

# **Fuel management and associated risks**

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## **About myself**

Airline Transport Pilot since 1999 currently flying A330/A340

IFALPA Accredited Accident Investigator since 2004

Technical Director of the Spanish Airline Pilots' Association  
(2005-2009)

Chairman of the IFALPA Accident Analysis & Prevention  
Committee (2010-2014)

Member of the European Aviation Safety Advisory Committee  
(2012-2014)

Member of the ICAO Safety Management Panel (2011-2016)

# Outline

Is fuel still relevant today in air transport operations?

Some case studies

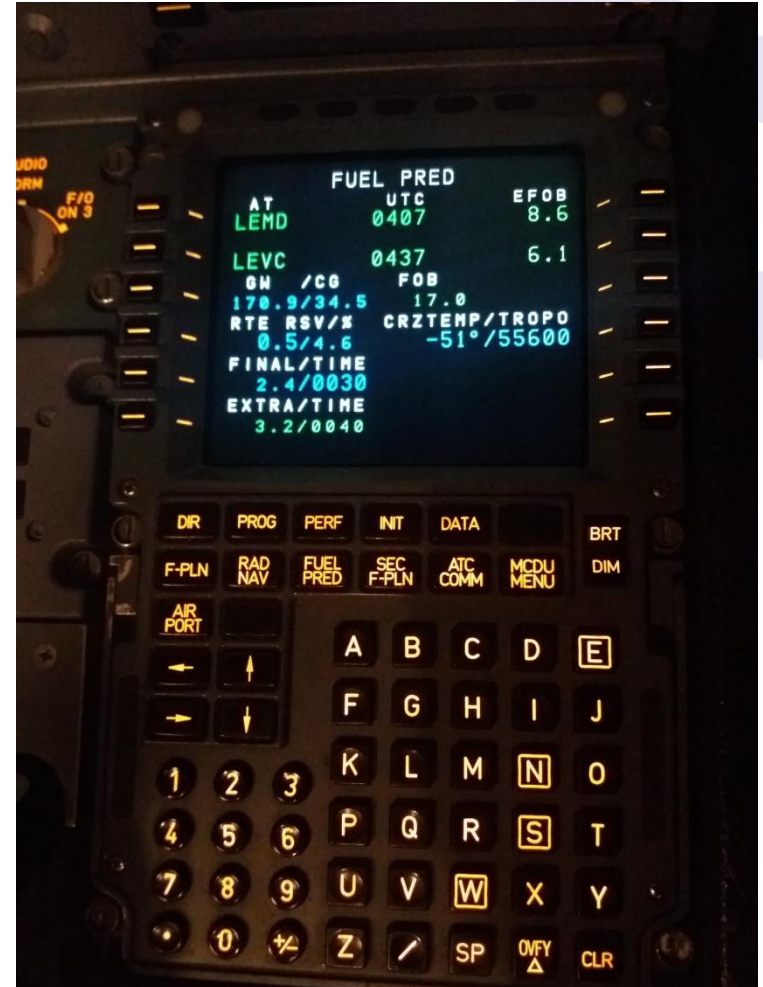
Fuel management by ICAO

Conclusions



***Is fuel still an issue in aviation ops?***

Advances in computerized flight planning and flight management systems (FMS) bring increased accuracy and predictability to operational and fuel planning



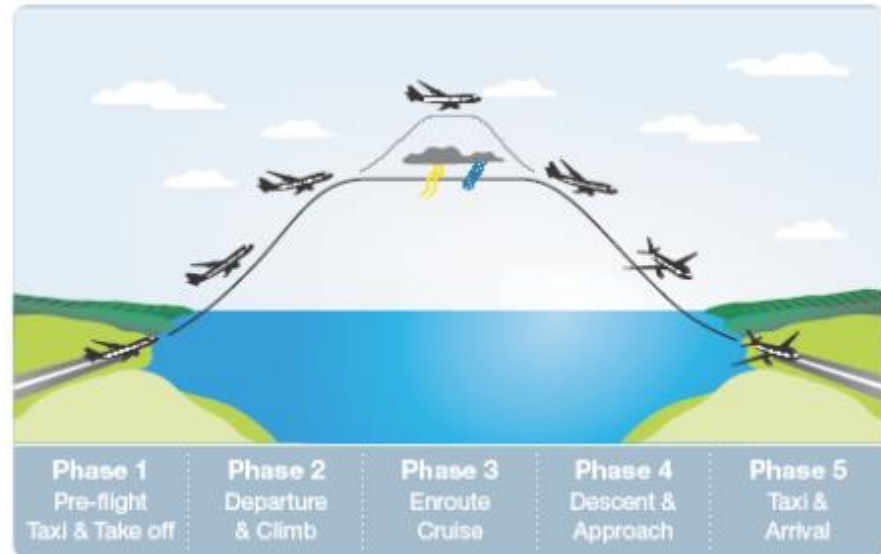
Statistically-based fuel consumption programs accurately predict fuel burn and contingency fuel use



