NATIONAL TRANSPORTATION SAFETY 3343

AIRCRAFT ACCIDENT REPORT

Delta Air Lines, Inc.

Douglas DC-9-32, N3329L

Louisville, Kentucky

September 8, 1970

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D. C. 20591

REPORT NUMBER: NTSB-AAR-71-15

DELTA AIR LINES, INC.
DOUGLAS DC 9-32, N3329L
LOUISVILLE, KENTUCKY
SEPTEMBER 8,1970

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File No. 1-0016

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Adopted: November 17, 1971

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SYNOPSIS

At approximately 2114 eastern daylight time September 8, 1970, Delta Air Lines Flight 439, Douglas Model DC-9-32, N3329L, touched down 156 feet short of Runway 29 at Standiford Field, Louisville, Kentucky, during a night landing visual approach. In the area of initial contact, the ground sloped upward toward the runway threshold at a measured 2° 44' or an approximate 5 percent gradient.

The aircraft made firm contact on the main gear, rolled 73 feet in the direction of the runway threshold and then became airborne. It touched down a second time on the runway, 662 feet beyond the runway threshold. From the point of second touchdown, ground marks continued approximately 4,457 feet to where the aircraft came to rest. The aircraft was substantially damaged by the initial ground contact but there was no fire.

The 89 passengers and five crewmembers on board deplaned safely; however, one stewardess and 14 passengers received minor injuries.

The National Transportation Safety Board determines that the probable cause of this accident was the pilot's misjudgment of altitude due to the absence of sufficient lights in the approach area, misleading information produced by deceptive sloping terrain, and that the pilot did not position the aircraft on the ILS glide slope while he was establishing the final approach profile.

INVESTIGATION

Delta Air Lines Flight 439 was a scheduled domestic flight from Chicago, Illinois (O'Hare Field), to Atlanta, Georgia, with intermediate stops at Louisville and Lexington, Kentucky.

Flight 439 of September 8, 1970, departed Chicago at 2013 eastern daylight time en route to Louisville, Kentucky, on an Instrument Flight Rules (IFR) flight plan.

At 2101,[1] Louisville Approach Control established radar contact with Flight 439. Vectors and altitude information were given the crew until the flight was turned to a heading that would intercept the inbound ILS[2] localizer course to Runway 29 at Standiford Field. The flight was subsequently cleared for an ILS approach. (Attachment 1.)

Landing weight had been computed to be 92,000 pounds, which established an approach reference airspeed of 123 knots. Flaps had been extended to 50°. The captain stated that the approach appeared normal in all respects, and that the last time he observed the airspeed indication it was 130 to 132 knots. He believed that the aircraft did not flare properly for landing, which resulted in hard landing and a bounce.

[1] Unless otherwise noted, all times used herein are eastern daylight, based on the 24-hour clock.

[2] Instrument Landing System.

The first officer thought that the approach had been normal in all respects, and that an airspeed of **130** knots had been maintained. All instrument indications were normal as he checked them when the aircraft was about **2,500** feet from the end of the runway.

A witness who saw and heard the aircraft as it Passed over a toll road, approximately 1,000 feet from the approach end of Runway 29, thought the aircraft was low. He stated "I have seen many airplanes come in low before landing on the runway. Usually the airplanes that come in low increase the engine power as they pass over the toll road, but this airplane didn't do that."

Runway 29 at Standiford Field is 7,200 feet long, 150 feet wide. The airport elevation is 497 feet and the elevation at the approach end of Runway 29 is 479 feet. At the time of the accident, approach lighting was not installed. The threshold is marked with standard green lights. When Flight 439 made the approach which terminated in the accident, the high-intensity runway lights were set at step 3, medium bright, and the reported flight visibility was 7 miles. Runway **29** did not have a prepared underrun/overrun area. The ground leading to the threshold slopes upward **2°44'**, a gradient of approximately 5 percent.

Flight **439** made initial ground contact on this incline 156 feet short of the threshold of the runway, rolled forward 73 feet, and became airborne. The aircraft then contacted the runway 262 feet beyond the threshold and continued to roll/skid on the runway before it came to rest **4,457** feet beyond the threshold. (See Attachment **2.)**

There were 89 passengers and a crew of five on board. One stewardess and 14 passengers received minor injuries from the hard landing. However, all deplaned safely.

The aircraft was damaged substantially, but there was no fire.

Wreckage examination showed that the fuselage had fractured and buckled in the area between fuselage stations **737** and **794.** The fracture path was almost identical on each side of the fuselage.

The seat track on the right side of the cabin separated at row **32** and the left track separated at row **31.**

There was no visible damage to the landing gear components or to any support or mounting structure.

The left main landing gear tires revealed flat spots on both tires. Holes in these areas penetrated through the tire tread and casing.

The tail cone rested on the runway. The underside of the cone had been worn flat, and heat discoloration was visible on the sides.

There was no separation of seat belts or seat belt attachments.

The following components were removed from N3329L for testing:

Speed command of attitude and thrust computer
Speed command of attitude and thrust indicator
Altimeters – two
Vertical speed indicators – two
Air data computer
Anti-skid control box
Anti-skid wheel speed transducers – two

Functional testing of these components was conducted in accordance with the specific overhaul requirements. These tests revealed that the components were operational within the requirements and/or limitations set forth by the manufacturer.

The captain's airspeed indicator was checked at indicated speeds of **123** knots and **128** knots, and was within the prescribed tolerance.

The aircraft pitot and static systems were checked with a field test unit. This check did not reveal any systems discrepancies.

The aircraft had been maintained in accordance with Federal Aviation Administration and company procedures. A special airframe inspection for turbulence encounters or for hard or overweight landings had never been required.

