

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



CEN22FA208

AIRPLANE PERFORMANCE STUDY

October 17, 2023

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A. ACCIDENT

Location: Broomfield, Colorado
Date: May 22, 2022
Time: 1149 MDT
1749 GMT
Airplane: Piper PA-32-260 Cherokee Six, N85CT

B. AIRPLANE PERFORMANCE STUDY

No airplane performance group was formed.

C. ACCIDENT SUMMARY

On May 22, 2022, about 1149 mountain daylight time (MDT), a Piper PA-32-260 "Cherokee Six", N85CT, was substantially damaged when it was involved in an accident near Broomfield, Colorado. The pilot and pilot-rated passenger sustained fatal injuries. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

According to the Preliminary report for this accident, the airplane departed Erie Municipal Airport (EIK) on Runway 16. About 3,000 ft from the departure end of the runway, the airplane made a left turn, descended, and impacted terrain. See Figures 1 and 2.

The airplane impacted a grassy area of a residential community. About 35 ft beyond the initial impact, six propeller strike marks spaced about 1 ft apart were located on a paved road. The airplane bounced and subsequently impacted a large tree about 100 ft from the propeller strike marks, which resulted in the engine/cockpit area separating from the remainder of the fuselage.

Times in the study are quoted in MDT. Greenwich Mean Time (GMT) = MDT + 6 hr.

D. THE AIRPLANE

A picture of the accident airplane, a Piper PA-32-260 Cherokee Six, N85CT, is shown in Figure 3. The airplane was manufactured by Piper Aircraft in 1966 and is registered to AEROBSESSION, LLC.

E. WEATHER SUMMARY

A routine weather observation for Erie Municipal Airport about six minutes after the accident was reported as:

KEIK 221755Z AUTO 19008KT 10SM BKN046 BKN075 12/M01 A3020

The automated surface weather observation at Erie Municipal Airport on May 22 at 1155 MDT reported wind from 190° at 8 knots (kt); 10 statute miles visibility; broken ceiling at 4,600 ft above ground level (agl), broken clouds at 7,500 ft agl; temperature 12° Celsius (C) / 54° Fahrenheit (F), dew point -1°C/30°F; altimeter 30.20" of mercury.

F. AIRPLANE PERFORMANCE STUDY

The airplane performance study is based largely on data from a Dynon SV HDX1100 primary flight display (PFD) and multi-function display (MFD) that were recovered. See the "Cockpit Displays" Specialist's Factual report for additional details.

Altitude and airspeed data recorded on the Dynon HDX1100 during take-off are shown in Figure 4 for the accident flight as well as for a take-off on the same runway three weeks earlier¹. Rotation on both flights was at about 60 kt. However, on the accident flight, the airplane did not accelerate much beyond the rotation speed, and the rate of climb (ROC) was 200-300 feet per minute (fpm) less than the previous take-off. The airplane was airborne less than a minute and reached a maximum altitude of 5,300 ft above mean sea level (msl) or about 230 ft agl before abruptly pitching down, descending, and impacting the ground.

Figure 5 indicates that the airplane pitched up to over 20° during the accident take-off attempt, approximately twice the pitch attitude obtained during the previous take-off. The airplane banked left to about 30° during the accident flight and 30° to the right during the earlier take-off: runway 16 at EIK has a right traffic pattern.

The Piper Cherokee Six Owner's Handbook indicates a take-off distance of approximately 1,300 ft is required at a "standard altitude" or density altitude² of about 5,100 ft and a take-off weight of 2,900 lb³. See Figure 6. The manufacturer's performance data along with the 4,700 ft of runway available on EIK runway 16 indicate that N85CT should have had sufficient runway to successfully take-off.

¹ The previous take-off occurred 4/30/22 on runway 16 about the same time of day.

² The pressure altitude was approximately 4,840 ft and the temperature was 12°C.

³ This is about 300 lb more than the estimated accident take-off weight of 2,600 lb. The elevation of EIK is listed as 5119.4 ft.

To better understand the reduced take-off performance during the accident flight, engine data recorded on the Dynon HDX1100 for the accident was compared with equivalent data from the flight three weeks earlier. Figures 7 through 15 compare exhaust gas temperatures (EGT), fuel flows, engine RPM, and manifold pressures for the two take-offs.

The EGT's on cylinders #1, #5, and #6 were 70°F, 65°F, and 130°F hotter for the accident take-off compared to the previous take-off, respectively, while cylinders #2, #3, and #4 had similar EGT's. In addition, the fuel flow was 5 gph less (16 gph vs. 11 gph) on the accident take-off (or about 45%) while the engine RPM and manifold pressure during the two take-offs were similar.

Fuel flow is proportional to engine horsepower (hp) and can be used to estimate the horsepower being produced by the engine. The Piper 32-260 uses the six-cylinder, horizontally opposed Lycoming O-540 reciprocating engine. The O-540 has a brake specific fuel consumption (BSFC) of approximately 0.4075 lb/hp per hour at peak power. The fuel flow, BSFC, and the approximate 6 lb/gal weight of aviation fuel can be used to estimate brake horsepower (BHP), or the power delivered to the propeller shaft: 14.72 BHP for every 1 gal/hr (gph).

The recorded fuel flows shown in Figure 13 average about 11 gph during the accident take-off in the final five seconds and equivalently 16 gph during the previous take-off. The resulting horsepower estimates are:

- $14.72 \text{ BHP/gph} \times 11 \text{ gph} = 162 \text{ BHP}$ in final five seconds of the accident flight
- $14.72 \text{ BHP/gph} \times 16 \text{ gph} = 235 \text{ BHP}$ for previous take-off (or about 45% more)

Note: the Lycoming O-540 is rated at 260 BHP at sea level standard temperature and a peak power fuel flow, whereas the estimates above use fuel flows recorded at the actual conditions.

In addition to fuel flow, the Dynon records "percent power". The percent power parameter recorded by the Dynon at 1149:52 (just before impact) was 64% and is shown in Figure 16. Assuming it is a percent of the 260 BHP rated horsepower, the recorded horsepower was 64% or $260 \text{ BHP} \times 0.64 = 166 \text{ BHP}$. This compares well with the horsepower estimated from fuel flow in the accident. However, on the previous take-off, the Dynon recorded about 75%, which would equate to about 195 BHP, substantially less than the 235 BHP calculated from the fuel flow.

Finally, Lycoming Power Chart #12955 at the manifold pressure, RPM, altitude, and temperature recorded at 1149:52 and shown in Figure 17 results in a peak power of approximately 215 BHP. While this is 33% more than the accident fuel-flow based power estimate and 30% more than the recorded Dynon percent power, this is to be

expected: the Lycoming Power Chart assumes a fuel flow that is higher than that recorded in the accident.

G. STUDY SUMMARY AND CONCLUSIONS

The airplane performance during the accident take-off was less than that recorded during the previous take-off which occurred three weeks earlier on the same runway and about the same time of day. During the accident flight, the airplane did not accelerate much beyond the 60 kt rotation speed, and the recorded percent power was slow to respond relative to the previous take-off. The recorded fuel flow was about 45% less on the accident flight.

The reason for the lower fuel flow could not be determined. However, one possibility is that the pilot of N85CT leaned the mixture during extended ground operations and subsequently forgot to enrichen the mixture before take-off. N85CT was idling on the ground for about an hour before the attempted take-off according to the recorded data⁴, and leaning the mixture would be appropriate to avoid fouling the spark plugs.

A second possibility for the lower fuel flow is carburetor ice. Carburetor ice can affect the fuel flow by disturbing the venturi effect in the carburetor throat that draws fuel into the cylinders. The result is lower fuel flows and higher EGT's.

Figure 18 is an excerpt from the FAA Pilot's Handbook of Aeronautical Knowledge and suggests that carburetor ice was not likely⁵. Alternatively, Figure 19 includes the carburetor icing possibility as predicted by the National Weather Services' (NWS) High-Resolution Rapid Refresh Model (HRRR). The HRRR model shows a possibility of carburetor ice between 5,000 ft and 10,000 ft msl with the greatest potential between 7,000 ft and 9,000 ft msl.

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⁴ The airplane recently had new avionics installed, and the pilot may have been reviewing the operation of the new equipment.