Although the contribution of aviation emissions to the total CO2 emissions is relatively small, scheduled aviation traffic continues to grow



Growing competition has also encouraged many airlines to implement fuel conservation and operational efficiency programs to reduce costs





# EFFICIENT OPERATIONS

# ENVIRONMENTAL CONCERNS

What about safety?



case studies

## Case1: Flight LMI2933. 29 November 2016



# LMI2933 accident factual (I)

Investigation is ongoing

Flight from Santa Cruz (Bolivia) to Medellín (Colombia) with 4 crew and 73 pax

Aircraft fueled up to maximum (9,300 Kg)

Pilots discussed the need to divert to Bogotá (Colombia) for refueling. However the flight continued to destination



## LMI2933 accident factual (II)

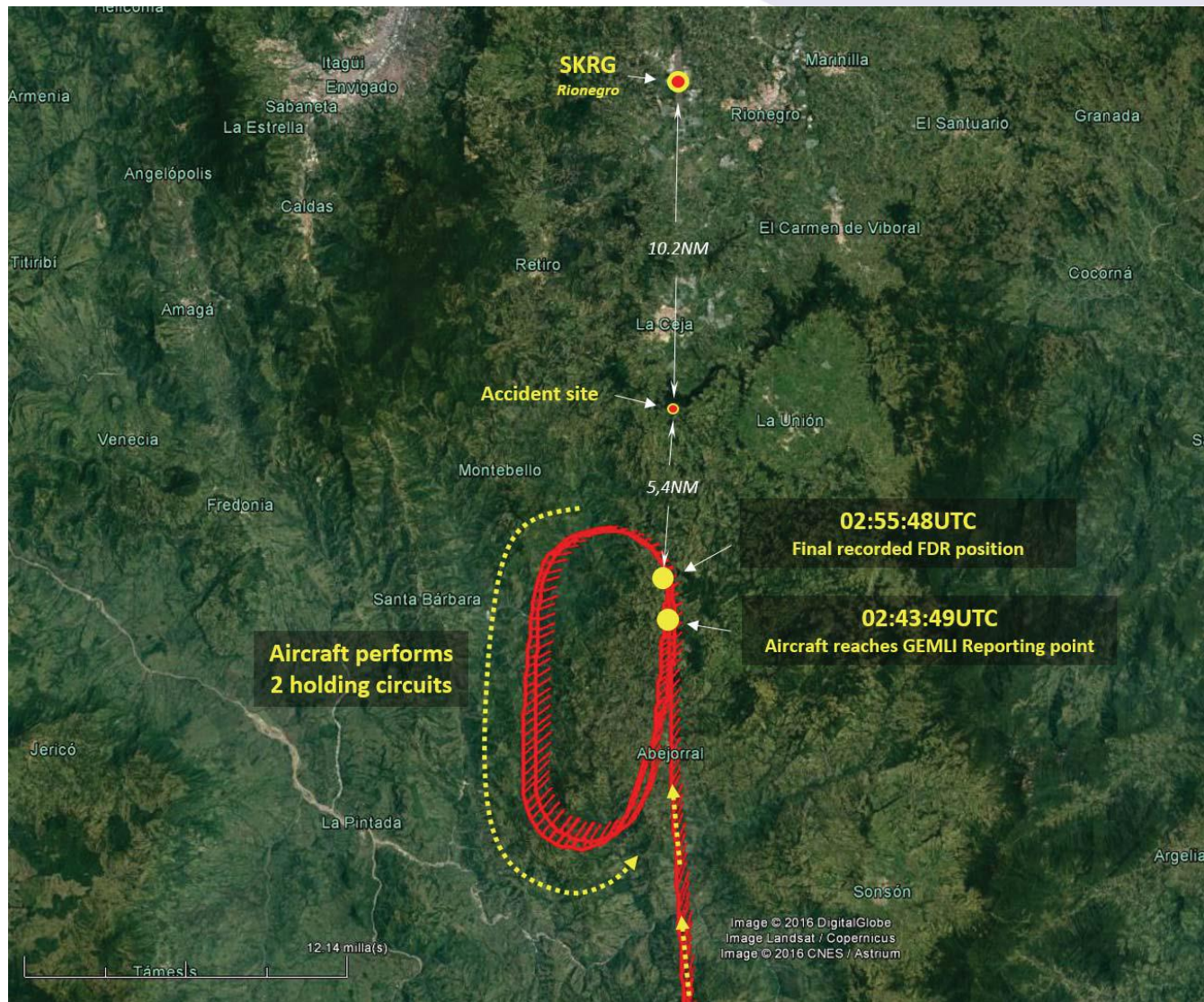
Flight plan route (1,611 NM + taxi) required 8,858 kg of fuel

