene which gave it a total of approximately 4,950 gallons of fuel aboard before taxi-out. The total aircraft weight was 123,013 pounds and the c.g. was computed to be 26.2 percent MAC, within the limits specified for this operation.

The aircraft was equipped with three Pratt and Whitney JT8D-1 engines. Two of these engines were installed by the manufacturer of the aircraft and had 610 hours of operation. The No. 2 engine was installed July 5, 1965, and had operated a total of 344 hours. None of these engines had been overhauled.

All the airworthiness directives applicable to this aircraft had been complied with.

1.7 Meteorological Information

The 2200 surface weather chart prepared by the National Meteorological Center showed a quasi-stationary front extending southeastward across Lake Michigan from near Milwaukee, Wisconsin to near South Bend, Indiana.

The weather at O'Hare, reported at 2120, was an estimated ceiling of broken clouds at 10,000 feet, visibility seven miles, temperature 72°F, dew point 68°F, wind from 120 degrees at four knots, and the altimeter setting was 29.94 inches of mercury. At 2100 the Glenview Naval Air Station, Glenview, Illinois, reported the weather to be an estimated ceiling of broken clouds at 10,000 feet, visibility 10 miles, temperature 74°F, dew point 70°F, and a wind from 090° at 6 knots. Thunderstorms were observed by weather radar located at the Chicago Weather Bureau forecast center but none were in the area where the accident occurred. There is no evidence available to indicate that UAL 389 flew in any thunderstorms.

The 1834 Peoria radiosonde ascent showed that the air below 23,000 feet contained alternate layers of stable and conditionally unstable air which was relatively moist at all levels. The freezing level was near 14,000 feet m.s.l.

The crew of a B-707 was flying approximately 30 miles behind UAL 389 at FL 280 as they approached Lake Michigan. The captain of the B-707 stated that the descent over the lake was made on instruments from FL 280 until they descended to 8,000-10,000 feet where they broke out of the clouds 15-20 miles off shore. Light turbulence and areas of precipitation were encountered during the descent. The B-707 crew could see only the lights on shore when they broke out of the clouds and the captain stated that visibility was "fuzzy and unclear." The first officer said he could see the water clearly, it was hazy, and the lights on the shoreline were visible.

The terminal weather forecast for O'Hare for the period 2100-0300 called for 10,000 feet broken clouds visibility 4 miles in smoke.

The company dispatcher at LaGuardia stated that he provided no weather briefing to the captain of UAL 389, however, a self-help weather briefing board was available to the crew at LaGuardia and the dispatch representative at LaGuardia provided the crew with UAL forecasts, sequence weather reports from Service "A" circuits 8022 and 8025, copies of the John F. Kennedy, Dulles, and O'Hare forecasts, and a copy of the 1700 jet winds. 13/

The accident occurred in dark, hazy, VFR conditions.

1.8 Aids to Navigation

There were no reported discrepancies to any aids to navigation in use at the time of the accident.

1.9 Communications

The aircraft was in radio contact with Chicago Air Traffic Controllers with no reported discrepancies.

1.10 Aerodrome and Ground Facilities

Not involved in this accident.

1.11 Flight Recorder

N7036U was equipped with a Fairchild Waste King Model 5424 flight data recorder S/N 1740 installed July 17, 1965. Service Bulletin No. 159 requiring the installation of protective plates to prevent damage to the recording medium in the event of an accident, had been accomplished. The top and side cover,

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13/ The dispatcher for this flight was physically located in Chicago and had a delegated representative who signed the clearance in the dispatcher's name and provided service to the crew on the dispatcher's behalf.

recovered as one piece, and the rear cover of the recorder were the only portions recovered. None of the recording medium, an Inconel (stainless steel with high nickel content) tape has been recovered. The two portions of the recorder case were recovered in two locations within the main wreckage area.

1.12 Wreckage

The main wreckage area was located on September 2, 1965, and the center plotted as 87°27' 56" West - 42°15' 02" North. Several thousand pounds of floating material were recovered from the lake in the three days following the accident but little else until the discovery of the main wreckage area. Recovery operations were discontinued December 21, 1965, with approximately 82 percent of the wreckage by weight, and all occupants of the aircraft recovered.

Search and recovery operations were resumed June 17, 1966, and terminated September 25, 1966. Particular emphasis was given to the recovery of the flight recorder, the flight recorder tape, and the missing portions of the No. 3 engine. No flight recorder parts or tape were recovered during this search. One small piece of an engine case was recovered with a small section of flange mounting and case splice attached. Approximately 1,500 pounds of additional wreckage was recovered, consisting mostly of wing skin and small fuselage parts.

Included in the floating wreckage recovered in the first three days were honeycomb material from the outboard ailerons, trailing edge flaps, and spoilers, portions of the fiberglass tail cone, passenger seats, and seat cushions. The wreckage recovered from the lake bottom included the main portion of the empennage, the landing gears, portions of all entrance doors, three of

the four emergency exit windows, portions of the engine cowls of all three engines, portions of the fuselage from the radome to the empennage, and portions of both wings with parts of their attached components including both wing tips. All or part of all major components including control surfaces were recovered.

Following recovery of the Nos. 1 and 2 engines and portions of No. 3, the engines were disassembled and inspected. Both Nos. 1 and 2 were relatively intact but badly damaged although the damage to No. 1 was less severe.

Examination of the No. 1 engine revealed that there were no signs of operational distress or overtemperature operation. The bearings and lubrication system showed no evidence of preimpact failure or inadequate lubrication. The turbine section had evidence of rotational rubbing on both rotating and fixed components. The front compressor drive shaft was intact and had no perceptible twisting. However, there was a measurable runout [14/] of the shaft which varied from .003 inch at the No. 4 1/2 bearing location to 1.295 inches forward of the splines. A number of compressor blades on the front and rear compressors were bent opposite the direction of rotation and there was damage on the leading edges of many compressor blades and trailing edges of many stator vanes. Damage to the trailing edge of the stator vanes was in the direction of rotation. There was no evidence of operational distress in the combustion chambers or combustion chamber inner cases. The first stage nozzle guide vanes showed little evidence of foreign object damage but there were light aluminum splatters on the vanes. The fuel manifold was pressure checked and exhibited no evidence of fuel leaks. The clamshell doors were just out of the "open," forward thrust position.