The Douglas Aircraft Company computed the loads and forces necessary to cause fuselage separation at stations 737 to **794,** as well as the

effect of touching down on an inclined plane of 2°44'. In part, the Douglas report states:

> "In this analysis, an airplane sink speed of 8.5 feet per second was assumed. It should be noted that the effect of an airplane landing on a 2°44' incline at 120 knots with zero sink speed is equivalent to landing at approximately 10 feet per second. This situation is accounted for in the analysis. The total effective sink speed felt by the airplane would therefore be 18.5 feet per second in this case. . . .
>
> "We conclude from the foregoing that the primary cause of the damage to the Delta airplane was the increase in effective. sink speed caused by landing on the inclined surface short of the- runway. Under the same circumstances, if the airplane had landed on the runway, it is not likely that damage would have occurred."

Both the flight data recorder and the cockpit voice recorder were recovered.

The readout of the cockpit voice recording did not yield any information that was pertinent to the cause of this accident. Upon playback of the original tape, it was discovered that there was an extraordinary amount of background noise on the cockpit area microphone ***(CAM)*** channel which served effectively to mask out any intracockpit conversation which may have transpired during the approach and landing.

The flight data recorder foil medium was undamaged. All parameters were active and clearly discernible. The trip and date/reference binary trace was missing. This trace is normally located near the bottom edge of the foil medium and provides the base for all vertical measurements.

The readout was accomplished by substituting an artificial reference line for the missing reference line, based on the standard position of 0.115 inch above the bottom edge of the recording medium. The tape was read out beginning approximately 3 minutes prior to the point where all parameter traces became aberrant and continued to the end of the recorded traces, comprising a total readout time of approximately 4 minutes. The altitude depicted on the flight data recorder graph was corrected to mean sea level altitude using the reported altimeter setting of 29.90 inches of mercury. No other corrections were made to any parameter. (See Attachment 3.)

The altitude shown at the point where all recorder traces became aberrant is 300 feet mean sea level. The actual altitude at point of impact is 472 feet mean sea level.

Standiford Field is located 5 miles south of Louisville, Kentucky, a sprawling city with an irregular complex of lights. The approach course to Runway 29 is over a vaned distribution of lights and, after it crosses the four-lane highway, the upward sloping area preceding the threshold is devoid of lights.

At the time of the accident, the Standiford Field weather was reported at 3,000 feet scattered clouds, 10,000 feet scattered clouds, estimated ceiling 25,000 feet broken clouds, visibility 7 miles, wind 310° at 8 knots.

Navigation and approach aids available at Standiford Field included both radar service and an instrument landing system. No equipment malfunctions during the approach or in the preceding **30** days were reported.

A flight check of the ILS and navigation aids indicated that the systems were operating satisfactorily subsequent to the accident.

The crewmembers of Flight 439 were certificated for the operation involved. (See Appendix B for details.)

The captain had been flying into Louisville for 8 years. The first officer had been flying into Louisville since May 1969.

During an approach, the path described by the main landing gear differs from that described by the pilot's eye level, because the pilot is located above and ahead of the main landing gear. The path described by the landing gear ultimately terminates in the touchdown point, whereas the path described by the eye level of the pilot intersects the runway in what is known as the aiming point. The pilot judges his position above or below the glidepath by reference to the horizon and the aiming point at the runway threshold. As the aircraft approaches the threshold, the pitch attitude of the aircraft is changed and a new aiming point on the runway is used.

This aiming point is always some distance down the runway from the touchdown point.

In a 1950 study which concerned visual judgment during the landing approach, Dr. Calvert of the Royal Aircraft Establishment repprted:

> "The brain interprets the two-dimensional perspective image in the retina, selecting the possible meaning it may have in light of all other data available to it. If the wrong meaning is attached to the visual scene, then so-called illusions occur. The most important features of the visual field are: the plane of the ground and objects of known size on the surface."

In subsequent studies he concluded that a method of determining the descent flightpath of jet aircraft during the approach was essential, even in good visual conditions, if landing approaches were to be conducted safely. Other studies confirmed his opinions, and led to the development of the visual approach slope indicator that is now installed at air carrier airports on runways not served by an ILS.

Because the vertical situation is difficult to assess accurately, the pilot usually tries to check his judgment of it in every way he can. One way of checking this at low altitudes is to estimate the height of textural features such as trees, houses, roads, and to a lesser extent, the size and spacing of approach lights, where they are installed. Then, by means of past experience, the pilot sets this height against estimated range from touchdown. The accident probability rate increases if the terrain has a pronounced slope, or if there is some other peculiarity which gives a false impression of the real position of the horizon.

Between the Standiford **ILS** outer marker and the runway, residential and commercial light complexes provide a height stimuli. **A** four-lane highway transverses the inbound course, 1,000 feet from the threshold on Runway 29. There were no fixed ground lights between the highway and the runway threshold lights, and height stimuli must be transferred to the runway and the threshold lighting complex. Directly over the four-lane highway centerline, ILS (2.99") glide slope projection provides approximately 130 feet clearance above ground level.

ANALYSIS

There were no aircraft system or component malfunctions.

The aircraft had not been previously subjected to excessive airframe load conditions that would have induced a premature fuselage fracture.

No extenuating circumstances, such as turbulence, restriction TO visibility, or in-flight emergency, were present which otherwise might have contributed- to^ the cause of the accident. Accordingly, the Safety Board focused its attention on the circumstances ana~conditions relative to the final approach path.

