

National Transportation Safety Board
Office of Research and Engineering
Washington, D.C. 20594

Radar Performance Study

Specialist Report Timothy Burtch

A. ACCIDENT

Location: Detroit, Michigan
Date: December 3, 2019
Time: 1334 GMT (0834 EST)
Airplane: BAE 125 Series 800A, N469RJ
NTSB Number: CEN20LA028

B. GROUP

No vehicle performance group was formed.

C. SUMMARY

On December 3, 2019, about 0834 eastern standard time (EST), a BAE 125-800A, N469RJ, impacted terrain during an instrument landing system (ILS) approach to runway 33 at the Coleman A. Young Municipal Airport (DET) near Detroit, Michigan. The airline transport pilot and copilot were uninjured. The airplane's right wing sustained substantial damage during the impact with terrain.

The airplane was registered to and operated by Business Jet Managers Inc. as a Title 14 Code of Federal Regulations Part 91 repositioning flight for a subsequent Part 135 flight. Day visual meteorological conditions prevailed in the area about the time of the accident, and the flight was operating on an instrument flight rules flight plan. The flight originated from the Willow Run Airport (YIP) near Detroit, Michigan about 0819 EST.

[Note: Times in the study are quoted in EST or Greenwich Mean Time (GMT). EST = GMT – 5 hr.]

D. THE AIRPLANE

A picture of the accident airplane, a BAE 125 Series 800A, is shown in Figure 1. The airplane was manufactured by British Aerospace in 1986.

E. WEATHER SUMMARY

METAR KDET 031253Z 26008KT 10SM OVC011 M01/M03 A2987 RMK AO2 SLP121 T10111028=

On December 3rd, at 0753 EST, the surface weather observation at DET was reporting wind 260° at 8 knots (kt); 10 statute miles visibility; overcast clouds at 1,100 feet (ft) above the ground (agl); temperature -1° Celsius (C); dew point -3°C; altimeter 29.87" mercury. Remarks: automated station with a precipitation discriminator, sea level pressure 1012.1 hectopascal (hPa), hourly temperature -1.1° C, dew point -2.8° C.

Images provided by the National Center for Atmospheric Research included the Current Icing Product (CIP) valid for 0700 EST and 0800 EST on the day of the accident. The CIP are shown in Figures 2 through 5. The figures indicate a greater than 65% probability of light icing conditions at altitudes of 1,000 ft and 3,000 ft over eastern Michigan in the vicinity of the accident. No icing was forecast at 6,000 ft.

Figure 6 depicts an AIRMET for moderate icing from the surface to 7,000 ft around the time of the accident. See the NTSB Meteorology Weather Study for more details about the accident weather conditions.

F. RADAR STUDY

The accident airplane was equipped with a Cockpit Voice Recorder (CVR) but did not have nor was it required to have a Flight Data Recorder (FDR). As a result, the data used in the study are largely from secondary radar returns (transponder code 5206) recorded by the short-range Airport Surveillance Radar (ASR-9) located at the Detroit Metropolitan Wayne County Airport, DTW, approximately 20 NM southwest of the accident site.

Short-range radar have approximately a 60 NM range and an inherent uncertainty of ± 2 Azimuth Change Pulses (ACP) = $\pm (2 \text{ ACP}) \times (360^\circ / 4096 \text{ ACP}) = \pm 0.176^\circ$ in azimuth, ± 50 ft in altitude, and $\pm 1/16$ NM in range.

An overview of the accident airplane's radar ground track from Willow Run to Coleman Young Municipal airport with paraphrased CVR comments and approximate GMT is shown in Figure 7. The airplane approached DET from the west and flew an extended left base to runway 33 while receiving radar vectors from air traffic control and capturing the instrument landing system (ILS) signals to runway 33.

The flight progressed without incident according to radar and CVR data. Altitude and radar-derived airspeed for the short 15-minute flight are shown in Figure 8. Figure 9 highlights the final 6 minutes of the flight. (Note: Figures 8 and 9 also contain data from a second airplane, N122LJ, that will be discussed later.) However, at 0834:04, airport security video captured N469RJ over the runway 33 threshold and entering an abrupt right-wing-down roll that resulted in the right wingtip striking the runway at about 0834:06. See Figure 10.

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Pictures of the airplane's left wing taken as the airplane sat on the grass infield adjacent to runway 33 after the accident are shown in Figures 11 and 12. In addition to the ice on the ground underneath the left wing (that had broken off), ice accretions still attached to the left wing leading edge can be seen. The ice on the right wing likely broke off when the wing struck the runway¹.