No allowance for diversion, holding or contingency

Investigation has estimated a TOW of 42,148 kg while the MTOW is 41,800 per AFM

The EET (Estimated Enroute Time) was the same as the endurance





*"The evidence available to the investigation at the time of issue of this preliminary report has not identified a technical failure that may have caused or contributed to the accident.*

*The available evidence is however consistent with the aircraft having suffered fuel exhaustion."*

From Preliminary Report Accident investigation CP2933  
Aeronáutica Civil Colombia (GRIAA)



## Case 2: Valencia Airport (LEVC), Spain. 26 July 2012



The screenshot shows a MailOnline news article. At the top, there's a navigation bar with links like Home, News, U.S., Sport, TV&Showbiz, Australia, Femail, Health, Science, and Money. Below this is a sub-navigation bar with links like Latest Headlines, News, World News, Arts, Headlines, France, Pictures, Most read, Wires, and Discounts. The article title is "Ryanair ordered to 'review' fuel policy after making THREE emergency landings because planes almost ran out". The byline is "By RAY MASSEY FOR THE DAILY MAIL". The publication date is "PUBLISHED: 20:55 BST, 20 September 2012" and the update date is "UPDATED: 07:34 BST, 21 September 2012". There are social media sharing buttons for Facebook, Twitter, Pinterest, Google+, and a generic share button. A comment count of 162 is shown. The article text begins with "Budget airline Ryanair has been ordered to 'review' the amount of fuel it carries after three of its planes - including".

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**Ryanair ordered to 'review' fuel policy after making THREE emergency landings because planes almost ran out**

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Budget airline Ryanair has been ordered to 'review' the amount of fuel it carries after three of its planes - including

## 26 July 2012

Severe convective weather  
at Madrid-Barajas (LEMD)