Referring to the flight data recorder graph, the actual pattern of each parameter-tiace and the values ascribed to the trace were reviewed. Indicated airspeed values from the data graph were converted to true airspeed values from which ground speed calculations were made. The touchdown is presumed to have occurred at flight data recorder time of 3:00 minutes. This is evidenced by the presence of a discontinuity or gap of about 6.6 seconds in the data recorder time trace. The altitude trace indicated that touchdown occurred at an elevation of 300 feet mean sea level. This was found to be in error, as the elevation at ground contact was 472 feet. However, with respect ,to the altitude trace, experience has shown that any calibration error in the recorder will be constant throughout the altitude profile, and the profile itself will not be altered by an adjustment to a known altitude at a particular point in the altitude trace. Consequently, when the 172-foot altitude correction is made to the point of impact, an altitude profile of considerable accuracy can be plotted backward from that point along the approach path of the aircraft. This plot was made, and it indicates that the aircraft was constantly below the ILS glide slope throughout~the final appreach. This below-glidepath indication is **sup** ported by the witnesses' observation, and by the fact that the altitude trace shows a uniform—

descent rate with no indication of a "duck under" maneuver, If the aircraft had been stabilized on the approach, as the flight data recorder information indicates, and the aircraft had been on the glide slope, the wheel-path would have been approximately 50 feet above the runway threshold instead of below it.

From the foregoing, the Safety Board believes that the pilot did not use the ILS glide slope, but relied upon visual mound reference to maneuver the aircraft during the approach for landing. With respect to the use of the ILS glide slope, Part 91 of the Federal Aviation Regulations provides: "A turbine-powered airplane or a large airplane approaching to land on a runway being served by an ILS, shall, if the airplane is ILS equipped, fly that airplane at an altitude at or above the glide slope between the outer marker (or the point of interception with the glide slope, if compliance with the applicable distance from clouds criteria requires interception closer in) and the middle marker; . . ." This procedure was adopted after it was clear from past experience that a need existed for high-performance aircraft to establish a constant final approach flight condition. The approximate 3° glide slope establishes this constant approach flight condition and assists the crew in maintaining the proper approach profile.

Pilots through training and experience develop a visual frame of reference which allows them to conduct safe conventional approaches to flat terrain. Many successful approaches are made by effectively maintaining a visual null (no change to the subject angle). Pilots may **"fly the null"** so consistently that when deceptive conditions ate introduced (such as irregular light patterns, up slope lights, and other topographical features) their approach paths may result in flight at lower altitudes, and touchdowns short of the runway. These conditions and features were found to be present along the final approach path of Flight 439 to Standiford Field.

On the basis of this investigation, the Safety Board concludes that the cause of this accident is related to the crew's operational technique, the absence of adequate lighting in the approach zone, and the sloping terrain.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the pilot's misjudgment of altitude due to the absence of sufficient lights in the approach area, misleading information produced by deceptive sloping terrain, and that the pilot did not position the aircraft on the ILS glide slope while he was establishing the final approach profile.

CORRECTIVE ACTION

The Director of Airports at Louisville, Kentucky, stated that an abbreviated approach lighting system was programmed for the approach end of Runway 29 at Standiford Field. This installation was expected to be completed by January 1971.

The installation of the approach lighting system for Runway 29 was included in the Federal Aviation Administration's 1969, fiscal year projects and budget requirements. On January 21, 1971, the FAA did complete and commission for use a medium-intensity approach lighting system which included runway alignment indicator lights.

This action corrects the "Black Hole" effect preceding the threshold.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

s/ JOHN H. REED
Chairman

s/ OSCAR M. LAUREL
Member

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

APPENDIX A

INVESTIGATION AND HEARING,

1. Investigation

The National Transportation Safety Board received notification of the accident at 2200 e.d.t., on September 8, 1970. The Investigator in Charge was dispatched immediately to the scene from the Chicago Field Office, with technical assistance from Fort Worth, Texas, and Washington, D. C. Working groups were established for operations, witnesses, air traffic control, structures and systems. Parties to the investigation were Delta Air Lines, the Federal Aviation Administration, Air Line Pilots Association, and Douglas Aircraft Company. The on-scene investigation, which was accomplished at Louisville, Kentucky, was completed September 16, 1970.

2. Hearing

A public hearing was not held in connection with the investigation of this accident.

3. Preliminary Report

A preliminary report was not issued in connection with this accident.

CREW INFORMATION

Captain Jerry K. Reed, aged 30, held an airline transport pilot certificate and was type-rated in the Douglas DC-9. At the time of the accident, he had accumulated a total of 5,600 flying hours, of which 1,663 hours were in the DC-9, and 401 hours were flown as a DC-9 captain. When the accident occurred, he had been on duty 1 hour and 45 minutes, approximately 45 minutes of which was flying time. He held a first-class medical certificate dated May 18, 1970, with no limitations.