⁵ Relative humidity from the Meteorology Preliminary Event Review Worksheet

H. FIGURES

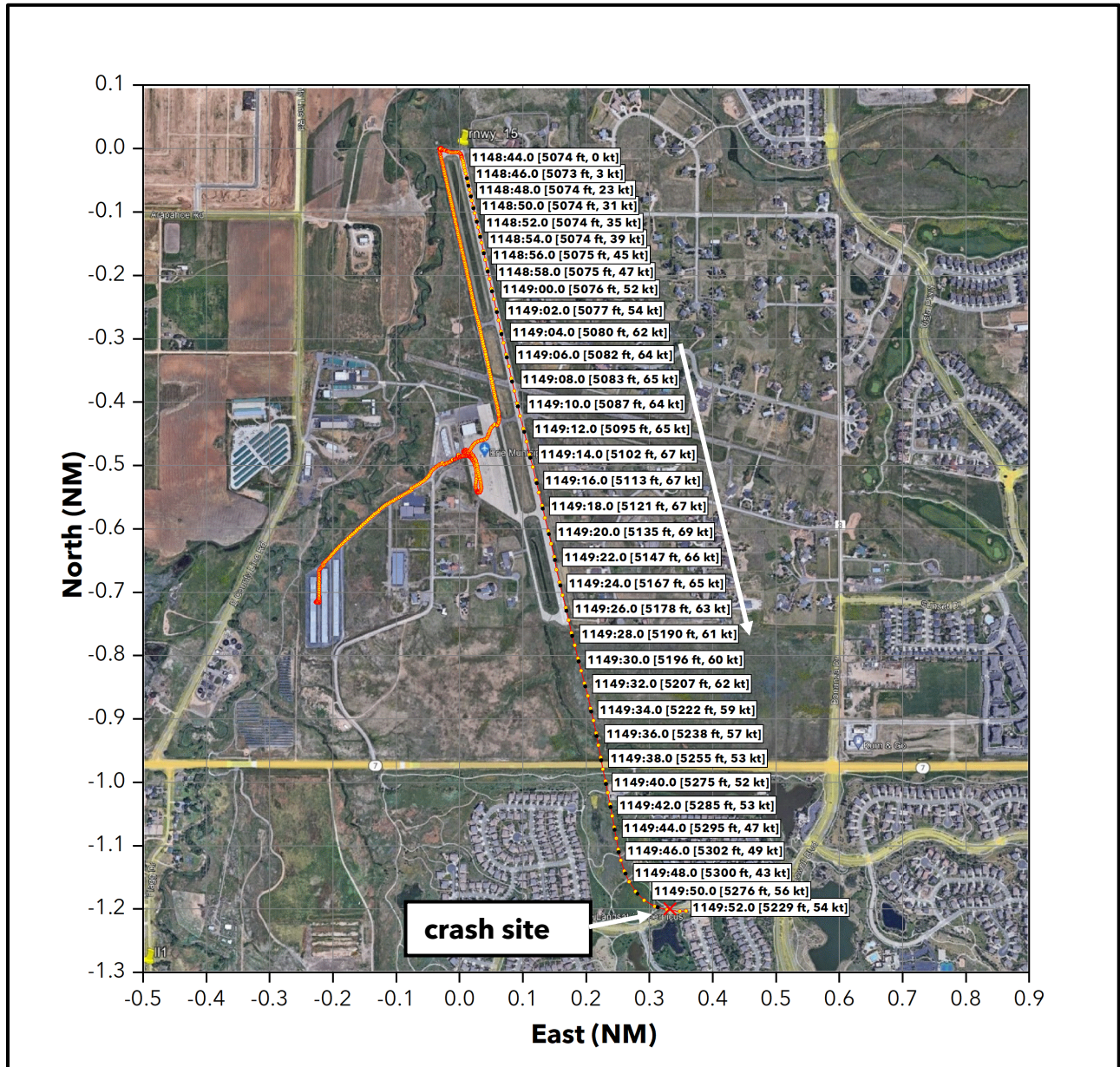


Figure 1: Overview of Accident Take-off from Erie Municipal Airport Runway 16 with Recorded Altitude and Indicated Airspeed

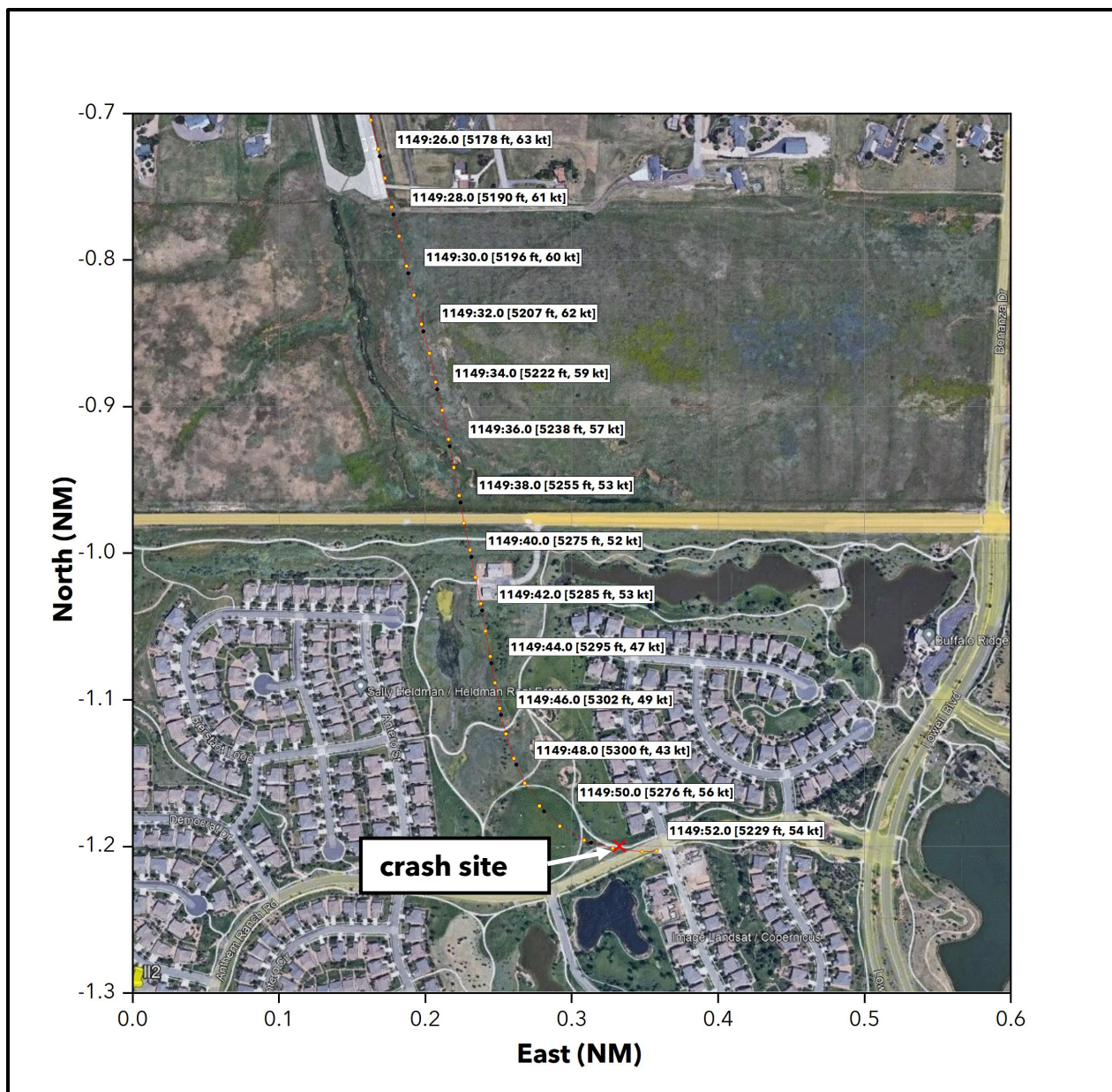


Figure 2: Overview of Accident Site with Recorded Altitude and Indicated Airspeed



