Air Force Future Fuel Utilization

Tim Edwards
Air Force Research Laboratory
Propulsion Directorate

MACCCR Fuels Research Review,
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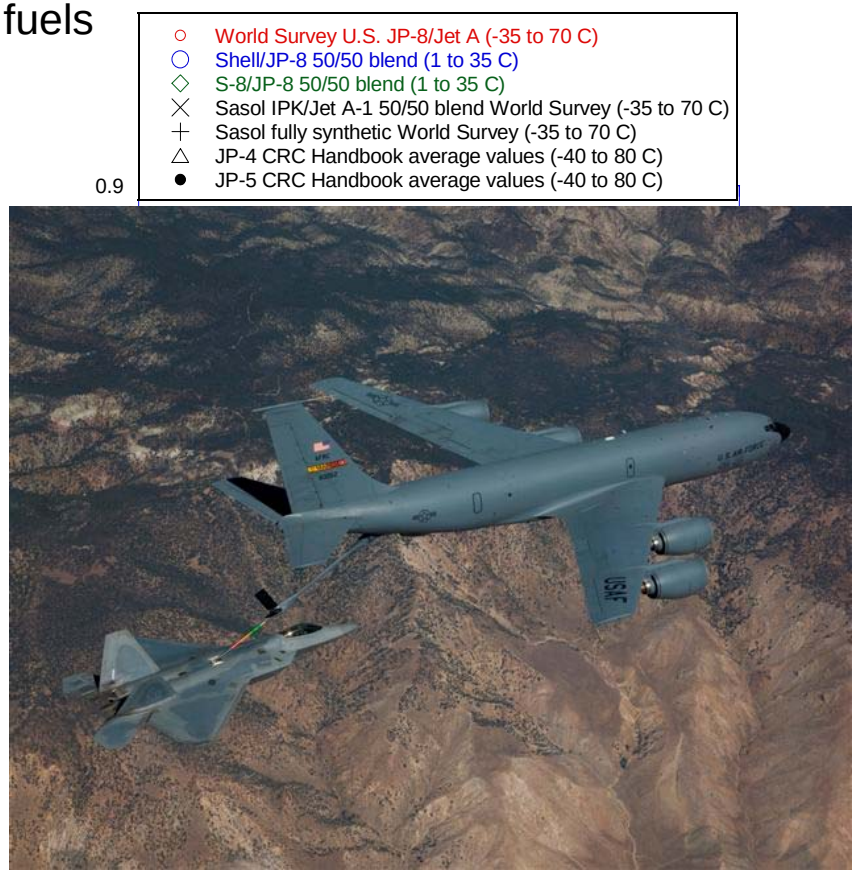
88ABW-2008-0011

AF Alternative Fuel Program

- Near-term goal: 50/50 F-T (SPK)/JP-8 blend certified in all AF vehicles by 2011 (POC: ASC Alternative Fuel Certification Office(AFCO))
  - Coordinating w/ Commercial Aviation Alt. Fuel Initiative (CAAFI)
  - Revisions to Jet A (ASTM D1655) and JP-8 (MIL-DTL 83133F)
  - Goal: “drop-in” replacement for current fuels

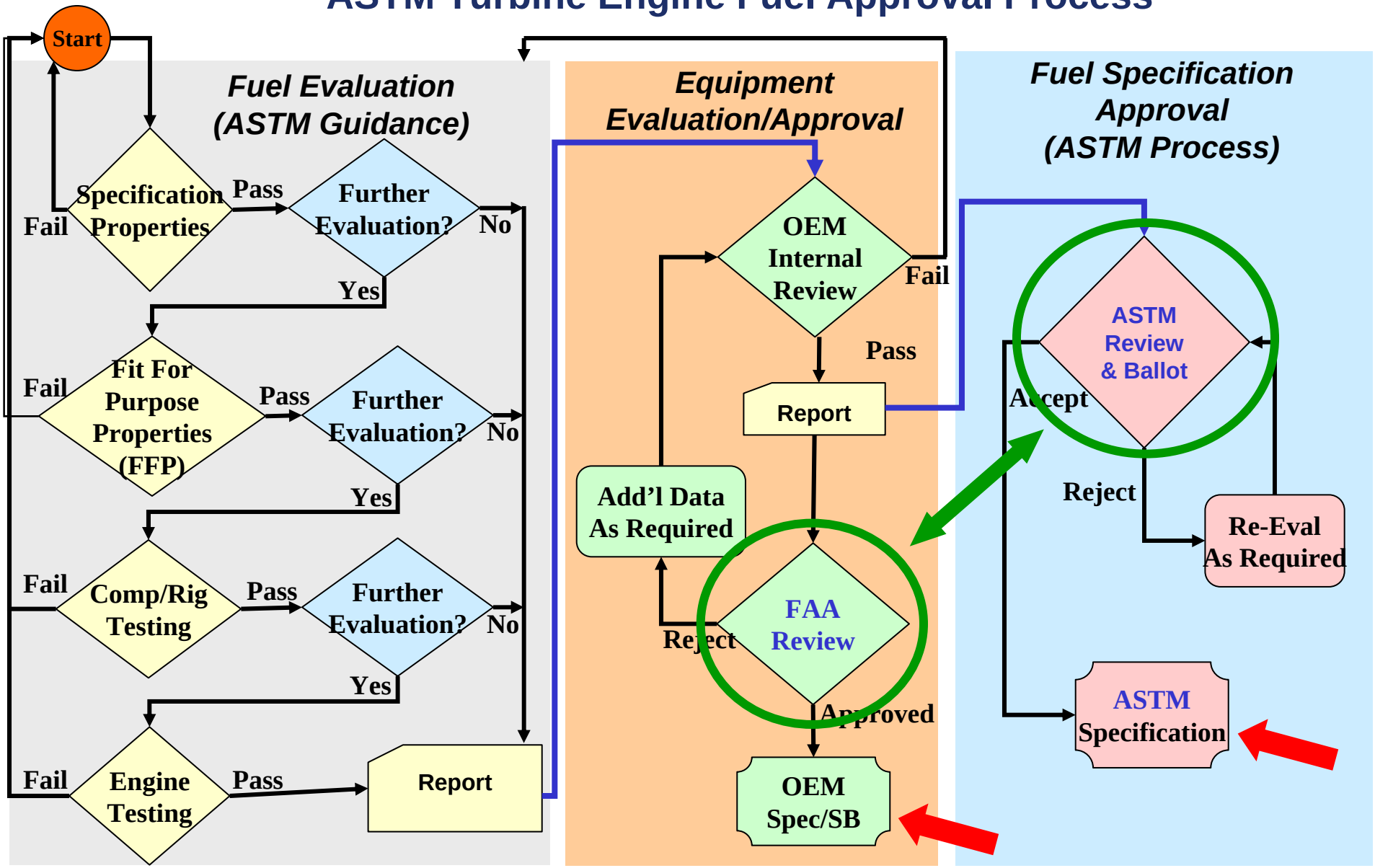
- SPK characteristics

	Jet (avg)	SPK
Density	0.81	0.75
Aromatics, %	17	0
Cetane (IQT)	45	60
ΔHc, BTU/lb	18600	18900