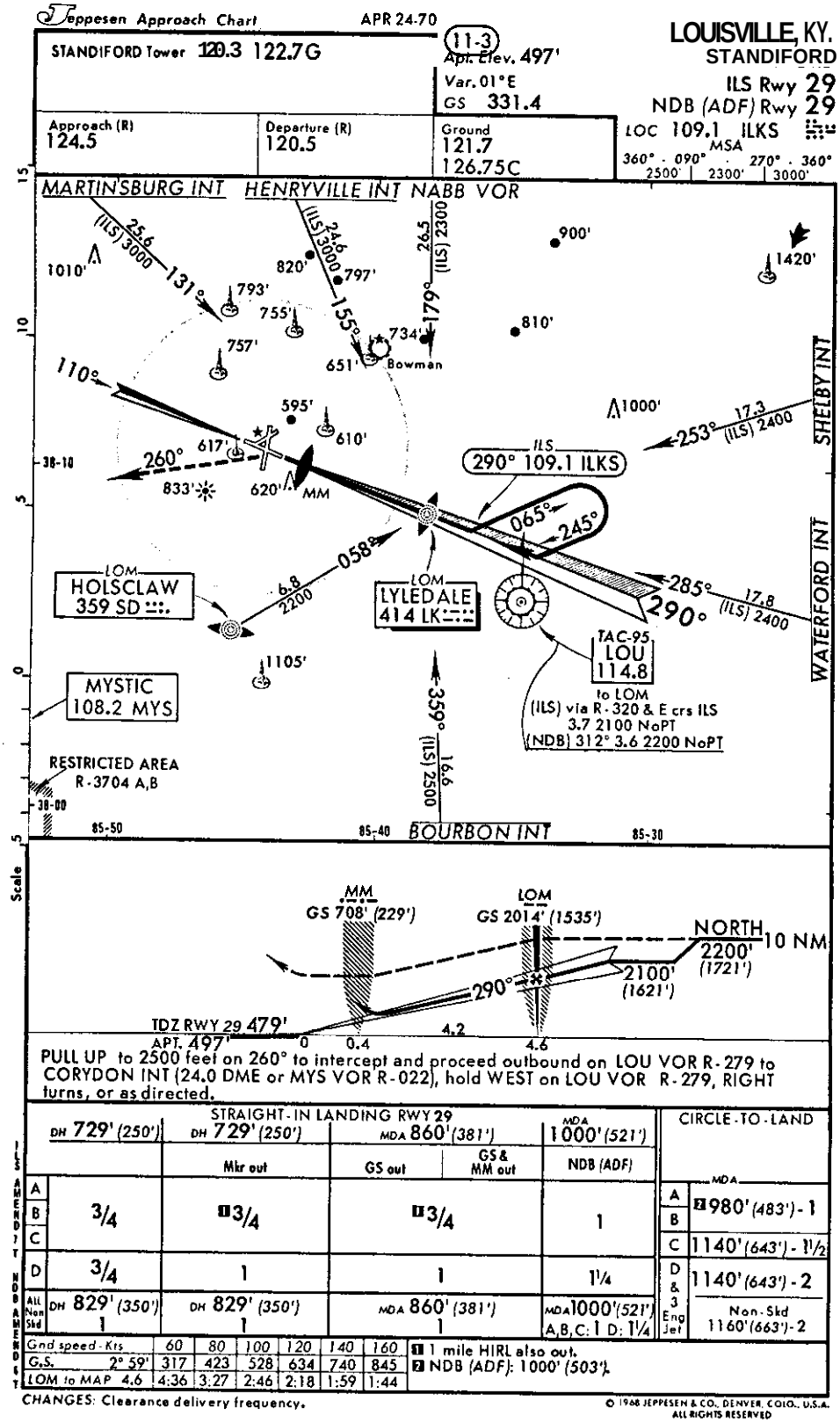
First Officer Robert A. Cartmill, aged 33, held a commercial pilot certificate with ratings for aircraft single- and multiengine land, instrument, and rotorcraft. At the time of the accident, he had accumulated a total of 3,485 flying hours of which, 638 hours were in the DC-9. He held a first-class medical certificate dated August 19, 1970, without limitations.

AIRCRAFT INFORMATION

N3329L, a Douglas DC-9-32, serial No. 47108, was manufactured by the McDonnell Douglas Corporation, January 22, 1968.

The total recorded aircraft flight time was 7,601.2 hours; 914.8 hours were recorded since the last major aircraft inspection. The flight time since the last letter check was 186 hours.

The aircraft was powered with two Pratt & Whitney JT8D-7 engines. The No. 1 engine (left), serial No. 657026, was manufactured on September 18, 1967, and had been in operation 7,419.9 hours since new. The No. 2 engine (right), serial No. 657049, was manufactured on October 13, 1967, and had accumulated 6,543.9 hours since new.


