SOUTH AFRICAN CIVIL AVIATION AUTHORITY

Section/division **Accident and Incident Investigations Division** Form Number: CA 12-12a

AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

Approved				Reference:	CA18/2/3/9520
Aircraft Registration	ZS-PME	**Date of Accident**	3 February 2016	**Time of Accident**	0945Z
Type of Aircraft	Piper PA-32-300			**Type of Operation**	Private (Part 91)
Pilot-in-command Licence Type	Private Pilot Licence	**Age**	63	**Licence Valid**	Yes
Pilot-in-command Flying Experience	**Total Flying Hours**	4130.90		**Hours on Type**	388.6
Last Point of Departure	Brakpan Aerodrome (FABB), Gauteng Province				
Next Point of Intended Landing	Entabeni Lodge, Limpopo Province				

Location of the accident site with reference to easily defined geographical points (GPS readings if possible)
500m past the end of Runway 36 at FABB (GPS position 26° 13, 35.54"S 028° 17' 54.06"E) Elevation 5300ft AMSL

Meteorological Information	Wind: 300⁰/10⁰kt; Temperature: 27°C; Dew point: 10°C; Visibility: CAVOK; Clouds: Few				
Number of People On-board	1+2	**No. of people Injured**	0	**No. of people killed**	3

Synopsis

On 3 February 2016 at approximately 0945Z, the pilot accompanied by two passengers took off from Runway 36 at Brakpan Aerodrome (FABB) after the aircraft's fuel tanks were refuelled to full capacity with 84 gallons (United States Gallons). This was followed by a pre-flight inspection that was carried out on the aircraft.

According to eyewitnesses at Wattville township, the aircraft was flying very low over the residential area; and it had appeared as if the aircraft was having trouble gaining height. The aircraft's right-hand main landing gear wheel then impacted the top section of the street light pole, where after, the right-hand wing dropped downwards and impacted a brick wall, causing the wing-tip to break off. The right wing then impacted the roof of a shack. The aircraft rolled over into an inverted attitude before the right-side wing collided with a tree, causing the wing to separate from the aircraft. The aircraft's main wreckage came to rest approximately 120 metres from the first point of impact. A post-impact fire erupted during the accident sequence when the aircraft collided with the tree. Some of the local community members who had witnessed the accident helped pull out the occupants from the main wreckage and had attempted to extinguish the fire using buckets filled with water. The pilot and the two passengers were fatally injured during the accident. The aircraft was destroyed during the impact sequence as well as by the post-impact fire that erupted thereafter.

The investigation revealed that although the aircraft was within its weight limit, it was operated close to its maximum weight limit, outside of its centre of gravity (CG) limit, and at high-density altitude, leading to a poor take-off and climb performance which resulted in a crash.

Probable Cause

The aircraft was operated close to its maximum weight limit, outside of its centre of gravity (CG) limit, and at a high-density altitude, leading to a poor take-off and climb performance which resulted in a crash.

Contributing factors

Poor or no pre-flight planning.

SRP Date	14 November 2017	Re-publication Date	28 October 2020

AIRCRAFT ACCIDENT REPORT

Name of Owner	**:** Trade A Place CC
Name of Operator	**:** Trade a place CC
Manufacturer	**:** Piper Aircraft Corporation
Model	**:** Piper PA-32-300
Nationality	**:** South African
Registration Marks	**:** ZS-PME
Place	**:** Wattville Township, Brakpan. Gauteng
Date	**:** 3 February 2016
Time	**:** 09:45Z

All times given in this report are Co-ordinated Universal Time (UTC) and will be denoted by (Z). South African Standard Time is UTC plus 2 hours.

Purpose of the Investigation:

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (2011) this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and ***not to apportion blame or liability****.*

Disclaimer:

This report is produced without prejudice to the rights of the AIID, which are reserved.

1. FACTUAL INFORMATION

1.1 History of Flight

1.1.1 On 3 February 2016 at approximately 0945Z, the pilot accompanied by two passengers took off on a private flight from Runway 36 at Brakpan Aerodrome (FABB) after the aircraft was refuelled to full capacity with 84 gallons (USG).

1.1.2 According to eyewitnesses at Wattville township, which is located next to FABB, the aircraft was flying very low over the residential area after take-off. It appeared as if the aircraft was having trouble gaining height, where after, the right-side main landing gear wheel impacted the top section of a street light pole, approximately 10 metres (m) above ground. The right-side wing of the aircraft then dropped and impacted a brick wall, as well as the roof of a shack.

1.1.3 The aircraft subsequently flipped into an inverted attitude, where after, the right-side wing collided with a tree, causing the right-side wing to separate from the aircraft. The aircraft's main wreckage came to rest approximately 120m from the first point of impact. A post-impact fire had erupted during the accident sequence when the aircraft collided with the tree.

1.1.4 Some of the community residents who witnessed the accident had rushed to pull out the occupants from the main wreckage. They had also attempted to extinguish the fire using buckets filled with water.

1.1.5 The aircraft was destroyed during the impact sequence, as well as by the post-impact fire that erupted.

1.1.6 The Emergency Services arrived at the accident site but found that the occupants had already succumbed to their injuries. The accident occurred 500m past the end of Runway 36 at FABB (GPS position 26° 13, 35.54" S 028° 17' 54.06" E) at an elevation of 5300 feet (ft) above mean sea level (AMSL).

Figure 1: The accident site in relation to Brakpan Aerodrome.

1.2 Injuries to Persons

Injuries	Pilot	Crew	Pass.	Other
Fatal	1	-	2	-
Serious	-	-	-	-
Minor	-	-	-	-
None	-	-	-	-

1.3 Damage to Aircraft

1.3.1 The aircraft was destroyed during the impact sequence and by the post-impact fire that erupted.

Figure 2: The aircraft in an inverted attitude.

Figure 3: Another view of the aircraft.

Figures 4 and 5: The left-hand wing at the accident site.

1.4 Other Damage

1.4.1 A street light pole, a brick wall and the roof of a shack were damaged during the accident sequence.

Figure 6: A street light pole that was impacted by the aircraft.

Figure 7: Damage to the brick wall.

Figure 8: The damaged shack.

1.5 Personnel Information

Nationality	Austrian	Gender	Male	Age	63
Licence Number	0270069867	Licence Type	PPL Aeroplane		
Licence Valid	Valid	Type Endorsed	Yes		
Ratings	Night rating				
Medical Expiry Date	31 May 2016				
Restrictions	Corrective lenses				
Previous Accidents	None as per CAA records				

1.5.1 Flying Experience:

The pilot hours were obtained from the competence check report in the South African Civil Aviation Authority's (SACAA) file, recorded on 1 April 2014 as this was the only source available. The pilot's flight bag and his flying logbook were removed from the aircraft by some of the local community members before the South African Police Service (SAPS) officials arrived at the aircraft accident site. These were not recovered by the SAPS.