Figure 3: Accident Airplane, N85CT, a Piper 32-260 Cherokee Six, N85CT

CEN22FA208: Piper PA-32-260 Cherokee Six, N85CT **Broomfield, CO** **5/22/2022**

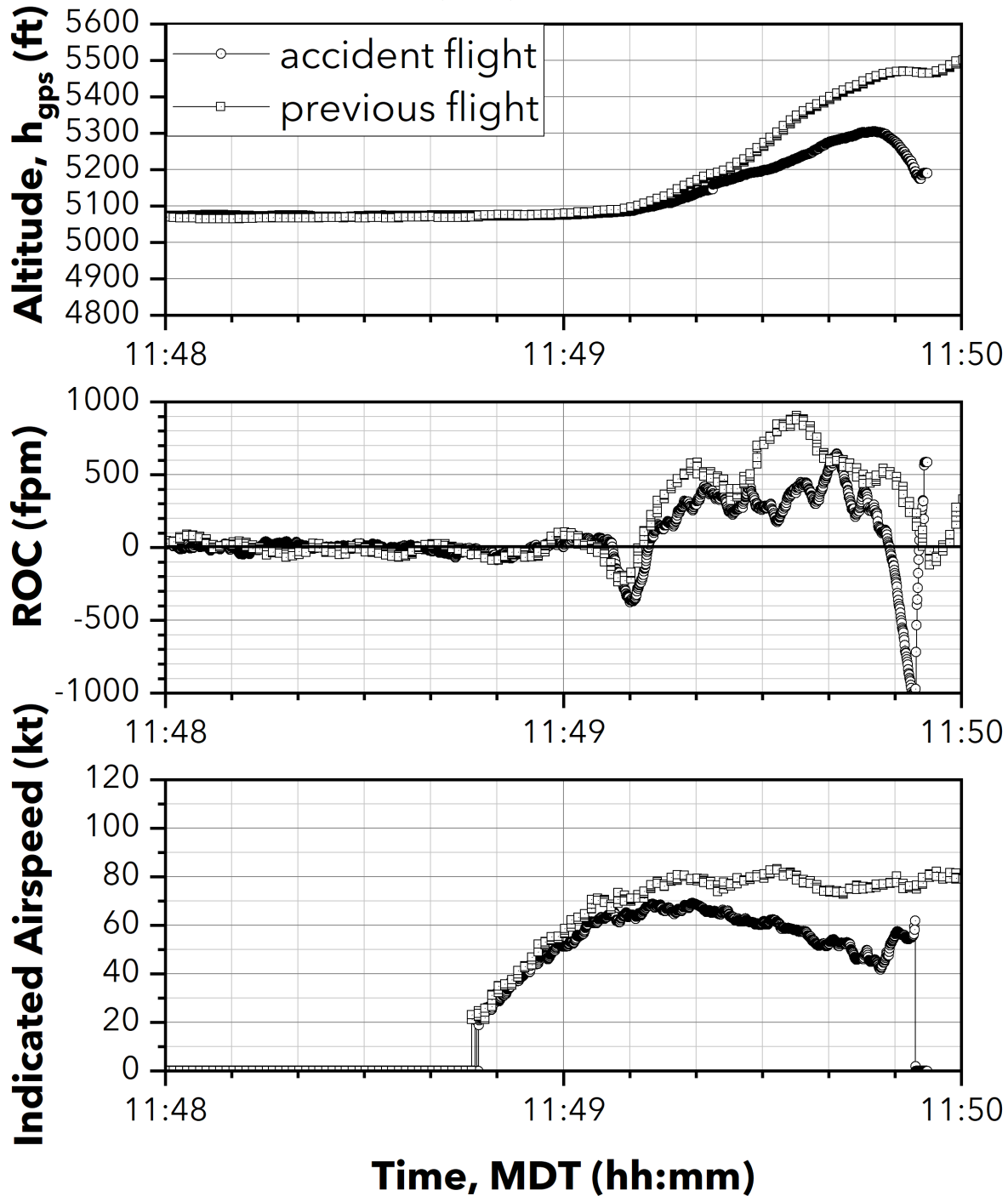


Figure 4: Altitude, ROC, and Airspeed for Accident and Previous Flight

**CEN22FA208: Piper PA-32-260 Cherokee Six, N85CT
Broomfield, CO
5/22/2022**

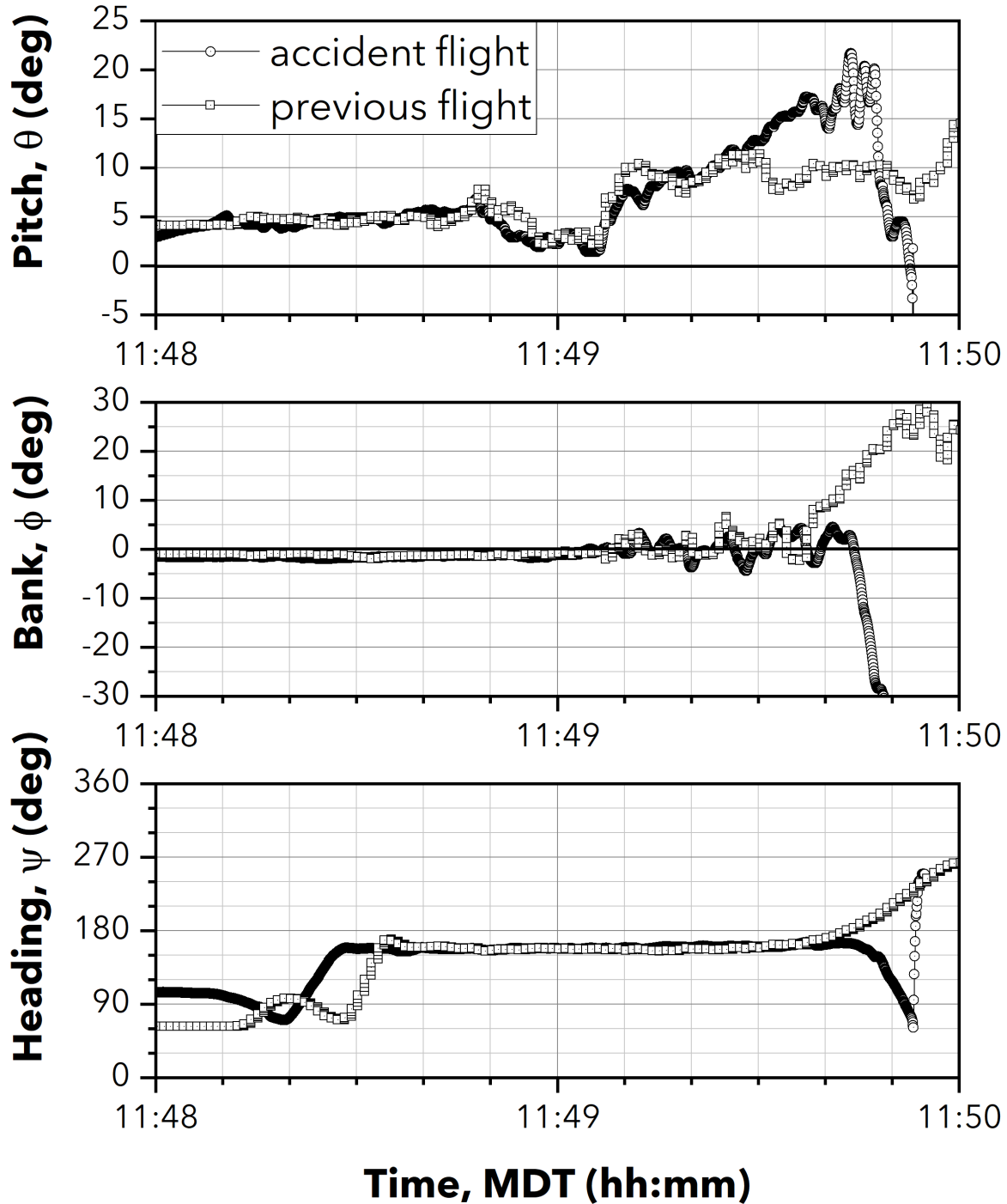


Figure 5: Pitch, Bank, and Heading Angles for Accident and Previous Flight

PA-32-260 CHEROKEE SIX

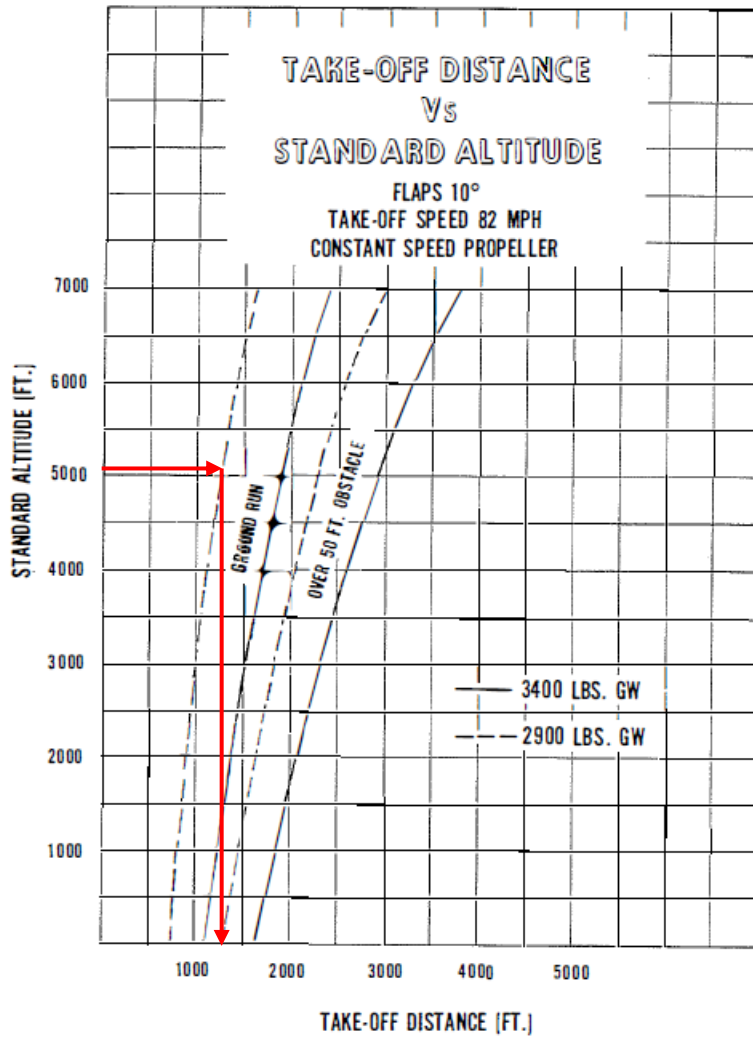