14/ Runout is measurable bending of the shaft along its longitudinal axis.

The No. 2 engine was recovered with the fan section and the first two compressor stages separated from the rest of the engine. The front accessory drive was not recovered. The recovered compressor blades of these stages were bent opposite the direction of rotation and the stators were bent and damaged in the direction of rotation. The majority of the compressor blades in the remainder of the front compressor, through the sixth stage, were bent opposite to rotation and the stators bent in the direction of rotation. There was no evidence of inadequate lubrication found in the engine. There was damage to the seventh through the twelfth stage stators on the trailing edges, in the direction of rotation. There was foreign object damage to the leading and trailing edges of the thirteenth stage stators. The compressor blades of the rear compressor were bent opposite rotation and showed some tip rub damage. There was no evidence of heat distortion or uncontrolled burning in the combustion chamber assemblies. There was no evidence of overtemperature in the nozzle guide vanes. The front compressor turbine drive shaft was separated at a point 53.5 inches from the forward face of the second stage turbine disk mounting flange. The break spiralled at an approximate 45-degree angle to the longitudinal axis of the shaft. The shaft was bent forward of the No. 4 1/2 bearing. The first three turbine stages showed minor rotational damage. There was no evidence of operational distress in the turbine section.

The fan inlet case assembly of the No. 3 engine inlet guide vanes remaining in the case were bent in the direction of rotation and six of them were broken on the hub end. The front compressor front hub and blade assembly was recovered with most of the blades attached. The blades were twisted and bent opposite the direction of rotation. There was no evidence of operational distress on the hub. The recovered stator vanes of the first stage were bent opposite the direction

of rotation and separated from the inner support. Approximately 50 percent of the second stage compressor blades of the front compressor were bent opposite to the direction of rotation. The remainder of the blades were bent aft. The third stage compressor disk was recovered separately with three compressor blades attached. These blades were bent 20-30 degrees in a direction opposite to rotation. The face of the disk was severely rubbed.

The recovered fuel boost pumps, valves, and fuel system components showed no evidence of malfunction or operational distress. There was no evidence of fire or overpressure in the fuel system plumbing except the sooting of two pieces. One was a section of fuel dump tubing and a connector assembly with sections of tubing attached. In the fuel dump tubing, sooting was seen over deformed areas, and in the connector, an area of deformed tubing pulled away from the inside diameter of the connector was not sooted, leaving a clearly defined line corresponding to the area that is normally under the connector. Approximately 75 sections and fragments of other fuel system tubing and tank structure were recovered and exhibited no evidence of fire, explosion, or electrical arcing.

The Nos. 2 and 3 thrust reverser clam shell doors were in the "open" (forward thrust positions), and the Nos. 2 and 3 reverser lockout actuators were in the locked position. The directional control valve rocker arm of the No. 1 engine was bent outboard and broken off. The thrust reverser followup cam was free and the directional control valve could be operated manually. The thrust reverser control cam was in a position to have either the cam roller or the directional valve control in the reverse position. When the broken sections of the control arm were matched, the control valve was in the reverse thrust position.

Several pieces of air distribution and air conditioning ducting were recovered. This ducting was installed overhead in the fuselage area. There was no soot or fire damage on these pieces of ducting. Both engine bleed air valves were found in the open position. The components which make up the cabin pressure control were recovered. The rate of climb indicator was intact in the panel but the pointer was detached from the shaft. The differential pressure gauge was intact. The cabin altitude pointer was on 30,000 feet and the cabin differential pointer was set at approximately 6.3 psi. The automatic cabin controller was recovered intact with the cabin altitude pointer on 1,000 feet. The rate selector knob was turned to "decrease" and the barometric setting in the window was 29.29. The setting of the flight altitude and maximum differential in the window was between 24,000-25,000 feet. The manual cabin pressure control pointer was in the center of the automatic range. Only the top covers of the two outflow valves were recovered.

The automatic pilot control panel was recovered with the mode selector switch in manual, the integrated command knob slightly left of center in the turn mode and neutral in the pitch mode, the aileron and elevator engage switches in a mid-position between "engage" and "disengage," and the altitude hold switch "off."

The automatic pilot stabilizer trim servo assembly was tested and no discrepancies were found. The left and right elevator position and trim sensors were bench-checked and found to be 0.6° and 3.4° off zero, respectively.

The No. 1 VHF communications receiver and control selector were found tuned to 129.35 mcs., an ARINC (company radio) frequency for Chicago. The No. 2 VHF communication control selector was found set at 119.0 mcs., the frequency of the O'Hare Approach Control on which the flight had been communicating. The No. 2 receiver was not recovered.

The recovered wiring of the essential electrical power panel had no evidence of overheating, arcing, or burning. Examination of the three main engine generator feed cables and the male portions of the Nos. 1 and 3 generator connectors revealed no evidence of arcing, overheating, sooting, or burning. The generator control panel switches were set for normal operation. The essential power switch was set for the No. 3 engine, normal for UAL, and the No. 3 engine bus tie relay was in the "closed" (normal) position. The two constant speed drive units recovered from the Nos. 2 and 3 engines were found in the connected position. The electrical actuator for tail skid positioning was extended approximately 3 inches which corresponds to the skid retracted position.

