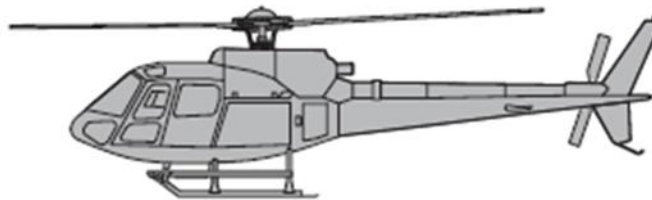


**Air Methods Corporation;  
AS350-B2; S/N: 3728; N352LN;  
Mosby, MO, 08-26-11**

## Fuel & Performance Report



**Ecureuil AS350 B2**

# AS350 B2 Fuel System Overview

## **FUEL TANK**

The 540-liter capacity (~143 total /142 usable gallons) fuel tank is manufactured from a spin-molded polyimide and does not have internal baffles. The tank is mounted in the fuselage body structure behind the passenger compartment and below the main transmission deck, between the left and right baggage compartments. It is equipped with a gravity refueling spot on the LH side of the aircraft, as well as a vent line and a water bleed valve.

## **ENGINE FUEL SUPPLY SYSTEM**

Fuel is supplied from the fuel cell to the engine through the following components in turn :

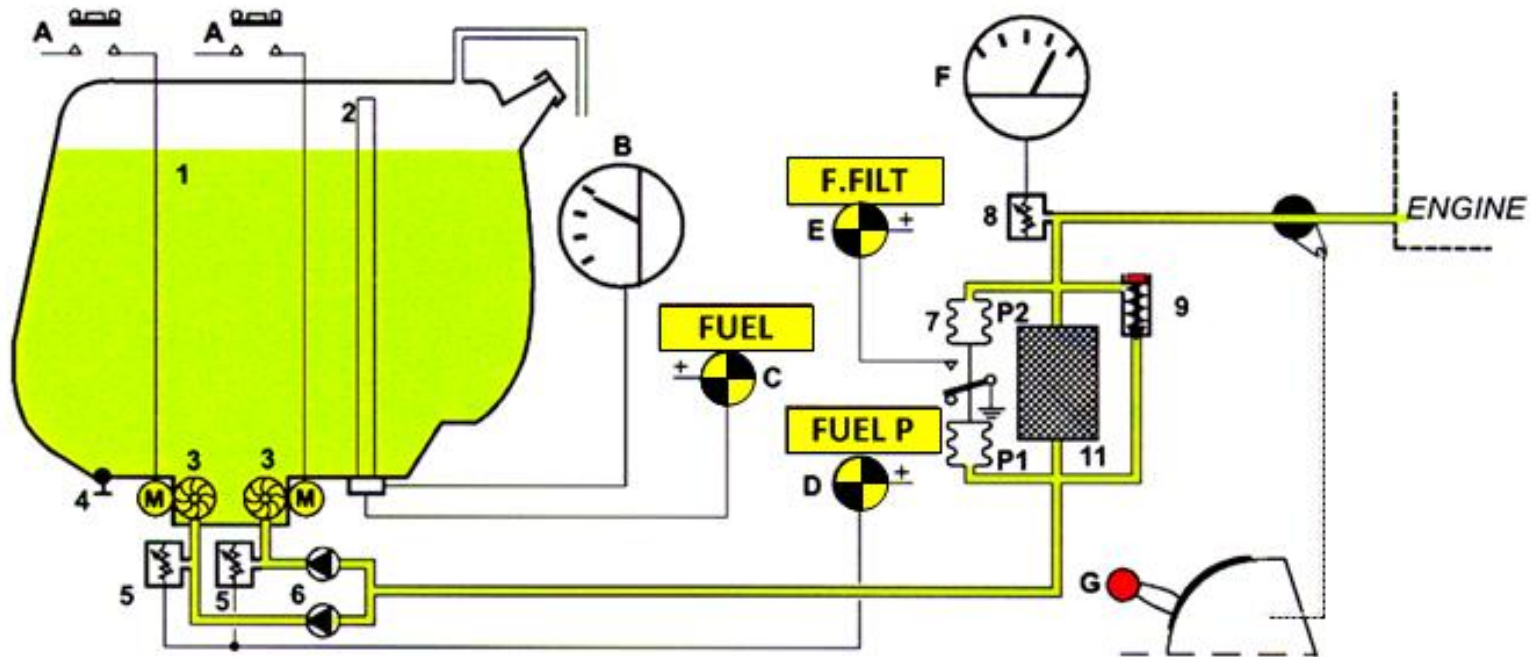
- Two booster pumps at the bottom of the fuel tank equipped with non-return valve
- A fuel filter
- A bypass valve
- Emergency fuel cut-off

## **FUEL SYSTEM CONTROLS AND MONITORING**

The following cockpit provisions are available to the pilot :

- A fuel flow control to meter the fuel on engine starting
- A fuel shutoff lever that actuates the shutoff valve in the engine fuel supply system
- A fuel contents gauge
- A fuel pressure indicator
- A "FUEL" light that illuminates to indicate a low fuel level in the tank
- A "F. FILT" light that illuminates when the pressure drop across the fuel filter exceeds 200 mb.
- A "FUEL P." light that illuminates when the fuel pressure is lower than 200 mb at either pump or both.

# Fuel system Diagram



- 1 - Fuel tank with 143 gallons max. capacity
- 2 - Variable capacitance transmitter.
- 3 - Electric boost pumps, delivering fuel at low pressure to engine pump.
- 4 - Fuel drain valve and water bleed valve.
- 5 - "Fuel low pressure" detectors, which illuminate the "F.PRESS" light when  $P < 0.2$  bar.
- 6 - Non-return valves, preventing fuel flowing through an inoperative pump.
- 7 - Differential pressure switch, detecting  $\Delta P = P_1 - P_2$
- 8 - Fuel pressure transmitter
- 9 - Bypass valve with visible "open" indicator. When visible, valve is open and filter unclogged.