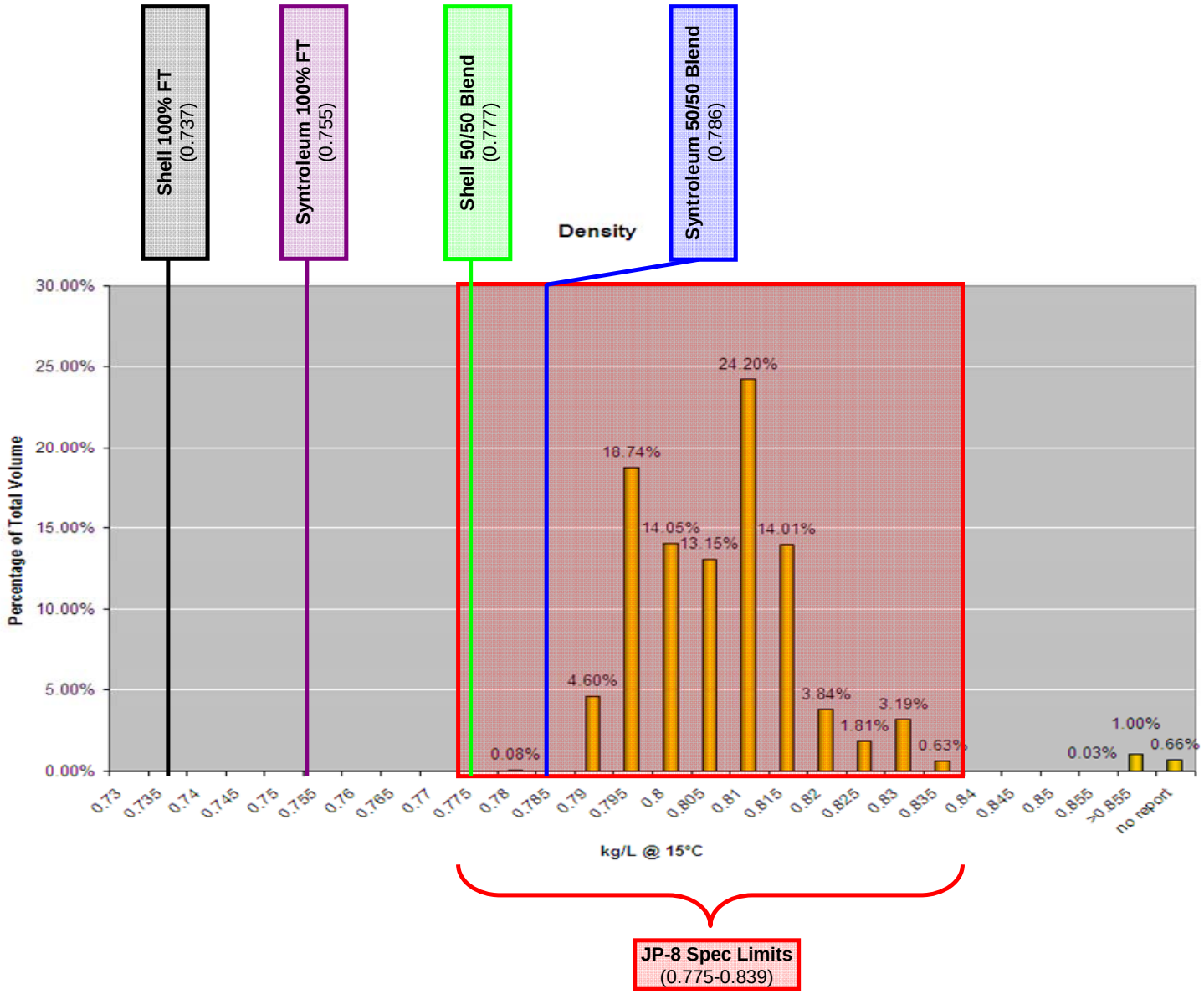


Dielectric constant

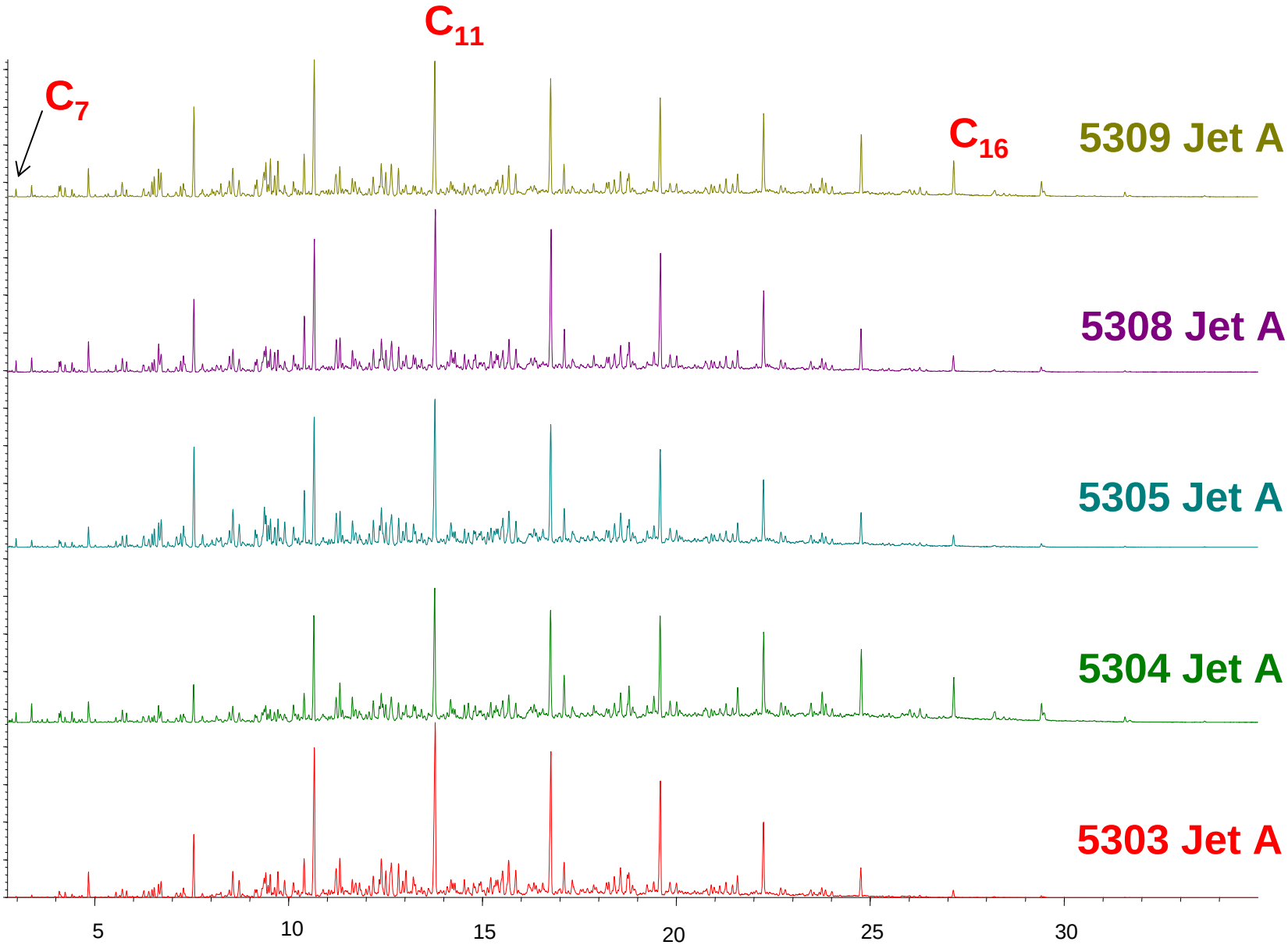
ASTM Turbine Engine Fuel Approval Process



Property "Experience Base"



Composition?



