



# National Transportation Safety Board

## Office of Aviation Safety Central Region

### Fuel Quantity Estimates and Weight and Balance Summary

|                        |                                       |
|------------------------|---------------------------------------|
| NTSB Accident No:      | CEN20FA001                            |
| Accident Date/Time:    | Thursday, 3 October 2019, at 0858 EDT |
| Accident Location:     | Lansing, Michigan                     |
| Aircraft Make/Model:   | Socata TBM 700 C2                     |
| Aircraft Registration: | N700AQ                                |
| Aircraft Serial No:    | 252                                   |

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#### FUEL QUANTITY ESTIMATES

The fuel quantity onboard the airplane at takeoff was estimated from recent refueling records that were confirmed by two fix based operators (FBO), and the amount of fuel used as reported by the Shadin Engine Trend Monitor on the flight directly preceding the accident flight. The airplane was topped-off (281.6 gallons useable) on September 27, 2019, at Austin Executive Airport (EDC), Austin, Texas, before it was flown to Indy South Greenwood Airport (HFY), Greenwood, Indiana. The Shadin Engine Trend Monitor recorded 179.2 gallons were used during the 3 hour 2 minute flight from EDC to HFY. This left about 102 gallons remaining in the aircraft. Before the accident flight, 100 gallons were added to the airplane (50 per tank) to bring the total fuel quantity to about 202 gallons (1,374 lbs) before engine start and takeoff.

The fuel consumed during the accident flight was estimated by calculating an average fuel burn rate versus flight duration from all the past recorded flights in the aircraft flight logs, dating back to September 4, 2018. There were about 40 flights where pilots had recorded the flight duration and fuel used. An average fuel burn rate (gallons per hour) was calculated with these data. Flights of about one hour were estimated to burn about 70 gallons. As such, the airplane likely used about 70 gallons (476 lbs) during the accident flight from HFY to Capital Region International Airport (LAN), Lansing, Michigan, on the morning of October 3, 2019.

To decrease uncertainty in these estimates, the data downloaded from the Shadin Engine Trend Monitor was reconciled with fuel receipts for additional flights extending back to September 18, 2019. A running total of fuel onboard was calculated after each flight based on fuel burned recorded by the Shadin instrument, and fuel added as recorded on refueling receipts. This running total method independently predicted a top-off (281.6 gallons useable) after 182 gallons of fuel was added at HFY on September 26, 2019, before the flight from HYF to EDC. The fueler at HFY

stated that the fuel tanks were topped-off with the pilot witnessing the refueling on September 26, 2019. Additionally, the flight from HYF to EDC consumed 204.8 gallons as reported by the Shadin instrument. The FBO fuelers at EDC confirmed they topped-off the fuel tanks with 205 gallons before the airplane departed back to HYF. This confirmed the Shadin data was accurate and could be used to estimate the fuel onboard the aircraft.

## WEIGHT AND BALANCE CALCULATIONS

According to the current weight-and-balance record, dated May 24, 2017, the airplane had an empty weight of 4,674.28 lbs and a useful load of 2,719.92 lbs. The empty weight center-of-gravity (CG) was 187.17 inches aft of the datum. At maximum takeoff weight, 7,394 lbs, the forward and aft CG limits were 187 inches and 193.65 inches, respectively.

The airplane's weight and balance at takeoff were calculated using the reported weights and seat positions for the pilot and the 5 passengers, and 202 gallons (1,374 lbs) of fuel. The takeoff weight and CG location were estimated to be 7,626.28 lbs and 196.18 inches, respectively. At takeoff, the airplane was about 232 lbs over the maximum allowable takeoff weight and about 2.53 inches past the aft CG limit. The engine burned about 70 gallons (476 lbs) of fuel during the flight. The estimated airplane weight and CG location at the time of impact were 7,150.28 lbs and 196.60 inches, respectively. At impact, the airplane was about 126 lbs over the maximum allowable landing weight and 2.95 inches past the aft CG limit.

| <b>N700AQ</b>                   | Weight<br>(lbs.) | Arm<br>(in.) | Moment<br>(in-lbs.) |
|---------------------------------|------------------|--------------|---------------------|
| Basic Empty Weight              | 4674.28          | 187.1737     | 874902.3            |
| Forward Baggage (110 lbs. Max)  | 25               | 128          | 3200                |
| Pilot                           | 185              | 178.5        | 33022.5             |
| Front Passenger                 | 197              | 178.5        | 35164.5             |
| Left-Mid Passenger              | 294              | 222.7        | 65473.8             |
| Right-Mid Passenger (ballast)   | 287              | 222.7        | 63914.9             |
| Left-Aft Passenger (ballast)    | 281              | 267.1        | 75055.1             |
| Right-Aft Passenger (ballast)   | 299              | 267.1        | 79862.9             |
| Aft Baggage (220 lbs. Max)      | 25               | 303          | 7575                |
| Fuel (281 Gal Max Useable)      | 1374             | 189.8        | 260785.2            |
| Zero Fuel Weight                | 6267.28          | 197.5611     | 1238171             |
| Ramp Weight (7430 lbs. Max)     | 7641.28          | 196.1656     | 1498956             |
| Fuel for start, taxi and runup  | -15              | 189.8        | -2847               |
| Takeoff Weight (7394 lbs. Max.) | 7626.28          | 196.1781     | 1496109             |
| Fuel Burn (estimated 70 gal)    | -476             | 189.8        | -90344.8            |
| Landing Fuel Weight             | 7150.28          | 196.6027     | 1405764             |

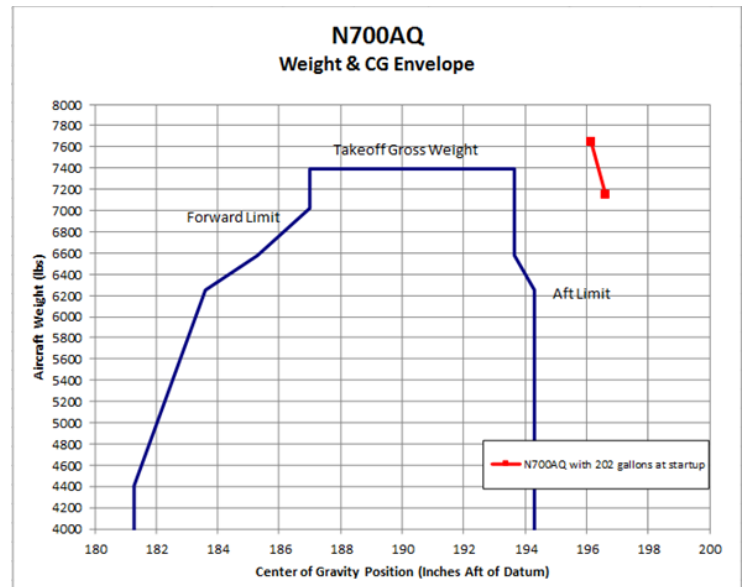


Figure 1. Weight and Balance Calculations and Plot