

WPR24LA130

FUEL STARVATION ANALYSIS REFERENCE

Summary of data, specifications, calculations used

ENVIRONMENTAL CONDITIONS

Parameter	Value	Source
Airport Elevation	3,831 feet MSL	E95 Benson Municipal Airport data
Barometric Pressure	29.91 inHg (14.69 psi)	KDMA METAR (28.6nm NW)
Reported Temperature	29°C (84.2°F)	KDMA METAR (28.6nm NW)

FUEL SPECIFICATIONS

Parameter	Value	Source
Automotive Fuel Used	91 octane (unleaded auto fuel, retail service station)	Pilot provided info
Aviation Fuel Used	100 octane (100LL)	Pilot provided info
Fuel Blend Ratio	85% automotive, 15% aviation	Pilot provided info
Fuel Blend Calculated Octane	92.3 octane (approx.)	Linear blending calculation
100LL Avgas vapor pressure	38.0 kPa min – 49.0 kPa max (5.5 – 7.0 psi) @ 100°F (typical 100LL is ~RVP 6)	ASTM D910, “Standard Specification for Aviation Gasoline” and ExxonMobil, “Avgas 100LL - Product Data Sheet”
Winter Fuel vapor pressure (Regulatory Maximum)	15 psi @ 100°F (RVP 15)	Arizona Revised Statutes § 3-3495
Summer Fuel vapor pressure (Federal Standard)	9 psi @ 100°F (RVP 9)	EPA 40 CFR 1090.215
Winter Fuel Delivery Season (Tucson)	October 1 - March 31 winter blend is mandatory Winter blend commercial deliveries must end by May 1, and service stations must stop selling by June 1 (summer blend transition period: 4/1-6/1**)	Arizona Administrative Code § R3-7-708

** Spring Transition from Winter to Summer Blend Fuel – Tucson AZ/Area B:

- March 31: End date for oxygenated gasoline requirement in Tucson
- May 1: Terminals and upstream suppliers must stop selling winter-grade fuel to retailers
- June 1: Retailers must complete the transition to summer-grade gasoline (empty tanks of winter blend fuel)
- Winter blend gasoline oxygen content must be 1.8-2.7% by weight in Tucson area

AIRPLANE FUEL SYSTEM SPECIFICATIONS

Parameter	Value	Source
Fuel Line Length (Lateral)	~10 feet (header tank to fuel pumps)	Pilot provided data/NTSB examination
Fuel Line Vertical Lift	~1 foot (header tank to fuel pumps, level flight attitude)	Pilot provided data/NTSB examination
Calculated Static Head Loss	0.43 psi	Fluid mechanics calculation (0.433 psi/ft elevation)
Fuel System Assessment	Fuel line sizes too restrictive for the installed system/engine (supply/return lines)	Engine manufacturer exam statement
System Type	Dual electric fuel pumps producing 40+ PSI, suction-fed from rear-mounted header tank	Pilot provided data/NTSB examination

PRESSURE CALCULATIONS (DERIVED ESTIMATES)

Condition	Value (psi)	Calculation
Atmospheric Pressure (Ground)	14.69	29.91 inHg × 0.491154
Winter Fuel Vapor Pressure (Tucson)	15.0	Regulatory maximum
Available Pressure (Ground, static loss only)	14.26	14.69 - 0.43
Atmospheric Pressure (6,000 ft)	12.52	Standard atmosphere at 6,000 ft
Available Pressure (6,000 ft, static loss only)	12.09	12.52 - 0.43
Pressure Deficit (Ground)	-0.74	14.26 - 15.0
Pressure Deficit (6,000 ft)	-2.91	12.09 - 15.0

FLIGHT TIMELINE DATA

(all times baselined from EFIS startup)

Event	Log Time (elapsed seconds)	Time (minutes)	Source
Engine Start	550 sec		Flight data/graphs
Ground Operations	550-1100 sec	9.2 min	Calculated (1100-550)
Departure (Airborne)	1100 sec		Flight data/graphs

Flight Duration to Failure	410-1510 sec	6.8 min	Calculated (1510-1100)
Engine Failure	1510 sec		Flight data/graphs
Total Engine Run Time	960 sec	16.0 min	Calculated (1510-550)

FLIGHT DATA:

Parameter	Value	Log Elapsed Time	Source
Fuel Flow (Normal Ground Ops)	~40 GPH **	550-1100s	Flight data/Figure 1
Fuel Flow (Start of Degradation)	~35 GPH **	~1100s	Flight data/Figure 1
Fuel Flow (End of Degradation)	~22 GPH **	~1250s	Flight data/Figure 1
Fuel Flow (At Failure)	0 GPH	1510s	Flight data/Figure 1
Fuel Pressure (Normal)	~40 psi	550-1250s	Flight data/Figure 2
Fuel Pressure (At Failure)	0 psi	1510s	Flight data/Figure 2
EGT (At Failure)	775-780°C	1510s	Flight data/Figure 3
Altitude at Failure	~6,000 feet MSL	1510s	Flight data/Figure 5

** The recorded fuel flow values were determined to be higher than actual fuel burn, due to return line flow; the data trend is indicative of relative fuel system performance changes throughout the accident flight.

GASOLINE REGULATORY REQUIREMENTS:

Regulation	Requirement	Relevance
Arizona Revised Statutes § 3-3495	Area B oxygenated gasoline Oct 1 - Mar 31	Tucson area winter fuel mandate
Arizona Administrative Code § R3-7-708	Minimum 1.8% oxygen by weight	Oxygenated fuel oxygen content
EPA 40 CFR 1090.215	Winter fuel RVP up to 15.0 psi allowed	Federal winter fuel volatility limits

REFERENCE VALUES USED:

Constant	Value	Source
Atmospheric Pressure Conversion	0.491154 psi/inHg	NIST standard
Fluid Head Conversion (Gasoline)	0.433 psi/ft	Fluid mechanics (SG = 0.72)
Standard Atmosphere Pressure Loss Rate	~1 psi per 2,300 feet	Standard atmosphere approximation