The BAE 125-800A is equipped with an anti-ice system to prevent ice on the windshield and a de-ice system that removes ice on the leading edge of the wing and tail using the TKS fluid-based system². The CVR indicates that the flight crew primed the TKS system before take-off, and the flight crew reported that they continued to run the system for the duration of the flight.

The Performance Sub-Section 5.8, Landing Procedures and Speeds, in the BAE 125-800A Airplane Flight Manual (AFM) states:

If icing conditions exist, or if ice has formed on the unprotected parts of the airframe prior to approach, add 10 knots to the normal approach and landing speeds. Landing Distance is increased by 15%.

Vref was calculated by the flight crew to be 128 KIAS based on a landing weight of 22,300 lb. According to the AFM, the normal approach speed is Vref + 10 kt. This results in a minimum normal approach speed of 138 KIAS for the accident flight; however, since ice was observed on the airframe, an approach speed of 148 KIAS was appropriate as per the AFM. After the accident, the flight crew reported flying approach speeds between 140-145 KIAS³.

¹ The co-pilot reported an ice build-up on the right wing at 1328:15 on the CVR, two minutes after descending to 3,000 ft. Cloud tops were reported at 3,000 ft by the flight crew.

² The TKS (Tecalemit-Kilfroth-Sheepbridge Stokes) Ice Protection System, manufactured by CAV Ice Protection, is a fluid-based ice protection system originally developed in World War II. The system pumps a fluid through holes in the leading edges of wings and stabilizers that depresses the freezing point of moisture encountered.

³ Radar-derived approach airspeeds were between 130 KIAS and 145 KIAS.

G. SUMMARY AND CONCLUSIONS

N469RJ was not equipped with a flight data recorder. However, airport security video shows the airplane entering an abrupt right-wing-down roll over the runway threshold that resulted in the right wingtip striking the runway.

The right roll was likely due to the right wing angle-of-attack (AOA) exceeding the critical AOA as a result of ice. Adding 10 kts to the normal approach speed for ice as recommended by the airplane manufacturer would have provided N469RJ with additional stall margin.

Figure 13 shows the radar ground track of a second BAE 125-800A, N122LJ, that landed at DET 26.5 minutes before N469RJ (in cyan). As previously mentioned, altitude and radar-derived airspeed for N122LJ are also shown in Figures 8 and 9. After shifting the data to account for the 26.5 minute time difference, the altitude and airspeed during approach for the two flights are similar.

The pilot of N122LJ stated that they too conducted a normal approach (based on a landing weight of 23,000 lb) with full flaps using a reference speed of 130 KIAS. The recommended 10 kt additive for ice was not applied. However, after landing, the flight crew noticed some ice on the unprotected surfaces. A combination of the slightly earlier flight time and the approach made from the east may explain the better outcome for N122LJ⁴.

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⁴ Textron reviewed the photographs in Figures 11 and 12 and the ice accumulation for the 15-minute flight. Textron assessed the ice accretion as appearing to be in the moderate range. They also stated that the TKS system on the BAE 125-800A, if operating properly and turned on at the appropriate time, should have been sufficient to clear the ice. Textron reiterated that the AFM instructs flight crews to increase the approach speed to account for icing conditions.