Total Hours	4130.90
Total Past 90 Days	+70.00
Total on Type Past 90 Days	Unknown
Total on Type	388.6

1.5.2 According to the SACAA Pilot's File, the pilot's total flying hours were 4130.90 and 388.6 hours on type on 17 January 2015. The total flying hours were recorded on the following aircraft:

BN-2A Islander/Defender
Cessna C150
Cessna C152
Cessna C172-Skyhawk, Cutlass, Hawk XP, Reims Rocket
Cessna C177-Cardinal
Cessna C182-Skylane
Cessna C206- Super-Skywagon/Stationair
Cessna C210
De Havilland-DH82-Tiger Moth
Piaggio P-166 A/B/C/DL2/M/S, Portofino
Piper PA28/140/150/151/160/161/180/181
Piper PA-28/201T/235/236
Piper PA-22 Tri-Pacer, Caribbean, Colt
Piper PA-30/39 Twin Comanche
Piper PA-32 Cherokee Six, Six Saratoga, Turbo Saratoga
Piper PA-34 Seneca

1.6 Aircraft Information

Airframe:

Type	PA-32-300	
Serial Number	32-7340102	
Manufacturer	Piper Aircraft Corporation	
Date of Manufacture	1973	
Total Airframe Hours (At time of Accident)	6725.46	
Last MPI (Date & Hours)	21.12.2015	6723.95
Hours Since Last MPI	1.51	
C of A (Issue Date)	07/02/2011	
C of R (Issue Date) (Present owner)	15/05/2013	
Operating Categories	Standard Part 135	

Engine:

Type	Lycoming IO-540-K1A5
Serial Number	L-29853-48A
Hours Since New	6725.46
Hours Since Overhaul	429.66

Propeller:

Type	Hartzell
Serial Number	CH36443B
Hours Since New	6725.46
Hours Since Overhaul	72.47

1.6.1 The aircraft was within its 100-hour inspection period. The engine had a Time Before Overhaul (TBO) of 2000 hours and the propeller also had a TBO of 2000 hours.

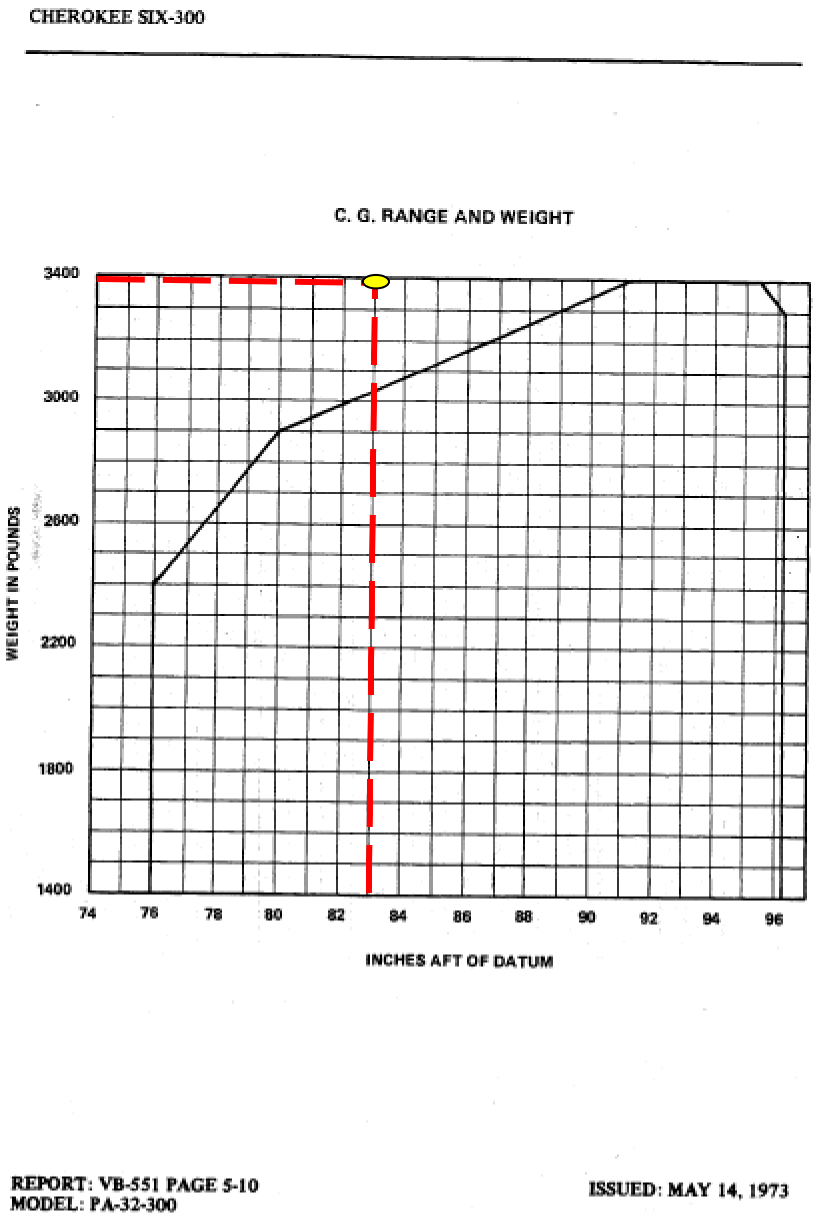
1.6.2 Weight and Balance

1. The baggage was removed from the wreckage by the first responders and the investigators could not determine if they were in the forward or rear baggage compartment. Two scenarios are proposed, and the calculations below show the two possible weight and balance results. The Piper PA32-300 Cherokee Six Maximum Certified weight is 1542.21kg (3400 lbs) and the Empty Weight is 811.0 kg (1787lbs):

Table 1: Weight and balance for the forward compartment scenario

Items	Weight (Lbs)	Arm Aft Datum (inches)	Moment (In-lbs)
Basic Empty Weight	2015.35	77.86	156915.6
Pilot & Front Passenger	573	85.5	48991.5
Passenger Centre Seat	198	118.1	23383.8
Fuel (84 USG)	503	95.0	47785.0
Baggage Forward	100	42.0	4200.0
Total Loaded Airplane	**3389.4**	**82.98**	**281275.9**
Maximum Take-off Weight	3400		
Below Maximum Take-off Weight	10.6		

Graph 1: Indicates the forward CG position scenario



The Piper PA32-300 Cherokee Six Maximum Certified Mass is 1542.21kg (3400 lbs) and the empty weight is 811.0kg (1787lbs). The following calculations on the table indicate that the weight of the aircraft at the time of the accident was 10.6 pounds below the Maximum Take-off weight of the aircraft if the baggage was stored in the rear baggage compartment:

Table 2: Weight and balance for the rear compartment scenario

Items	Weight (Lbs)	Arm Aft datum (Inches)	Moment (In-Lbs)
Basic Empty Weight	2015.35	77.86	156915.6
Pilot & Front Passenger	573	85.5	48991.5
Passenger Centre Seat	198	118.1	23383.8
Fuel (84 USG)	503	95.0	47785.0
Baggage Rear	100	178.7	17870.0
Total Loaded Airplane	**3389.4**	**87.01**	**294945.9**
Maximum Take-off Weight	3400		
Below Maximum Take-off Weight	10,65		

1.7 Meteorological Information

1.7.1 The following information was provided by the South African Weather Service (SAWS) for O.R Tambo International Aerodrome (FAOR) which is the closest aerodrome to Springs Aerodrome (FASI):

Wind direction	300^0	Wind speed	10kt	Visibility	CAVOK
Temperature	27ºC	Cloud cover	Few	Cloud base	Nil
Dew point	10ºC				

1.7.2 The Satellite at 0945Z as well as the Radar images recorded clear skies over Brakpan, with mid-level clouds in the west containing embedded towering cumulus (TCU) and/or cumulonimbus clouds (CB) that caused showers and thundershowers in the Vereeniging area (see Attachment A).