Jeppesen Approach Chart
APR 24-70
11-3
LOUISVILLE, KY.
STANDIFORD
STANDIFORD Tower 120.3 122.7G
Apt. Elev. 497'
Var. 01°E
GS 331.4
ILS Rwy 29
NDB (ADF) Rwy 29
LOC 109.1 ILKS
MSA
360° - 090° 2500' | 090° - 270° 2300' | 270° - 360° 3000'
Approach (R) 124.5
Departure (R) 120.5
Ground 121.7 126.75C
MARTINSBURG INT
HENRYVILLE INT
NABB VOR
25.6 (ILS) 3000
131°
24.6 (ILS) 3000
155°
179°
26.5 (ILS) 2300
1010'
820'
797'
793'
755'
757'
734'
651'
Bowman
900'
810'
1420'
1000'
110°
595'
610'
617'
260°
833'
620'
MM
ILS
290° 109.1 ILKS
065°
245°
253°
17.3 (ILS) 2400
SHELBY INT
LOM HOLSCLAW 359 SD
6.8
2200
058°
LOM LYLEDALE 414 LK
285°
290°
17.8 (ILS) 2400
WATERFORD INT
TAC-95 LOU 114.8
to LOM
(ILS) via R-320 & E crs ILS
3.7 2100 NoPT
(NDB) 312° 3.6 2200 NoPT
1105'
MYSTIC 108.2 MYS
359°
16.6 (ILS) 2500
RESTRICTED AREA
R-3704 A,B
38-10
38-00
85-50
85-40
BOURBON INT
85-30
Scale
MM
GS 708' (229')
LOM
GS 2014' (1535')
NORTH
10 NM
2200'
(1721')
2100'
(1621')
290°
TDZ RWY 29 479'