H. FIGURES



Figure 1: Accident Airplane, N469RJ, a BAE 125-800A

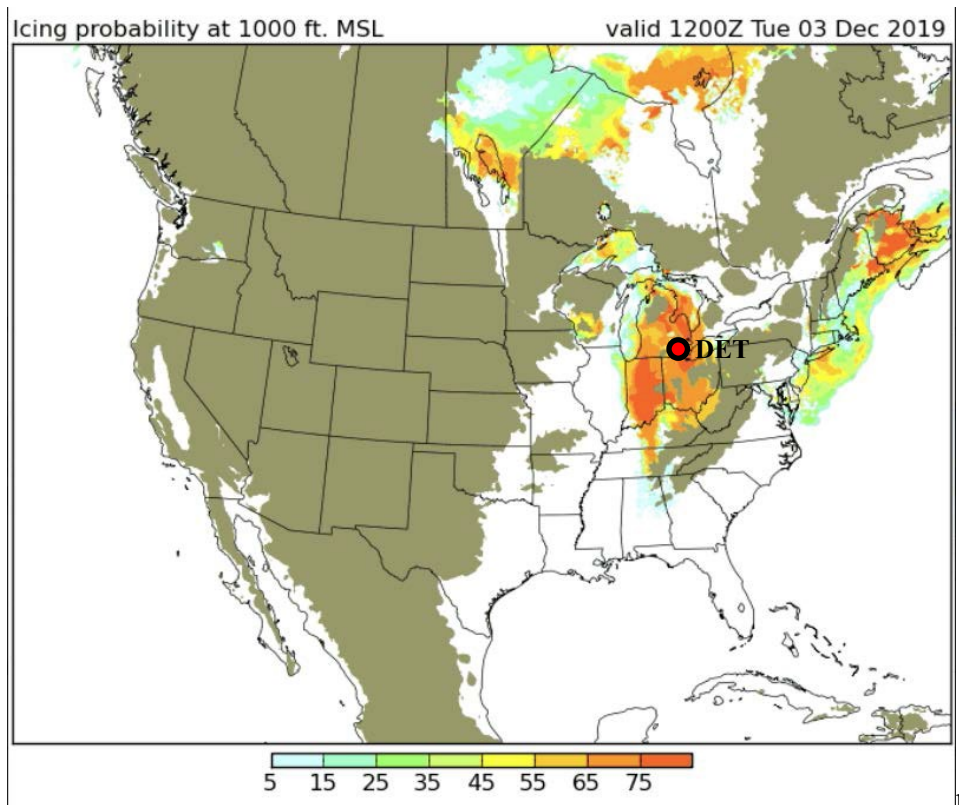


Figure 2: CIP Icing Probability for 1,000 ft at 0700 EST

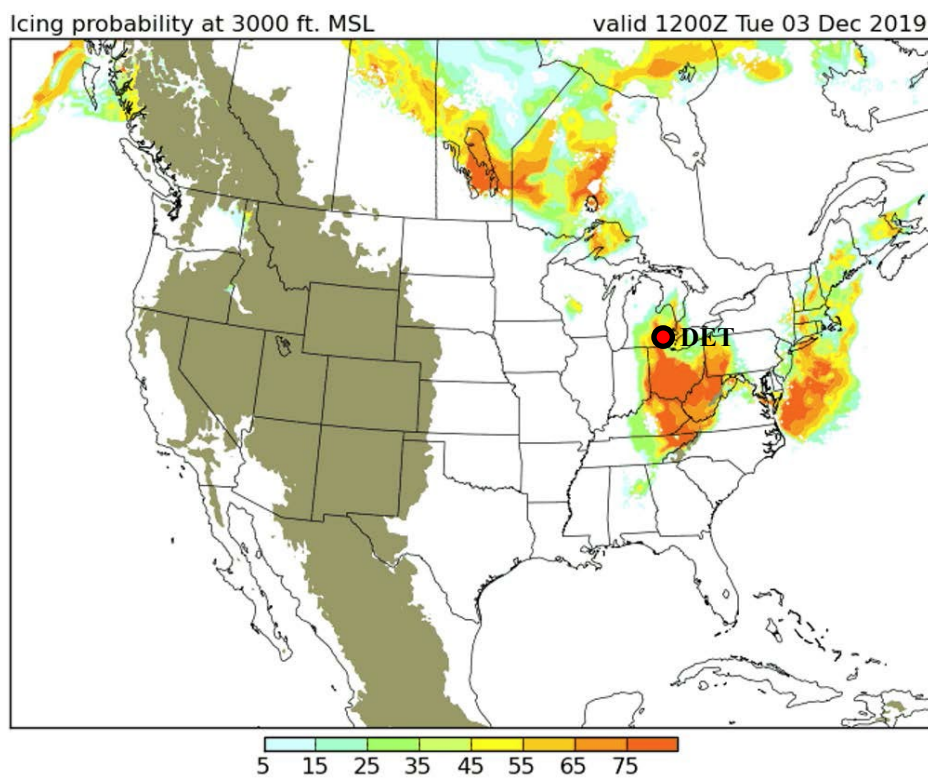