1.7.2.1 Vertical wind and temperature profile from FAOR: Attachment B

A SkewT-LogP diagram vertical profile of the wind and temperature was constructed from data acquired by an aircraft which took off from FAOR at approximately 0934Z. The wind profile showed light (<10knots) south-westerly winds near the surface level with a slight shift to a westerly (moderate to fresh westerly) wind at a level closer to the 10 000 feet pressure altitude (equivalent of FL100).

1.7.2.2 Surface Observations: Attachment C

Meteorological Aeronautical Report (METAR) from nearby weather stations (FAOR and FASI) are included as Attachment C. This observational data shows that no wind information was recorded at FASI, and that the surface winds observed at FAOR were in agreement with that from the aircraft meteorological data relay (AMDAR) discussed in the preceding paragraph, i.e., westerly to south-westerly during the period 0900Z to 1000Z, Ceiling and Visibility Ok (CAVOK) conditions were also reported by the METAR from FAOR, in line with the Satellite and Radar images.

1.8 Aids to Navigation

1.8.1 The aircraft was equipped with standard navigational equipment as approved by the Regulator (SACAA) for the aircraft type. There was no record indicating that the navigation system was unserviceable prior to or during the accident flight.

1.9 Communication

1.9.1 The aircraft was equipped with standard communication equipment as approved by the Regulator for the aircraft type. There were no recorded defects prior to the accident flight.

1.10 Aerodrome Information

The accident occurred at the following GPS co-ordinates: 26°13' 35.54"S 28° 17' 54.06"E, which is approximately 500m past the end of Runway 36, after the aircraft took off from Runway 36 at FABB.

Aerodrome Location	Brakpan/Benoni Aerodrome	
Aerodrome Co-ordinates	S26º14' 17.0" E028º 18' 21.00"	
Aerodrome Elevation	5300ft AMSL	
Runway Designations	18/36	
Runway Dimensions	1440m(4724ft) x 15m(49ft)	
Runway Used	Runway 36	
Runway Surface	Asphalt	
Approach Facilities	None	

1.11 Flight Recorders

1.11.1 The aircraft was not equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR), and neither was required by regulation to be fitted on this aircraft type.

1.12 Wreckage and Impact Information

1.12.1 The aircraft's right-side main landing gear wheel initially impacted a street light pole approximately 500m past the end of the runway after the aircraft took off from Runway 36 at FABB. The aircraft's right-side wing-tip then collided with a brick wall 60m from the first point of impact, causing the wing-tip to break off.

1.12.2 The aircraft then impacted the roof of a shack, approximately 30m further on before the right-side wing impacted a tree and then the ground. The right-side wing was severed from the aircraft during the impact sequence with the tree, where after, the main wreckage skidded for approximately 28m before it came to rest in an inverted attitude. A post-impact fire erupted, which destroyed the main wreckage.

Figure 9: Illustration of points of impact during the accident.

1.13 Medical and Pathological Information

1.13.1 The post-mortem report of the pilot concluded that the cause of death was due to multiple injuries and charring.

1.13.2 The results of the toxicology report were not yet available at the time of completion of this report. If the findings of the toxicology report have a significant impact on the cause of this accident, the report will be reviewed.

1.14 Fire

1.14.1 A post-impact fire erupted, which caused further damage to the aircraft. The fire was extinguished by local community residents.

1.15 Survival Aspects

1.15.1 The accident was not considered survivable due to damage caused to the cockpit and cabin area, which resulted in fatal injuries to the pilot and the two passengers.

1.16 Tests and Research

1.16.1 The engine was transported to the SACAA-approved Engine Overhaul Facility (aircraft maintenance organisation (AMO) 227 for further examination and engine strip down. The engine shop report concluded that there were no abnormalities found during the strip down of the engine.

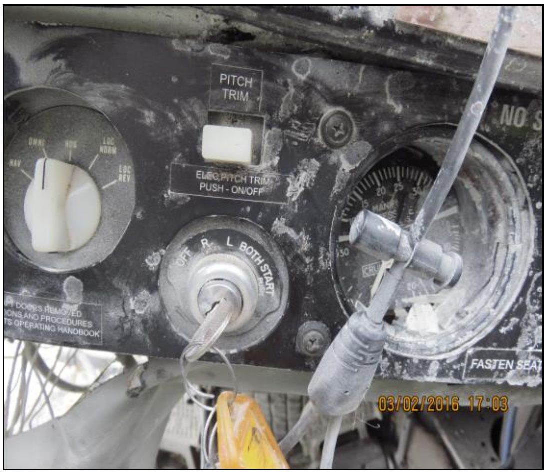


Figure 10: The image shows the ignition key and its position.

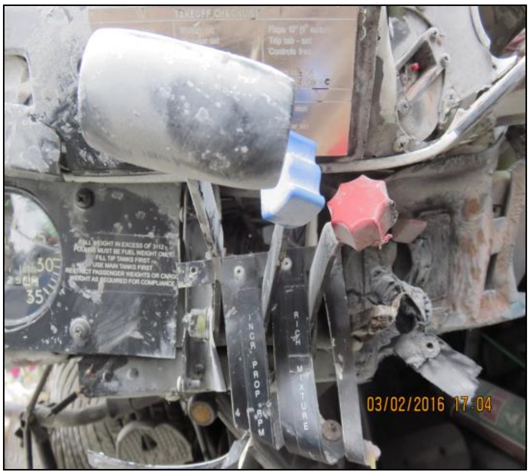


Figure 11: The engine and propeller controls and their positions.

1.17 Organisational and Management Information

1.17.1 The aircraft was maintained by an AMO that was in possession of a valid AMO Approved certificate by the SACAA.

1.17.2 The flight was conducted as a private flight under the provisions of Part 91 of the Civil Aviation Authority (CAR) 2011 as amended.

1.18 Additional Information

1.18.1 Why Does Density Altitude Matter?

High Density Altitude = Decreased Performance

The formal definition of density altitude is certainly correct, but the important thing to understand is that density altitude is an indicator of aircraft performance. The term comes from the fact that the density of the air decreases with altitude. A "high" density altitude means that air density is reduced, which has an adverse impact on aircraft performance. The published performance criteria in the Pilot's Operating Handbook (POH) are generally based on standard atmospheric conditions at sea level (that is, 59 oF or 15 oC. and 29.92 inches of mercury). The aircraft will not perform according to "book numbers" unless the conditions are the same as those used to develop the published performance criteria. For example, if an airport has an elevation of 500 MSL with a reported density altitude of 5,000 feet, aircraft operating to and from that airport will perform as if the airport elevation were 5,000 feet (see Appendix 3).
https://www.faasafety.gov/files/gslac/library/documents/2011/Aug/56396/FAA%20P-8740-02%20DensityAltitude[hi-res]%20branded.pdf

1.18.2 The density altitude was determined using a standard density altitude chart which determined it to be 8100ft (see Chart 1).