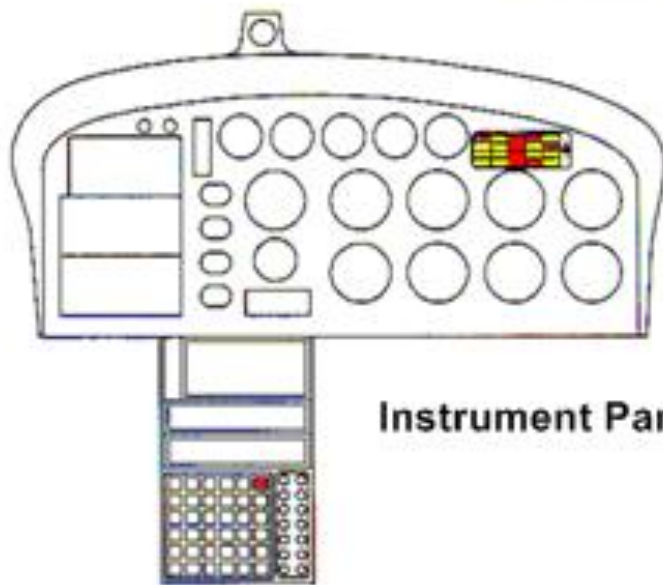
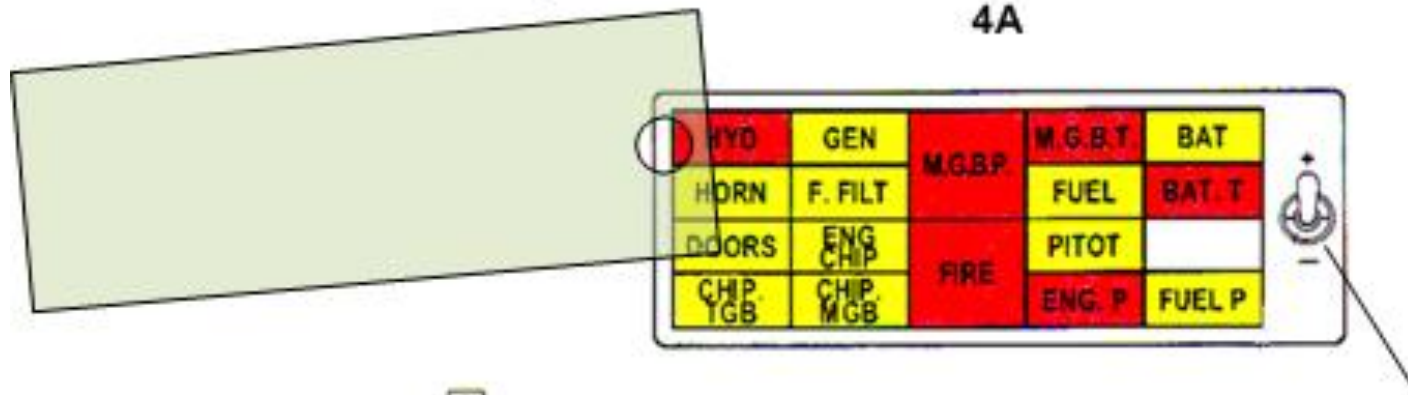
- 10 - Fuel shutoff valve, immediately cutting off fuel flow to engine (i.e. crash or engine fire).
- 11 - Fine filter ( $10 \mu$ )
- A - Pushbuttons for controlling fuel boost pumps 1 & 2.
- B - Fuel contents gauge
- C - "Level low" warning light
- D - "Fuel pressure low" warning light
- E - "Pre-clogging" warning light
- F - Fuel pressure indicator
- G - Fuel shutoff valve control lever

# Warning-Caution-Advisory Panel

AS350 B2 Version (NVG Optional equipment)

NVG Lens Overlay

4A



Instrument Panel

Brightness Adjustment Switch

+ (up) = Bright

- (down) = Dim

# Warning-Caution-Advisory Panel

- According to the AS350 B2 Flight Manual: Section 3.3, (Warning-Caution-Advisory Panel and Aural Warning), Paragraph 2.2 (Amber Lights): the warning caution advisory panel lights are colored “- Red to indicate a failure requiring immediate action, and - Amber to indicate a failure which does not require immediate action.” The illumination of the amber light identified as [FUEL] on the Warning-Caution-Advisory Panel indicates a “Fuel quantity less than 60 liters (15.8 US gal)”. The ‘Pilot Action’ is specified to “Avoid large attitude changes” with an additional “Note: Remaining usable fuel allows approximately 18 minutes level flight at maximum continuous power.” There are no aural warnings for amber colored caution advisory lights.

# Light and quantity at illumination

## Fuel Pressure

The fuel pressure < 0.2 bar

*(NOTE: B2's have dual boost pumps - failure can occur in one or both)*



- Check Fuel Boost Pump(s) switch is on
- Check fuel contents and fuses (if poss.)
- Check fuel pressure:
  - If failure is confirmed
    - Do not continue flight longer than necessary. It is prohibited to takeoff with inoperative fuel boost pump(s)
- FUEL P. > 0.2 bar on either or both.
  - If pressure is normal:
    - One pump is faulty (B1, B2), or system is faulty - flight may be continued
- Pressure Zero, pump(s) are faulty:
  - Flight may be continued at an altitude lower than 5000 ft.
- Low Pressure:
  - Press CAP test and check Fuel F. light
  - If light does not illuminate – continue flight otherwise land as soon as possible



## Fuel Quantity

Illuminates when the fuel quantity is below 15.8 US Gallons (60 Liters)

- Avoided large attitude changes
- Remaining usable fuel: approximately 18 minutes

# Light and quantity at illumination



## Fuel Filter

The fuel filter is clogging (impending bypass). P1 –P2 differential > 206 mb.