Figure 6: Take-off Distance from Piper Cherokee Six Owner's Handbook

**CEN22FA208: Piper PA-32-260 Cherokee Six, N85CT
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5/22/2022**

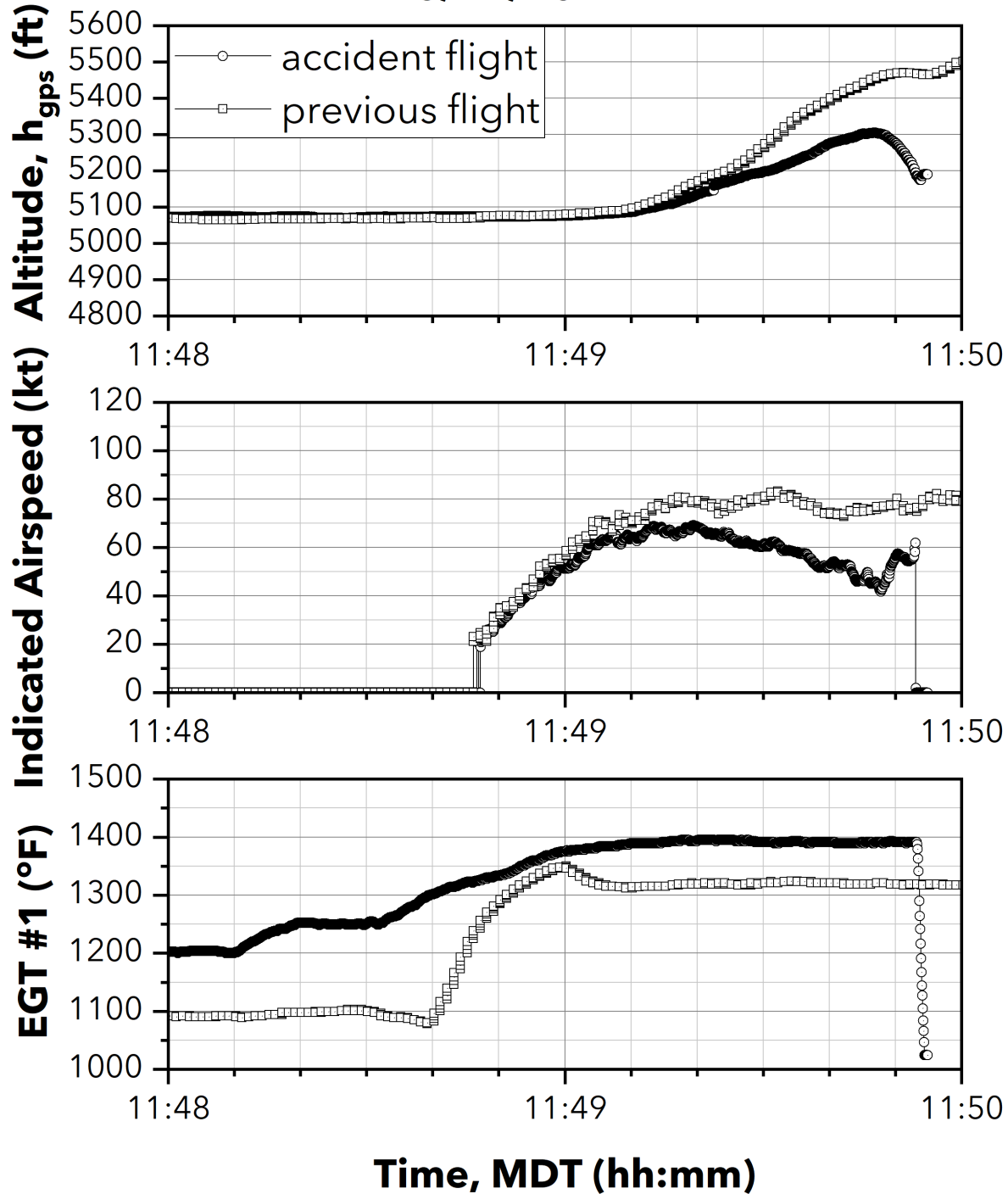


Figure 7: EGT for Cylinder #1 for Accident and Previous Flight

**CEN22FA208: Piper PA-32-260 Cherokee Six, N85CT
Broomfield, CO
5/22/2022**

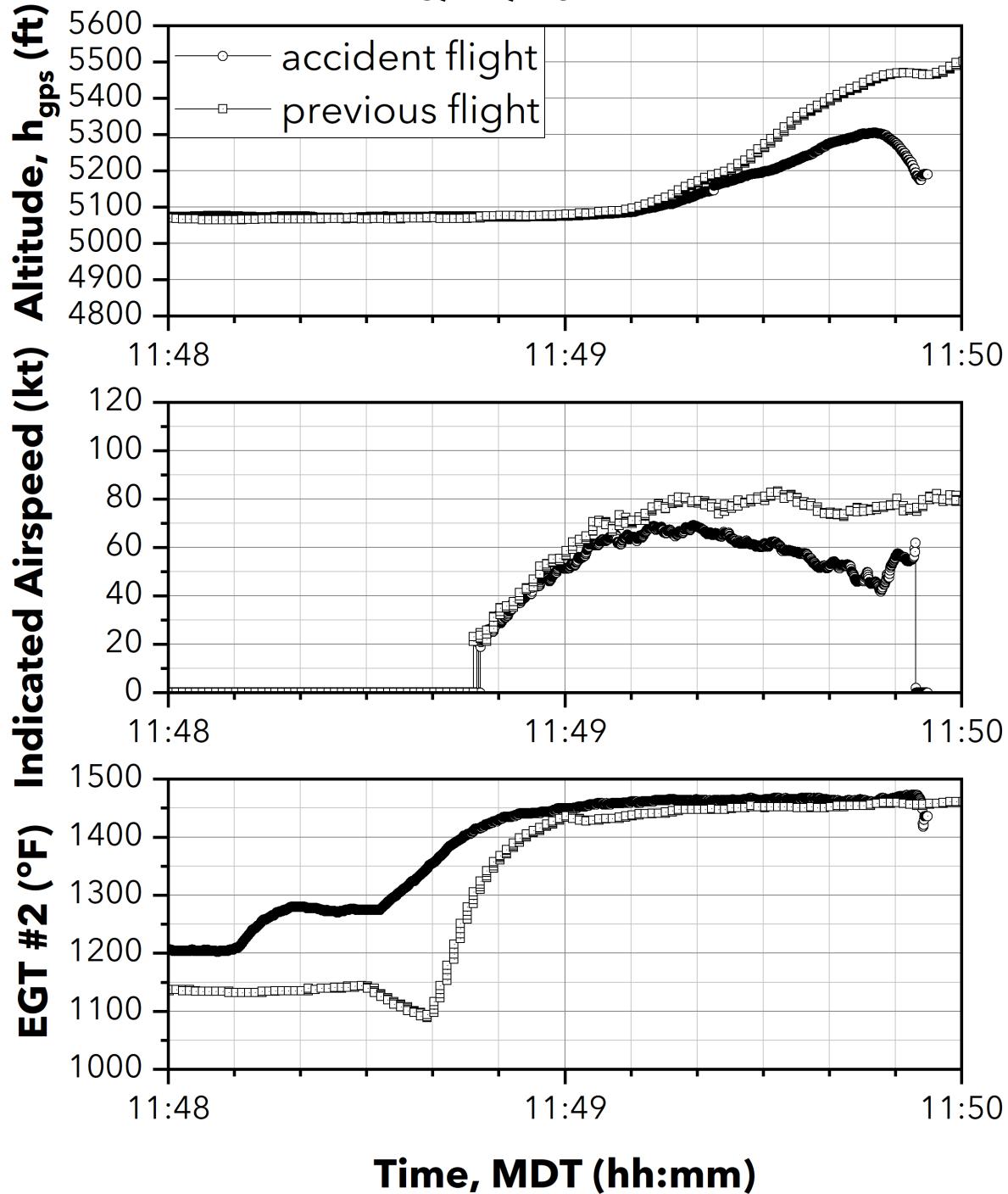


Figure 8: EGT for Cylinder #2 for Accident and Previous Flight

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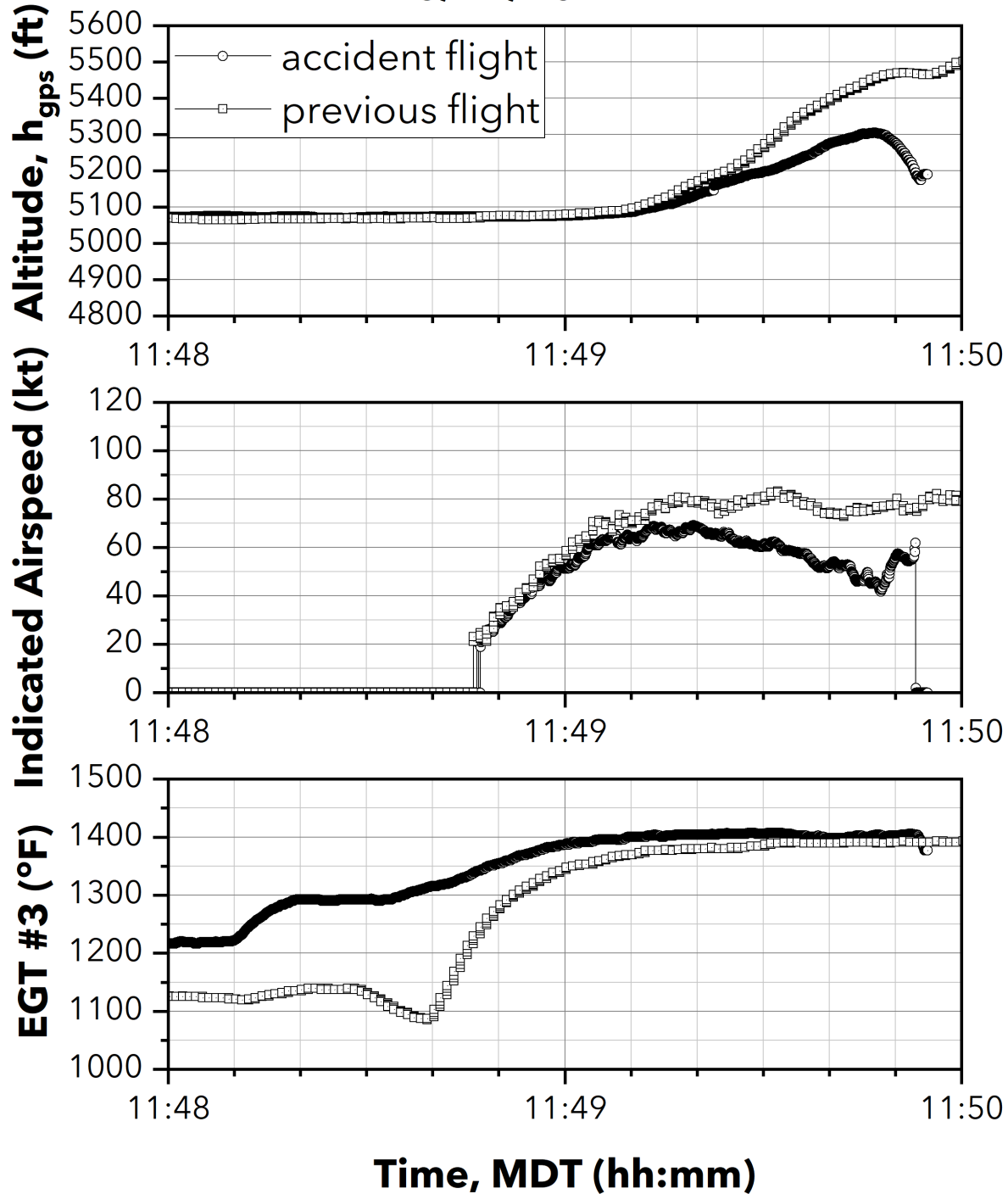