APT. 497'
0
0.4
4.2
4.6
PULL UP to 2500 feet on 260° to intercept and proceed outbound on LOU VOR R-279 to CORYDON INT (24.0 DME or MYS VOR R-022), hold WEST on LOU VOR R-279, RIGHT turns, or as directed.
STRAIGHT-IN LANDING RWY 29
DH 729' (250')
DH 729' (250')
MDA 860' (381')
MDA 1000' (521')
Mkr out
GS out
GS & MM out
NDB (ADF)
CIRCLE-TO-LAND
MDA
A
B
C
D
3/4
1 3/4
1 3/4
1
980' (483') - 1
1140' (643') - 1 1/2
1140' (643') - 2
1 1/4
All Non Std
DH 829' (350') 1
DH 829' (350') 1
MDA 860' (381') 1
MDA 1000' (521') A,B,C: 1 D: 1 1/4
A, B, C, D & 3 Eng Jet
Non-Std 1160' (663') - 2
Gnd speed-Kts 60 80 100 120 140 160
G.S. 2° 59' 317 423 528 634 740 845
LOM to MAP 4.6 4:36 3:27 2:46 2:18 1:59 1:44
1 mile HIRL also out.
2 NDB (ADF): 1000' (503').
CHANGES: Clearance delivery frequency.
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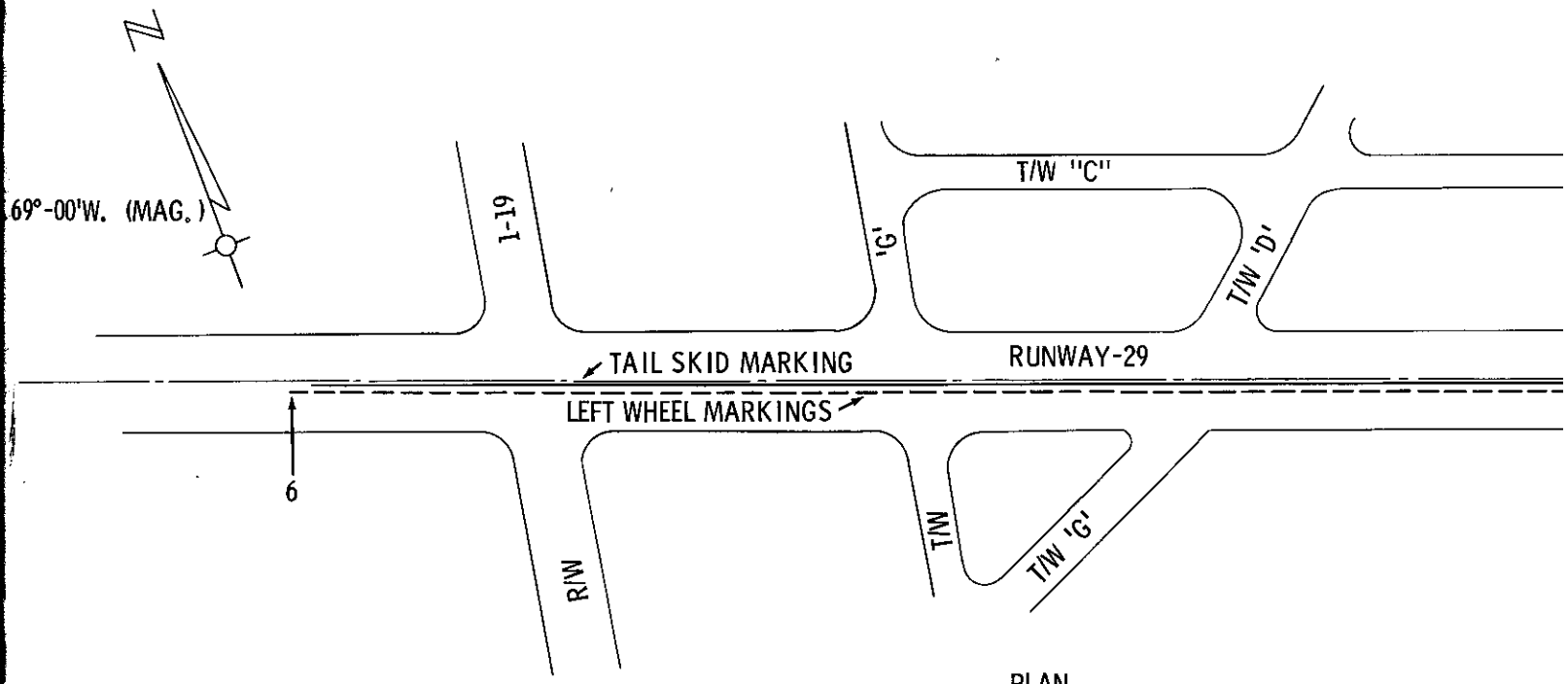
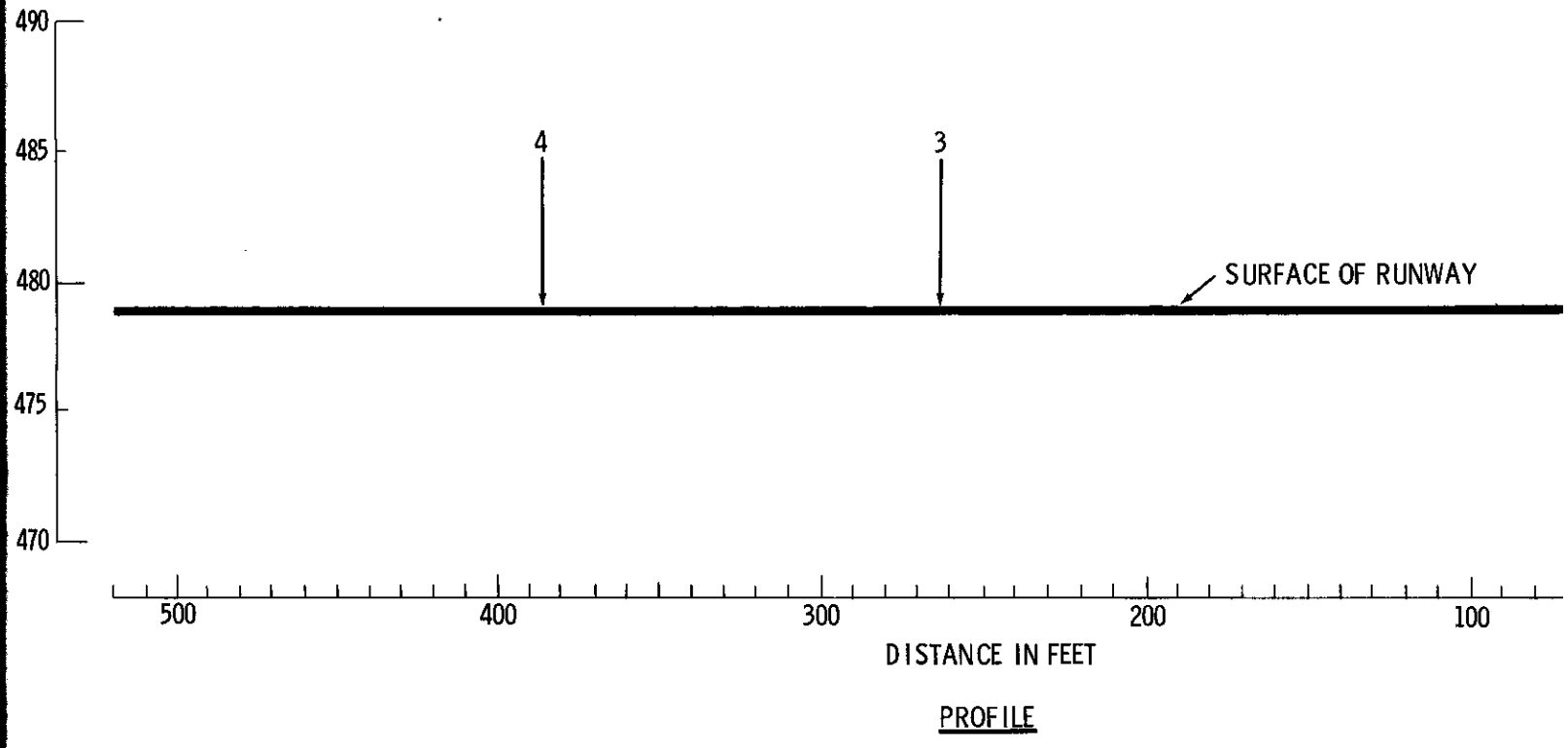
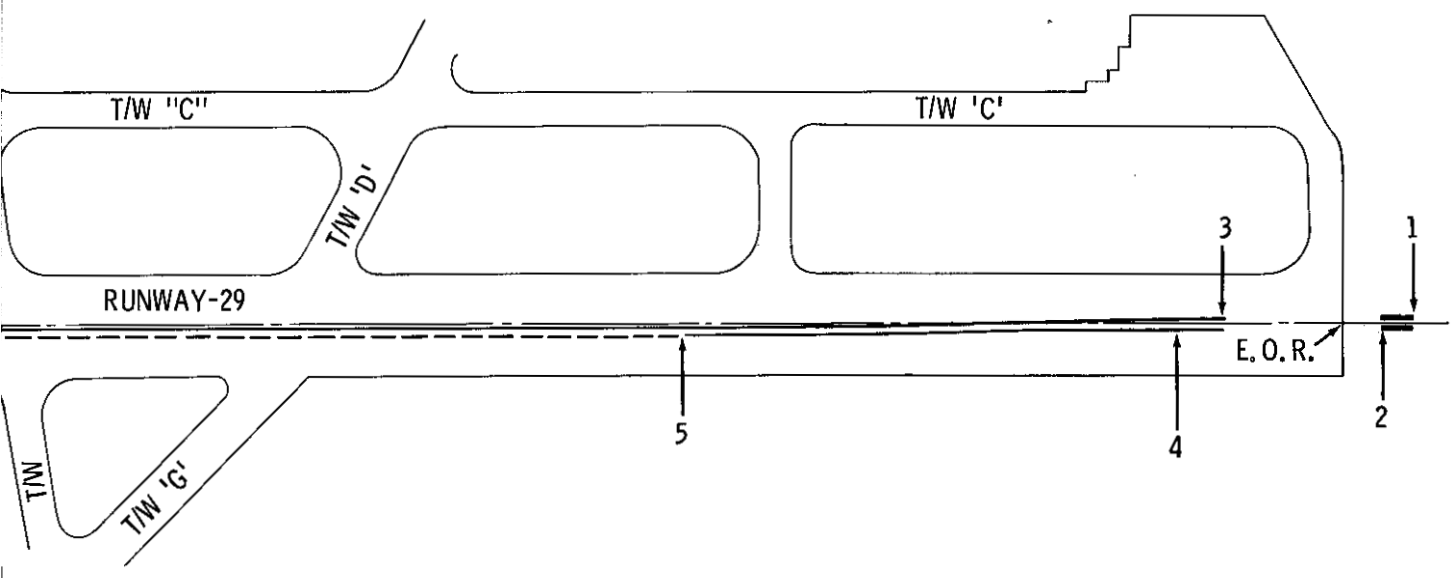