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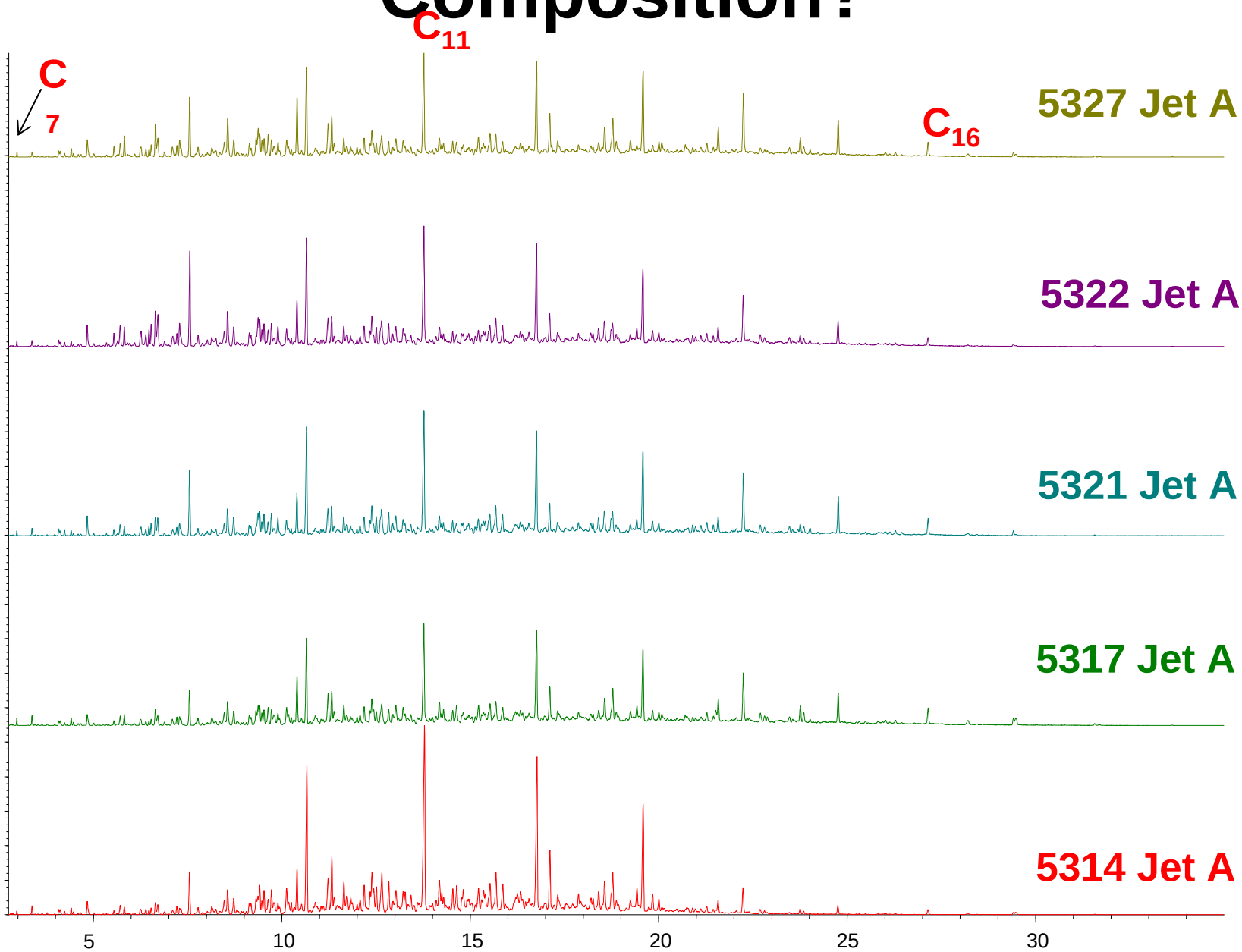
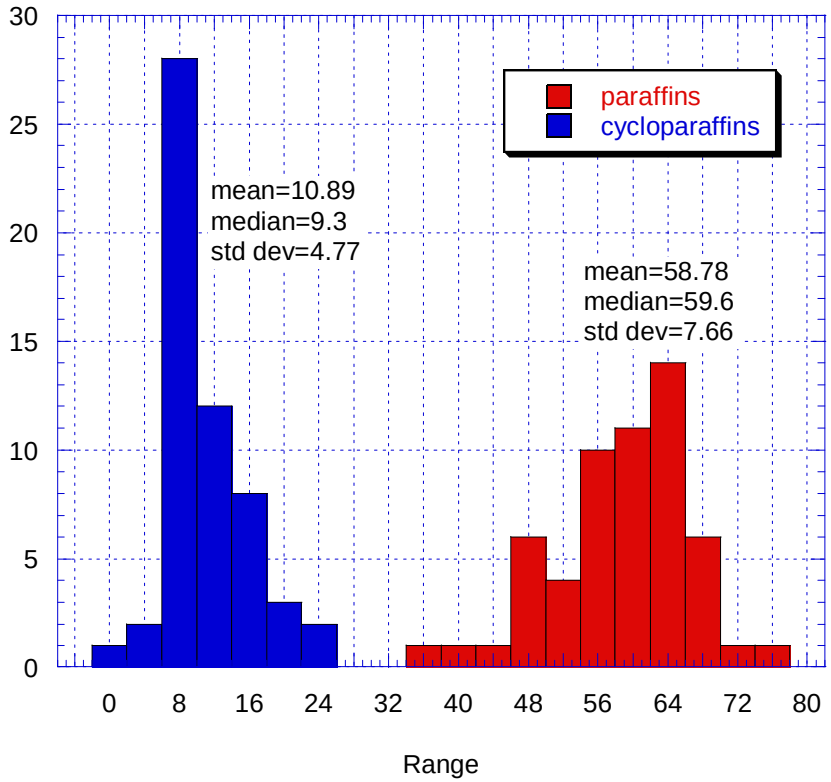
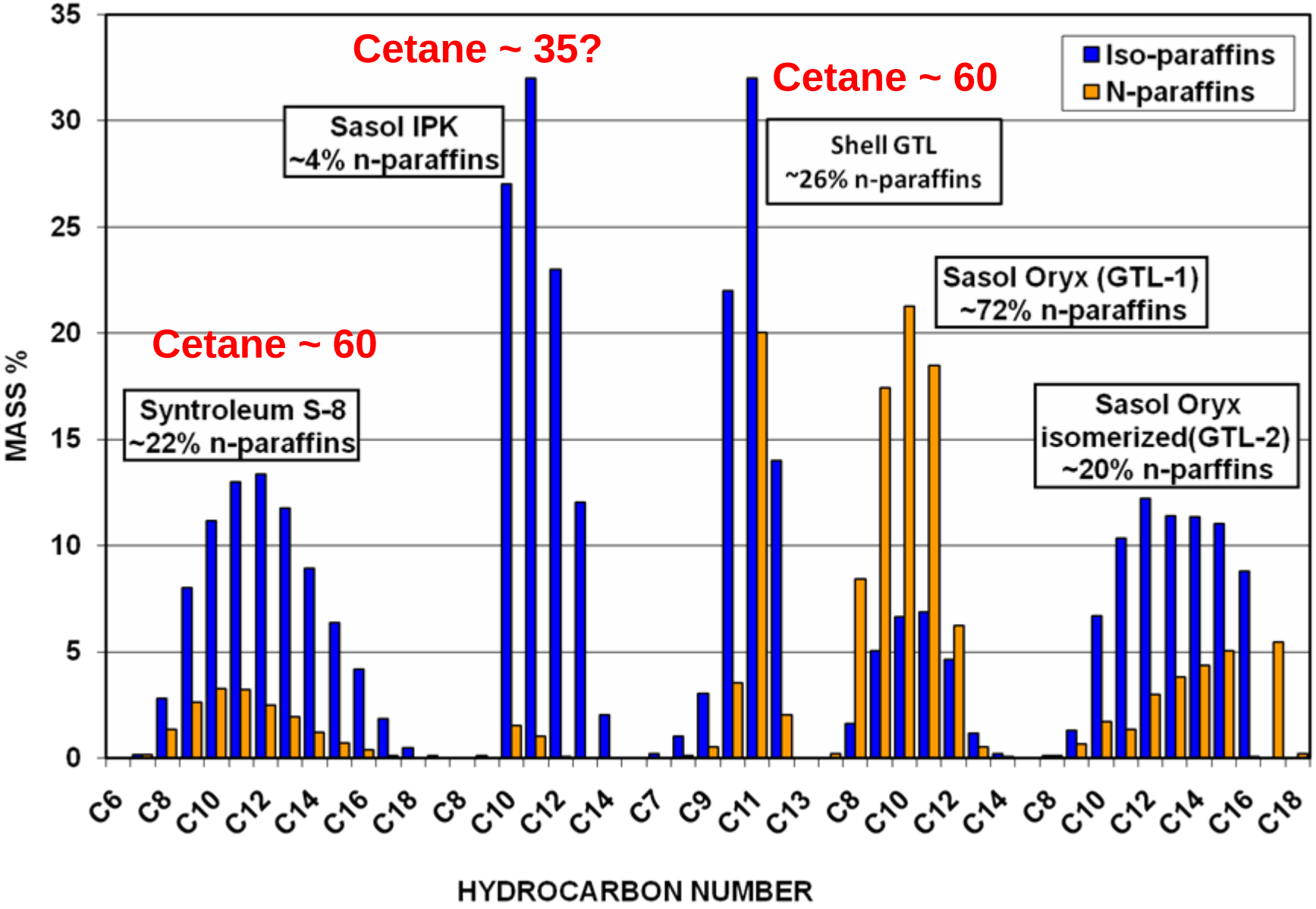