Figure 9: EGT for Cylinder #3 for Accident and Previous Flight

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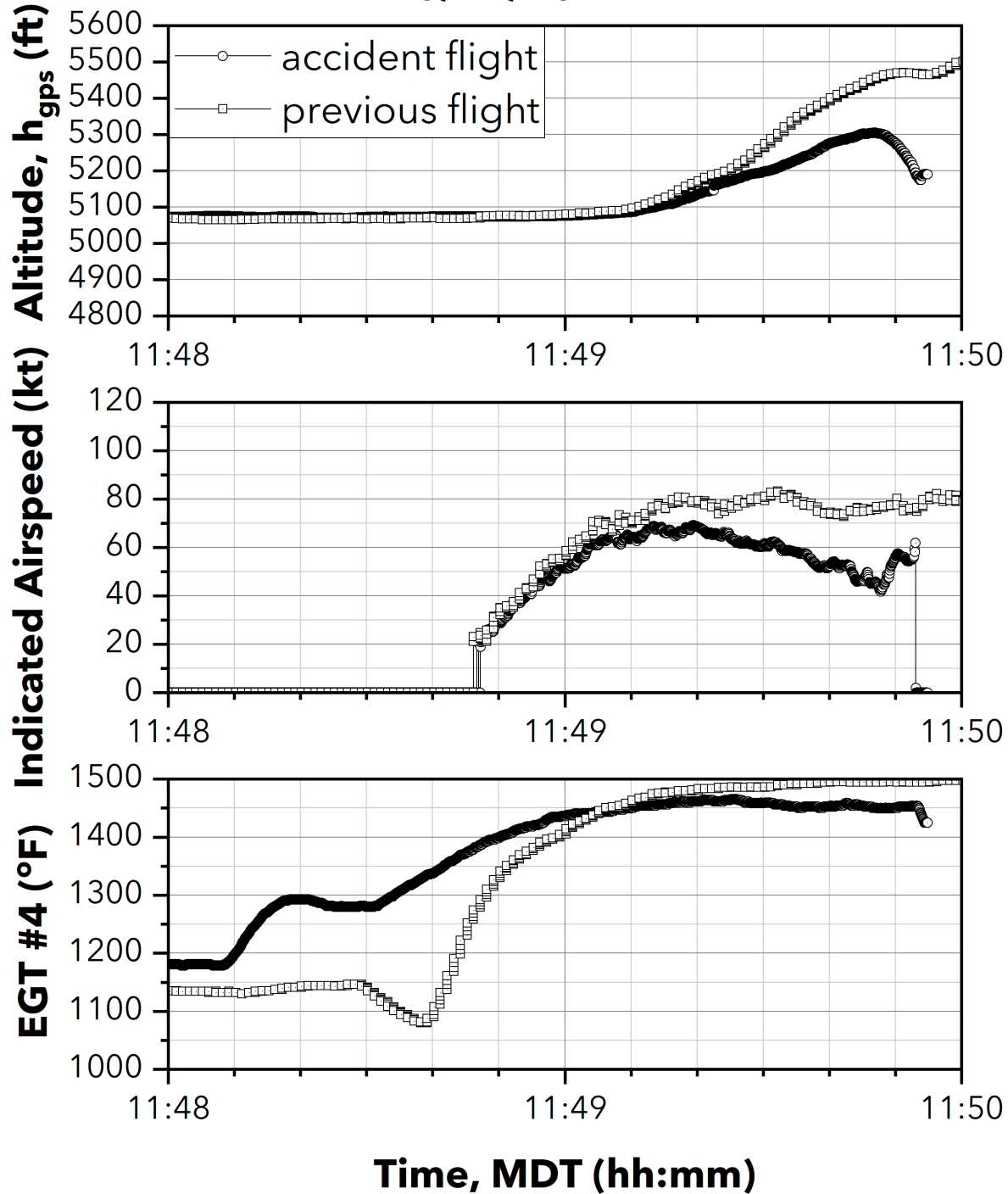


Figure 10: EGT for Cylinder #4 for Accident and Previous Flight

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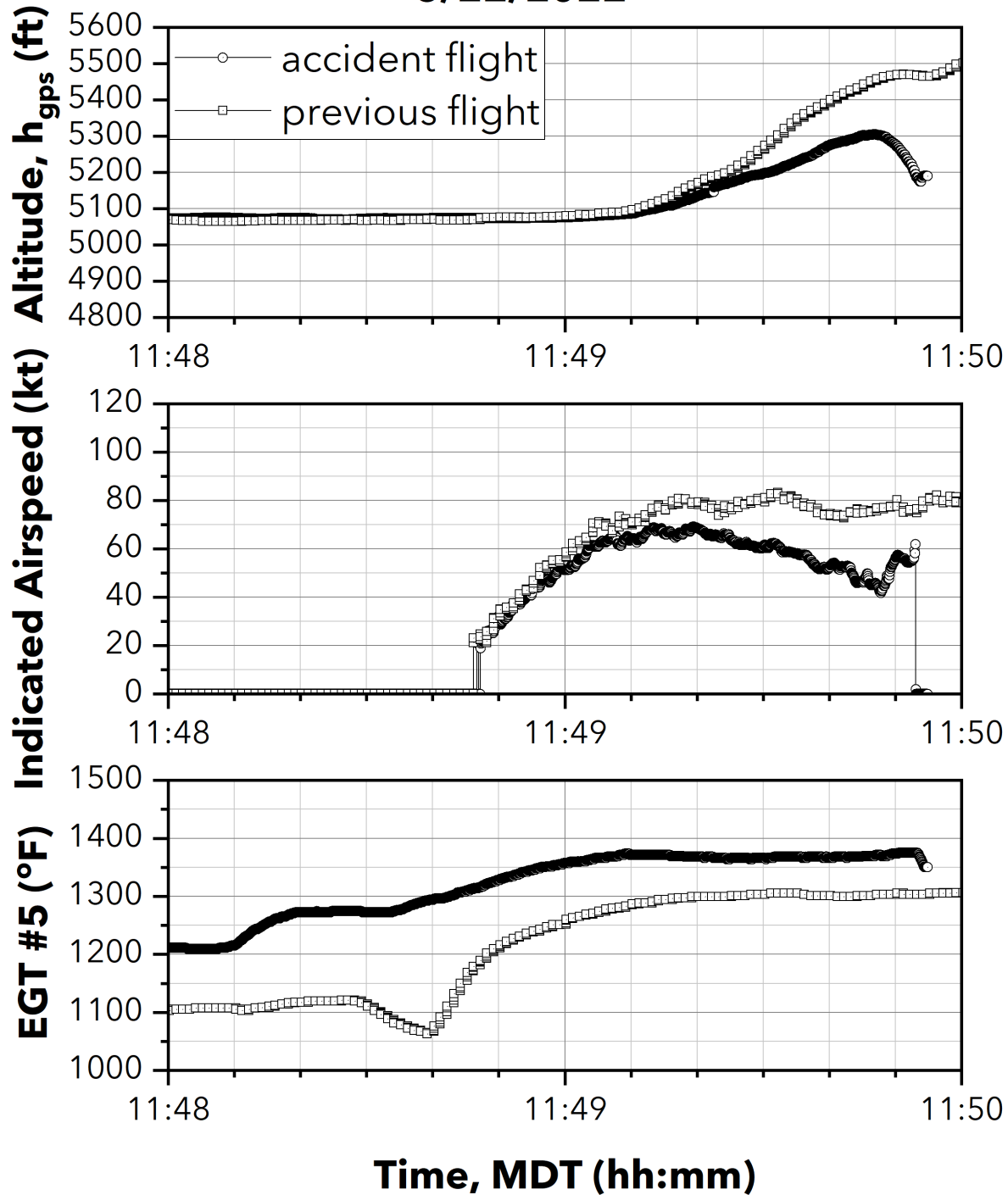