- Reduce Power
- If light goes out, continue flight at reduced power
- If light remains on, land as soon as possible.



## Horn

The Alarm Horn is Not set.

- St the Horn by pressing the push button on the center console
- The Horn will sound under the following circumstances
  - Hyd caption light – Pressure < 30 bars
  - NR between 250-360
  - NR > 410 intermittent

# Fuel Quantity Indicator

## 143 gallons fuel cell

100% = 143.0 gal.

90% = 128.7 gal.

80% = 114.4 gal.

70% = 100.1 gal.

60% = 85.8 gal.

50% = 71.5 gal.

10% = 14.3 gal.



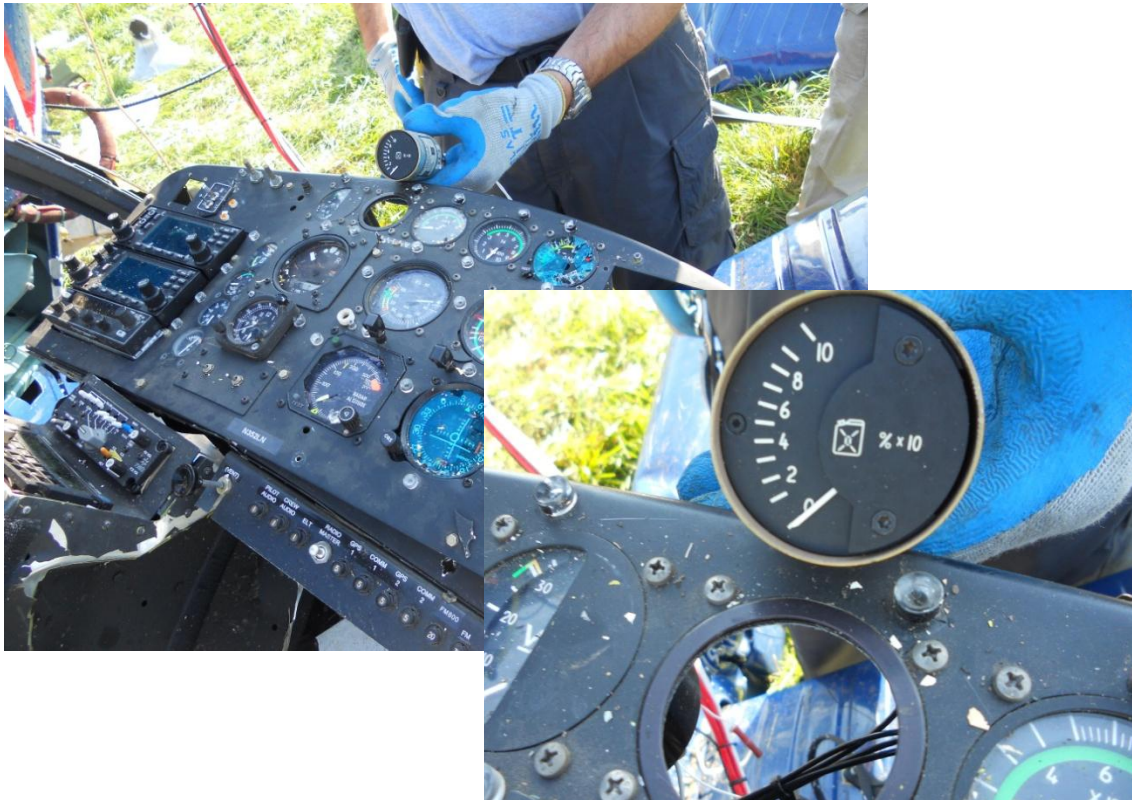
11% = 15.8 gal.





# Fuel Quantity Gauge

- The *fuel quantity gauge* instrument was found loose behind the instrument panel, separated from its panel mounted position
- A visually inspection and exhibited a missing face lenses and only minor damage from the impact event