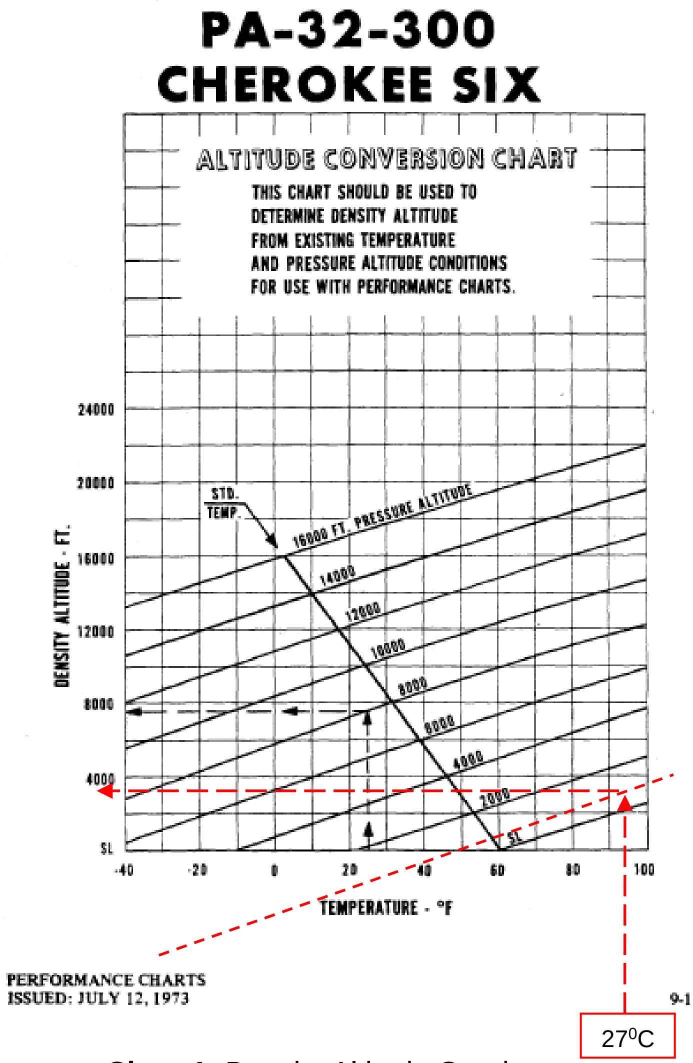


Chart 1: Density Altitude Graph.

1.18.3 The investigation determined that the PA 32-300 take-off performance chart invalidates any operations above 7000ft density altitude and the density altitude was calculated to be at 8100ft (see the take-off performance chart).

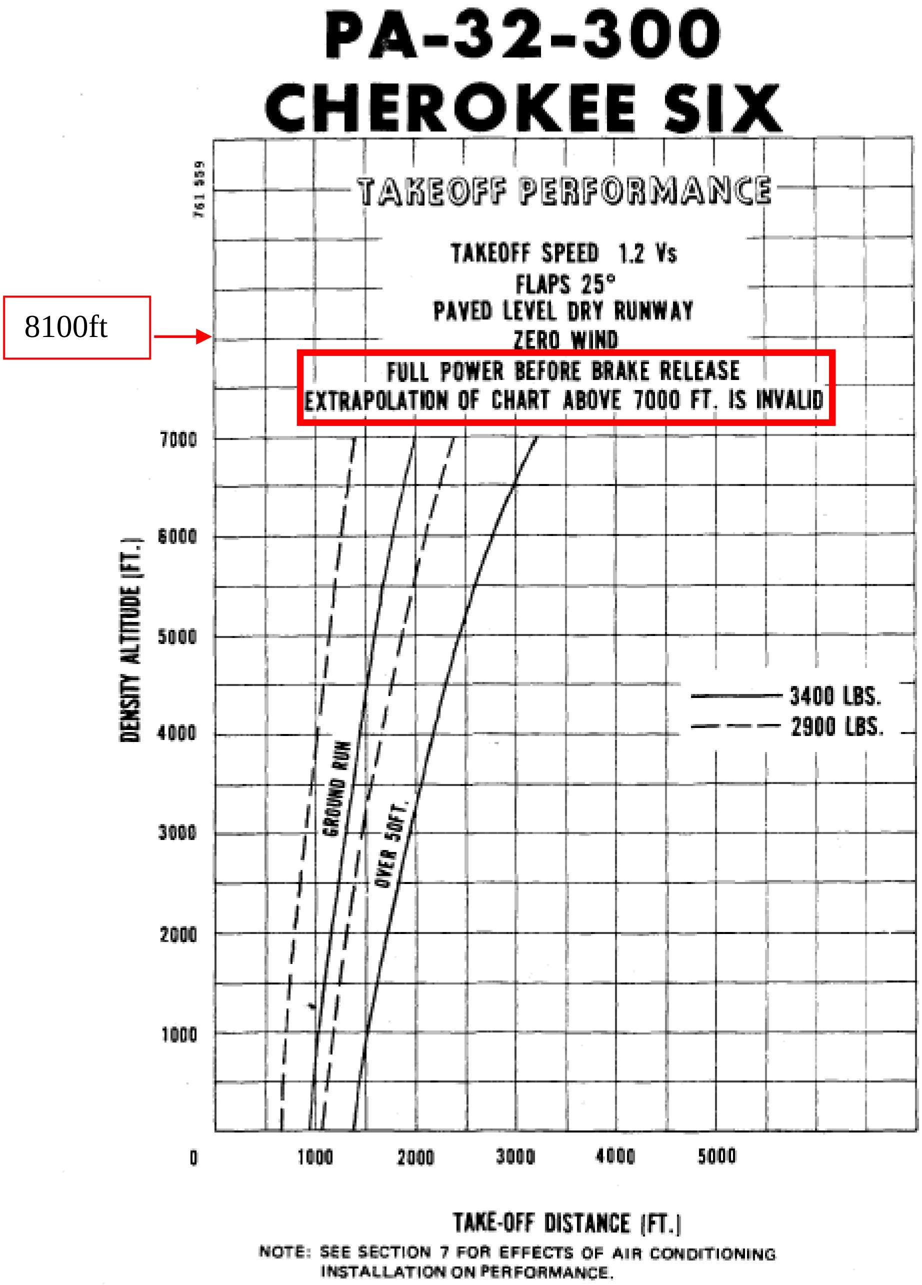
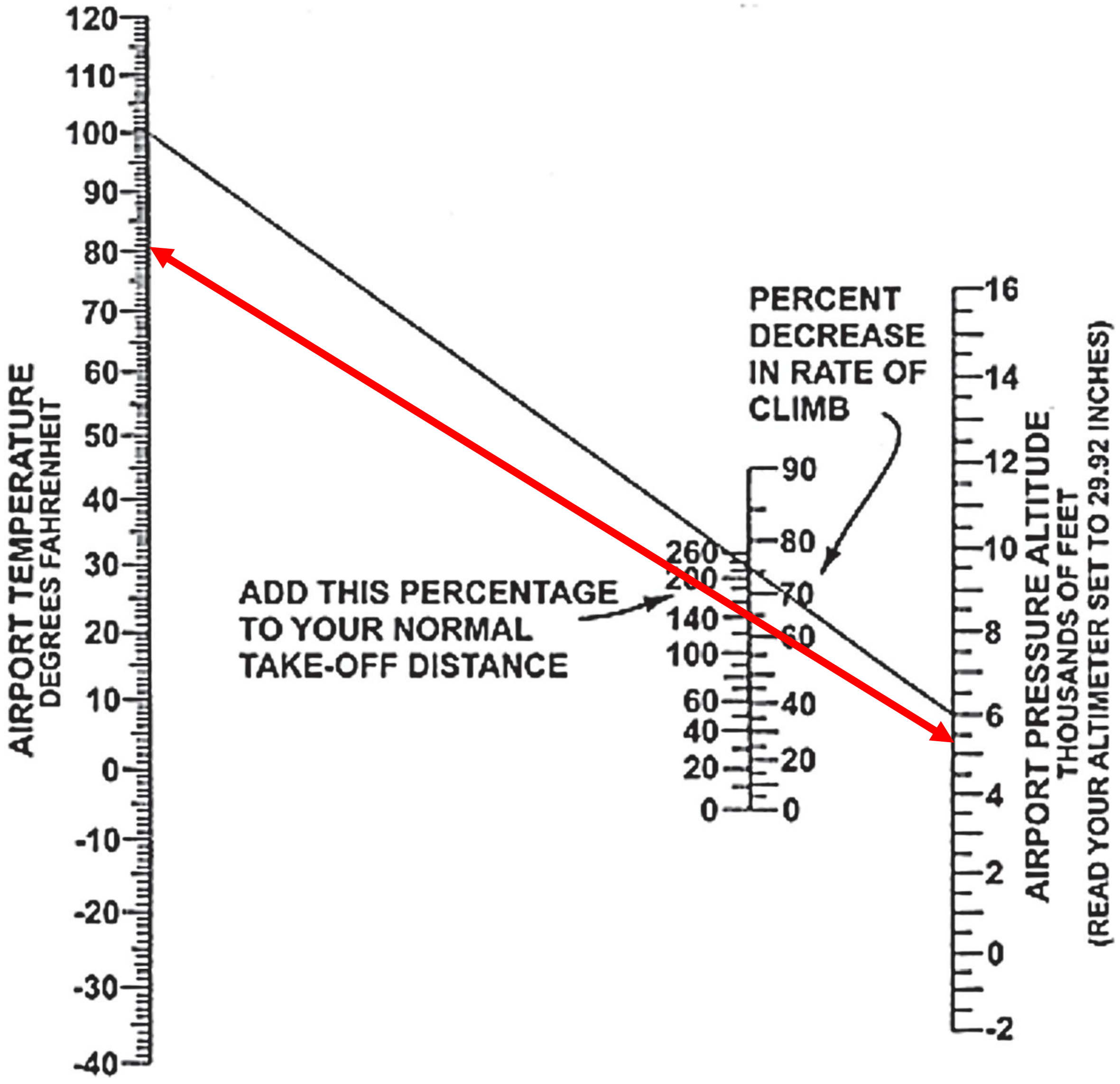