Figure 11: EGT for Cylinder #5 for Accident and Previous Flight

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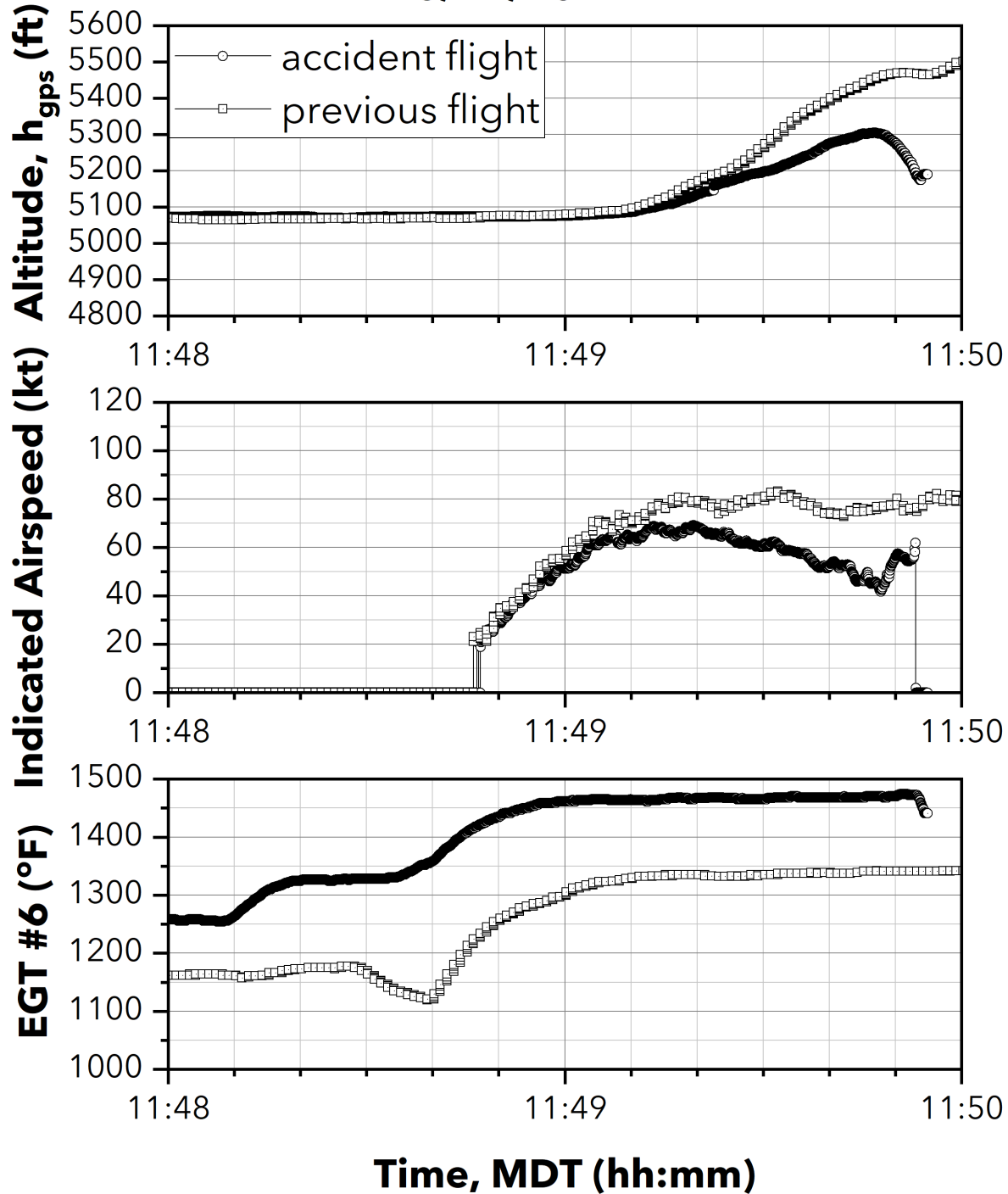


Figure 12: EGT for Cylinder #6 for Accident and Previous Flight

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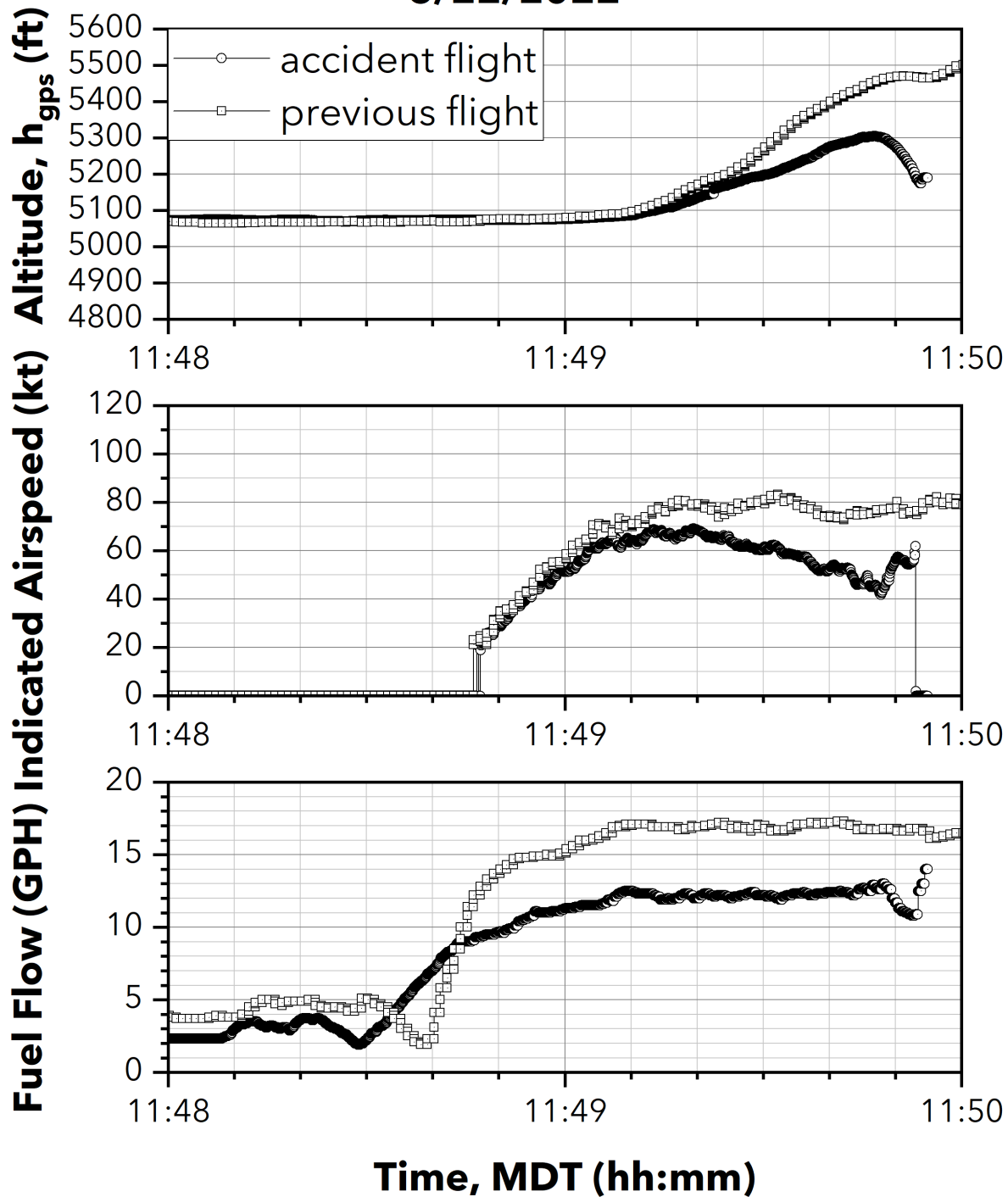


