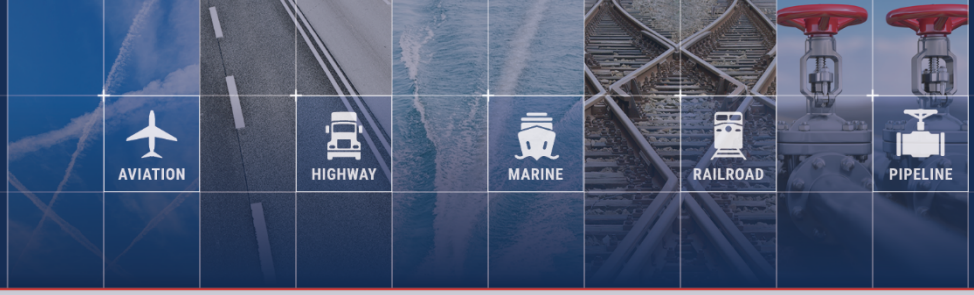

Aviation Investigation Final Report

Location:	Chicago, Illinois	**Incident Number:**	OPS18IA015
Date & Time:	June 21, 2018, 09:58 Local	**Registration:**	B-18711
Aircraft:	Boeing 747	**Aircraft Damage:**	None
Defining Event:	Miscellaneous/other	**Injuries:**	4 None
Flight Conducted Under:	Non-U.S., commercial		

Analysis

CAL5148 was conducting an ILS autoland approach to runway 10R. Instrument meteorological conditions prevailed at the time of the incident, with an overcast ceiling of 600 feet above ground level (agl), and visibility of 2 and 1/2 miles with moderate rain. These conditions required protection of the ILS critical area by ATC which they did according to FAA Order JO 7110.65, Air Traffic Control. ATC issues control instructions to protect ILS critical areas and avoid signal interference from vehicle traffic and taxiing aircraft when the reported weather is a ceiling of less than 800 feet or visibility of less than 2 miles. However, this restriction does not include consideration for preceding arriving or departing aircraft.

While a previously departed aircraft was airborne and over the ILS critical area, CAL5148 experienced localizer deviations while on short final. In math modelling analysis of this event conducted by the FAA; the results were consistent with the localizer deviations determined from CAL5148 flight data recorder (FDR) data. Specifically, the modelling indicated the deviation beginning at 1/4 mile from threshold would lead the aircraft to turn left to continue to follow the localizer course line during an autoland approach. The FAA National Resource Engineer for Navigation who performed the modelling wrote *"I am 90% confident that the location of departing ENY3544 caused sufficient Multipath (signal deflection) to produce a fly left indication to arriving CAL5148."*

"Multipath" is a term used to describe the distortion of the radiated signal which is caused by the signal being deflected off either stationary or moving objects such as aircraft or vehicles in the localizer or glide slope critical area(s).

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this incident to be:

Interference with the localizer signal resulting in a Multipath condition experienced by CAL5148 while conducting an ILS CAT III (autoland) approach. This condition resulted in a runway excursion and subsequent go-around. The interference was most likely caused by a previous departure flying through the ILS critical area while departing the same runway.

Findings

Environmental issues	Localizer - Effect on equipment

Factual Information

History of Flight

Landing	Runway excursion
Landing	Miscellaneous/other
Landing-aborted after touchdown	Miscellaneous/other (Defining event)

CAL5148 was performing an Instrument Landing System (ILS) autoland approach under conditions that allowed for the exception listed in FAA Order JO 7110.65, *Air Traffic Control* paragraph 3-7-5a1(a)(2) to be applied. Envoy flight 3544 (ENY3544) had departed runway 10L but was still over the ILS critical area while CAL5148 was attempting to land. Audio recordings of ATC communications were provided by the FAA and were used in producing the following timeline. Times are in CDT and rounded to the nearest minute, and altitudes are in feet above mean sea level (msl).