Figure 3: CIP Icing Probability for 3,000 ft at 0700 EST

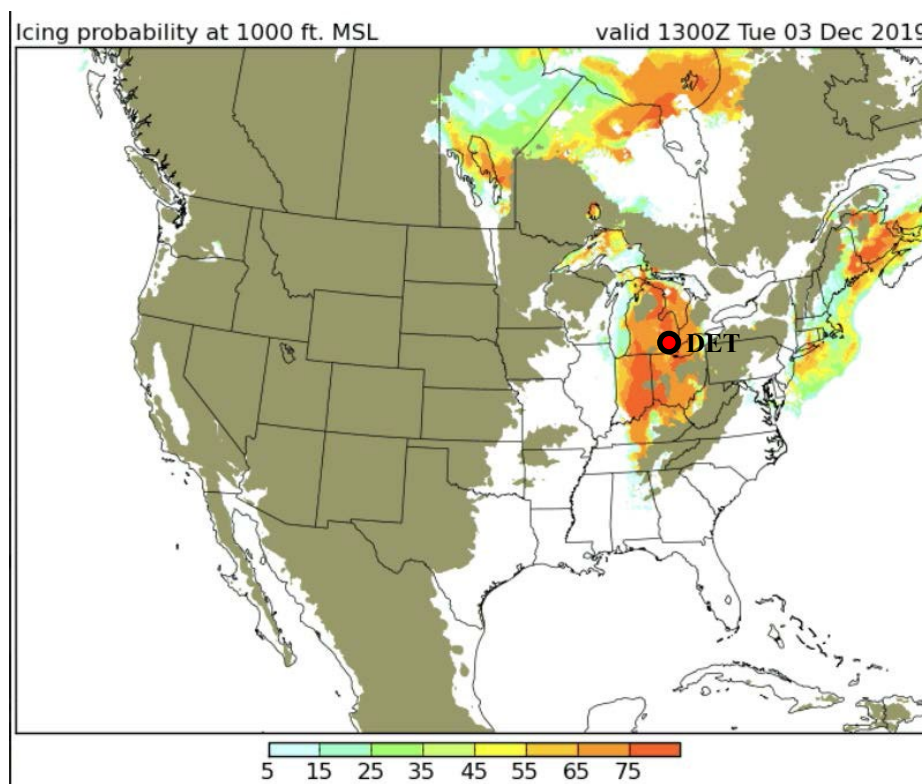


Figure 4: CIP Icing Probability for 1,000 ft at 0800 EST

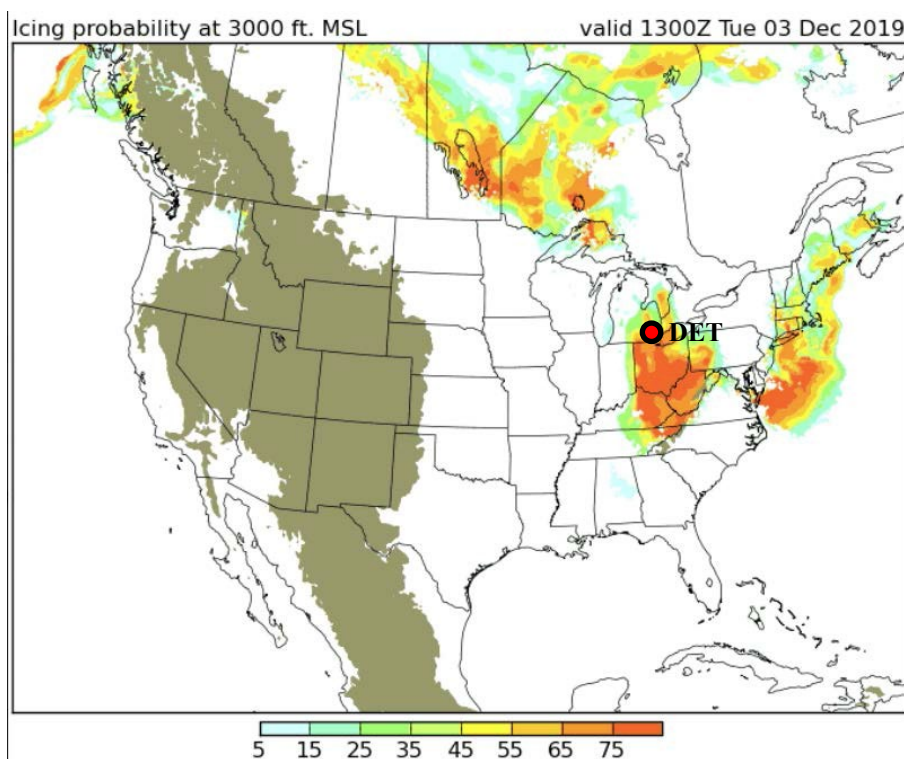