Examination of the flight control systems showed the aileron components were damaged with the aileron centering mechanism in neutral (centered). The aileron power control unit and linkage were intact, although broken away from the structure. The mechanical linkage was in a 5 degree left aileron down position. The power unit was separated from the mechanical unit and the broken ends of the cable strands were necked down in the area of separation. The aileron trim indicator cable drum

was in the neutral position. The elevator centering spring assembly was in the center position and could be moved to contact both stops. While the elevator control linkage was damaged, there was no evidence of pre-impact distress or failure. The elevator feel computer and feel control units were functionally tested and met all test requirements. The horizontal stabilizer jackscrew was examined and the "B" dimension between the stops measured at 5-3/4 inches. This is equivalent to 0.5 units of aircraft nose up trim. The stabilizer trim brake assembly was recovered but the drive sprocket, brake release arm and mounting flanges were not recovered. The left hand stabilizer brake stop pawl and attached spring cartridge were found in an overcenter position against the case. This pawl is designed to stop stabilizer movement in the aircraft nose up direction. In this position the pawl was beyond the designed limit of its travel and could not function as a brake or stop device. The stabilizer trim brake system is actuated by operation of either pilot's control column to stop stabilizer out-of-trim motion. Should a runaway stabilizer cause a pitch in an unwanted direction, moving either pilot's control column in the opposite direction will stop the stabilizer from further movement in the out-of-trim direction, but will permit movement in the opposite direction. A measurement was taken of the control stand stabilizer trim jack assembly and 1.7 inches existed between the trunion and the nut assembly. This is equivalent to 1.25 units aircraft nose down. The hydraulic power units of the ailerons, rudder and elevators were recovered and tested. The aileron power control unit passed the functional

test. During the testing of the upper rudder power units it was determined that the linear position transducer slide was not free to move resulting in an over-tolerance of the phase log test. No other discrepancies were noted. Testing of the elevator power control units showed no discrepancies except that the transducer output voltage was low and the autopilot override velocity timing was slow.

Testing of the ten flight spoiler actuators revealed that the Nos. 4 and 5 and Nos. 10 and 11 units did not pass a cold soak test. Further, the internal piston of the No. 10 actuator was broken and when power was applied the actuator went to the extended position.

The leading edge slat selector valve was recovered with the slide assembly in the retracted position and the No. 3 left hand slat actuating cylinder was found with the piston rod locked in the retract position.

The electrical stabilizer trim actuator was tested to stall torque specifications of 600-650 inch pounds in clockwise and counter clockwise directions. The unit stalled at 480 inch pounds clockwise and 456 inch pounds counter clockwise. Both the main stabilizer and autopilot cruise trim switches were found in the "on" position.

Two attitude indicators were recovered. One showed evidence of a 74-degree right bank and the other of 53-degree left bank. The second indicator showed a pitch attitude of approximately 5 degrees nose up. A master heading indicator was recovered and displayed a heading of 260 degrees on a test stand with a selected course of 251 degrees. Both automatic direction finding receivers were recovered. One was found set at approximately 390 kcs. and the other at approximately 780 kcs. The mode selector was in the loop position.

A VHF navigational receiver was recovered set at 113.0 mcs., the frequency of the Northbrook VORTAC north of O'Hare Airport.

The first officer's altimeter was recovered with a barometric setting between 29.91 and 29.92. There are two three-pointer type altimeters installed in the cockpit, one on each pilot's instrument panel. These altimeters have three concentrically mounted pointers, coded in length and shape. The long pointer indicates 100's of feet, the short, stubby, roughly diamond-shaped pointer indicates 1,000's of feet, and the shortest pointer, with a short cross bar, indicates 10,000's of feet. The 100's pointer makes one complete revolution per 1,000 feet of altitude change; the 1,000's pointer makes one complete revolution per 10,000 feet of altitude change, and the 10,000's pointer makes one complete revolution per 100,000 feet of altitude change. The 10,000 feet pointer is painted on a rotating plate which has a slot cut around part of its circumference and a wedge-shaped cutout on the face of the plate approximately 90 degrees to the left of the pointer. The two cutouts are arranged so that at zero elevation the wedge exposes a black and white hash marked area and the circumferential cutout exposes a black background on the instrument face. As the altimeter is taken to higher altitudes the plate rotates clockwise gradually exposing a white arc to the left of the 10,000 feet pointer and gradually covering up the hash mark area. At an altitude of approximately 16,000 feet the hash mark area is completely covered and the white arc is exposed to a point approximately halfway between the Nos. 1 and 2 on the face of the altimeter. As the altimeter is taken further up in altitude more of the white arc is exposed. As the aircraft descends the situation is reversed and the white arc is gradually covered up and at approximately 16,000 feet the hash marked area is again brought into view. For examples of altimeter presentations see Attachment #2.

The two altimeters are served by separate static sources and there is no way in which the information on one altimeter can be displayed on the other. Any error that occurs in one system cannot be displayed on the other instrument thus providing a continuing cross-check capability for the crew. A review of the aircraft records revealed no history of altimeter malfunctions or problems.

1.13 Fire

A majority of the witnesses reported an explosion and fire on or just above the horizon over Lake Michigan. Those witnesses nearest the accident, on ships in the area, reported the time of the explosion at about 2120. Several pieces of floating wreckage were recovered which exhibited smoke and soot discoloration particularly on the broken edges. While there was a fire and explosion on impact with the water, there is no evidence of a fire in flight.

Both engine fire extinguisher bottles were recovered with the discharge discs intact. Three fire extinguishers installed in the cockpit and cabin were recovered. The charging cartridge in a water type extinguisher was not discharged. A dry chemical extinguisher was still charged and a functional test revealed that it operated properly. A CO_2 extinguisher was recovered in a damaged condition and could not be discharged.

1.14 Survival Aspects

This was a non-survivable accident. Pathological and toxicological examinations of the flight crew revealed no evidence of pre-impact incapacitation nor was there any evidence of foul play.

A special investigation was conducted at New York to review the pre-takeoff activities of the crew and passengers and the activities of the ground servicing personnel. No evidence was discovered which could be related to this accident.

1.15 Tests and Research

As a part of this and other B-727 investigations a special study group reviewed the flight characteristics and applicable aerodynamic data of the B-727. 15/ One of the areas of investigation of this study was an evaluation of the pilots response to the question "have you ever experienced altimeter lag or sticking, particularly after descent from high altitude, at high rate, with aircraft cold soaked and entering weather conditions of high moisture content at the lower altitudes." The affirmative comments on altimeter sticking or jumping which were received in reply to this question were associated with altitudes above 20,000 feet. None of the pilots questioned reported any difficulty with erroneous altimeter readings at altitudes below 20,000 feet.