Overall Jet Fuel Composition



~Jet fuel: 20% n-paraffins, 40% iso-paraffins, 20% naphthenes (cycloparaffins), 20% aromatics

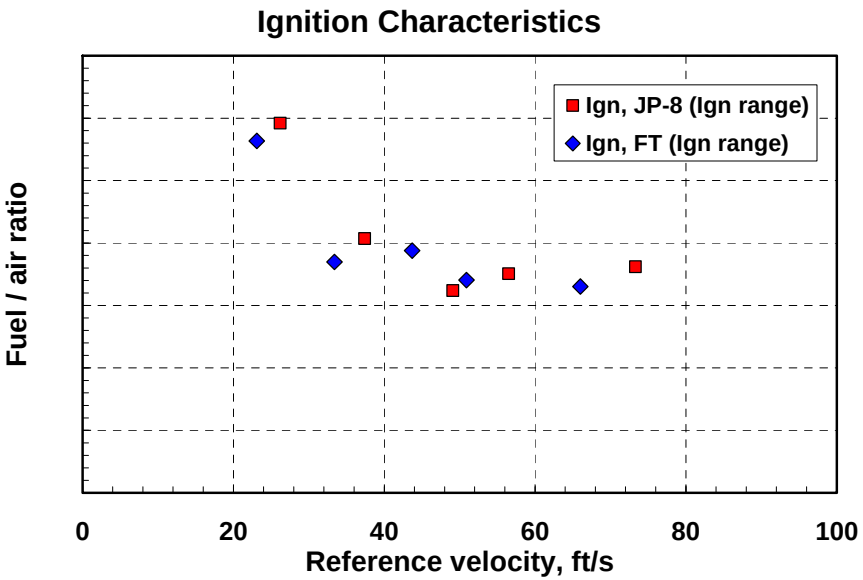
Alternative Fuel Composition

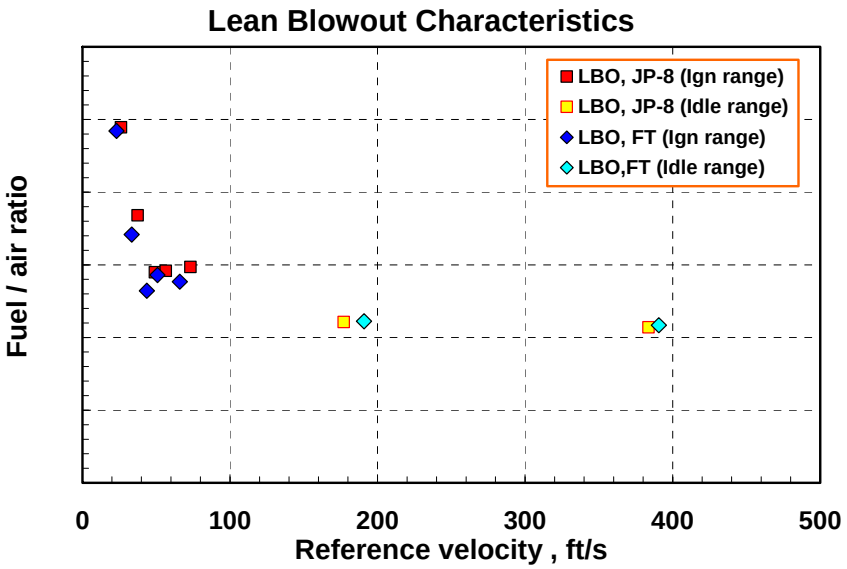


Combustion Results (1)

- AE3007 full annular combustor
- JP-8 and 100% F-T (S-8)