PLAN

SCALE: 0' 100' 200' 300'



PROFILE



PLAN

0' 100' 200' 300'

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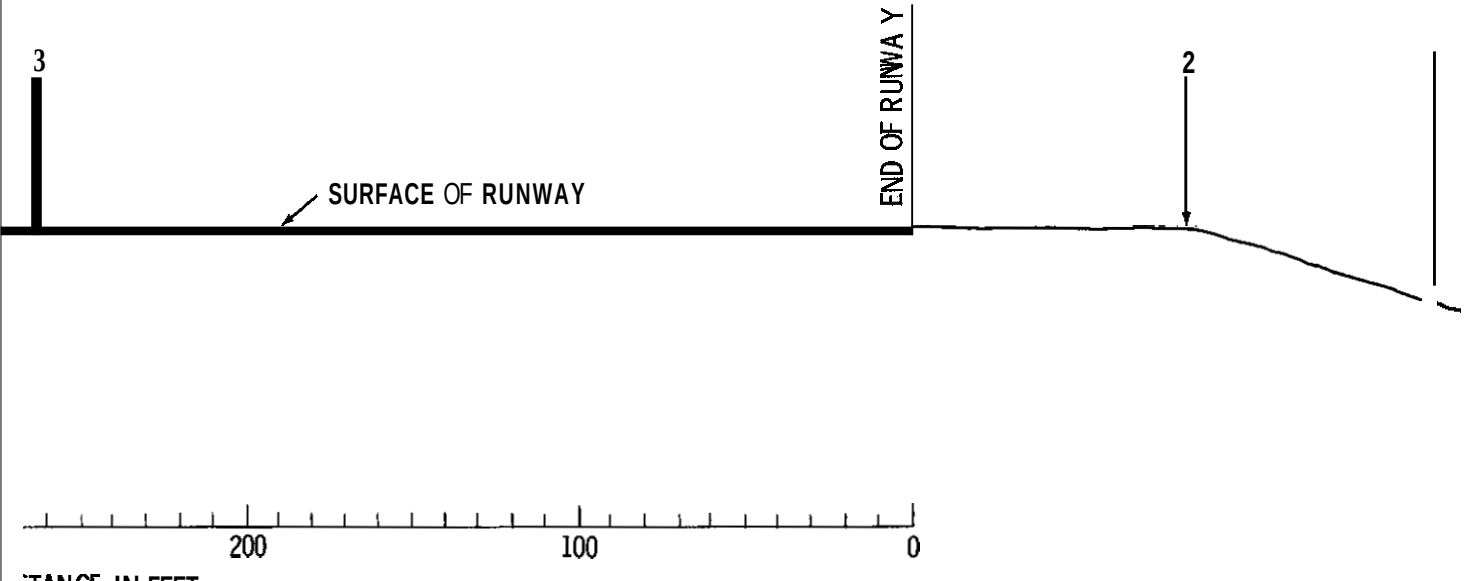
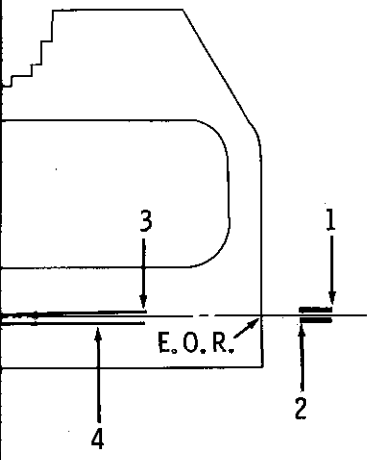