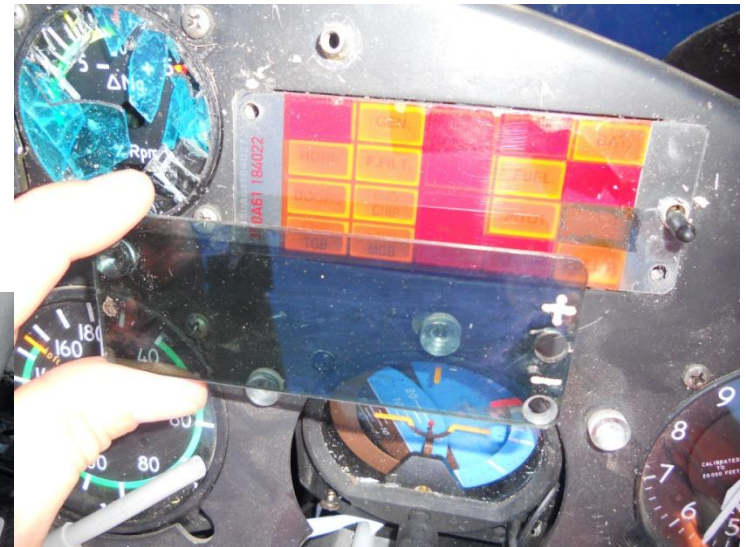
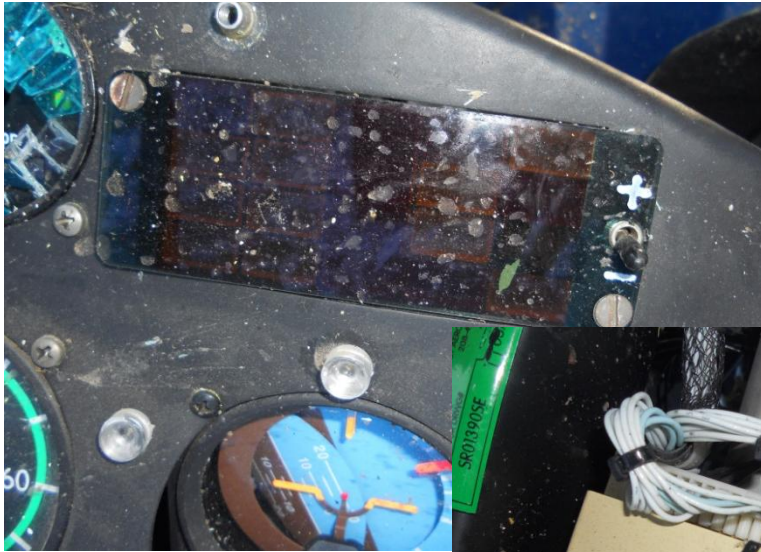
# Fuel Tank

- The fuel tank was partially separated from the airframe, and remained situated in the middle of the fragmented airframe structure during the impact event
- The tank was found relatively undamaged – no cracks or broken ports
- No fuel was observed in the tank, and no fuel smell was noted at the mishap site by the investigative team members, or by the first responders to the accident scene.
- Investigative team removed the tank from the wreckage, and sealed and prepped for shipping for further examination



# (4 Alpha) Caution-Warning Annunciator Panel

- The 4 Alpha *panel* was found intact and still attached to the cockpit instrument panel
- Equipped with a Night Vision Goggle (NVG) face plate lenses (P/N: 350A61 184022/7)
- The Day/Night dim switch was in the “dim” position.
- The annunciator panel unit was visually inspected – No visible damage from the impact event was noted.



# Fuel System Exam

The fuel tank and fuel system components (*fuel quantity gauge, and caution-warning annunciator panel*) were shipped to, and retained at, American Eurocopter in Grand Prairie, TX for examination.

- On 10-14-11 the investigative party assembled at the American Eurocopter facility to review, examine, and test the fuel tank assembly and system; the cockpit fuel gauge, and caution-warning annunciator panel.
- The electrical plugs (with the lead wires), from the back of the fuel quantity gage and caution-warning annunciator panel units were connected with its fuel quantity transmitter probe (located inside the fuel tank), both electric boost pumps, per the AS350B2 Wiring Diagram Manual schematic to assemble the components for testing.
- The tank and its structure was visually inspected.
- No damaged was noted to the structure that would have prevented the tank's ability to support a normal capacity of 540 liters of fuel.
- The fuel tank was secured to a test stand and leveled for an operational test and functionality. A fuel tank drain plug was installed in the ferry tank connector port.
- A borscope was used to inspect the inside the empty tank and the capacitance type fuel quantity transmitter located inside the tank; no anomalies were found.

# Exam Findings

The *caution-warning annunciator panel* and the *fuel quantity gauge* were connected to the fuel system.

## No fuel in the tank

- Battery power (26.3 Vdc) was supply.
- The *fuel quantity gauge* read 0 % of fuel
- The *caution-warning annunciator panel* low “**FUEL**” light was illuminated.

## Fuel was added

- Fuel was added at a slow and incremental rate.
- The *fuel quantity gage* needle moved off of 0% respectfully as fuel was added.
- When the fuel volume reached approximately 15% (17.7 gallons) the “**FUEL**” light extinguished.

## Fuel was drained

- When battery power was supplied to the tank’s two fuel bust pumps
- Both pumps operate normally and fuel was drained from the tank.
- The low “**FUEL**” light reilluminated as soon as fuel was drained to at ~ 17.7 gallons
  - (Same level noted earlier on the tank, when the light extinguished as it was being filled.

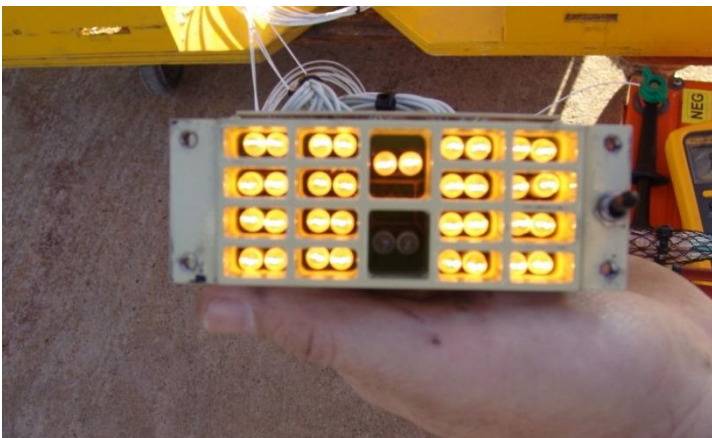
No pre-mishap anomalies were noted to the fuel systems functionality