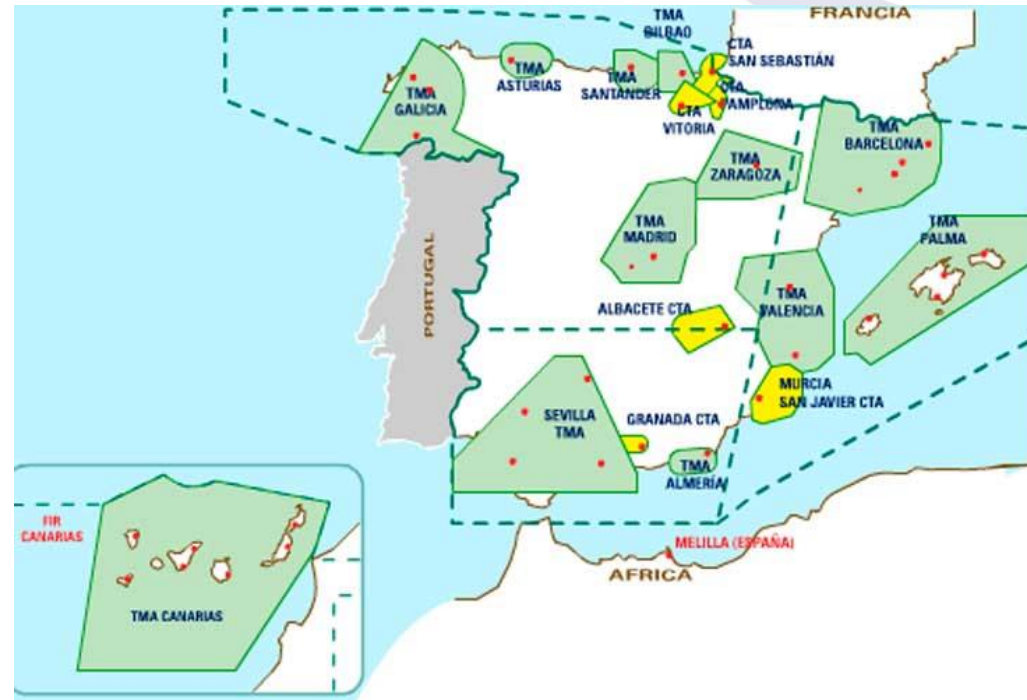
LEMD is a busy airport

Several alternate airports  
were available

LEVC (dist aprox 190NM)

LEAL (dist aprox 200NM)

LEZG (dist aprox 140NM)



# Flight LAN705, EDDF-LEMD

Airbus A340-300

Go-around at LEMD

Proceeded to LEVC as alternate (7250 kgs.)

Emergency (MAYDAY) declaration due to “engine failure”

Engine stopped due to lack of fuel

Landing fuel was 2365 kgs. (reserve fuel was 2452 kgs.)

# Flight FR2054 LEPA-LEMD

B737-800 - Flight plan fuel: 5887 kgs – Fuel load: 6500 Kgs

Go-around at LEMD and instructed to hold

Crew decided to proceed to alternate airport (LEVC)

ATC instructed the flight to hold due to high traffic volume at LEVC

Crew declared emergency (MAYDAY)

Landing fuel was 1029 kgs (reserve fuel was 1104 kgs)

# Flight FR5998, EGSS-LEMD

B737-800 - Flight plan fuel: 8917 kgs -Crew loaded 9200 kgs due to weather at LEMD

Go-around and instructed to hold

Crew decided to divert to LEVC

Delays expected at LEVC due to high traffic volume

Crew declared emergency

Landing fuel was 1160 kgs (reserve fuel was 1119 kgs)

# Flight FR5389, ESKN-LEMD

B737-800 - Flight plan fuel: 11828 kgs.- Crew decided to load 12720 kgs due to weather in destination (LEMD)

Go-around and instructed to hold

Crew decided to proceed to LEVC as alternate

35 min delay expected at LEVC

Crew declared emergency (MAYDAY)

Landing fuel was 1228 kgs (reserve fuel was 1090 kgs)



# Incident investigations

2 investigations were held (Spain & Ireland)

Similar conclusions:

*A special procedure requiring more fuel should be establish at LEMD TMA when severe weather is expected*

*The operator's fuel policy should be modified to better address fuel issues*

*Operator's training should include scenarios similar to those incidents*

## Case 3: Madrid-Barajas (LEMD) Airport 29/04/2016

### TAFOR (Terminal Area Forecast Report)

TAF LEMD 05:00 Z TAF LEMD 290500Z 2906/3012 VRB05KT 9999  
SCT060 TX19/2915Z TN07/3006Z PROB30 TEMPO 2906/2909 BKN014  
PROB40 TEMPO 2912/2920 SHRA FEW030TCU **PROB30 TEMPO**  
**2912/2920 VRB15G25KT 3000 TSRA SCT040CB**

# Madrid-Barajas (LEMD) Airport. 29 April 2016

Strong winds from South forced a change in airport configuration (APP from the North, landing southerly)

A severe thunderstorm blocked the approach path

ATC APP frequencies completely saturated due to aircraft requesting information about delays



## Madrid-Barajas (LEMD) Airport. 29 April 2016

40 flights affected

3 emergency  
declarations due to  
fuel shortage

alternate airports  
limited in capacity



OK, but now weather is fine.

Should I plan any  
contingency?