Chart 2: Take-off performance chart

1.18.4 **Koch Chart**

To find the effect of altitude and temperature, connect the temperature and airport altitude by a straight line. Read the increase in take-off distance and the decrease in rate of climb from standard sea level values. Referenced from the Federal aviation Agency (FAA), FAA–P–8740–2 • AFS–8 (2008) which can be obtained by following the link below (See Koch Chart)

https://www.faasafety.gov/files/gslac/library/documents/2011/Aug/56396/FAA%20P-8740-02%20DensityAltitude[hi-res]%20branded.pdf



Koch graph

1.18.5 The Red diagonal line shows that 140% must be added for a temperature of 27˚C (80.6˚F) and a pressure altitude of 5300ft (1615.4m). Therefore, with the standard temperature for the sea level take-off distance requiring 1500 feet of runway to climb to 50 feet, it would become 3600 feet under the conditions shown in the chart. In addition, the rate of climb would be decreased by 65 percent. Which means this aircraft normal sea level rate of climb is 1050 feet per minute, it would become 368 feet per minute.

1.19 Useful or Effective Investigation Techniques

1.19 .1 None.

2. ANALYSIS

2.1 MAN

The pilot had a valid Private Pilot Licence (PPL) issued by the Regulator on 7 September 1978. The licence was valid at the time of the accident and the aircraft type was endorsed in his licence. His flight medical was current at the time of the accident with no abnormalities evident.

It is the opinion of the investigators that the correct pre-flight planning had not been carried out. The aircraft balance (CG) was outside the manufacturer's envelope. The current weather conditions were not viable for a departure as the density altitude had increased to the above the limits set out by the performance charts provided by the manufacturer.

2.2 MACHINE

A Mandatory Periodic Inspection (MPI) was carried out on the aircraft on 21 December 2015. The aircraft had only flown 1.51 hours since its last MPI was carried out on the aircraft.

During the on-site investigation, no abnormalities were found on the aircraft. The cockpit controls showed that the aircraft was configured for take-off. The engine investigation revealed no anomalies which could have contributed to the accident. The magnetos were selected to both and the engine and propeller controls were configured for take-off.

The take-off distance required was 150% more for the take-off with a temperature of 27°C as reduced air density (reported in terms of density altitude) adversely affects aerodynamic performance and decreases the engine's horsepower output. Take-off distance, power available (in normally aspirated engines), and climb rate are all adversely affected.

The balance of the aircraft was outside the operating envelope as set out by the manufacturer. The aircraft had undergone various modifications over the period of its operational lifespan. The total take-off mass on the day was 3389 lbs. At this mass, the forward limit of the envelope was 91.4 inches from the datum and the aft limit was 95.5 inches from the datum.

100 lbs of luggage were found at the accident scene. It could not be determined whether the luggage was placed in the forward or aft baggage holds (refer to Table 1 and 2 for weight and balance calculations). In the case of luggage being loaded in the

front hold, the centre of gravity was located at 82.98 inches from the datum. In the case of the aft hold, the centre of gravity was at 87.01 inches from the datum. In both cases, the centre of gravity is forward of the required envelope limit.

The forward centre of gravity will cause the nose to be "heavy". To compensate for this, the pilot will need to use more elevator input than in a neutral centre of gravity position. A nose-heavy aircraft is also harder to rotate, and the stall speed increases due to the additional aerodynamic forces being applied to keep the aircraft level.

The pilot may have had the option of lowering the aircraft mass prior to take-off to get the weight and balance back into the allowable envelope. In this scenario the pilot would have had to lower the mass by approximately 100-300lbs depending on the luggage location.