# All Lights Working Properly

On “Bright” with NVG lens and no Lens



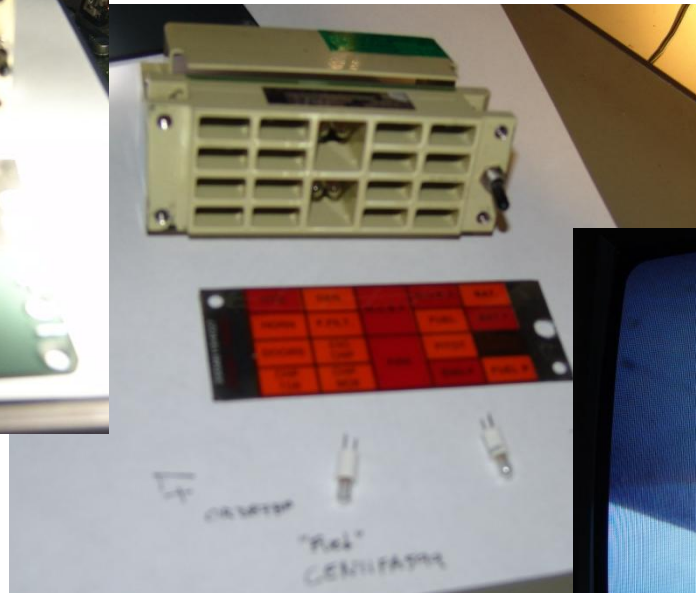
On “Dim” with NVG lens. and no Lens



*Note: Bottom center light port is not used.*

# 4 Alpha lights

- For further analysis; the two light bulbs (AO387BP) from the low “**FUEL**” light segment of the *caution-warning annunciator panel* (4A) were inspected in a cold state, with a 20x video microscope.
- The filaments of both bulbs exhibited a slightly stretched coil and smaller bend radii in the filament profile at the bulbs support wires when compared to an exemplar light bulb.
- *The slightly stretched filament coil indicates that the light was illuminated at the time of the event.*



# Performance Info

- Per a/c W&B records; A/C Operational empty weight = 3,326.7 pounds, longitudinal arm 137.2 inches
- Per AMC, helicopter weight = 3,326.7 pounds,
  - pilot weight 261 pounds,
  - medical crew positions 174 pounds /226 pounds,
  - medical equipment 209 pound,
  - Patient weight (102 pounds),
  - Total, No fuel = **4,195.2 pounds** center of gravity at **129.1 inches**
- Per AMC, generated loading table maximum fuel load would equate to 77% (738 pounds)
- If the total aircraft weight with load was **4,934 pounds**, and the moment arm was at **129.7 inches**.
- Maximum gross weight as 4,961 pounds.
  
- Temp = 29°C (84F)
- Wind 110 @ 7 kts (Approximate cross wind in travel)
  
- 107 nm total trip KSTJ to Accident Site.
- Low level fuel light comes on at ~ 11% (15.8 gallons) (~ 22 NM)
- 39% (56 gallons) of fuel could be consumed in 107 NM (see chart information in following slides)
- Fuel calculations from charts did not include time spent during shut-down and start-up.
- Note: Total fuel exhaustion varies on conditions:
  - Altitude / Speed / Air Temp / Press Alt. / True Weight of Aircraft...



# Map route

Following information estimated from flight manual charts in following slides:

**KSTJ to 75K**

**[050° @ 51nm]**

**Fuel Burn ~30 gals**

**75K to Accident Site [KGPH -2nm]**

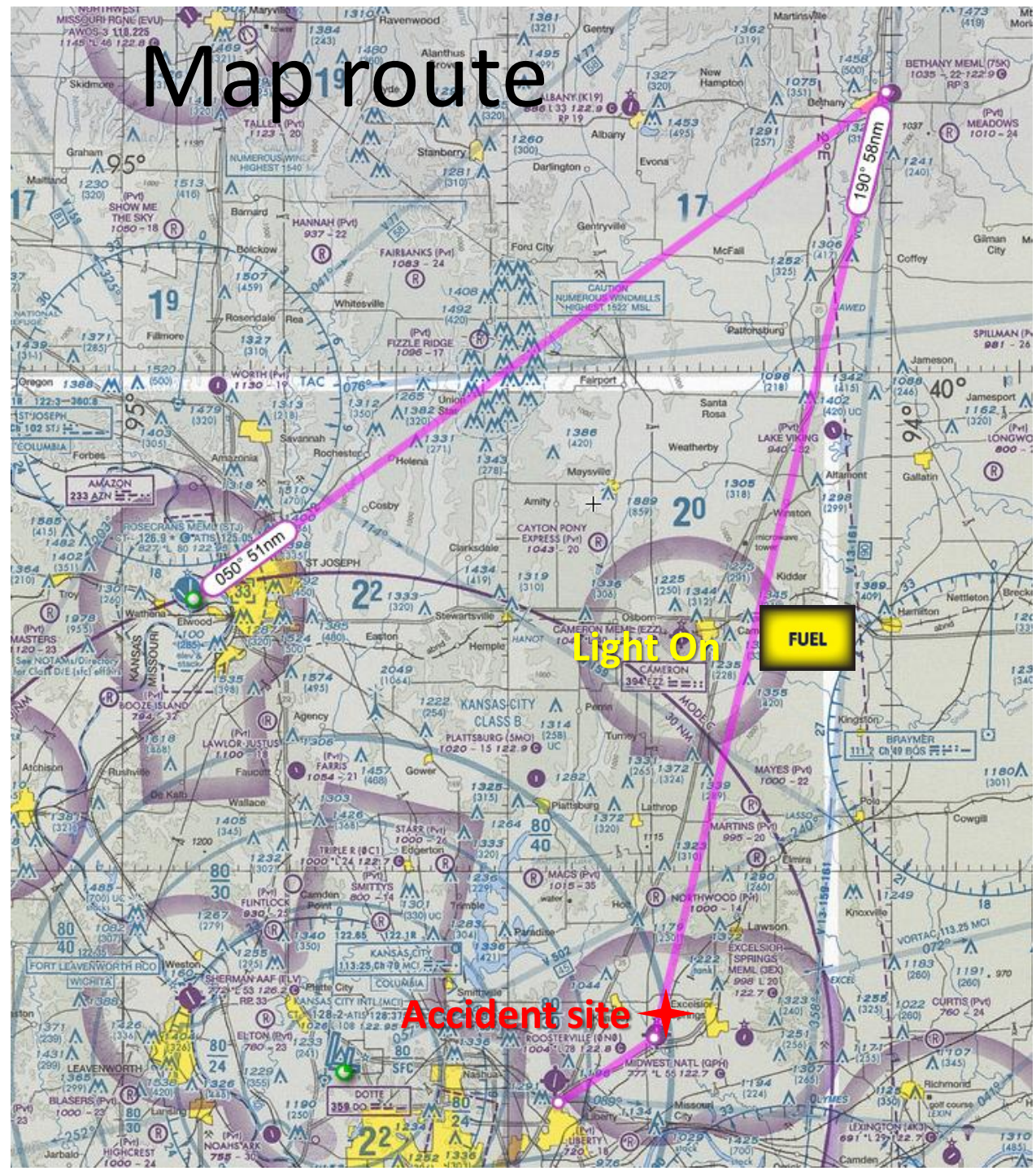
**[190° @ 56nm]**

**Fuel Burn ~26 gal**

**Approx. Total Fuel Burn = ~56 gal**

**Fuel Light "On" at ~11% 15.8 gals  
= ~ 22nm north of Accident site.**

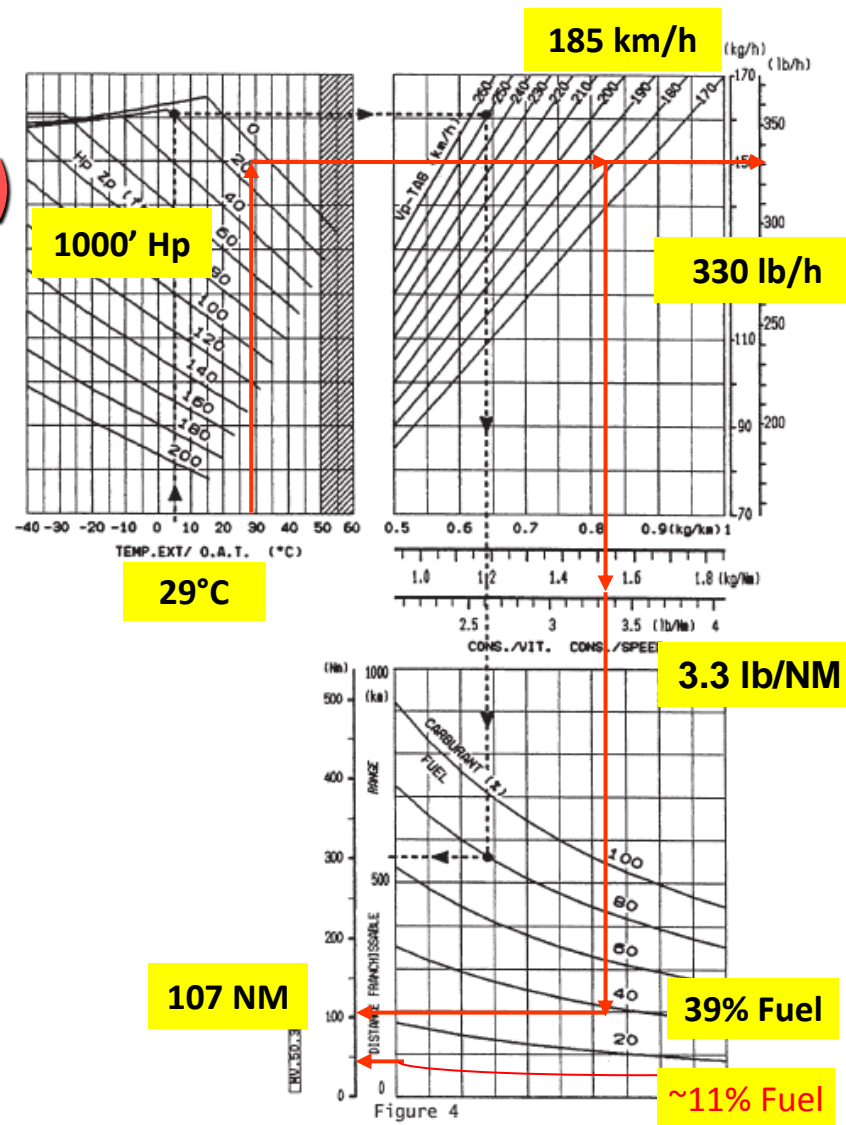
**Total Trip 107nm**



# FUEL CONSUMPTION - RANGE IN FAST CRUISE (100 kts)

OAT: 29°C  
 Hp: 1000 ft  
 Fast Cruise (TAS): 100 kt (185 km/h)  
 Fuel: ~39 %  
 Hourly Cons: 330 lb/h  
 Cons/Speed: 3.3 lb/NM  
 Range: ~107 NM

Note: Shut-down and start-up not accounted for.