This group also reviewed the pilot training program with regard to information disseminated to the flight crews regarding the flight characteristics of the aircraft. The results of this study disclosed no evidence of any design or performance deficiency and pilots were generally pleased with the flight characteristics of the aircraft and they had experienced no major difficulties in the operation of the aircraft. All of the air carrier training and operations manuals reviewed stressed the fact that high rates of descent close to the surface of the earth should be avoided.

15/ Exhibit No. 12-A, SA-387, AAL B-727 accident near Constance, Kentucky, November 8, 1965.

In addition to the above study, a review of Mechanical Reliability Reports on the B-727 was conducted to determine if there was any discernible trend in reports of static system problems or instrument problems traceable to the static system. No history of static systems or instrument problems was found.

Because of the failure of some of the speed brake actuators to pass a post-accident cold soak test, the history of spoiler malfunctions in the B-727 fleet was reviewed. It was found that when spoilers malfunctioned and the actuators would not pass a cold soak test, the problem appeared as a failure of some of the spoilers to extend when the speed brakes were selected to the extended position. This failure to extend resulted in unwanted rolling of the aircraft but was found to be controllable by the pilots. It was also noted that this problem only appeared at the high altitudes and was not reported at lower levels where an unwanted roll might be more hazardous.

As a part of this investigation a review of research on altimeter reading problems was conducted. There are some fifty studies relating to the various altimeter systems of presenting information to pilots which have been conducted since 1947. One of the most recent studies completed by the Naval Research Laboratory, Washington, D. C. [16/] was conducted to determine the relative effectiveness of various altimeter displays. These investigations, consisted of laboratory research at NRL and flight test at a nearby naval air facility, were in support of a Department of Defense program. Four types of altimeter presentations, the counter-pointer (CP), counter-drum-pointer (CDP), drum-pointer (DP) and three pointer (3P) were compared in a series of laboratory

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16/ NRL Report 6242, Altimeter Display Evaluation, Final Report, Jan. 26, 1965.

experiments measuring reading time and accuracy with both pilots and non-flying enlisted men. The same instruments were also compared by the pilots in flight, using the questionnaire technique to elicit pilot judgments. The results of the various phases of laboratory research showed that the three-pointer altimeter consistently ranked poorest. The pilot preference in the flight tests was overwhelmingly in favor of one of the other types of altimeter. In all objective measurements taken, the three-pointer altimeter ranked the poorest among the instruments tested. The finding that the three-pointer was poorest proved to be statistically reliable in every study in which tests of statistical significance were applied. In a preceding part of this study [17] the mean exposure time and number of errors on each altimeter was recorded for the two test groups, one consisting of pilots, and the other of non-pilot enlisted men. In 1080 readings of the four altimeters by 18 pilots the mean exposure time in seconds was 0.80 for the CP, 0.84 for the CDP, 1.38 for the DP, and 2.28 for the 3P. The number of reading errors was 7 for the CP, 14 for the CDP, 26 for the DP, and 80 for the 3P. The same data collected during 420 reading trials using 7 non-pilot enlisted men resulted in mean exposure times of 0.85 for the CP, 0.86 for the CDP, 1.50 for the DP, and 2.93 for the 3P. The number of errors by this group were 5 for the CP, 2 for the CDP, 10 for the DP, and 52 for the 3P. The mean number of errors made on each altimeter for pilots was 0.39 CP, 0.78 CDP, 1.44 DP, and 4.44 3P, and for enlisted men 0.71 CP, 0.29 CDP, 1.43 DP, and 7.43 3P.

17/ NRL Report 6232, An Experimental Evaluation of Four Types of Altimeters Using Both Pilot and Enlisted Men subject, December 18, 1964.

2. ANALYSIS AND CONCLUSIONS

2.1 Analysis

A review of the available evidence has eliminated all causal areas other than those involving the operation of the aircraft. No evidence was found that would indicate other than normal operation of the powerplants and systems at the time of impact. There is no evidence that will support a finding of sabotage, flight crew incapacitation, or any malfunction of the aircraft.

There is no indication that the weather played any part in this accident. The weather observed and reported by the U. S. Weather Bureau and the crew of the B-707 aircraft that was operating behind UAL 389 revealed that the weather was suitable for this type of operation. The only possible problem the weather may have presented was limited visibility, but there is no evidence to indicate that after descending through the clouds, the flight was required to operate in less than VFR weather conditions. Light airframe icing could have occurred in the descent down to about 13,000 feet however, this should have had no effect on the safe operation of the flight. The thunderstorm activity in the area was all to the north of the aircraft's flightpath and there is no indication of other than light turbulence during the latter part of the flight.

The damage to the structure indicated the aircraft struck the water slightly nose up, with a slight right-wing-down attitude. The breakup of the fuselage and wings was extensive with the area below the cabin floor fragmented, and little of this area was recovered. The wreckage pattern indicates the aircraft struck the water on a heading of approximately 256

degrees magnetic, and the slight right-wing-down attitude caused the wing to dig in and rotate the aircraft to the right as it broke up. Damage to the right wing was more extensive than to the left and the leading edge devices received considerable damage, much more so than the leading edge devices on the left wing. The fractures on the horizontal stabilizers had a downward component indicating forces which overloaded the spars, resulting in a complete failure. All the fractures examined were caused by gross overloads and there was no evidence of pre-impact damage or fatigue.

The aircraft's mass, the rate of descent of the aircraft, and the hydraulic action of the water caused the destruction of the lower portion of the fuselage and started the failure of the No. 2 engine mounts. Immediately after the initial impact the forward lower section of the airframe and the lower wing surfaces struck the water. The amount of destruction to the airframe indicated a high rate of speed. The distortion of the engine tubing attached to the No. 3 engine strut attests to the fact that the engine separated from the strut in a forward and downward direction. The location of the recovered components of this engine indicates separation of the engine at the time of initial impact or immediately thereafter. The separation of the engine this early in the accident sequence explains its severe disintegration.

The separation of the No. 1 engine was in an outward and rearward direction based on fracture examination and the engine's location in the wreckage area. It did not separate at initial impact but rather after the aircraft started to rotate to the right.