0956 The KORD ATCT local control (LC) controller instructed ENY3544 to line up and wait on runway 10L. At the same time, CAL5148 was on a 4-mile final for the same runway.

0957 CAL5148 reported inbound on the ILS runway 10L and was instructed by the LC controller to continue inbound and expect clearance in approximately 2 miles.

0957 ENY3544 was cleared for takeoff by LC controller.

0958 The LC controller cleared CAL5148 to land runway 10L and advised the pilot of traffic [ENY3544] departing the same runway.

0958 CAL5148 crossed landing threshold at about 700 feet msl (less than 100 feet above the ground).

0959 The first officer of DAL2012 holding short of runway 10L at taxiway DD stated "goin off the runway."

0959 CAL5148 reported going around due to "last minute deviation on the runway."

While on short final and attempting to land, CAL5148 drifted left of the runway centerline and the left main landing gear touched down left of the runway, but still on the paved surface. The airplane then traveled into the grass between taxiway DD and taxiway N1 leaving deep ground scarring and damaging a windsock. Figure 1 shows the accident airplanes flight track overlaid on satellite imagery in which the ground scarring can still be seen. CAL5148 executed a go-around and subsequently returned to the airport, landing on runway 9R without further incident at about 1020.

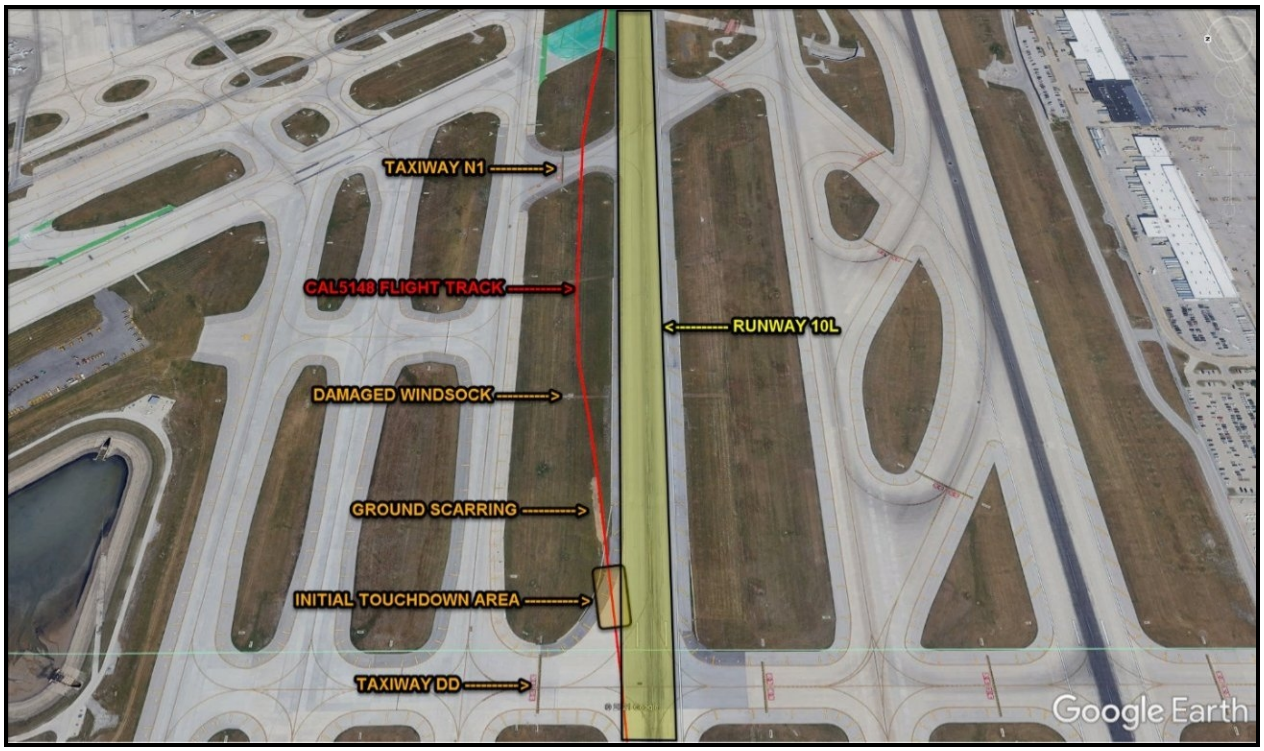

Figure 1. Figure showing a portion of CAL5148's flight track, with initial touchdown area and other pertinent information also illustrated.

Information

Certificate:	**Age:**
Airplane Rating(s):	**Seat Occupied:**
Other Aircraft Rating(s):	**Restraint Used:**
Instrument Rating(s):	**Second Pilot Present:**
Instructor Rating(s):	**Toxicology Performed:**
Medical Certification:	**Last FAA Medical Exam:**
Occupational Pilot:	**Last Flight Review or Equivalent:**
Flight Time:	

Aircraft and Owner/Operator Information

Aircraft Make:	Boeing	**Registration:**	B-18711
Model/Series:	747	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Transport	**Serial Number:**	Foreign
Landing Gear Type:	Tricycle	**Seats:**	