**CONDITION**

- Stabilized level flight

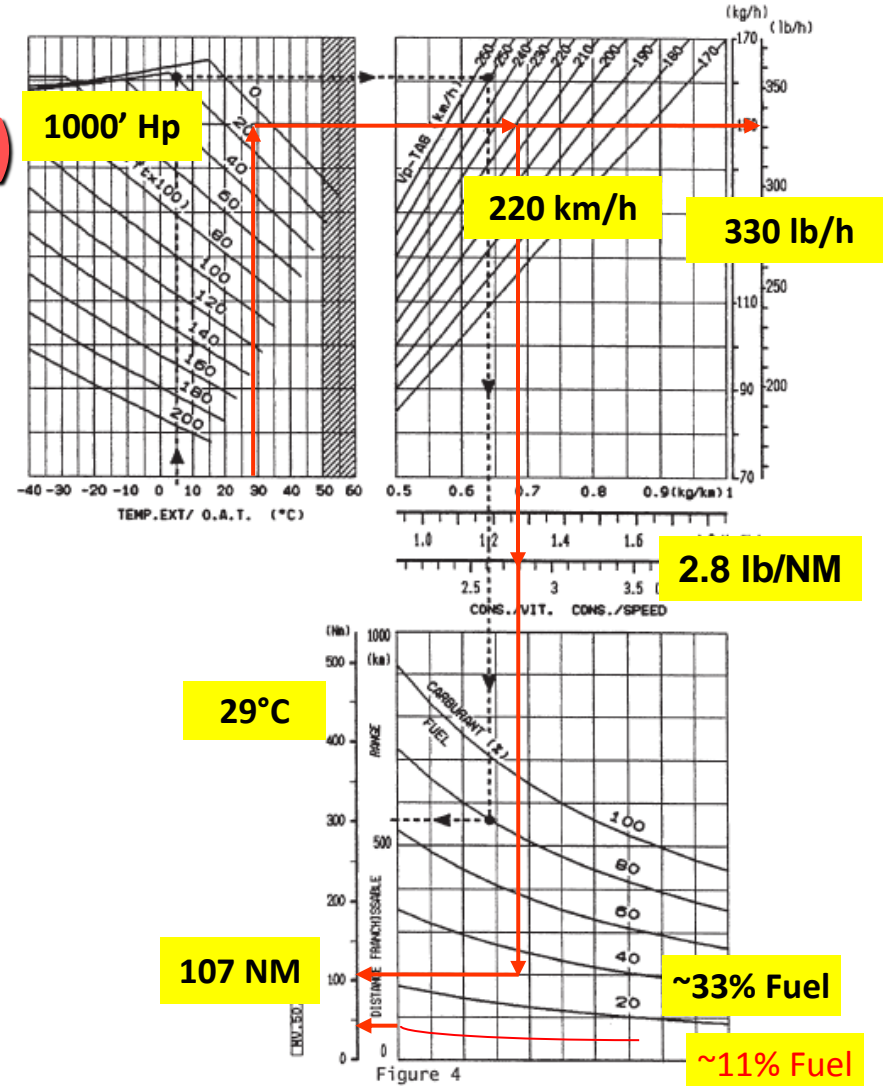
**FUEL CONSUMPTION - RANGE IN FAST CRUISE**

Note:  $Kt \times 1.852 = km/h$

# FUEL CONSUMPTION - RANGE IN FAST CRUISE (120 kts)

OAT: 29°C  
 Hp: 1000 ft  
 Fast Cruise (TAS): 120 kt (222 km/h)  
 Fuel: ~33 %  
 Hourly Cons: 330 lb/h  
 Cons/Speed: 2.8 lb/NM  
 Range: ~107 NM

Note: Shut-down and start-up not accounted for.