Portions of all the control surfaces and trim tabs were in the recovered wreckage. There was no evidence of unusual wear, distress, or pre-impact malfunction in any of the control system components recovered.

There was no evidence of an inflight fire or explosion. Only a few small pieces of wreckage were recovered with soot or smoke discoloration. This condition was caused by exposure to burning fuel on the water after impact.

The aircraft was in a clean flight configuration with the landing gear, trailing edge flaps, leading edge devices, and the speed brakes retracted, and all structural components were capable of normal operation prior to impact with the water.

The No. 1 engine was the least severely damaged of the three installed. While the bending of compressor and turbine blades opposite the direction of rotation indicates that the engine was rotating at impact with the water, the condition of the compressor turbine drive shaft, with no noticeable twisting, indicates that deceleration rate was lower than that of the other two engines. The bending of the shaft indicates that there was a considerable side load imposed on the engine when it struck the water. There was no evidence of any lubrication deficiency or bearing operational distress that would have impeded normal engine rotation. There was no evidence of any pre-impact failure, overtemperature operation, or structural failure of this engine before impact.

The No. 2 engine was rotating at a higher speed than No. 1 when No. 2 struck the water. This is evidenced by the more severe bending of the compressor and turbine blades in a direction opposite to rotation as well as the twisting fractures of the two compressor drive shafts. There is no evidence of structural failure of the basic engine components prior to impact with the water, nor is there any evidence of lubrication or bearing distress. There is no evidence of an overtemperature condition existing in the engine prior to the accident.

Examination of the fragments of the No. 3 engine that were recovered indicates that the engine was rotating at the time of impact. While there is a possibility of an inflight catastrophic problem with this engine, there is no evidence such as fire damage or shrapnel damage to the recovered portions of the engine cowling to support this possibility. Catastrophic engine failures ordinarily make themselves known through fire damage and puncture damage to the surrounding structure and the engine cowling. Also, the crew was conducting a radio conversation with approach control until just before the accident and gave no indication that any problem existed with the aircraft or any of its systems.

Examination of the fuel boost pumps revealed no evidence of fire, overheating or other operational distress. The fuel valves were found in the positions prescribed by the carrier for normal flight operation. One piece of the recovered fuel system evidenced some soot or smoke damage but the rest of the system was free of any evidence of fire. This sooting was probably the result of the explosion that occurred on impact.

The thrust reversers were found to have been in the forward thrust, normal flight position, at impact. While the No. 1 thrust reverser doors were slightly out of the forward thrust position when recovered, this was judged to have been the result of impact damage.

There is no evidence on which we can base a finding of engine failure before impact. All three engines were operating when the aircraft struck the water. Based on the relative damage to the compressor blades of the Nos. 2 and 3 engines they were operating at a higher rotational velocity than No. 1. This further supports the theory that the aircraft was right-wing-down at initial

impact and the RPM of the No. 1 engine had time to be reduced more than the other two engines before No. 1 hit the water. The fuel system valve positions indicate that no intentional shutdown of any engine was initiated by the crew. Finally, there is no evidence of intentional or inadvertent thrust reversal in flight.

The recovered air conditioning ducting revealed no evidence of fire or smoke. The pressurization switch and valve positions were those established for normal operation and both bleed air valves were open. In the event of fire, the checklist requires these valves be closed, as is also required in the event of a pressurization emergency.

While there had been a history of autopilot writeups, the discrepancies were not of such a nature as to affect the control of the aircraft, but were rather a nuisance to flight crews. The only effect this problem would exhibit to the crew would have been a stabilizer out-of-trim light being "On".

There was no evidence found to indicate any pre-existing malfunction or problem with the electrical system. The only burn damage found on wire insulation is attributed to the flash fire which occurred after impact. There was no evidence of overheating, arcing, or any unusual appearance resulting from a malfunction of the electrical system. The generator control switches were recovered set in the positions prescribed by the carrier for normal flight operation.

The only discrepancy found in the flight control system that could not be attributed solely to impact damage was the condition of the stabilizer brake pawl. The position in which it was found made it useless as a brake device. This pawl is designed to prevent unwanted aircraft nose up movement

of the stabilizer. Because the pawl is located in such a position as to be protected from damage during impact a possibility exists that the crew actuated the pawl to stop an unwanted nose up maneuver of the aircraft. It is also possible that the crew initiated an aircraft nose up maneuver just prior to impact and that impact forces caused a subsequent movement of the control column that activated the stabilizer brake and displaced the pawl. However, the position of the stabilizer jack screw in a 0.5 unit aircraft nose up at impact would indicate the pawl position was probably the result of impact. The low torque of the stabilizer trim actuator and the failure of the four flight spoilers to pass a cold soak test are not considered to be in causal relationship to this accident. The worst possible result of this situation would be one or more spoilers failing to extend when selected to the extended position. This would cause an unexpected and unwanted roll condition. However, the evidence indicates that the spoilers were in the down or retracted position at impact and thus an unwanted roll probably was not a problem to the crew. Furthermore, the review of pilot reports of spoiler difficulties indicated they were a high altitude phenomena. The crew of this flight indicated no concern in their last radio contact with the approach controller and were within 15 seconds of impact at the time of the last transmission. The crew had already descended below their assigned altitude of 6,000 feet and the accident was about to occur. Lastly, the evidence indicates the aircraft initially struck the water in a normal descent attitude.

Examination of the recovered components of the hydraulic system reveal no evidence of pre-impact malfunction. The four anti-icing valves were recovered in the closed position which indicates the anti-icing system was "off" at impact. One pilot's directional indicator showed that the course selected,

251 degrees, and the heading of 260 degrees, were in consonance with the inbound course of 254 and the wreckage distribution direction of 270 degrees.