Figure 5: CIP Icing Probability for 3,000 ft at 0800 EST

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ZULU 2019-12-03 12:00:00

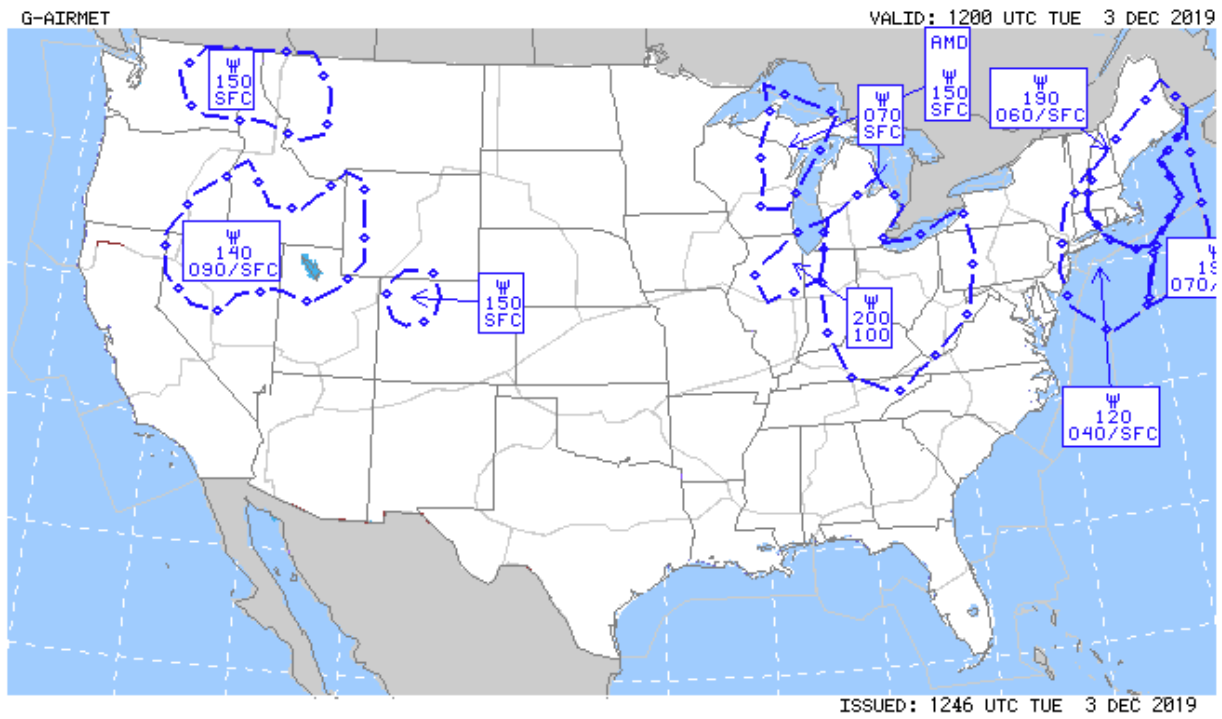
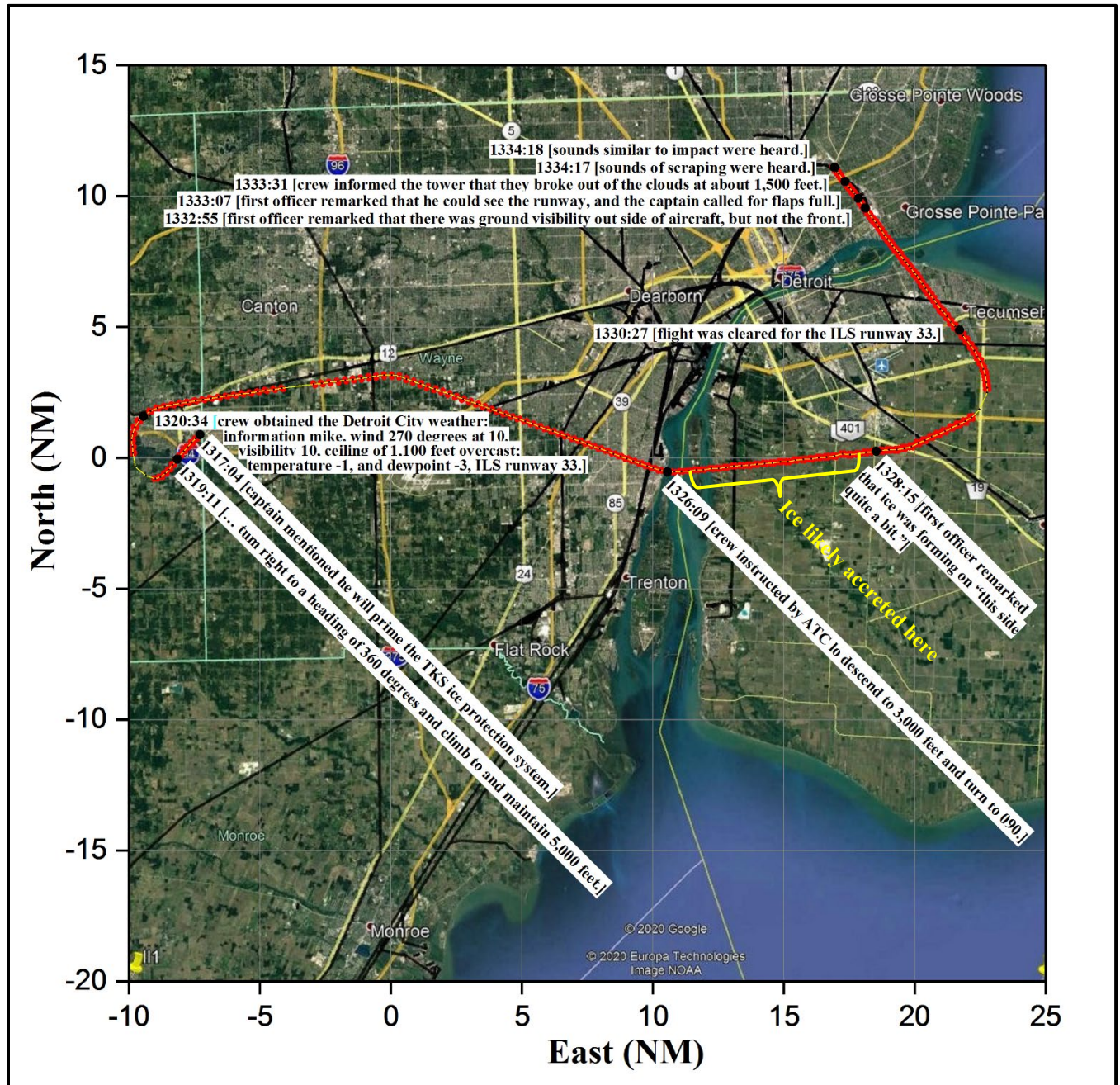