Date/Type of Last Inspection:		**Certified Max Gross Wt.:**	
Time Since Last Inspection:		**Engines:**	
Airframe Total Time:		**Engine Manufacturer:**	
ELT:		**Engine Model/Series:**	
Registered Owner:		**Rated Power:**	
Operator:		**Operating Certificate(s) Held:**	Foreign air carrier (129)
Operator Does Business As:		**Operator Designator Code:**	SAJF

Meteorological Information and Flight Plan

Conditions at Accident Site:	Instrument (IMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KORD,680 ft msl	**Distance from Accident Site:**	0 Nautical Miles
Observation Time:	09:51 Local	**Direction from Accident Site:**	0°
Lowest Cloud Condition:		**Visibility**	2.5 miles
Lowest Ceiling:	Overcast / 600 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	12 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	60°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.78 inches Hg	**Temperature/Dew Point:**	19°C / 18°C
Precipitation and Obscuration:			
Departure Point:	Anchorage, AK (ANC)	**Type of Flight Plan Filed:**	IFR
Destination:	Chicago, IL (KORD)	**Type of Clearance:**	IFR
Departure Time:		**Type of Airspace:**	Air traffic control;Class D

KORD had an Automated Surface Observing System (ASOS) whose reports were supplemented by certified weather observers. The ASOS site was located at an elevation of 680 feet msl and had a 3° westerly magnetic variation.

Surface Observations

[0934 CDT] SPECI KORD 211434Z 06010KT 2SM RA BR OVC006 19/18 A2978 RMK AO2 LTG DSNT E P0019 T01890178=

[0951 CDT] METAR KORD 211451Z 06012KT 2 1/2SM RA BR OVC006 19/18 A2978 RMK AO2 LTG DSNT E SLP080 P0025 60056 T01890178 58001=

KORD weather at 0951 CDT, wind from 060° at 12 knots, 2 and a half statute miles visibility, moderate rain, mist, overcast ceiling at 600 feet agl, temperature 19° Celsius (C), dew point temperature 18° C, altimeter 29.78 inHg. Remarks, station with a precipitation discriminator, lightning distant to the east, sea level pressure 1008.0 hectoPascals (hPa), 0.25 inches of precipitation since 0851 CDT, 6-hourly precipitation of 0.56 inches, temperature 18.9° C, dew point temperature 17.8° C, 3-hourly pressure decrease of 0.1 hPa.