The risks associated with an overweight aircraft include:

- higher take-off speed required
- longer take-off run
- reduction in the rate of climb
- decrease in range
- cruising speed is slower
- reduction in aircraft manoeuvrability
- higher stalling speed

2.3 ENVIRONMENT

The Satellite at 0945Z as well as the Radar images recorded clear skies over Brakpan, with mid-level clouds in the west containing embedded TCUs and/or CBs that caused showers and thundershowers in the Vereeniging area. The wind direction was south-westerly at 10kt and the visibility >10km. The temperature was 27°C and the dew point 10°C. Cloud base was reported as CAVOK.

Surface Observations:
METARS from nearby weather stations (FAOR and FASI) are included as Attachment C. This observational data shows that no wind information was recorded at FASI, and that the surface winds observed at FAOR were in agreement with that from the aircraft report (AMDAR) discussed in the preceding paragraph, i.e. light westerly to south-westerly during the period 0900Z to 1000Z. CAVOK conditions were also reported by the METAR from FAOR, in line with the Satellite and Radar images.

2.4 INVESTIGATION REVEAL

The investigation revealed that although the aircraft was within its weight limit, it was operated close to its maximum weight limit, outside of its centre of gravity (CG) limit and at high-density altitude, leading to a poor take-off and climb performance which resulted in a crash.

3. CONCLUSION

3.1 Findings

3.1.1 The pilot held a valid PPL licence and the licence was type endorsed. He also was issued a valid medical certificate.

3.1.2 The aircraft had a valid Certificate of Airworthiness and a valid Certificate of Registration and was maintained in compliance with the existing regulations and procedures.

3.1.3 There was no evidence of any defects or malfunction on the aircraft that could have contributed to the cause of the accident.

3.1.4 The Pilot-in-command was properly licensed and qualified for the flight in accordance with existing regulations.

3.1.5 This was a private flight although the company was in possession of a valid AOC.

3.1.6 The accident was not survivable due to the impact forces and post-impact fire that erupted during the accident sequence during take-off.

3.1.7 The aircraft take-off weight was calculated, and it was determined that the take-off weight of the aircraft was below the maximum take-off weight of the aircraft.

3.1.8 The aircraft was refuelled before take-off. There were no anomalies observed during the refuelling procedures.

3.1.9 In accordance with the Density Altitude calculations, the density altitude was 7863ft which was higher as per the PA-32-300 Cherokee Six take-off performance chart for the aircraft.

3.2 Probable Cause/s

3.2.1 The aircraft was operated close to its maximum weight limit, outside of its centre of gravity (CG) limit, and at high-density altitude leading to a poor take-off and climb performance which resulted in a crash.

3.3 Contributing factors

3.3.1 Poor or no pre-flight planning.

4. SAFETY RECOMMENDATIONS

4.1 Safety message: Pilots, at all times, must ensure that they do a proper pre-flight planning that includes the correct calculation of the weight and balance, effects of the Density Altitude, as well as the weather conditions.

4.2 A decal should be placed in the cockpit to notify the pilot of any changes in mass from the standard mass listed in the POH.

5. APPENDICES

5.1 Appendix 1: Weather report
5.2 Appendix 2: Aircraft Performance
5.3 Appendix 3: FAA report on density altitude

This Report is issued by:

Accident and Incident Investigations Division
South African Civil Aviation Authority
Republic of South Africa

Appendix 1: Weather report

South African Weather Service

ISO 9001 Certified Organisation

AIRCRAFT ACCIDENT REPORT

Record Reference: ZS-PME-2016-02-03
Document Type: Report
Version: 1

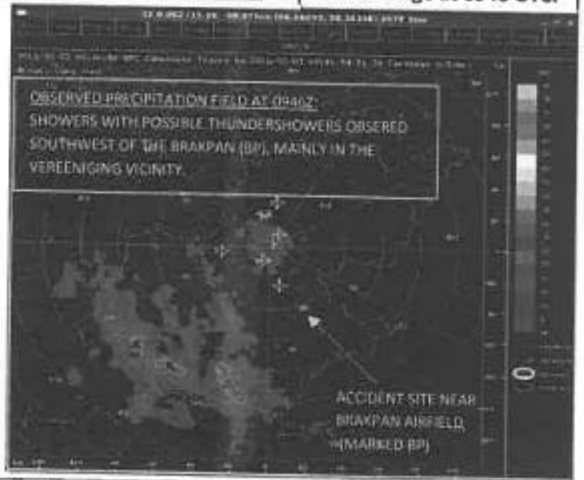
Document Control

This document is controlled in terms of the South African Weather Services' Quality Management System and may not be edited, distributed or deemed obsolete without permission of the Management Quality Representative

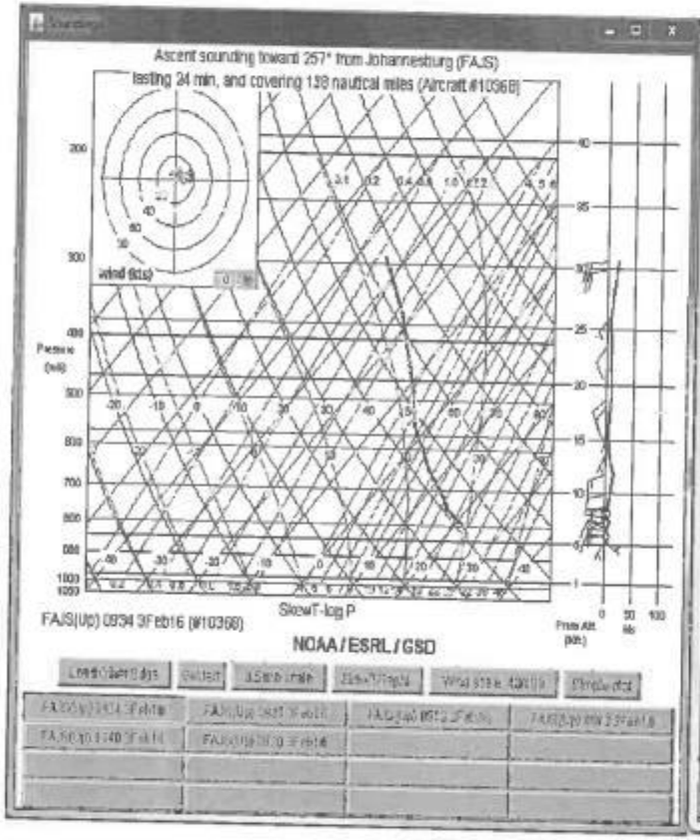
ATTACHMENT A: Accident site (top image), satellite and Radar images (bottom) recorded on the 3rd February 2016.

Satellite image at 0945 UTC:

Radar image at 0946 UTC:



ATTACHMENT B: SkewT logP diagram recorded by an aircraft departing from OR Tambo Int. Airport (FAOR) on the 3rd February 2016 at 0934Z.