**Of course!**



## Case 4: London-Gatwick Airport (EGKK). 2 July 2017

[NATS video](#)



ICAO

## ***Fuel management by ICAO***



## ICAO Annex 6, chapter 4:

*4.3.6.1 'All aeroplanes' - A flight shall not be commenced unless , **taking into account both the meteorological conditions and any delays that are expected in flight** , the aeroplane carries sufficient fuel and oil to ensure that it can safely complete the flight. In addition , a reserve shall be carried to provide for contingencies*

## ICAO Annex 6, chapter 4

### *4.3.7 In-flight fuel management*

*4.3.7.1 An **operator** shall establish policies and procedures, approved by the State of the Operator, to ensure that in-flight fuel checks and fuel management are performed.*

*4.3.7.2 The **pilot-in-command** shall continually ensure that the amount of usable fuel remaining on board is not less than the fuel required to proceed to an aerodrome where a safe landing can be made with the planned final reserve fuel remaining upon landing.*

# Guidance on fuel management can be found in ICAO Doc 9976 “Flight Planning and Fuel Management Manual”

Handwritten mathematical derivation on graph paper:

$$u(x) = \frac{4x-3}{\sqrt{2x^2-3x+1}}$$

$$u'(x) = \frac{4 - \frac{(4x-3) \cdot 2x}{\sqrt{2x^2-3x+1}}}{2x^2-3x+1}$$

$$= \frac{4\sqrt{2x^2-3x+1} - 2x(4x-3)}{(2x^2-3x+1)^{3/2}}$$

$$= \frac{4\sqrt{2x^2-3x+1} - 8x^2 + 6x}{(2x^2-3x+1)^{3/2}}$$

$$= \frac{4\sqrt{2x^2-3x+1} - 8x^2 + 6x}{(2x^2-3x+1)^{3/2}}$$

# ICAO Doc 9976 highlights

Prescriptive regulation regarding fuel

Performance-based compliance

In-flight fuel management

“MINIMUM FUEL”

“MAYDAY”



# “MINIMUM FUEL”

is NOT an emergency

informs ATC that all planned aerodrome options have been reduced to a specific aerodrome of intended landing

and any change to the existing clearance may result in landing with less than planned final reserve fuel

# "MAYDAY, MAYDAY, MAYDAY"

a situation of fuel  
emergency  
expected fuel at  
landing is less than  
planned reserve  
fuel

|                                      |                   |        |             |        |       |     |
|--------------------------------------|-------------------|--------|-------------|--------|-------|-----|
| 10 MOROX/F300 OSVOR/F340 TAROT/F360  |                   |        |             |        |       |     |
|                                      | AVG.OAT           | MAX.WS | AVG.GS      | AVG.WC | TIME  | DST |
|                                      | M46               | 07     | 461         | H4     | 10:13 | 470 |
|                                      | TAXI+APU          | 00:16  | 760         |        |       |     |
|                                      | TRIP              | 10:13  | 92830       |        |       |     |
| 2000                                 | HOLD SBGR         | 00:14  | 1820        |        |       |     |
| 5641                                 | CONTINGENCY       | 00:18  | 2790 / 3PCT |        |       |     |
| 5000                                 | ALT SBGL          | 00:46  | 6790        |        |       |     |
|                                      | FINAL RES         | 00:30  | 3750        |        |       |     |
| 6000                                 | ADDITIONAL        | 00:00  | 0           |        |       |     |
| 0                                    | UNUSABLE          |        | 0           |        |       |     |
|                                      | EXTRA             |        | 0           |        |       |     |
|                                      | TANKER            |        | 0           |        |       |     |
|                                      | RAMP FUEL         |        | 108740      |        |       |     |
|                                      | MIN FUEL ALT SBGL |        | 10540       |        |       |     |
| CIRCLE: S0949.2/W03312.1 RADIUS: 941 |                   |        |             |        |       |     |
| P.CRISTINA RIVERO MENCHERO           |                   |        |             |        |       |     |

# *Conclusions*



# **Saving fuel in aviation is paramount for economical and environmental reasons**



# **In aviation Fuel means Weight but also means Time**



# Weather issues at busy airports may evolve into complex situations



**ATC can help you;  
but consider your  
own options in case  
they cannot**



**Proceeding to an  
alternate airport  
does not mean  
problems have  
ended**



# Try to anticipate



**COPAC**



**Muchas gracias**  
**Thank you**