Figure 6: G-AIRMET Zulu for Moderate Icing from the Surface to 7,000 ft at 0700 EST

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**Figure 7: Radar Ground Track from YIP to DET for N469RJ
 with Paraphrased CVR Comments in GMT**

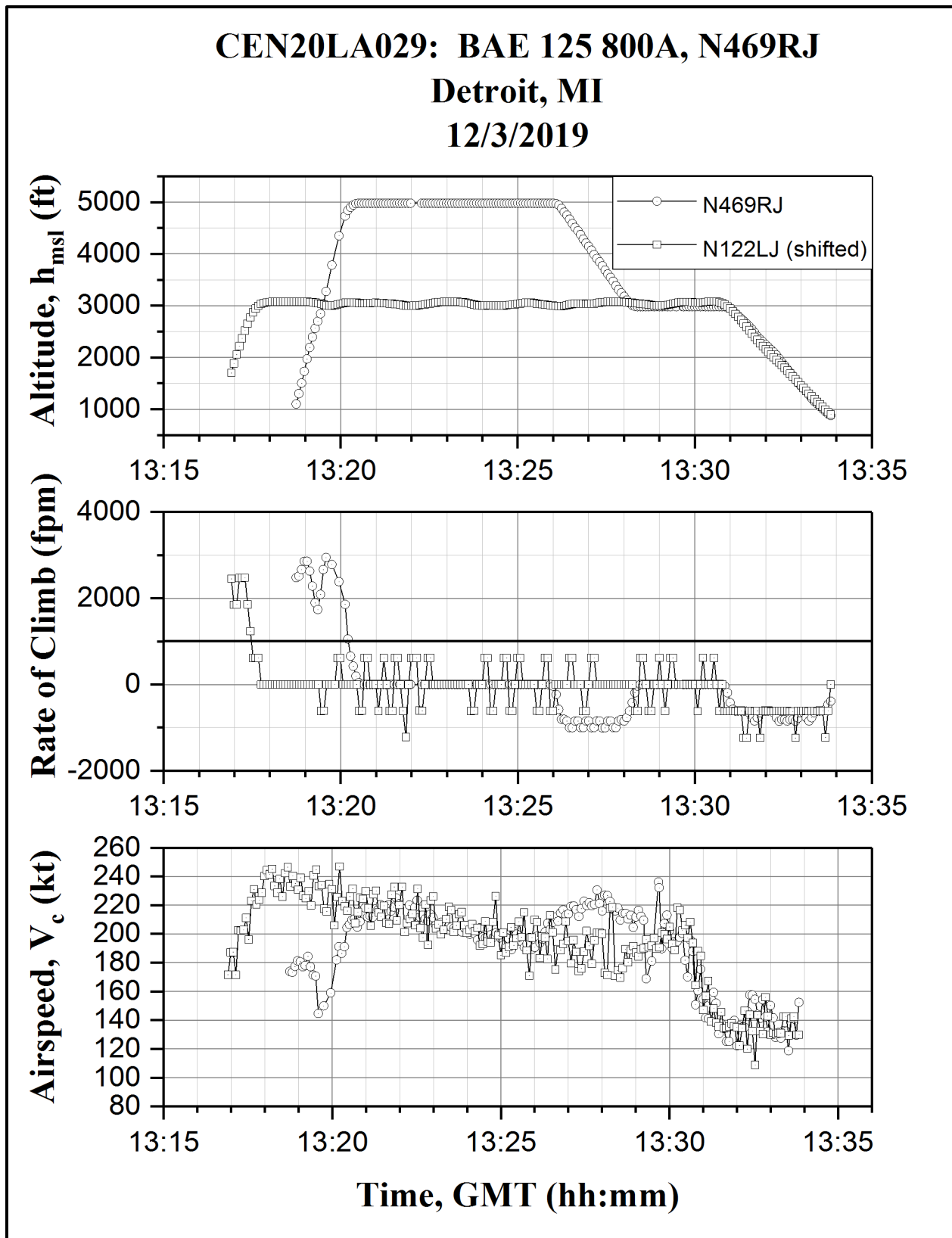


Figure 8: Airspeed and Altitude Derived from Radar for N469RJ

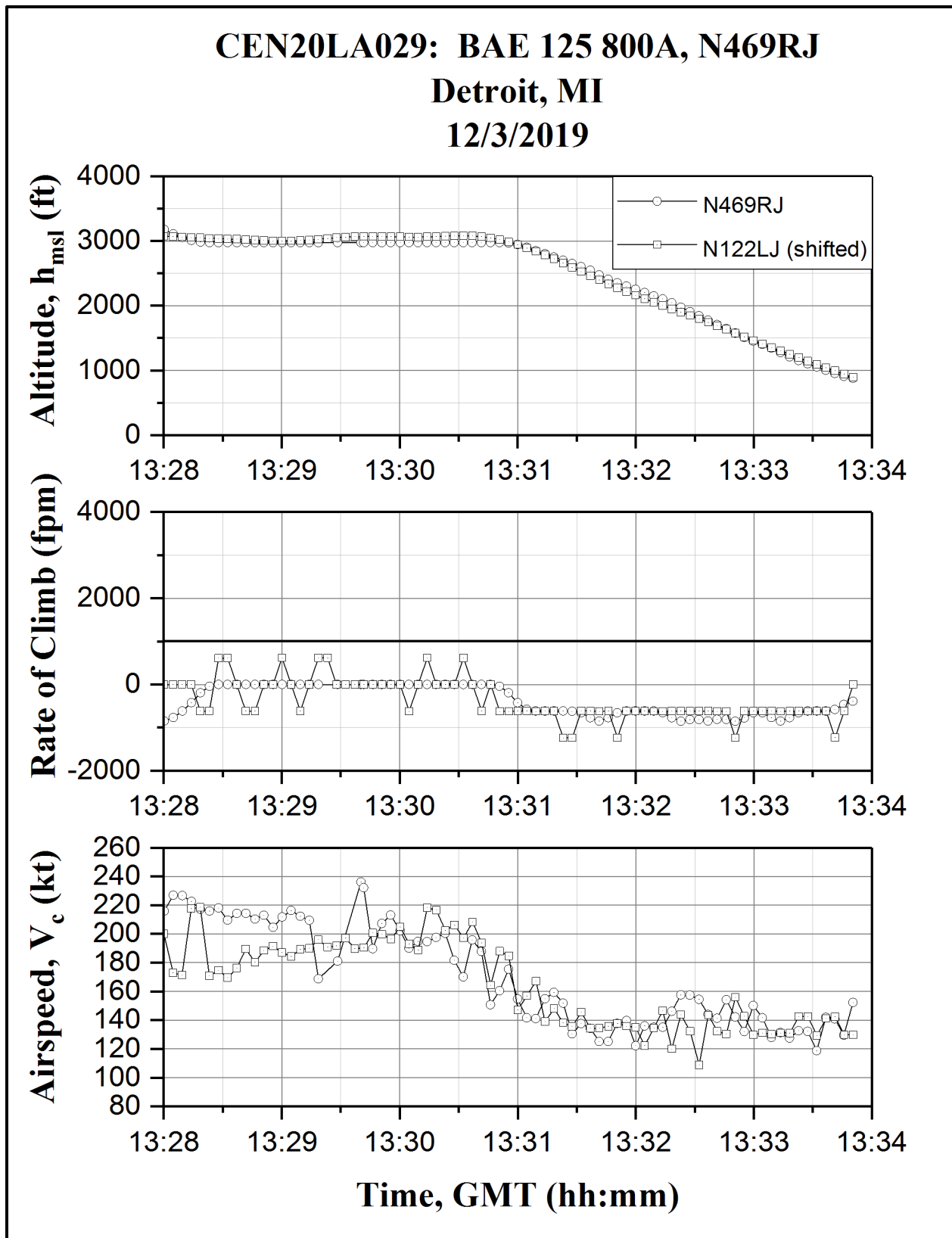


Figure 9: Airspeed and Altitude Derived from Radar for the Final the Minutes of Flight