FAJS(Up) 0934 3Feb16

FAJS(Up) 0934 3Feb16
Ascent sounding toward 257° from Johannesburg (FAJS;
lasting 24 min, and covering 138 nautical miles (Ai

P_alt (ft)	mb	t/td (°C)	w_dir/w_spd (kts)	Time (UTC)	Bng/Rng (nm)
5300	834	24.7/-----	123°/007	0934	252°/003
5400	831	24.2/-----	210°/005	0935	252°/003
5800	818	23.8/-----	272°/009	0935	272°/003
6100	809	22.8/-----	258°/006	0935	272°/003
6400	800	22.3/-----	273°/005	0935	272°/003
6700	791	21.2/-----	287°/005	0936	292°/003
7100	779	19.8/-----	273°/008	0936	292°/003
7400	770	18.5/-----	247°/006	0936	318°/003
7800	758	17.5/-----	271°/003	0936	318°/004
8000	753	16.6/-----	289°/002	0937	304°/006
8100	750	16.1/-----	280°/001	0937	296°/007
8500	738	15.6/-----	269°/003	0937	294°/008
8800	730	14.8/-----	245°/006	0938	291°/009
9882	700	12.1/-----	260°/010		
9900	700	12.1/-----	260°/010	0938	281°/011
11900	647	6.7/-----	249°/015	0940	271°/018
13900	598	2.2/-----	206°/006	0941	266°/023
16000	549	-2.9/-----	190°/004	0942	267°/031
18263	500	-6.8/-----	219°/009		
18900	487	-7.9/-----	227°/010	0944	268°/040
23532	400	-17.5/-----	220°/008		
25900	363	-22.2/-----	217°/007	0951	260°/085
30056	300	-32.9/-----	258°/019		
30600	293	-34.3/-----	263°/020	0958	257°/138

>>> back to summary page

ATTACHMENT C: METAR recorded by nearby weather stations (FAOR and FASI) on the 3rd February 2016

South African Weather Service
ISO 9001 Certified Organisation

Aviation Weather Centre
designated Aeronautical Meteorological Authority for South Africa

Weatherline 083 123 0500

Searching for historic data between 2016-02-03 and 2016-02-03

Results for Meteorological Aerodrome Report(s)

Station: FAOR

Date: 2016-02-03

FAOR 031030Z 30008KT 250V350 9999 FEW049 28/09 Q1021 NOSIG=
FAOR 031000Z 30007KT 260V340 9999 FEW045 27/10 Q1021 NOSIG=
FAOR 030930Z 27008KT 210V340 CAVOK 27/10 Q1021 NOSIG=
FAOR 030900Z 26007KT 200V330 CAVOK 27/10 Q1022 NOSIG=

Station: FASI

Date: 2016-02-03

FASI 031000Z AUTO /////KT //// // ////// 28/13 Q1020=
FASI 030900Z AUTO /////KT //// // ////// 27/14 Q1020=

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End of Report

GENERAL SPECIFICATIONS

PERFORMANCE

Published figures are for standard airplanes flown at gross weight under standard conditions at sea level unless otherwise stated. Performance for a specific airplane may vary from published figures depending upon the equipment installed, the conditions of engines, airplane and equipment, atmospheric conditions and piloting technique. Each performance figure below is subject to the same conditions as on the corresponding performance chart from which it is taken in the Performance Charts Section.

GROSS WEIGHTS	3400	2900
Takeoff Ground Run, 10° flaps, sea level (ft)	1050	750
Takeoff Distance Over 50-ft Obstacle, 10° flaps, sea level (ft)	1500	1200
Best Rate of Climb Speed (mph)	105	100
Rate of Climb (ft per min)	1050	1350
Best Angle of Climb Speed (mph)	95	–
Max Speed, sea level (mph)	174*	175*
Max Speed Optimum Altitude, 8,300 ft, 75% power (TAS) (mph)	168*	171*
Service Ceiling (ft)	16,250	20,000
Absolute Ceiling (ft)	18,000	21,500
Cruise Speed at Best Power Mixture (mph)		
65% power, 11,500 ft	163	167
55% power, 15,000 ft	155	163
Range at Best Power Mixture (mi)**		
75% power, 8,000 ft	780	779
65% power, 11,500 ft	845	850
55% power, 15,000 ft	905	935
Cruise Speed at Best Economy Mixture (mph)		
75% power, 8,000 ft	166	169
65% power, 11,400 ft	159	165
55% power, 15,000 ft	149	157
Range at Best Economy Mixture (mi)**		
75% power, 8,000 ft	850	865
65% power, 11,400 ft	945	980
55% power, 15,000 ft	1030	1080
Stalling Speed, flaps down, (CAS) (mph)	63	58
Stalling Speed, flaps up, (CAS) (mph)	71	66
Landing Roll, flaps down, sea level (ft)	630	540
Landing Distance Over 50-ft Obstacle, sea level (ft)	1000	850

*The speed stated is with optional wheel fairings installed. Subtract 3 mph if wheel fairings are not installed.

**No reserve.

Appendix 3: FAA report on density altitude

Federal Aviation
Administration

Density Altitude

FAA-P-8740-2 • AFS-8 (2008)
HQ-08561

Note: This document was adapted from the original Pamphlet P-8740-2 on density altitude.

Introduction

Although density altitude is not a common subject for "hangar flying" discussions, pilots need to understand this topic. Density altitude has a significant (and inescapable) influence on aircraft and engine performance, so every pilot needs to thoroughly understand its effects. Hot, high, and humid weather conditions can cause a routine takeoff or landing to become an accident in less time than it takes to tell about it.

Density Altitude Defined

Types of Altitude

Pilots sometimes confuse the term "density altitude" with other definitions of altitude. To review, here are some types of altitude:

- **Indicated Altitude** is the altitude shown on the altimeter.
- **True Altitude** is height above mean sea level (MSL).
- **Absolute Altitude** is height above ground level (AGL).
- **Pressure Altitude** is the indicated altitude when an altimeter is set to 29.92 in Hg (1013 hPa in other parts of the world). It is primarily used in aircraft performance calculations and in high-altitude flight.
- **Density Altitude** is formally defined as "pressure altitude corrected for nonstandard temperature variations."

Why Does Density Altitude Matter?

High Density Altitude = Decreased Performance

The formal definition of density altitude is certainly correct, but the important thing to understand is that density altitude is an indicator of aircraft performance. The term comes from the fact that the density of the air decreases with altitude. A "high" density altitude means that air density is reduced, which has an adverse impact on aircraft performance. The published performance criteria in the Pilot's Operating Handbook (POH) are generally based on standard atmospheric conditions at sea level (that is, 59 °F or 15 °C and 29.92 inches of mercury). Your aircraft will not perform according to "book numbers" unless the conditions are the same as those used to develop the published performance criteria. For example, if an airport whose elevation is 500 MSL has a reported density altitude of 5,000 feet, aircraft operating to and from that airport will perform as if the airport elevation were 5,000 feet.

High, Hot, and Humid

High density altitude corresponds to reduced air density and thus to reduced aircraft performance. There are three important factors that contribute to high density altitude:

1. **Altitude.** The higher the altitude, the less dense the air. At airports in higher elevations, such as those in the western United States, high temperatures sometimes have such an effect on density altitude that safe operations are impossible. In such conditions, operations between midmorning and midafternoon can become extremely hazardous. Even at lower elevations, aircraft performance can become marginal and it may be necessary to reduce aircraft gross weight for safe operations.

2. Temperature. The warmer the air, the less dense it is. When the temperature rises above the standard temperature for a particular place, the density of the air in that location is reduced, and the density altitude increases. Therefore, it is advisable, when performance is in question, to schedule operations during the cool hours of the day (early morning or late afternoon) when forecast temperatures are not expected to rise above normal. Early morning and late evening are sometimes better for both departure and arrival.