Terminal Aerodrome Forecast

Terminal Aerodrome Forecasts (TAF) were issued by the NWS for KORD and the KORD TAF that was valid at the time of the incident was issued at 0812 CDT and is provided below:

TAF KORD 2113/2218 07010KT 3SM -SHRA BR SCT005 OVC009
TEMPO 2113/2115 3/4SM +RA BR OVC005
FM 211500 08012G17KT 3SM RA BR VCTS SCT009 BKN015 OVC025CB
TEMPO 2115/2119 1 1/2SM +RA BR BKN009 OVC015
FM 212000 07012G17KT 5SM -SHRA BR SCT009 OVC012
FM 220100 07012KT 6SM -SHRA BKN010 OVC020
FM 220600 05012KT 5SM RA BR SCT007 OVC012

Between 0800 and 1000 CDT (on June 21), the forecast expected a wind from 070° at 10 knots, 3 miles visibility, light rain showers and mist, scattered clouds at 500 feet agl and an overcast ceiling of 900 feet agl. Temporary conditions were forecast between 0800 and 1000 CDT of 3/4 miles visibility, heavy rain, and an overcast ceiling of 500 feet agl.

Airport Information

Airport:	Chicago O'Hare Intl Airport KORD	**Runway Surface Type:**	
Airport Elevation:	861 ft msl	**Runway Surface Condition:**	Wet
Runway Used:	10L	**IFR Approach:**	ILS
Runway Length/Width:	13000 ft / 150 ft	**VFR Approach/Landing:**	

KORD was located 14 nautical miles northwest of Chicago, Illinois. It had an elevation of 680 feet, a 3° westerly magnetic variation, and had a latitude/longitude of 41-58-35.8640N 087-54-26.1110W (see figure 2).

The incident occurred during approach to runway 10L. Runway 10L was an asphalt and concrete grooved runway 13,000 feet in length and 150 feet wide. The declared landing distance for runway 10L was 12,246 feet. The runway was serviced by an ALSF 2 with standard 2,400-foot-high intensity approach lighting system with centerline sequenced flashers (category II or III), and a 4-light PAPI on the left of the runway (3° glide path).