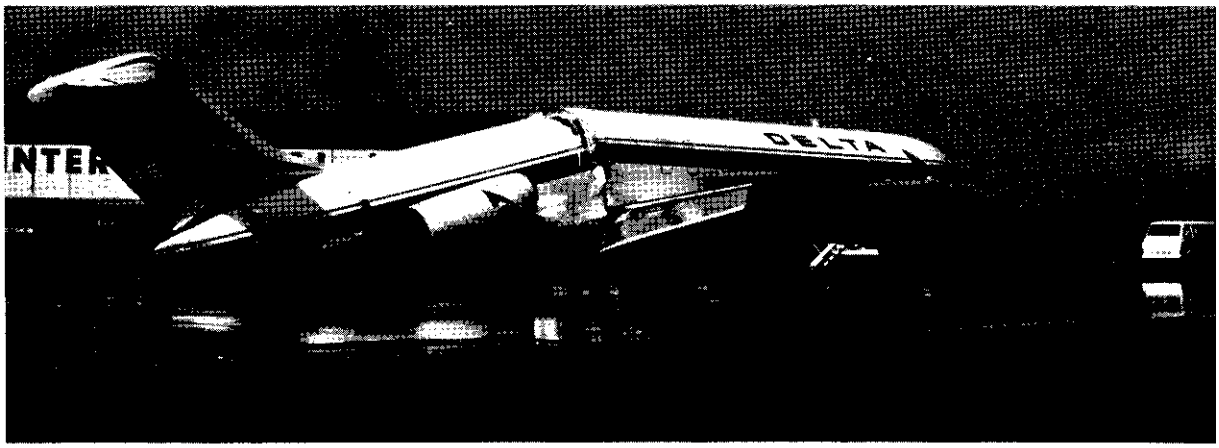
200 100 0

STANCE IN FEET

PROFILE

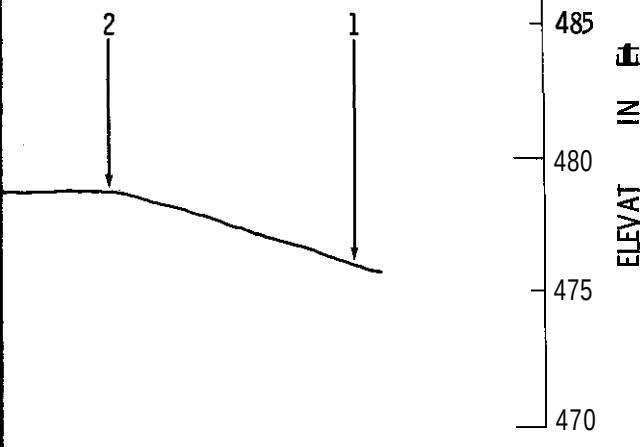
ATTACHMENT





LEGEND

1. TOUCHDOWN POINTS OF THE LEFT AND RIGHT MAIN LANDING GEAR TIRES 156 FEET BEFORETHE RUNWAY THRESHOLD.
2. TRACKS OF THE LEFT AND RIGHT MAIN LANDING GEAR TIRES END 83 FEET BEFORE THE RUNWAY THRESHOLD.
3. INDICATIONS OF REAR FUSELAGE CONTACT ON THE RUNWAY 262 FEET FROM THE THRESHOLD.
4. INDICATIONS OF THE LEFT MAIN LANDING GEAR TIRES SKIDDING ON THE RUNWAY SURFACE 385 FEET FROM THE THRESHOLD AND 8 FEET TO THE LEFT OF THE RUNWAY CENTERLINE.
5. INDICATIONS THAT THE LEFT MAIN LANDING GEAR TIRES HAD BLOWN-OUT 1,488 FEET FROM THE RUNWAY THRESHOLD AND 16 FEET TO THE LEFT OF THE RUNWAY CENTERLINE.
6. STOPPING POINT OF THE AIRCRAFT ON THE RUNWAY 4,457 FEET FROM THE THRESHOLD.



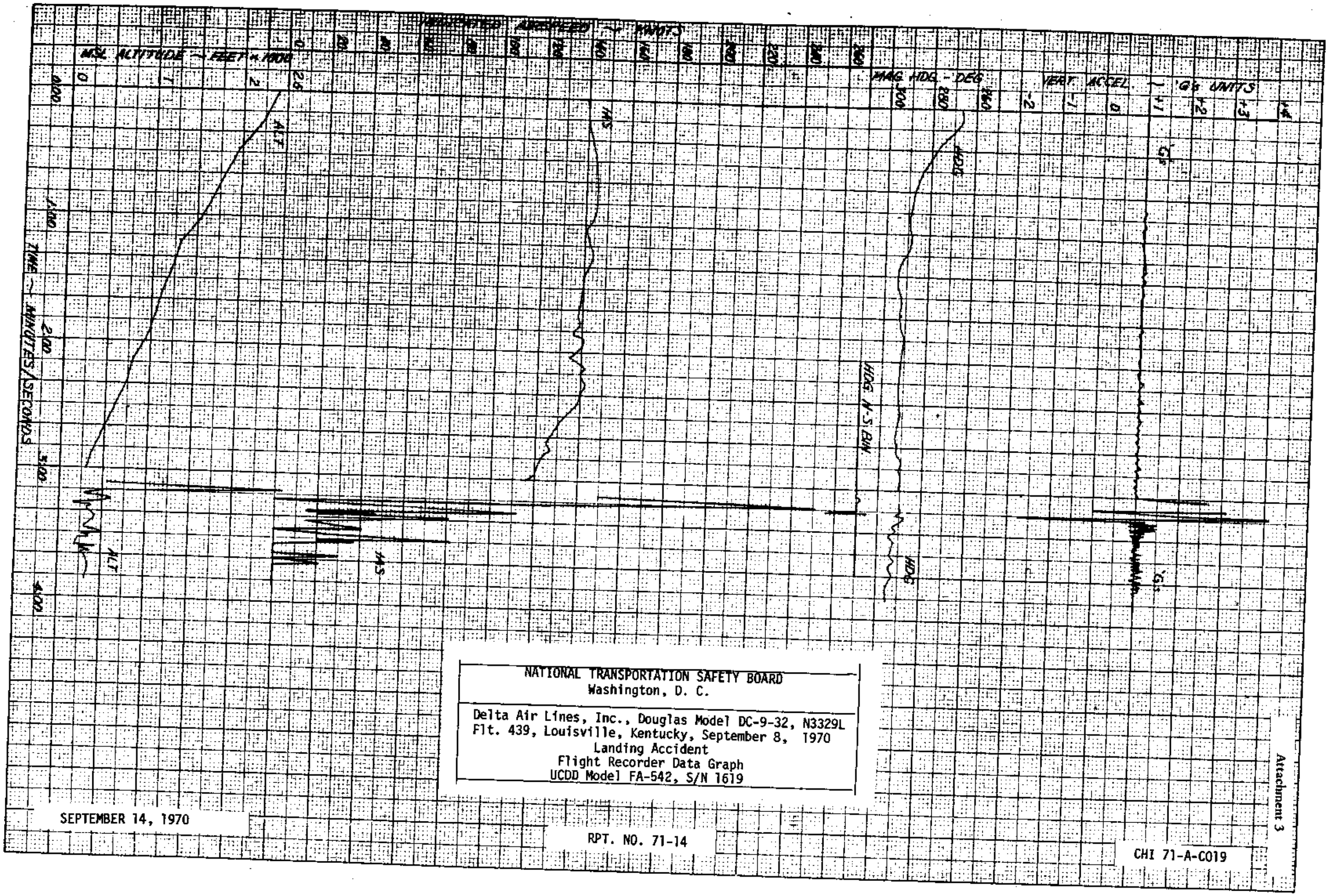
NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D.C.

PLAN AND PROFILE VIEW OF RUNWAY 29

DELTA AIR LINES, INC. DC-9-32, N3329L

STANDIFORD FIELD, LOUISVILLE, KENTUCKY

September 8, 1970



NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D. C.

Delta Air Lines, Inc., Douglas Model DC-9-32, N3329L
Flt. 439, Louisville, Kentucky, September 8, 1970
Landing Accident
Flight Recorder Data Graph
UCDD Model FA-542, S/N 1619

SEPTEMBER 14, 1970

RPT. NO. 71-14

CHI 71-A-C019

Attachment 3