3. Humidity. Humidity is not generally considered a major factor in density altitude computations because the effect of humidity is related to engine power rather than aerodynamic efficiency. At high ambient temperatures, the atmosphere can retain a high water vapor content. For example, at 96 °F, the water vapor content of the air can be eight (8) times as great as it is at 42 °F. High density altitude and high humidity do not always go hand in hand. If high humidity does exist, however, it is wise to add 10 percent to your computed takeoff distance and anticipate a reduced climb rate.

Check the Charts Carefully

Whether due to high altitude, high temperature, or both, reduced air density (reported in terms of density altitude) adversely affects aerodynamic performance and decreases the engine's horsepower output. Takeoff distance, power available (in normally aspirated engines), and climb rate are all adversely affected. Landing distance is affected as well; although the indicated airspeed (IAS) remains the same, the true airspeed (TAS) increases. From the pilot's point of view, therefore, an increase in density altitude results in the following:

- Increased takeoff distance.
- Reduced rate of climb.
- Increased TAS (but same IAS) on approach and landing.
- Increased landing roll distance.

Because high density altitude has particular implications for takeoff/climb performance and landing distance, pilots must be sure to determine the reported density altitude and check the appropriate aircraft performance charts carefully during preflight preparation. A pilot's first reference for aircraft performance information should be the operational data section of the aircraft owner's manual or the Pilot's Operating Handbook developed by the aircraft manufacturer. In the example given in the previous text, the pilot may be operating from an airport at 500 MSL, but he or she must calculate performance as if the airport were located at 5,000 feet. A pilot who is complacent or careless in using the charts may find that density altitude effects create an unexpected—and unwelcome—element of suspense during takeoff and climb or during landing.

If the airplane flight manual (AFM)/POH is not available, use the Koch Chart to calculate the approximate temperature and altitude adjustments for aircraft takeoff distance and rate of climb.

At power settings of less than 75 percent, or at density altitude above 5,000 feet, it is also essential to lean normally aspirated engines for maximum power on takeoff (unless the aircraft is equipped with an automatic altitude mixture control). Otherwise, the excessively rich mixture is another detriment to overall performance. *Note: Turbocharged engines need not be leaned for takeoff in high density altitude conditions because they are capable of producing manifold pressure equal to or higher than sea level pressure.*

Density Altitude Charts

Density Altitude Rule-of-Thumb Chart

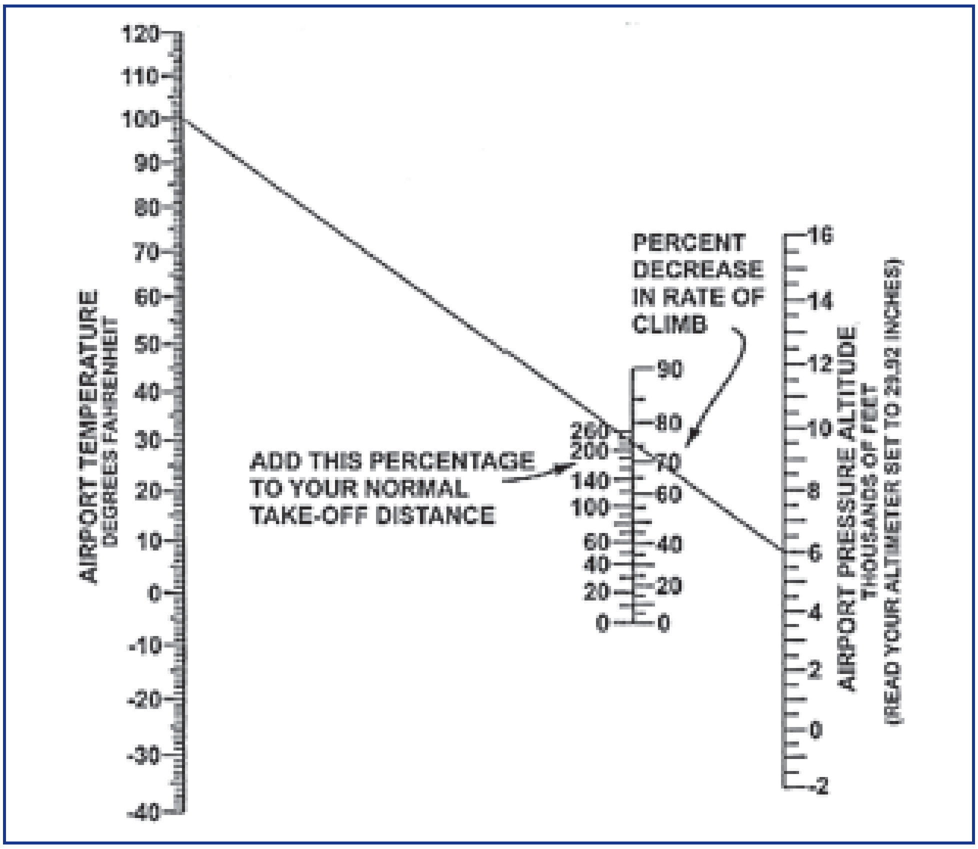
The chart below illustrates an example of temperature effects on density altitude.

Density Altitude Rule-of-Thumb Chart

STD TEMP	ELEV/TEMP	80 °F	90 °F	100 °F	110 °F	120 °F	130 °F
59 °F	Sea level	1,200	1,900	2,500	3,200	3,800	4,400
52 °F	2,000	3,800	4,400	5,000	5,600	6,200	6,800
45 °F	4,000	6,300	6,900	7,500	8,100	8,700	9,400
38 °F	6,000	8,600	9,200	9,800	10,400	11,000	11,600
31 °F	8,000	11,100	11,700	12,300	12,800	13,300	13,800

Koch Chart

To find the effect of altitude and temperature, connect the temperature and airport altitude by a straight line. Read the increase in takeoff distance and the decrease in rate of climb from standard sea level values.



3

For example, the diagonal line shows that 230 percent must be added for a temperature of 100 °F and a pressure altitude of 6,000 feet. Therefore, if your standard temperature sea level takeoff distance normally requires 1,000 feet of runway to climb to 50 feet, it would become 3,300 feet under the conditions shown in the chart. In addition, the rate of climb would be decreased by 76 percent. Also, if your normal sea level rate of climb is 500 feet per minute, it would become 120 feet per minute.

This chart indicates typical representative values for "personal" airplanes. For exact values, consult your AFM/POH. The chart may be conservative for airplanes with supercharged engines. Also, remember that long grass, sand, mud, or deep snow can easily double your takeoff distance.

About This Series

The purpose of this series of Federal Aviation Administration (FAA) safety publications is to provide the aviation community with safety information that is informative, handy, and easy to review. Many of the publications in this series summarize material published in various FAA advisory circulars, handbooks, other publications, and audiovisual products developed by the FAA and used by the FAA Safety Team (FAASTeam) for educational purposes.

Some of the ideas and materials in this series were developed by the aviation industry. The FAASTeam acknowledges the support of the aviation industry and its various trade and membership groups in the production of this series.

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