All the recovered VHF navigation and communications equipment was tuned for an approach to O'Hare and for communications with Approach Control. The air data computer provided only one piece of meaningful data, an indicated air speed of 200-210 knots. This reading was at the time of electrical power failure sometime after the initial impact with the water. The recovered altimeter had approximately the proper barometric setting for O'Hare Airport. It is noted however that this setting is also approximately the setting which should have been used in cruising flight, 29.92. Furthermore, all altimeter settings given the crew were within one or two hundreths of the 29.92 setting and it is possible the crew did not reset the altimeter because the maximum difference in indicated altitude would be approximately 30 feet which would not be significant during a VFR approach and landing, particularly with an ILS glide slope available for the approach.

The investigation of medical records, pathological findings, and toxicological results revealed nothing indicative of pre-existing disease or inflight incapacitation of any flight crewmember. Further, a study of associated psychophysiological factors such as recent schedules, recent psychological environment, and miscellaneous background data led to the conclusion that no physical or emotional impairment existed in the cases of any of the flight crewmembers when the aircraft departed New York.

The evidence indicates that the flight from New York to the point where the descent was initiated was normal and routine without any reported discrepancies or difficulties. A review of the air traffic control transcriptions

reveals no evidence of any irregularities or signs of unusual operation on the part of the crew. The record also indicates that there was no known or observed traffic that conflicted with UAL 389 during the period of its observation on radar inbound from the Pullman VORTAC. Additionally there were no components of another aircraft in the recovered wreckage nor were any aircraft reported missing in the accident area.

The flight's first descent clearance was issued at 2103 and called for an immediate descent through FL 310. Based on the shipboard witness testimony the impact measured to the last whole minute was at 2120. The pilot reported leaving 35,000 feet at 2103 and leaving 28,000 feet at 2108. At 2109 he reported leaving 26,000. At 2114:36 the SAGE computer reported track number A 039 to be at an altitude of approximately 16,500 feet, and finally at 2119:54 SAGE reported track K 047 to be at approximately 2,000 feet. At the time this latter altitude was recorded the flight was holding a clearance which limited its descent to 6,000 feet. Furthermore, the crew was in radio contact with the approach controller at this time in routine radio transmissions relating to their approach to the Chicago area. Included in this last transmission was a reference to the latest altimeter setting. Track K 047 is assessed as being associated with UAL 389 because there was no other known or observed radar traffic in the area where the track appeared plus its correlation with track A 039 which in turn can be associated with UAL 389 by comparison of the ARTCC controller's recollection of the flight path and positions of UAL 389 over known fixes. Again there was no other known or observed high altitude traffic that could have appeared in the computer as this track except UAL 389.

A study of the calculated flightpath of the aircraft using these points reveals that the flightpath was well within the normal operating parameters of a B-727 making a clean descent when operated in conformance with UAL's operating procedures and techniques. The resultant flight profile (See Attachment No. 1), shows an average rate of descent from 35,000 feet to the lake level of approximately 2,000 feet per minute. UAL 389 was cleared from cruising flight at 350 to several lower altitudes; however, these clearances were given in a manner which precluded the necessity of leveling the aircraft and holding any one altitude for a period of time. The descent was continuous and the pointers on the altimeters would have been in continuous motion, making them more susceptible to misreading. Upon breaking out of the clouds between 8,000-10,000 feet, the crew's attention would have been divided between their routine duties preparing for an approach and landing, and maintaining a lookout for other traffic.

Additional calculations were performed based on the flight's reports and the controller's recollection of its location at various times. Based on the extremes of their recollection the ground speed of the flight in the Sturgeon area would have been between 240-300 knots. Using 240 knots a straight line descent from 2,000 feet m.s.l. would have resulted in an impact with the water at 2120:38. If the speed were calculated to be 270 knots the impact would have been at 2120:27 and 2120:14 for 300 knots. All of these performances are well within the operating envelope of the aircraft.

If we assume the flight leveled off at 6,000 feet as their clearance required, and were at 6,000 at the time of their last radio communication with the approach controller, in order to proceed four miles at a speed of 240 knots

and strike the water at 2120:38, the aircraft would have to average a descent rate of 9,430 feet per minute, and arrest it so as to strike the water in a nearly level attitude. This calculation does not include any time allowance for initiation or recovery from this steep descent attitude. This was determined to be well outside the operating capabilities of the aircraft. Using the higher speeds and earlier impact times the rate of descent would go up to 15,000 and 30,000 feet per minute while covering ground commensurate with the aircraft's velocity. Therefore, it is determined that the aircraft was below 6,000 feet while conducting the last radio transmission with approach control.

The statements of the traffic controllers and a review of the SAGE readout indicate that the aircraft was decelerating as it approached the Sturgeon Intersection. This action is in accord with the speed restrictions on operating turbojet aircraft in a terminal area.

The statement of the flight crew operating three minutes behind UAL 389 indicated that the base of the broken cloud deck was approximately 8,000-10,000 feet m.s.l., and they could see the lights on shore from about 15 miles off shore. They also stated that there was haze in the area and visibility was fuzzy and unclear. UAL 389 was descending into an area of high traffic density and the crew may well have directed their attention to looking for other aircraft after breaking out of the clouds, rather than descending by use of their flight instruments. Although these considerations may have taken a majority of the crew's attention outside the cockpit no reasonable explanation for their failure to level the aircraft at 6,000 feet, their assigned altitude, can be offered. This is particularly true when one

considers the fact that the last communication from the flight which ended at 2120:03 made reference to the altimeter setting.

There has been no evidence recovered to date which will substantiate any pre-impact difficulties with the aircraft. The crew was in radio contact with approach control at a point in time that was about 3-4 miles, or about one minute away from the accident site, and reported no difficulties. There has been no evidence recovered that will substantiate a finding regarding a malfunction of the altimeters. In fact, the SAGE altitude data correlates favorably with the aircraft's reported altitude when such correlation is made in cruising flight. There is no history of altimeter problems in the aircraft's maintenance records and there were no altimeter writeups reported by the crew that flew the aircraft into New York.