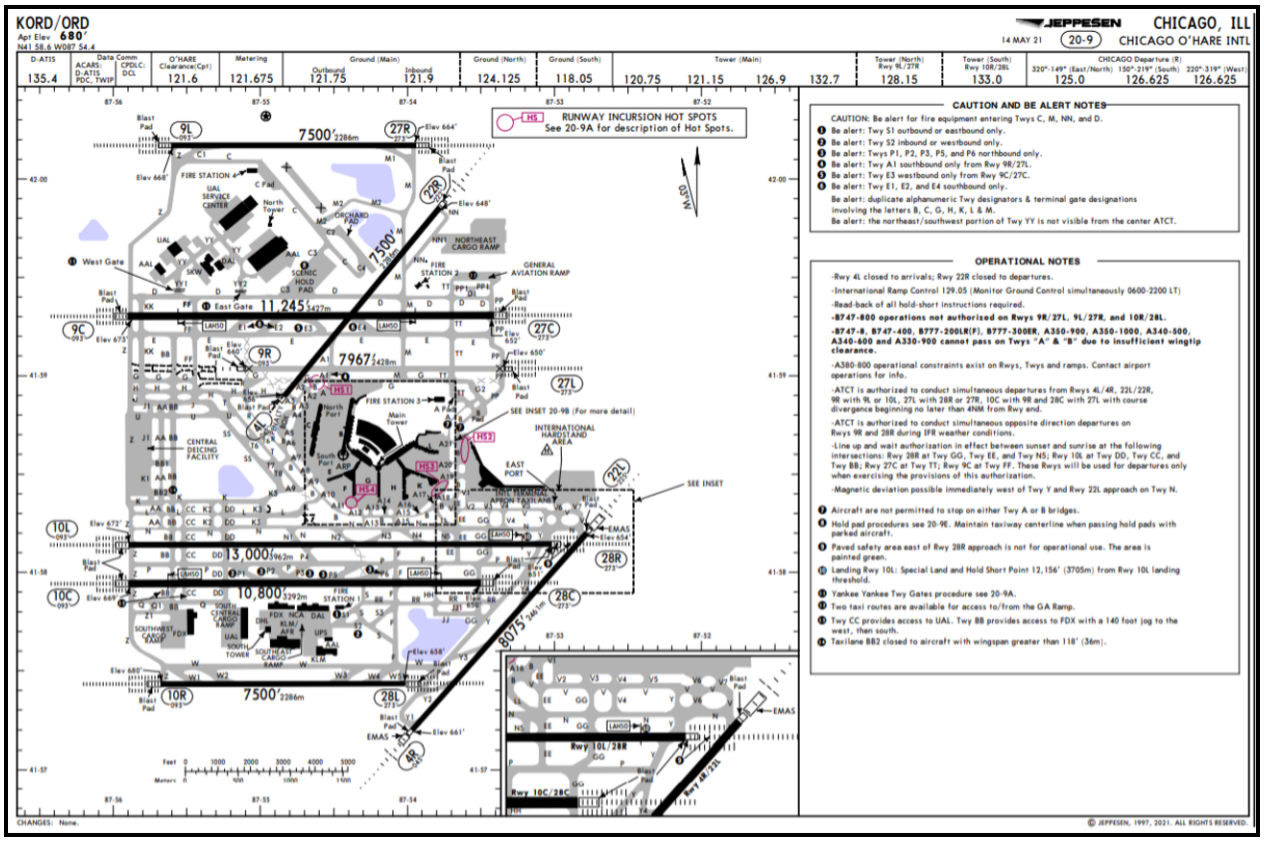

Figure 2. Chicago O'Hare International Airport (KORD) airport chart. [Source: Jeppesen]

Wreckage and Impact Information

Crew Injuries:	4 None	**Aircraft Damage:**	None
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	4 None	**Latitude, Longitude:**	41.969444,-87.918609

Deep ground scarring was visible near where the aircraft had touched down left of the runway on the paved surface and extending into the grass between taxiway DD and taxiway N1 (see figure 3).

Figure 3. Photographs of the ground scarring caused by the left main landing gear of CAL5148. [Source: FAA]

Flight recorders

The accident airplane was equipped with a Honeywell 4700 solid-state FDR that contained about 27 hours of flight data. The accident flight was the last flight of the recording, and its duration was about 5 hours and 52 minutes. The data were extracted normally.

The airplane was also equipped with a Honeywell CVR capable of recording 120 minutes of digital audio. It contained a two-channel recording of the last 120 minutes that power remained applied to the aircraft, however because power remained to the aircraft long after the event, all audio information from the accident flight was overwritten.

Tests and Research

Math modelling of this event was conducted by the FAA's National Resource Engineer for Navigation. The FAA applied a model that could consider if objects, like buildings and aircraft, could affect localizer and glide slope quality; however, this model was not capable of assessing the effects of an aircraft flying directly over the antenna. Therefore, an analysis was performed with ENY3544 located 2,800 feet from the localizer and 450 feet above the runway. Using several assumptions for aircraft orientation, the model's output was consistent with the localizer deviations determined from the CAL5148 FDR data (see figure 4).