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Figure 10: Video Stills from Airport Security Camera



Figure 11: Photo of Ice on Left Wingtip after the Accident (source: FAA)



Figure 12: Photo of Ice on Ground after the Accident (source: FAA)

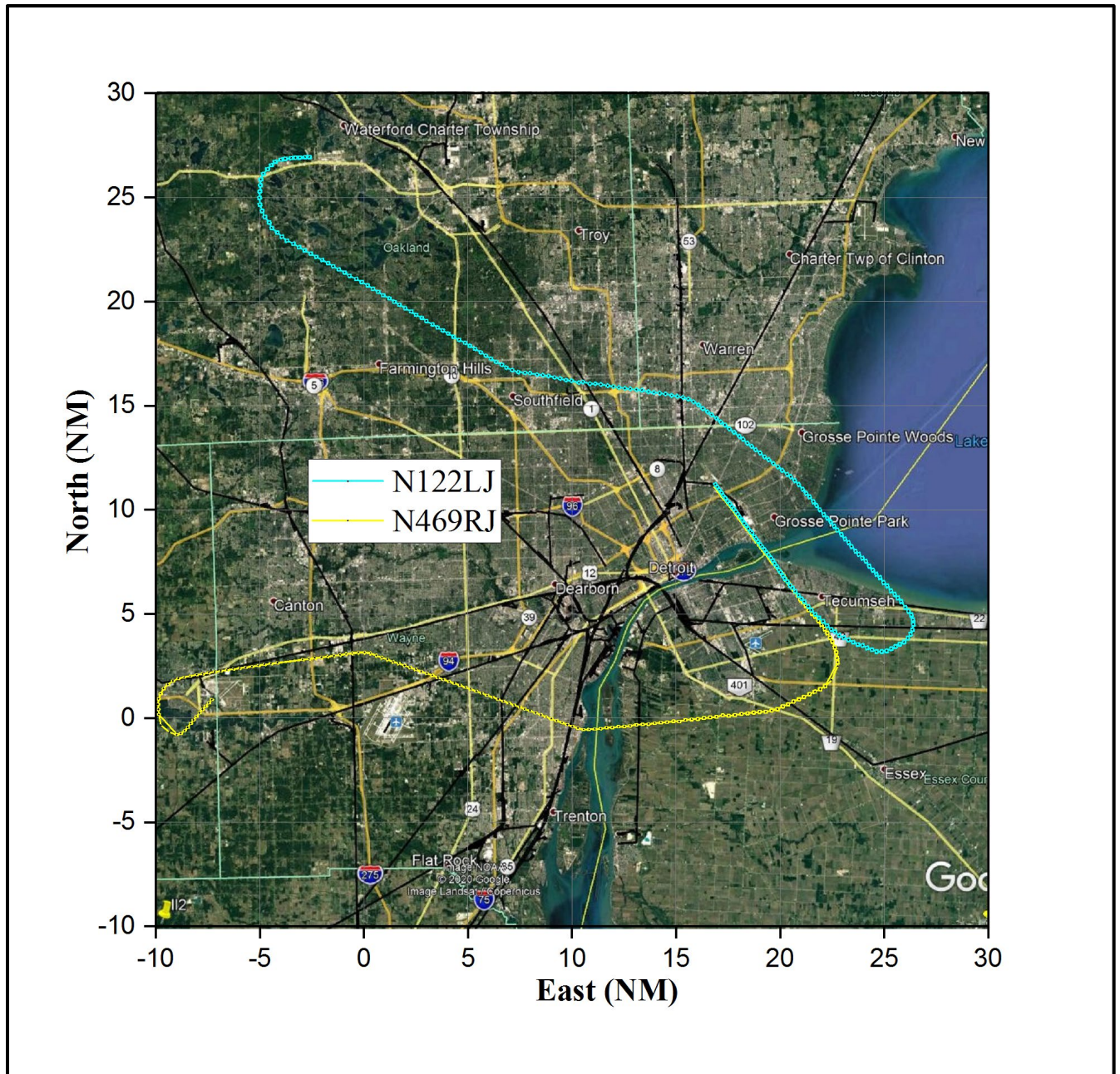


Figure 13: Radar Ground Track of N469RJ and N122LJ
N122LJ, also a BAE 125-800A, Landed 26.5 Minutes Before N469RJ without Incident