Figure 13: Fuel Flow for Accident and Previous Flight

CEN22FA208: Piper PA-32-260 Cherokee Six, N85CT
Broomfield, CO
5/22/2022

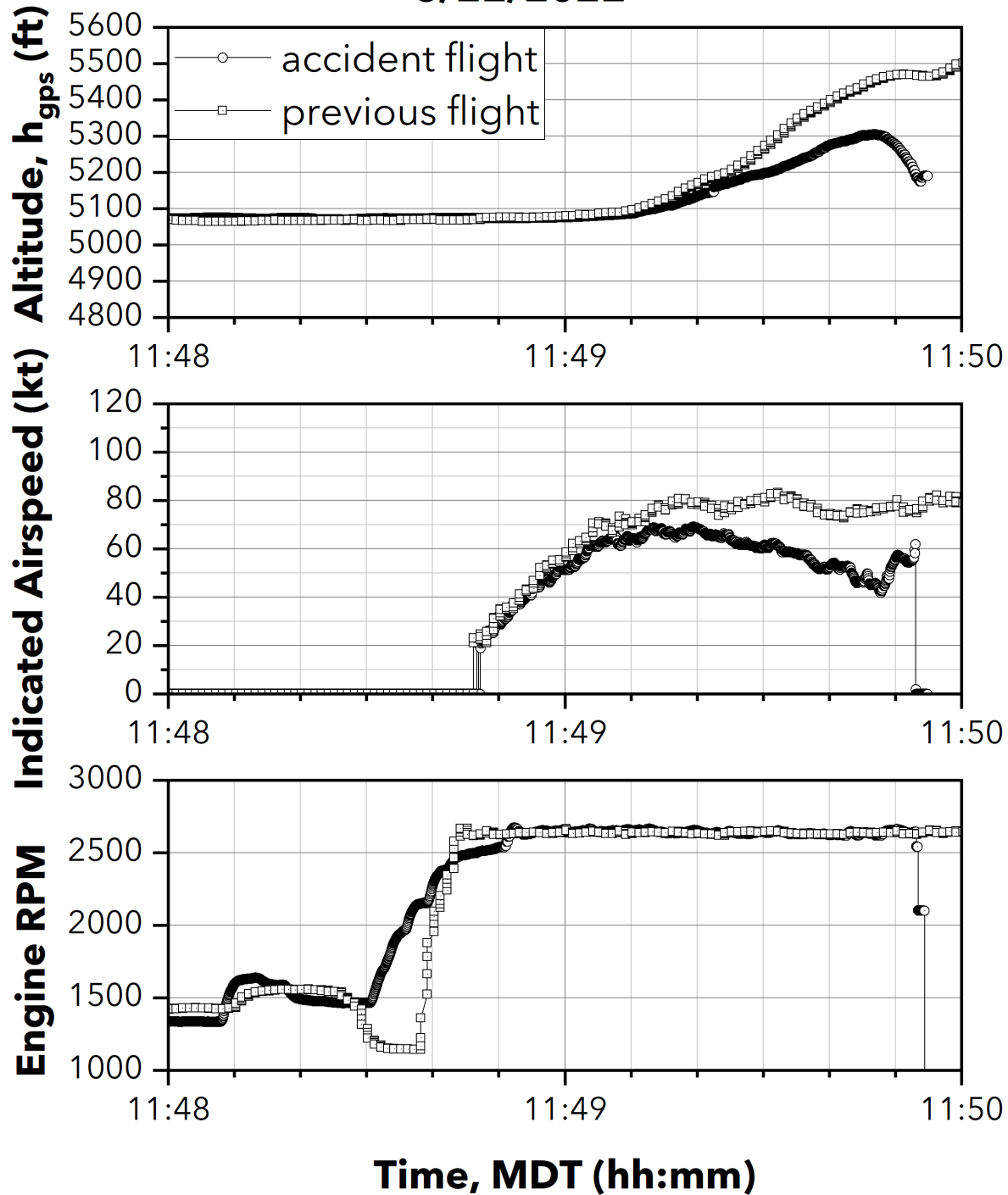


Figure 14: Engine RPM for Accident and Previous Flight

**CEN22FA208: Piper PA-32-260 Cherokee Six, N85CT
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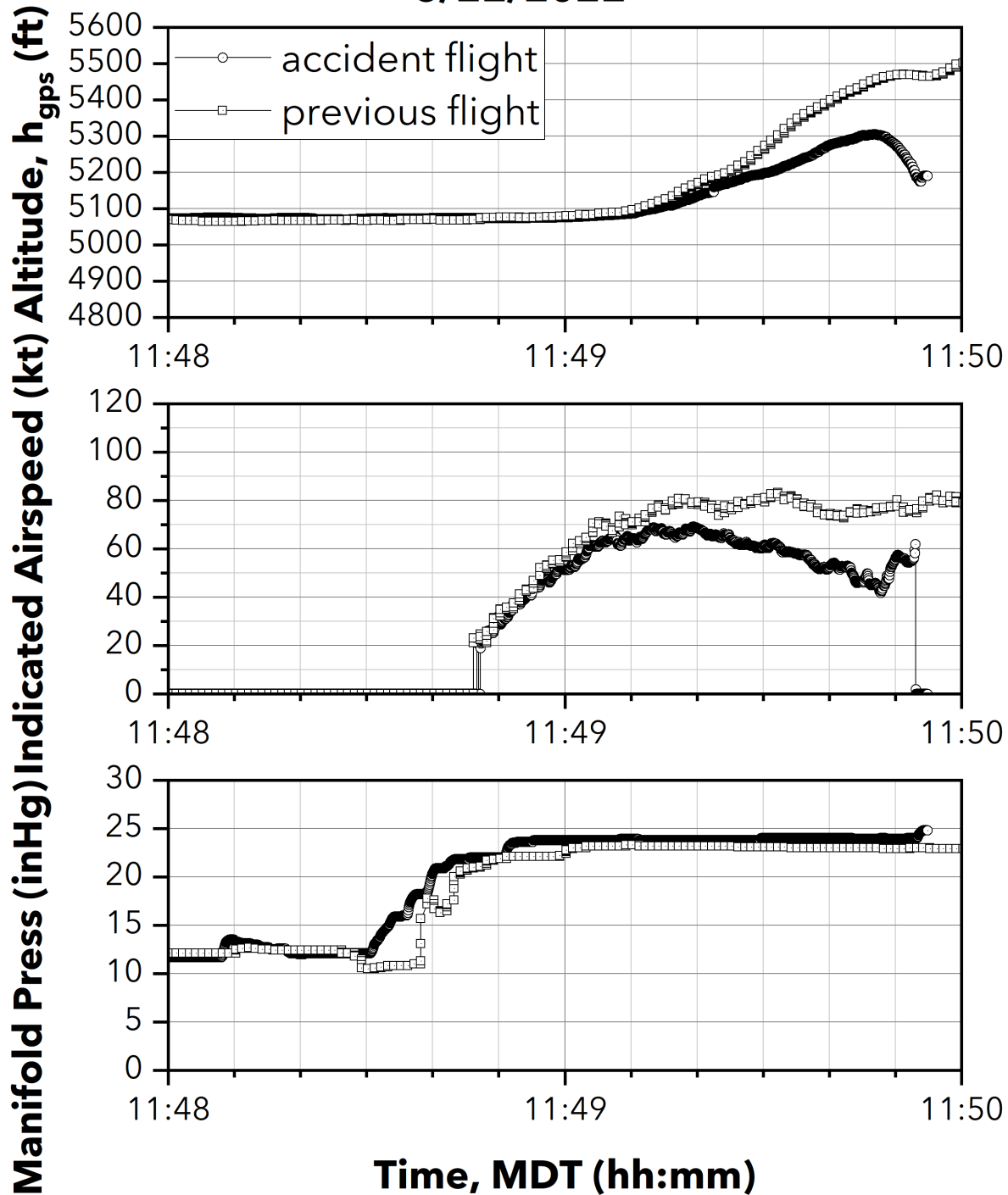


Figure 15: Manifold Pressure for Accident and Previous Flight

CEN22FA208: Piper PA-32-260 Cherokee Six, N85CT
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5/22/2022