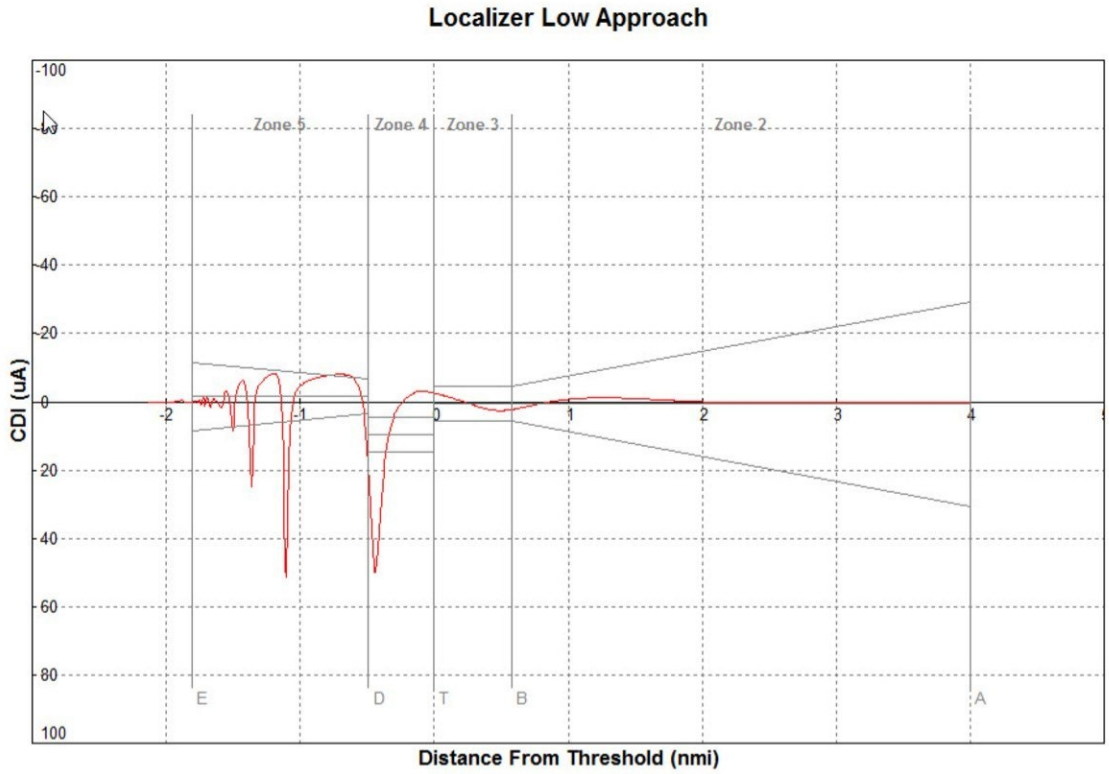

Figure 4. Graph displaying the simulation results of the math modelling conducted by the FAA.

The graph in figure 4 illustrates modelling simulation results of the effect of a regional jet [ENY3544] departing and overflying the runway 10L localizer at KORD. The location of the Regional Jet simulated was based on Airport Surface Detection Equipment – Model X (ASDE-X) surveillance data of the regional jet and B747 [CAL5148] positions around the time of the runway excursion. On the graph, the red line represents predicted deviations of the aircraft course deviation indicator for the localizer. The vertical scale is the predicted deflection in micro-amps. For an aircraft course deviation indicator, 150 micro-amps would produce full-scale deflection of the indicator. The horizontal scale is the B747 position referenced to runway threshold. The distance labels "0" and "T" are at the threshold. The numerical values are in nautical miles. The letters are used to illustrate flight inspection areas of interest. Point "D" is 3,000 feet down the runway from the threshold and is the end of the touchdown zone. The deviation beginning 0.25 mile from threshold would lead the aircraft to turn left to continue to follow the localizer course line during an autoland approach. Upon completion, the National Resource Engineer for Navigation who performed the modelling wrote, *"I am 90% confident that the location of departing ENY3544 caused sufficient Multipath (signal reflection) to produce a fly left indication to arriving CAL5148."*

Administrative Information

Investigator In Charge (IIC):	Soper, Brian
Additional Participating Persons:	Eric West; Federal Aviation Administration; Washington, DC Dan Carrico; National Air Traffic Controller's Association; Chicago, IL Simon Lie; The Boeing Company; Seattle , WA
Original Publish Date:	May 19, 2022 **Investigation Class:** 3
Note:	The NTSB did not travel to the scene of this incident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=97552