- No significant performance differences

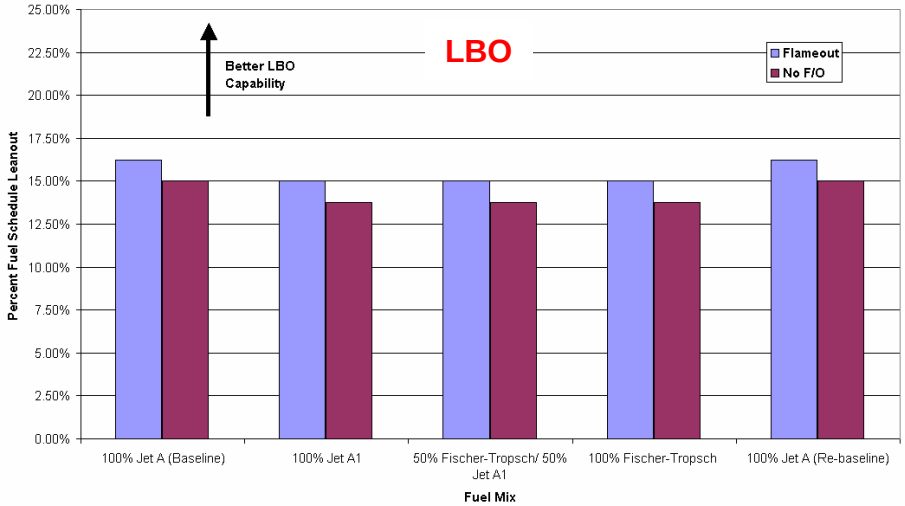


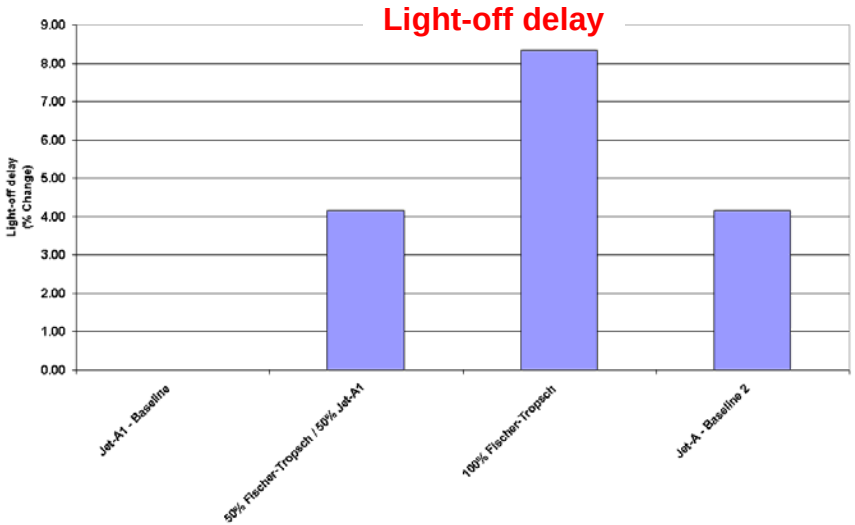


Combustion Results (2)