A review of Attachment No. 2 shows the position of the hands of the altimeter could be misinterpreted under certain operating conditions and the crew could have misread 6,000 feet to be 16,000 feet. It is believed the first officer was flying the aircraft. The captain's voice was identified on the air traffic control tapes and it is a normal custom in air carrier operations to have the pilot who is not flying the aircraft make the radio transmissions. If the captain were looking outside the aircraft for traffic or occupied with cockpit duties such as the completion of a checklist, and the first officer misread the altimeter, this error could escape undetected. To have such an error occur, however, it would be necessary for the pilot or pilots to fail to see the gradually increasing display of the cross-hatched warning section of the altimeter and the gradually decreasing display of the

white arc associated with the 10,000 feet pointer. This possibility is supplemented by the literature available regarding the various investigations of the readability of the three pointer altimeter which indicates it is the most susceptible to misreading of any of four types presently in use in commercial aviation. Therefore, the Board believes that the crew for reasons unknown allowed the aircraft to descend below the assigned altitude of 6,000 feet and ultimately crashed into the water.

2.2 CONCLUSIONS

A. Findings

1. The known medical information concerning the flight crewmembers is not indicative of any pre-existing disease or inflight incapacitation.
2. Post mortem examinations indicate that there is no evidence of incapacitation or pre-impact injury to the crew.
3. There is no evidence of any system failure prior to impact.
4. The aircraft was approximately on the correct inbound course.
5. The cockpit VHF radio controls were set in a manner appropriate for a descent and approach to O'Hare.
6. The recovered altimeter had a setting that could have introduced an error of approximately 20 feet in the instrument reading.
7. Based on the identification of the captain's voice on the ATC recording tape and common custom and practice in commercial aviation, it is believed the first officer was flying the aircraft.
8. The SAGE altitude reports referred to UAL 389 and recorded the altitude of the flight at 2119:54 as 2,000 feet with an accuracy of plus 500 - minus 1,000 feet.

9. The air data computer provides an indication of 200-210 knots at the time of electrical power interruption.

10. There was no major mechanical failure of the Nos. 1 and 2 engines before impact.

11. There is no evidence of a major mechanical failure in the forward fan section, forward bearing, or lubrication system of the No. 3 engine.

12. The rotational speeds of Nos. 2 and 3 were higher than No. 1 at engine impact.

13. The fuel system revealed no evidence of an intentional engine shutdown by the crew.

14. There is no evidence of thrust reversal inflight.

15. The aircraft was in a clean flight configuration at impact. The landing gear, trailing edge devices, leading edge devices, and speed brakes were fully retracted.

16. All structural components were capable of normal operation prior to impact.

17. There was no evidence in the recovered engine cowling and surrounding structure to indicate that anything had been ejected through the engine cowlings prior to impact.

18. There was no evidence of inflight explosion. The only fire that occurred during this accident was the flash fire which accompanied the impact with the water.

19. The aircraft's fire extinguisher system was not used.

20. Weather was not a causal factor in this accident.

21. The air traffic control handling of this flight was routine.

22. There was no evidence of any distress or inflight difficulties on the recorded transmission from the crew.

23. The aircraft made a continuous descent at an average rate of approximately 2,000 feet per minute from 35,000 feet to impact with the water.

24. The flight was cleared to descend to and maintain 6,000 feet.

25. At the time of the last radio communication with approach control, the aircraft had descended through 6,000 feet and was at an altitude of approximately 1,000-2,500 feet m.s.l. This is approximately 500 to 2,000 feet above the water.

26. The impact with the water occurred between 2120 and 2121.

B. Probable Cause

The Board is unable to determine the reason for the aircraft not being leveled off at its assigned altitude of 6,000 feet.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD.