CONDITION  
 - Stabilized level flight

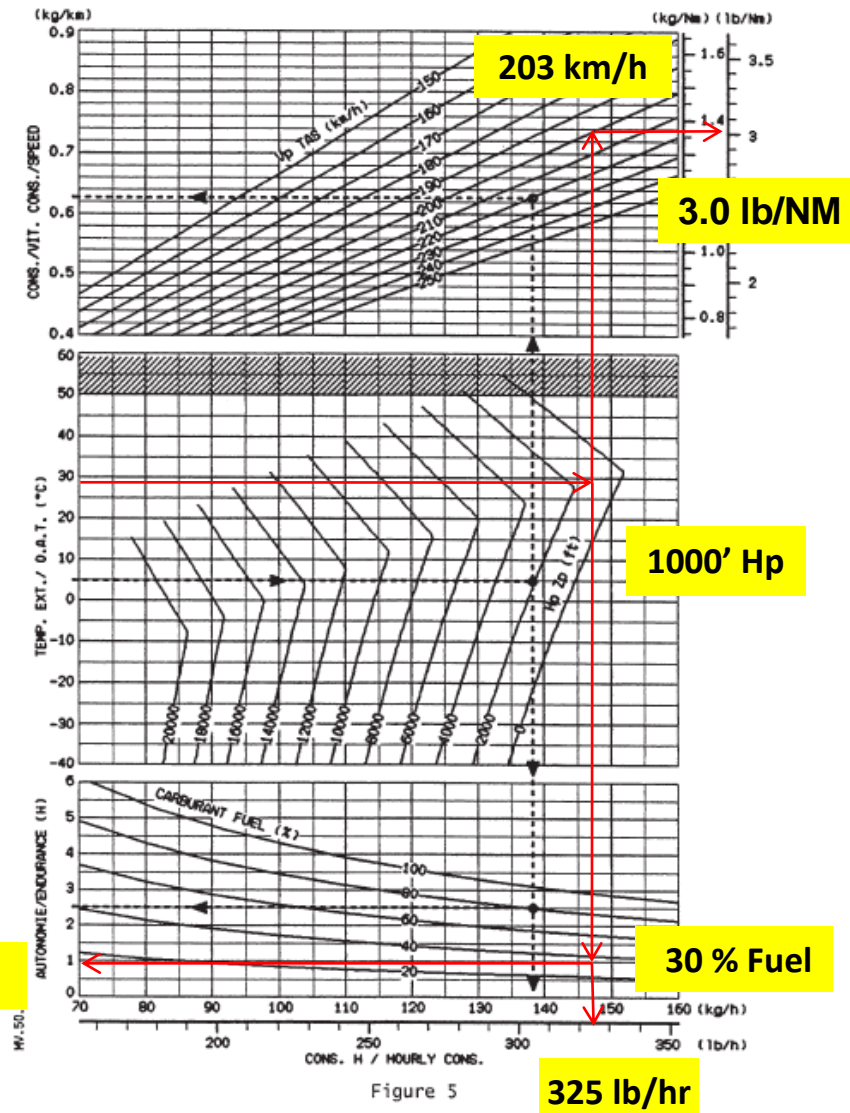
FUEL CONSUMPTION - RANGE IN FAST CRUISE

Note:  $Kt \times 1.852 = km/h$

# ENDOURANCE IN RECOMMEND CRUISE

OAT: 29°C  
 Hp (Altitude): 1000 ft  
 Cruise (TAS): 110 kt (203 km/h)  
 Fuel: 30 %  
 Hourly Cons: 325 lb/hr  
 Endurance: .9 hours  
 Cons/Speed: 3.0 lb/NM

Note in this example:  
 $3.0 * 107 = 321 \text{ Lbs, } \approx 47.9 \text{ gals, } = \sim 33.5\%$

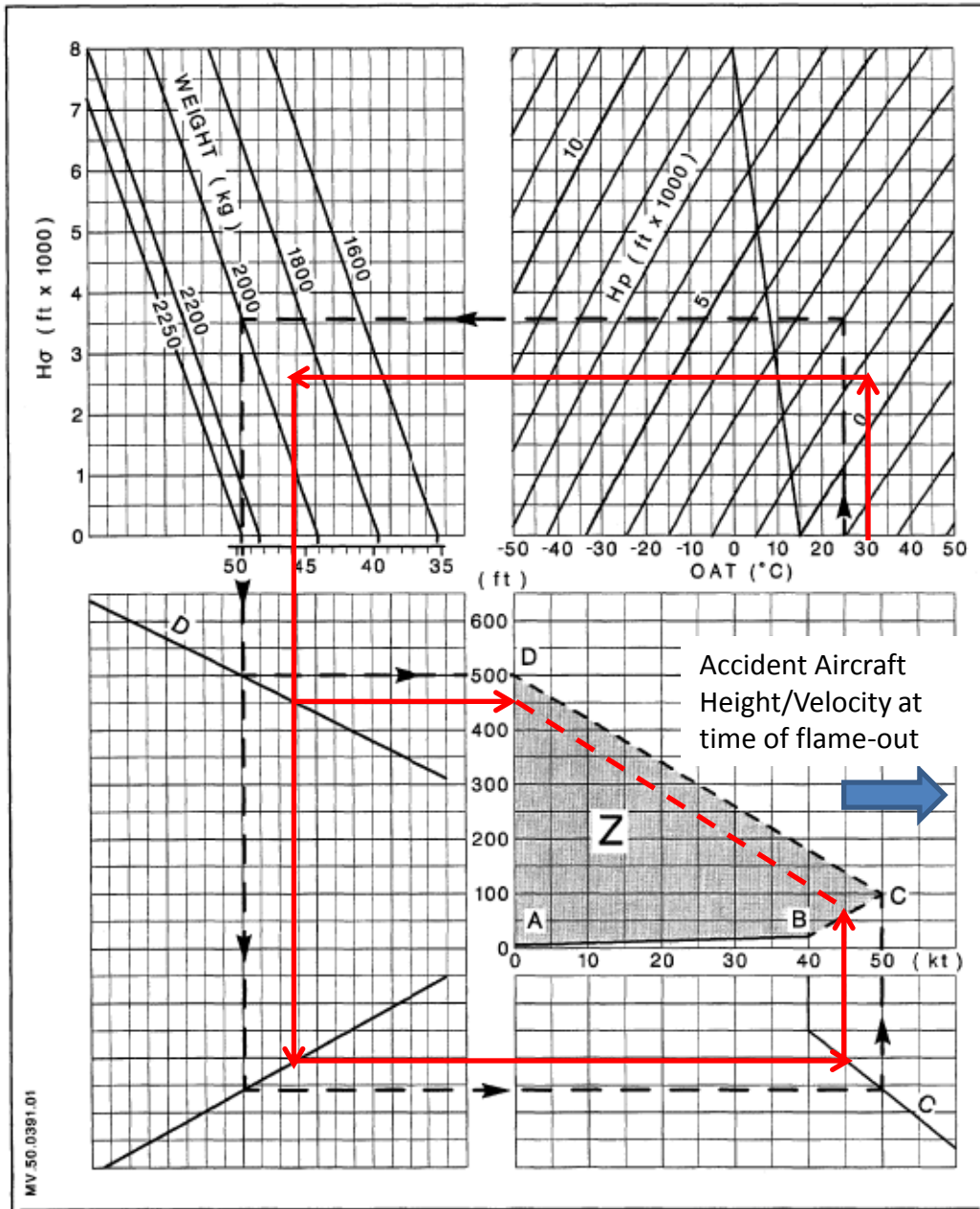


CONDITION

- Stabilized level flight

FUEL CONSUMPTION -  
 ENDURANCE IN  
 RECOMMENDED CRUISE

# Height/Velocity Data



Conditions:

- OAT 31 degrees C
- $Z_p$  925 ft.
- 1903 Kg.

Height and Velocity:

- 116 Knots
- ~275 AGL