- CFM 56 engine combustor
- Jet A-1 and 100% F-T (S-8), blend

- No significant performance differences



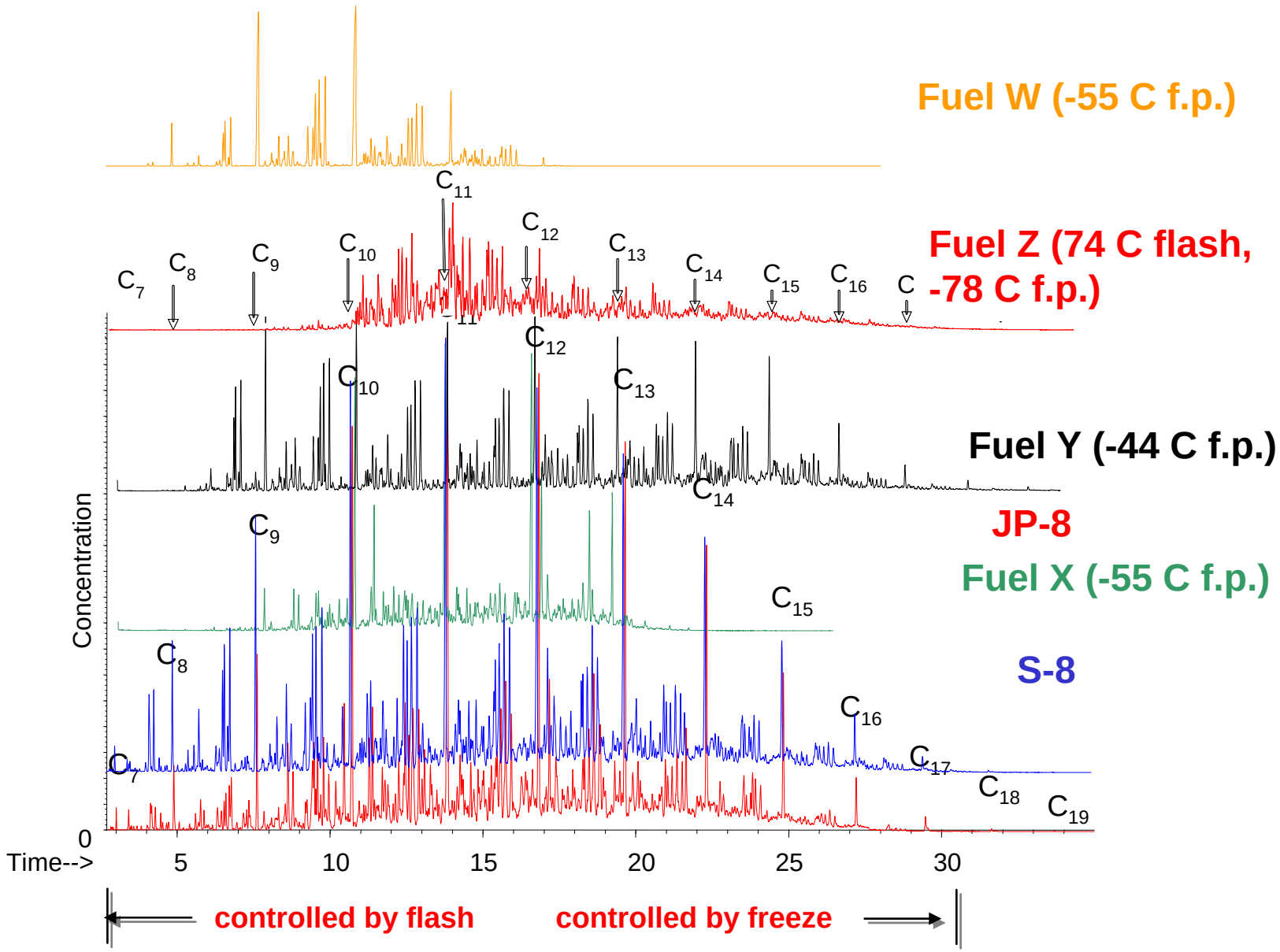


GEAE, Aug 2008

50/50 Blend Results

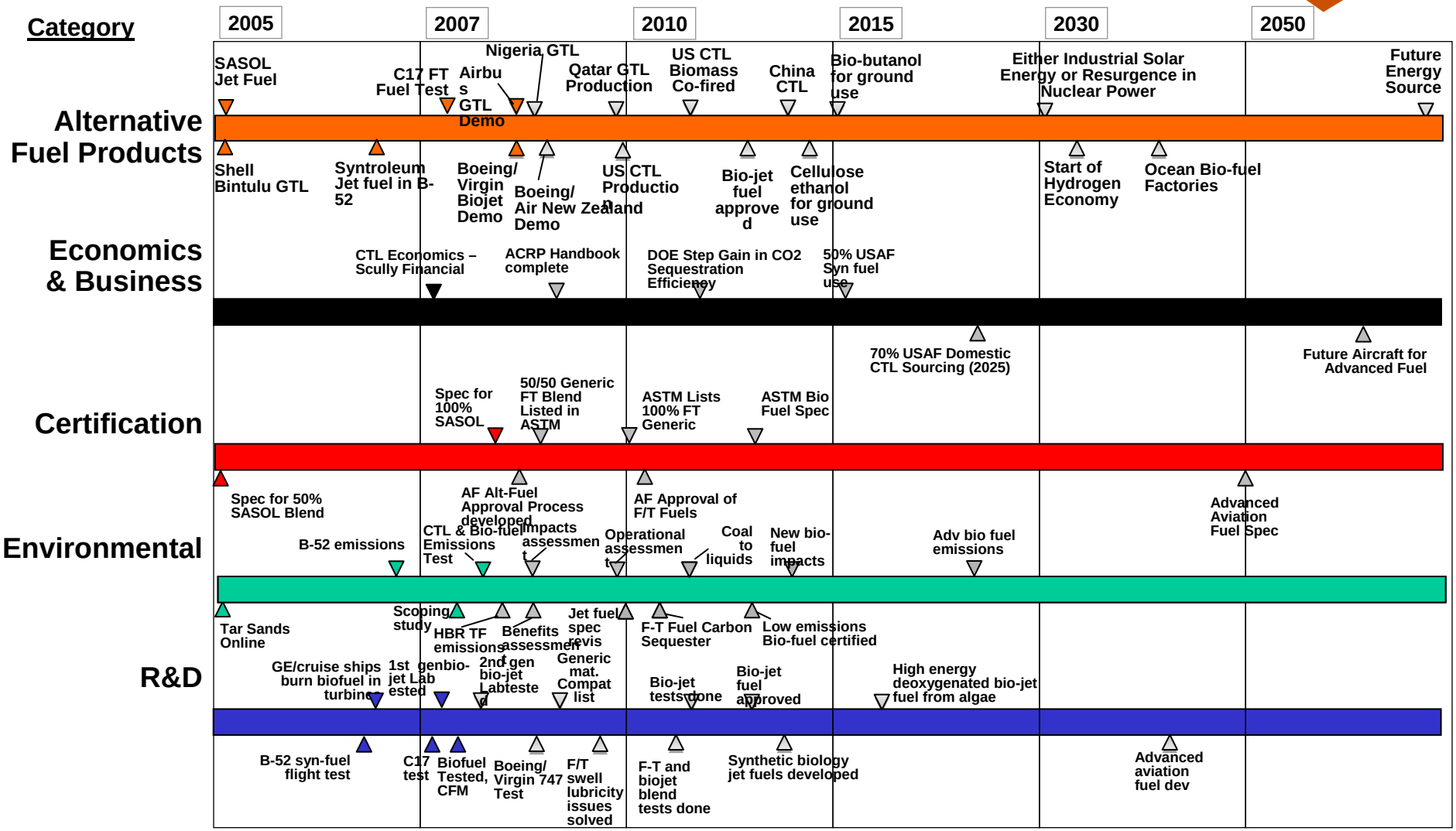
- No difference (except soot) seen in B-52, C-17, B-1, F-15, F-22, …
- So, further combustion research unnecessary, right? ....
- Well, ….NO. Specifying 50/50 SPK and moving beyond has identified a number of deficiencies in understanding:
  - Maximum flash point (vs density, viscosity)
  - Cetane requirement
  - Minimum aromatics
- On to biokerosene! (?)

All Alternative Fuels the Same?



CAAFI Aviation Alternate Fuels Roadmap

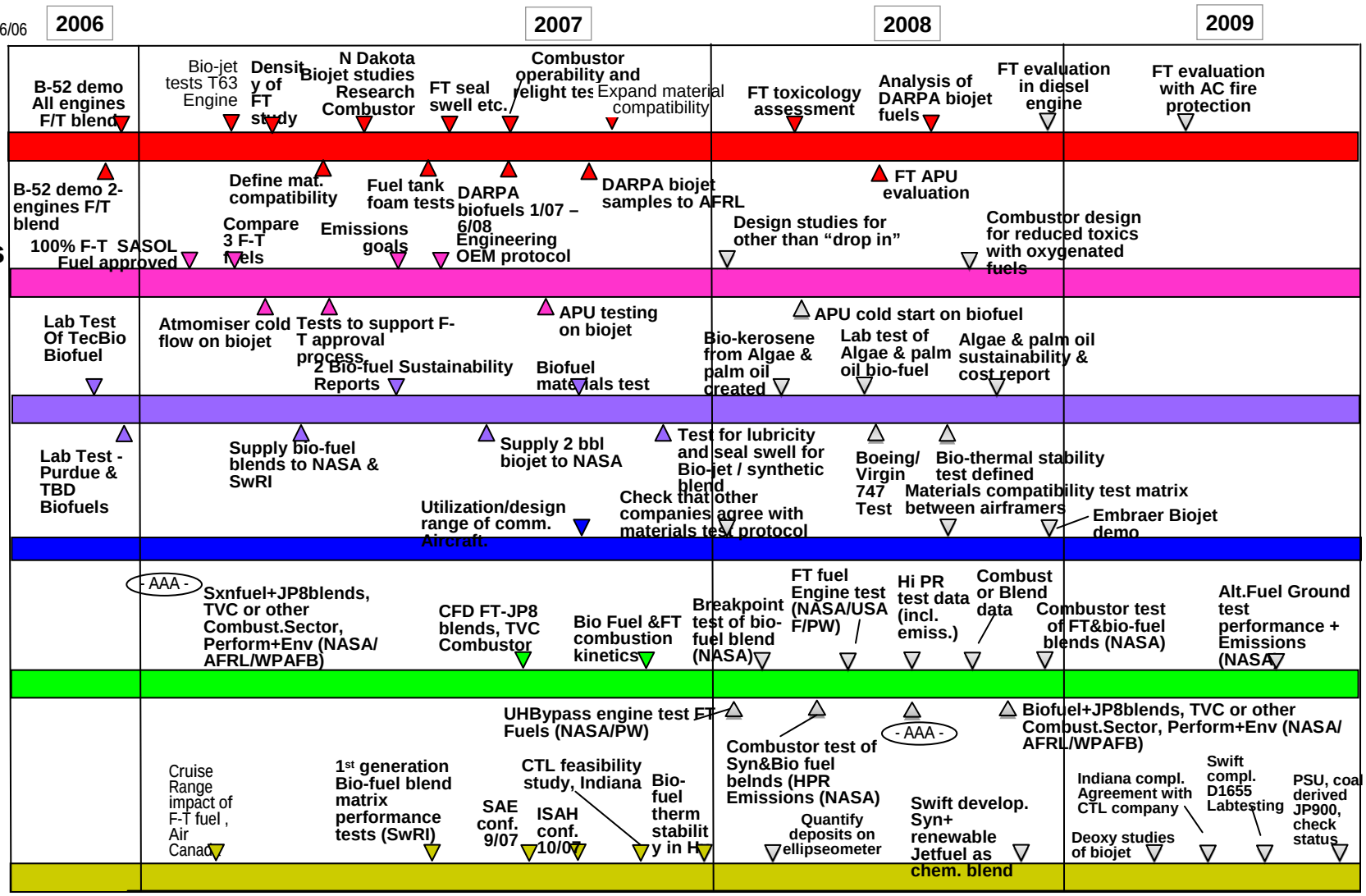
(Level 2 / Scenario 1 - Long Term)