JOSEPH J. O'CONNELL, JR.
Chairman

OSCAR M. LAUREL
Member

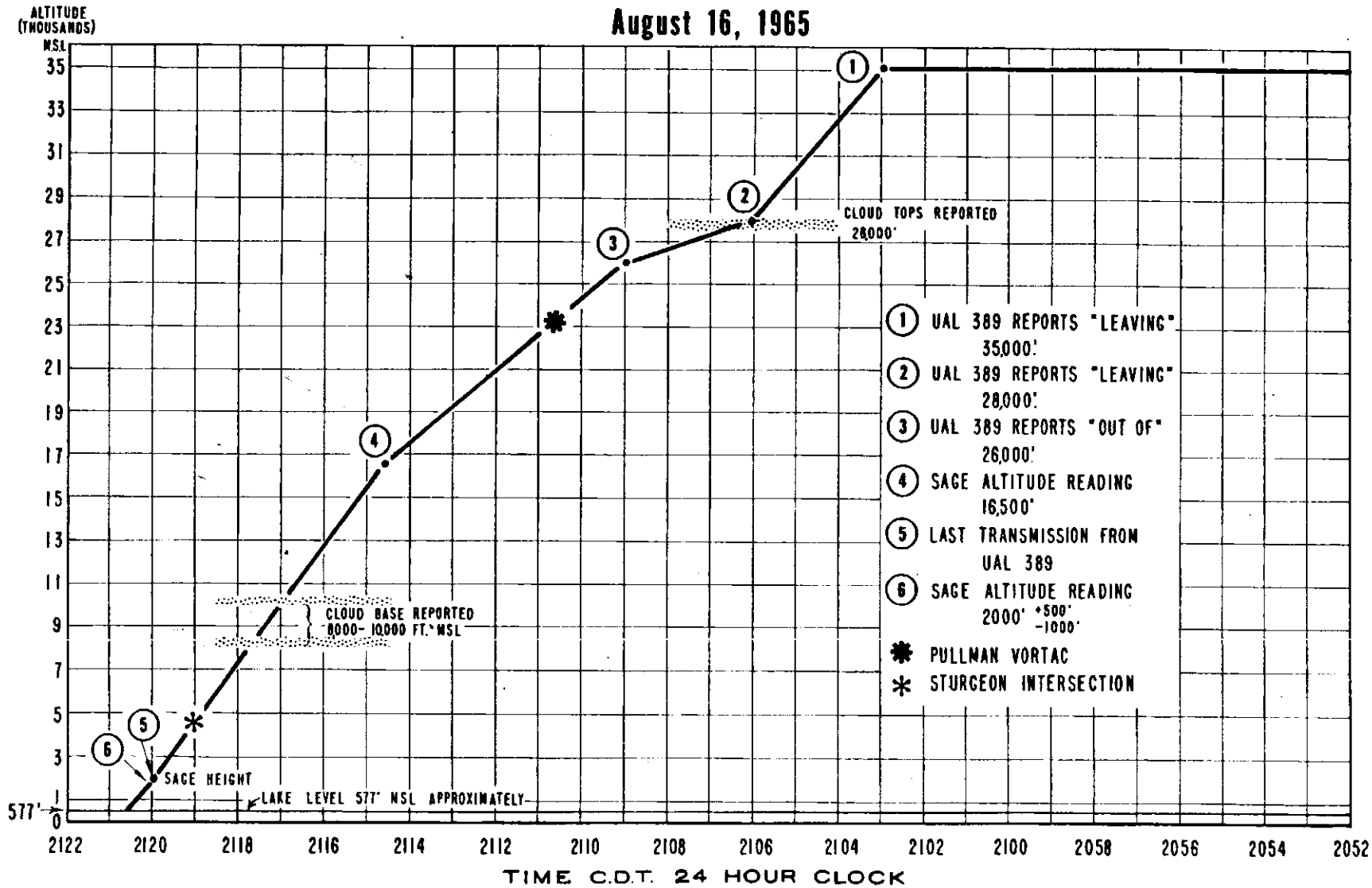
JOHN H. REED
Member

LOUIS M. THAYER
Member

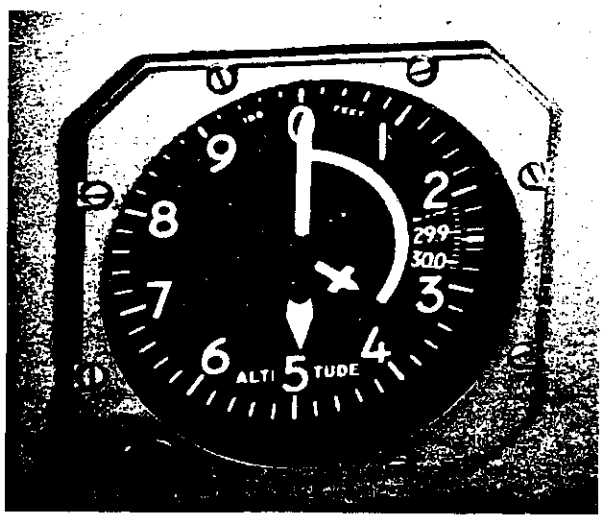
FRANCIS H. McADAMS
Member

ATTACHMENT 1

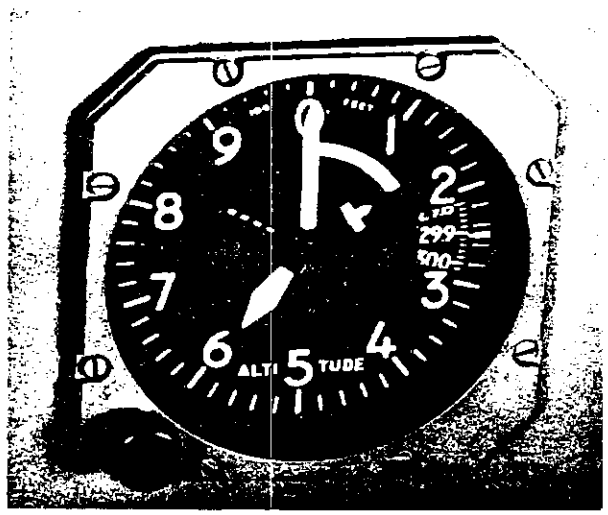
CALCULATED DESCENT UAL FLIGHT 389
August 16, 1965



ATTACHMENT 2

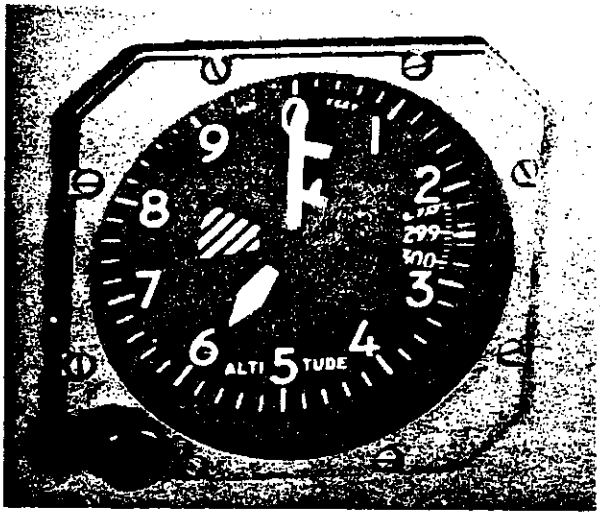


Setting (without parallax):	
Baro.	29.92
Alt.	35,000

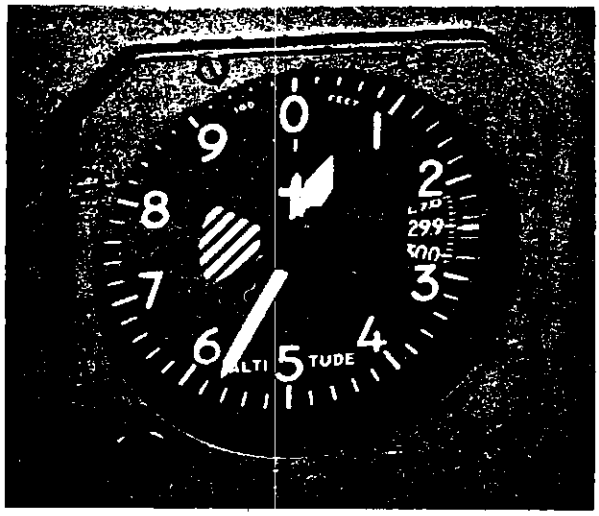


Setting (without parallax):	
Baro.	29.915
Alt.	16,000

Camera lens: 34'' from dial 22° above and 15° to left of altimeter axis



Setting (without parallax):	
Baro.	29.915
Alt.	6,000



Setting (without parallax):	
Baro.	29.915
Alt.	577

5061

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