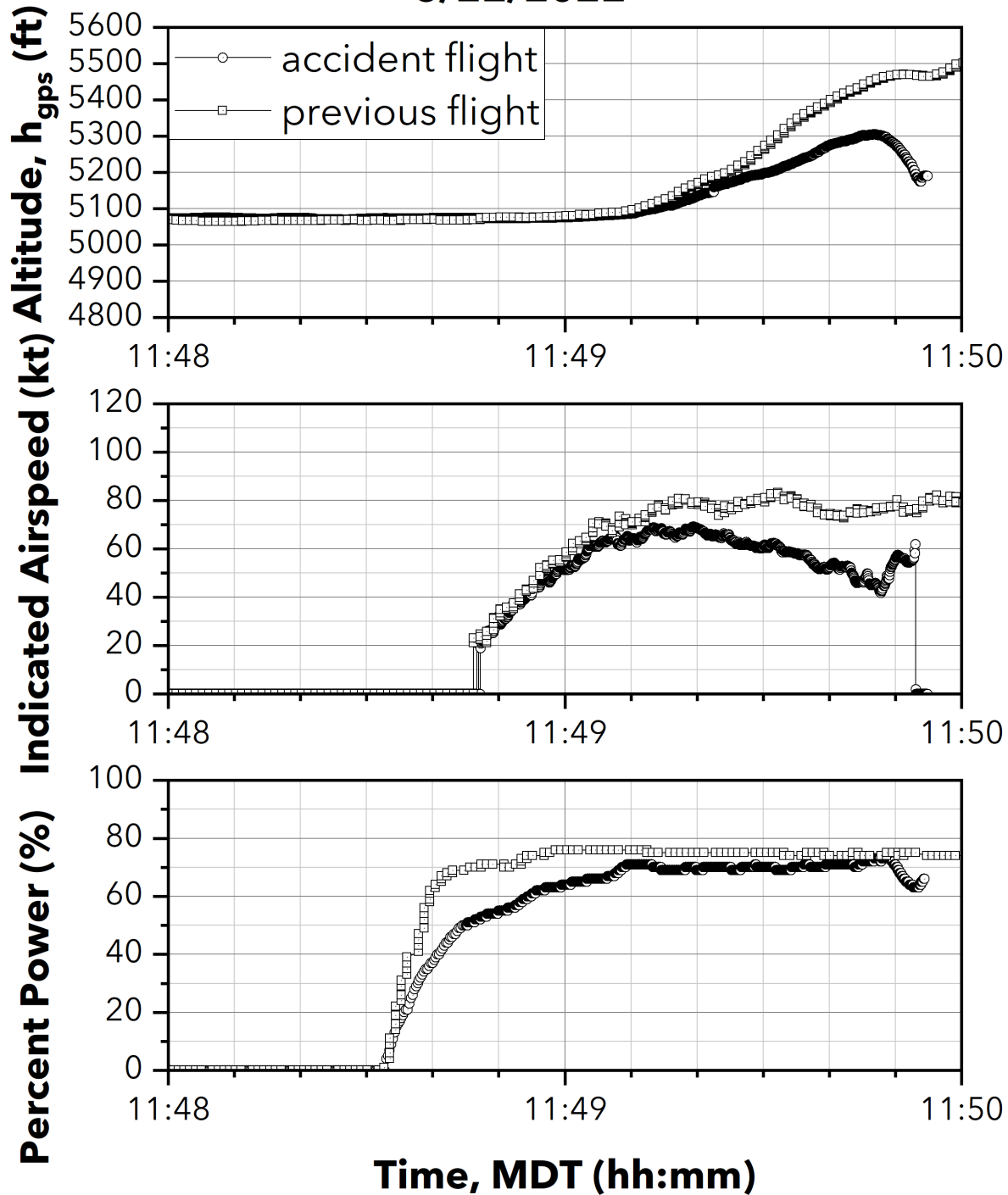


Figure 16: Recorded Percent Power for Accident and Previous Flight

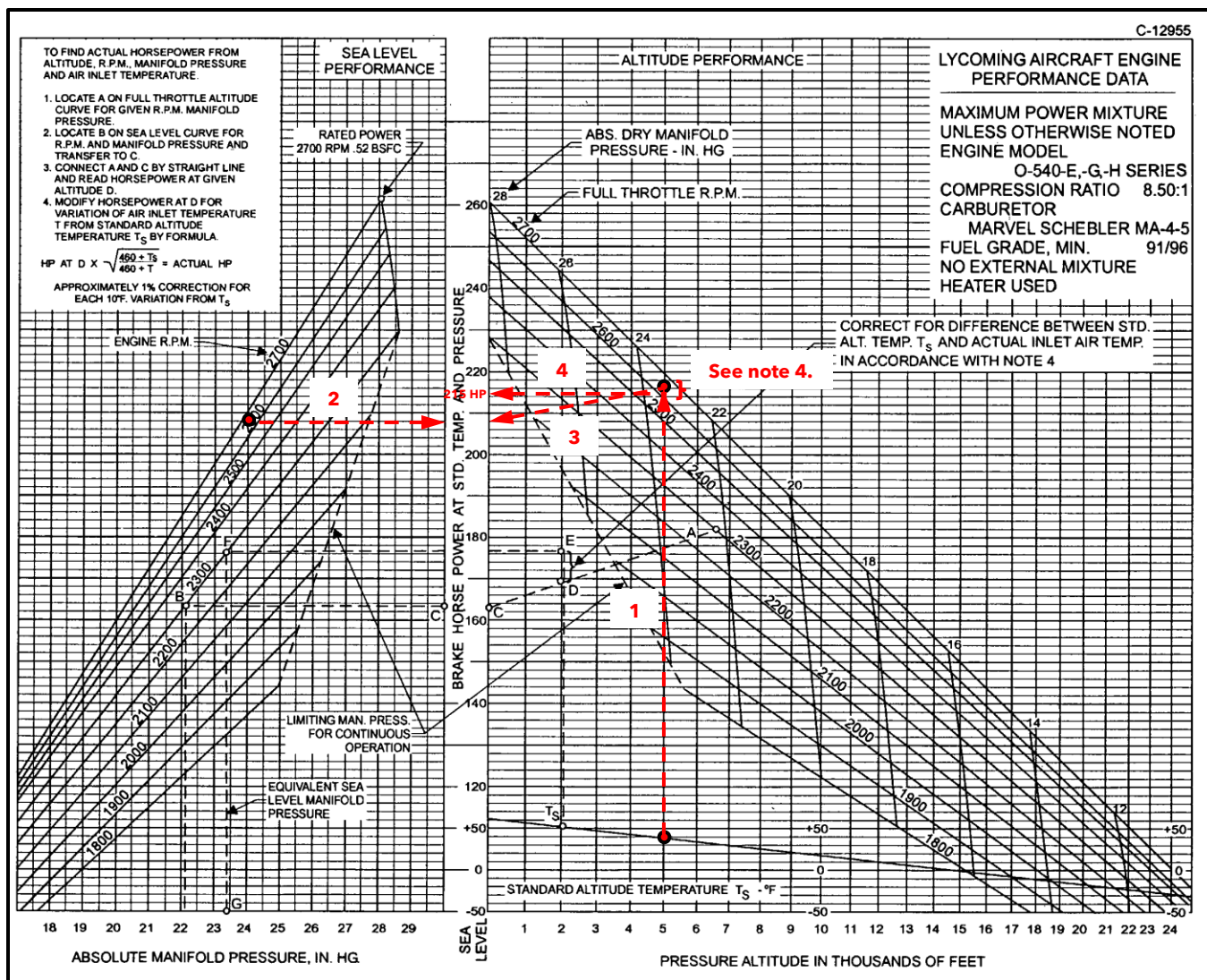


Figure 17: Sea Level and Altitude Performance Curve - O-540-E, -G, -H
MP = 24 inHg, RPM = 2640, Hp=5,000 ft, T = 54°F: BHP = 215 HP

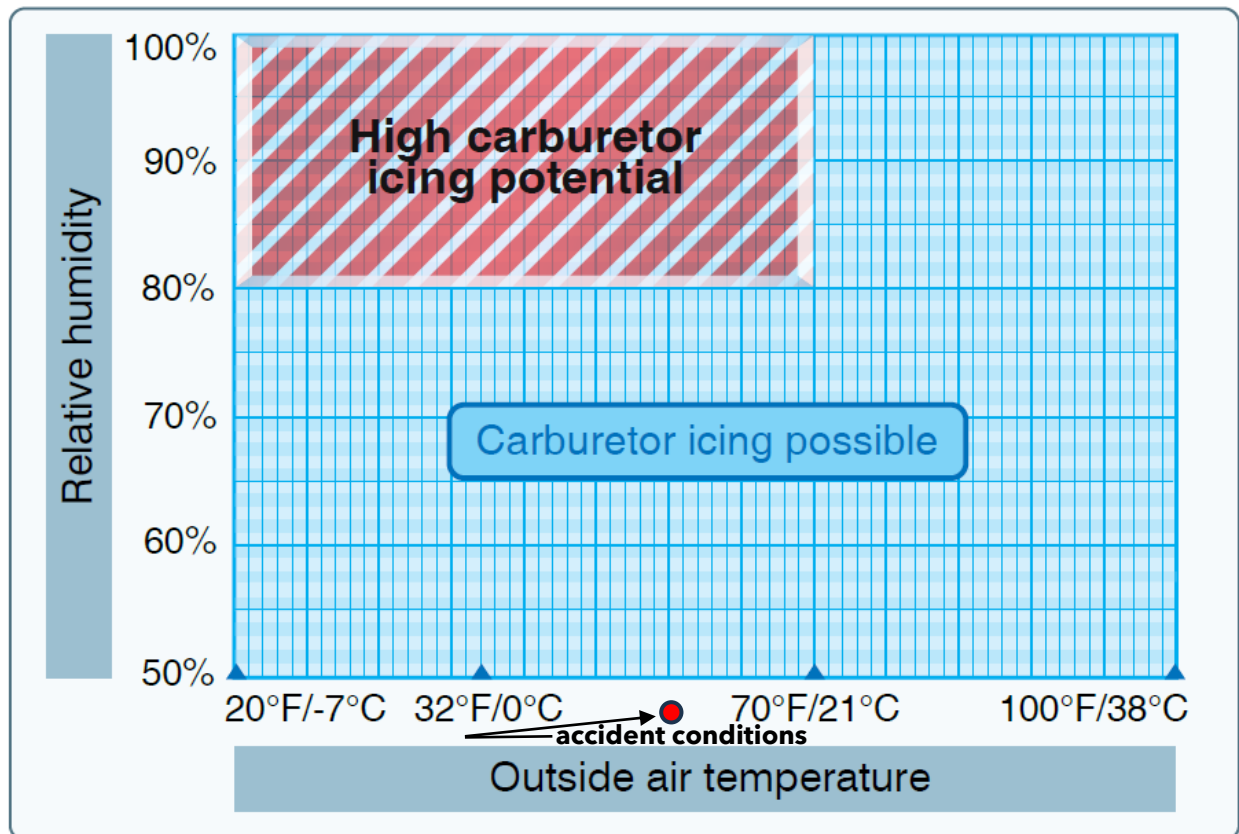


Figure 18: Carburetor Icing Potential Envelope from FAA Pilot's Handbook of Aeronautical Knowledge

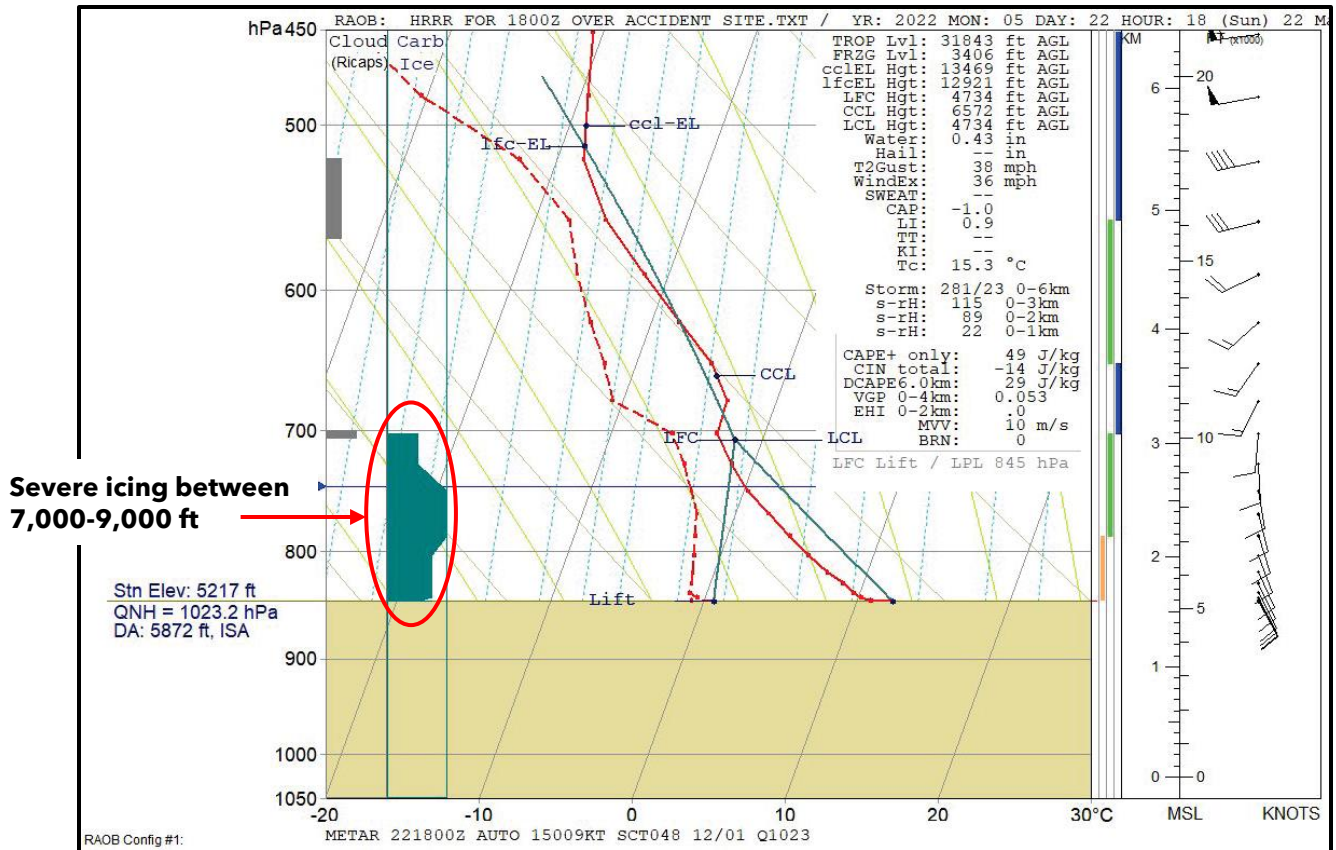


Figure 19: Carburetor Icing Possibility from NWS High-Resolution Rapid Refresh Model