Status as of April, 2008

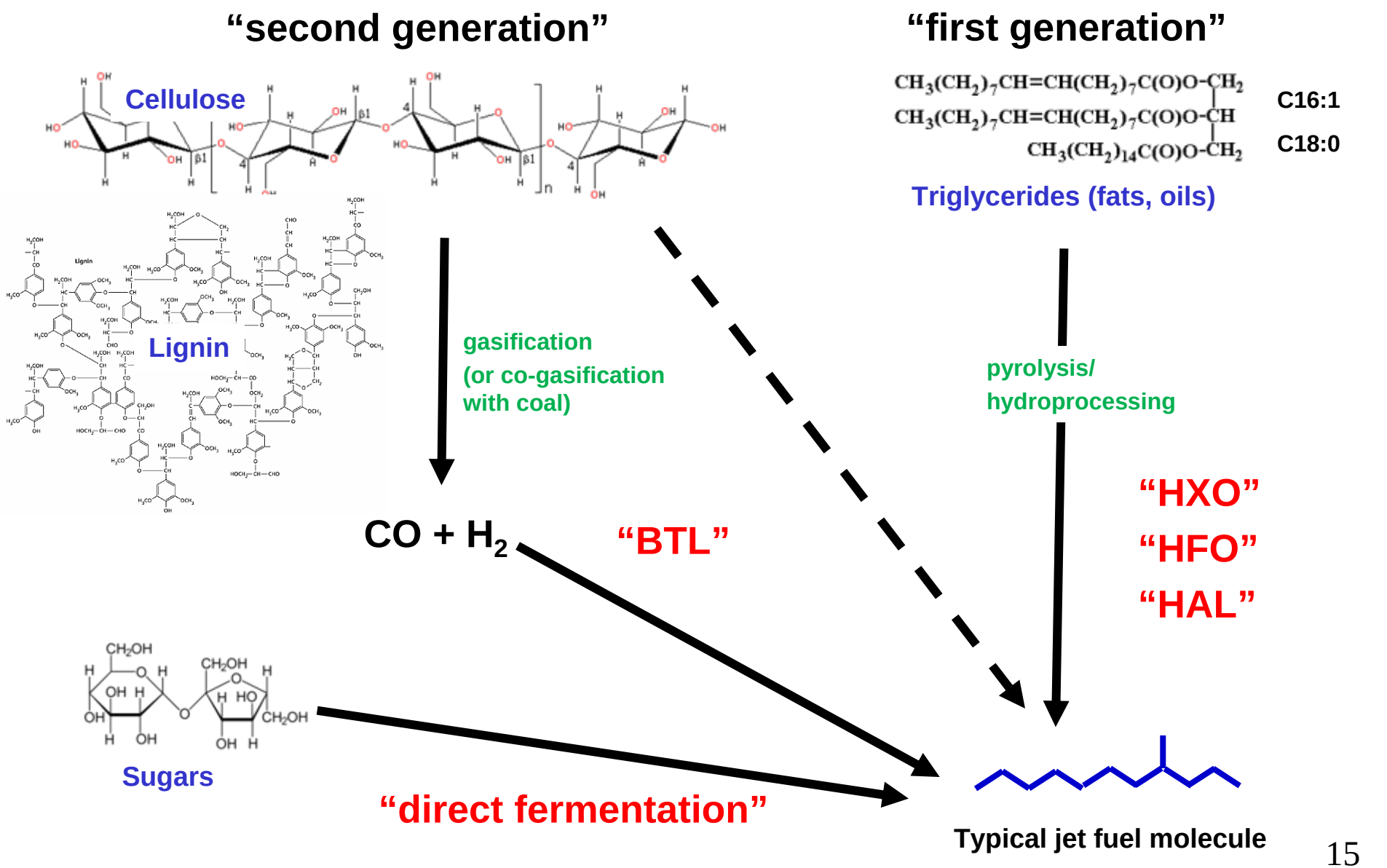
Aviation Alternate Fuels Roadmap

(Level 3 / Scenario 1, R&D Near Term Only)



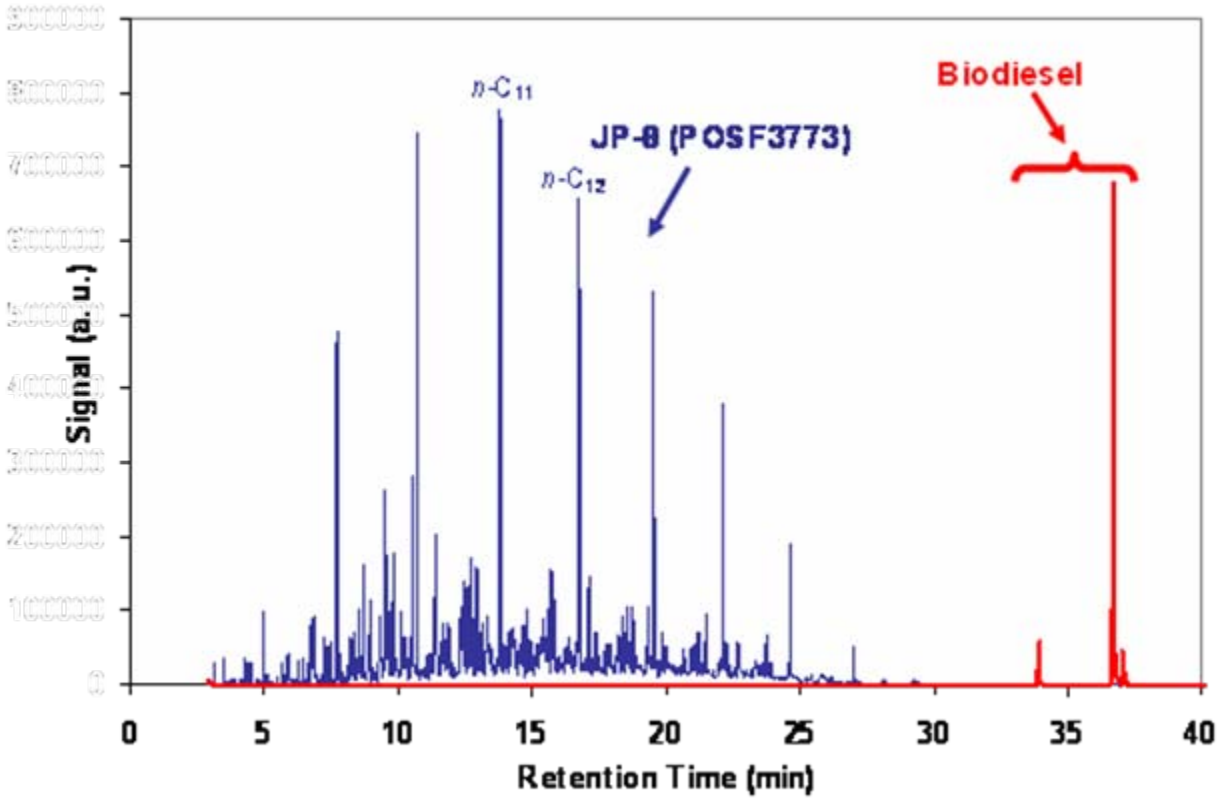
Status as of November 08, 2007

Production of “Bio” Jet Fuel



Jet Fuel vs Biodiesel

Key jet fuel requirement: -47 C freeze point



Ongoing "Biojet" Programs

- **DARPA – 3 contract awards in 2007**
  - **General Electric (GE)**
  - **Universal Oil Products**
  - **University of North Dakota's EERC**
- **Syntroleum/Tyson/Conoco - "waste animal fat"**
- **Boeing/Virgin fuels flight demo in 2008**
- **AFRL analyzing other submitted samples**
- **Key issues are production potential ("gallons/acre"), cost, and <u>environmental impact</u>**

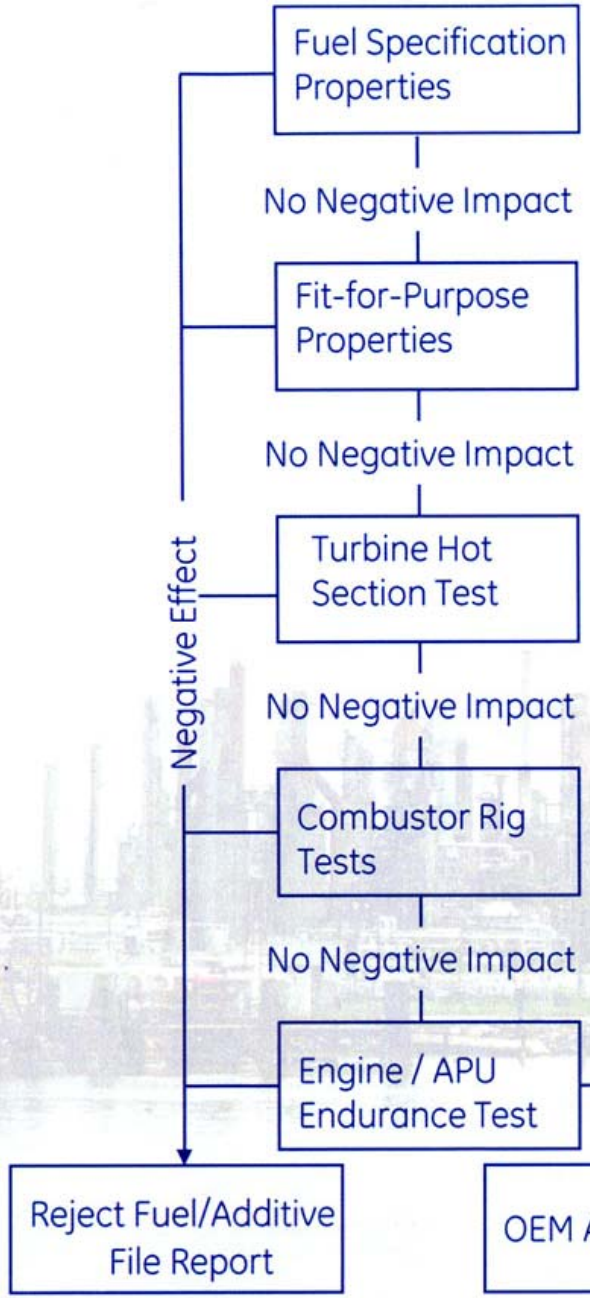
The Payoff

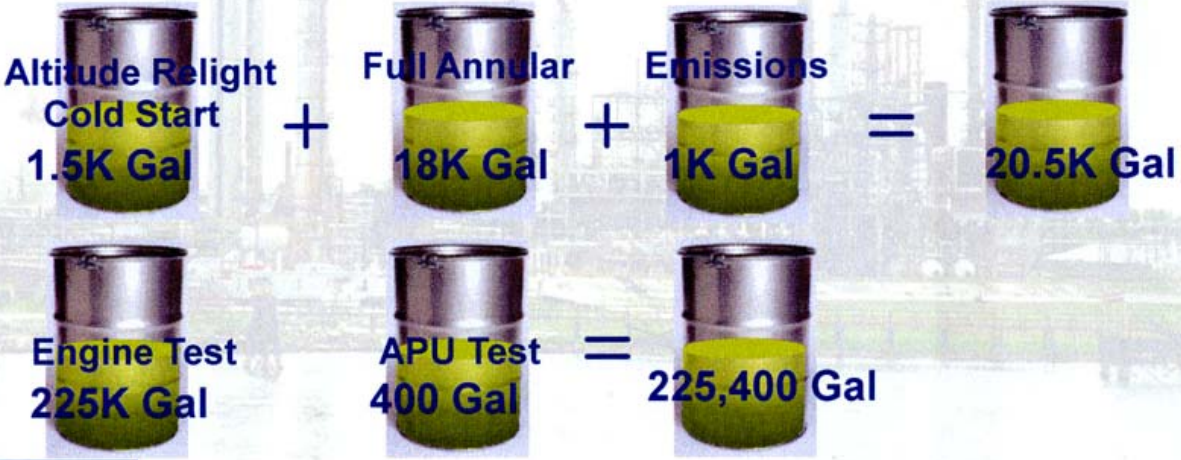
> …the emission factor for [jet] fuel produced from biomass will be zero.
>
> EU working document on aviation emissions trading*

*COMMISSION STAFF WORKING DOCUMENT, Accompanying document to the Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emission allowance trading within the Community

Estimate of Fuel Required for Approval Evaluation = 250K Gal.

ASTM Standard Practice – New Fuel and New Fuel Additive Approval Protocol. This is a guideline. Not every test is required.





Revised 7/22/08

Timeline Summary

Near-Term Strategy

- Draft FT ASTM Research Rpt
- FT ASTM Research Rpt Issued
- FT ASTM Research Rpt OEM App'l
- FT Fuel Spec ASTM Ballot
- FT ASTM Research Rpt ASTM Ballot
- ASTM Approval of Spec and Research Rpt

2008: July, Aug, Sept, Oct, Nov, Dec

Longer-Term Strategy

- DARPA Fuel Samples at WPAFB
- DXXXX Spec Wrkg Grp
- HRJ Task Force
- DXXXX Spec Ballot
- HRJ ASTM Research Rpt Issued
- HRJ xx% Blend ASTM App'l
- HRJ ASTM App'l

2008, 2009, 2010, 2011, 2012, 2013

Evolving Combustion Program

- **Biofuel/synfuel combustion program similar to early 80s program "Fuel Effects on Combustion"**
- **Referee fuels developed for team use**
- **Data developed from basic research to full-scale combustor/engine data**
- **Product: "Rules and Tools" for fuel properties/composition effects on combustion**

Summary

- **Air Force alternative fuel program has high-level backing and momentum**
  - **Near-term goal – certification of all AF systems on 50/50 JP-8/F-T blend by "early 2011".**
  - **Examining biofuels as possible next target**
- **Key issues**
  - **Consistency of jet fuels between manufacturers, processes and feedstocks**
    - **How to ensure consistent product in specification?**
    - **What are the limits of the fuel composition – property trade space?**
  - **Environmental Performance**
  - **Economic Viability**