# Aviation Fuels Update 2009

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# Why is this topic so very important?

- **The "Status Quo" has changed.**
- **We need to understand the *current* situation so that we can find a *future* solution for the piston aviation industry.**

# The "Status Quo"…

- **Leaded aviation fuel (100LL) will go away**
  - **Global economic, political, and regulatory pressure**
- **The situation in North America is dramatically different than the rest-of-world**
  - **Large installed base of legacy (100LL) aircraft**
- **U.S. Military logistics strategy is focused around a single fuel supply stream for all vehicles – Jet Fuel**
  - **50/50 Synthetic Blend JP-8 (Jet-A1)**
  - **Commercial jet aviation will likely follow**

# Engine and Fuel Evolution

# Engine and Fuel Evolution

**Continuous Combustion**

**Kerosene (Distillate)**

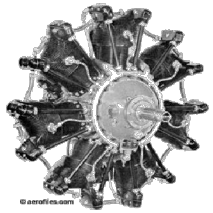
**Jet Fuel (Hydro-processed)**

| Engine | Fuel |
|---|---|

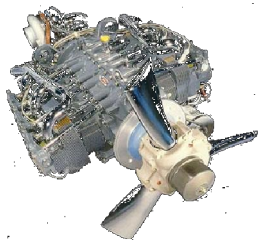
**Increased Performance, Reliability & Safety**

**Remove TEL & identify alternates and retain Performance, Reliability & Safety**

**Periodic Combustion**



**Gasoline (Distillate)**



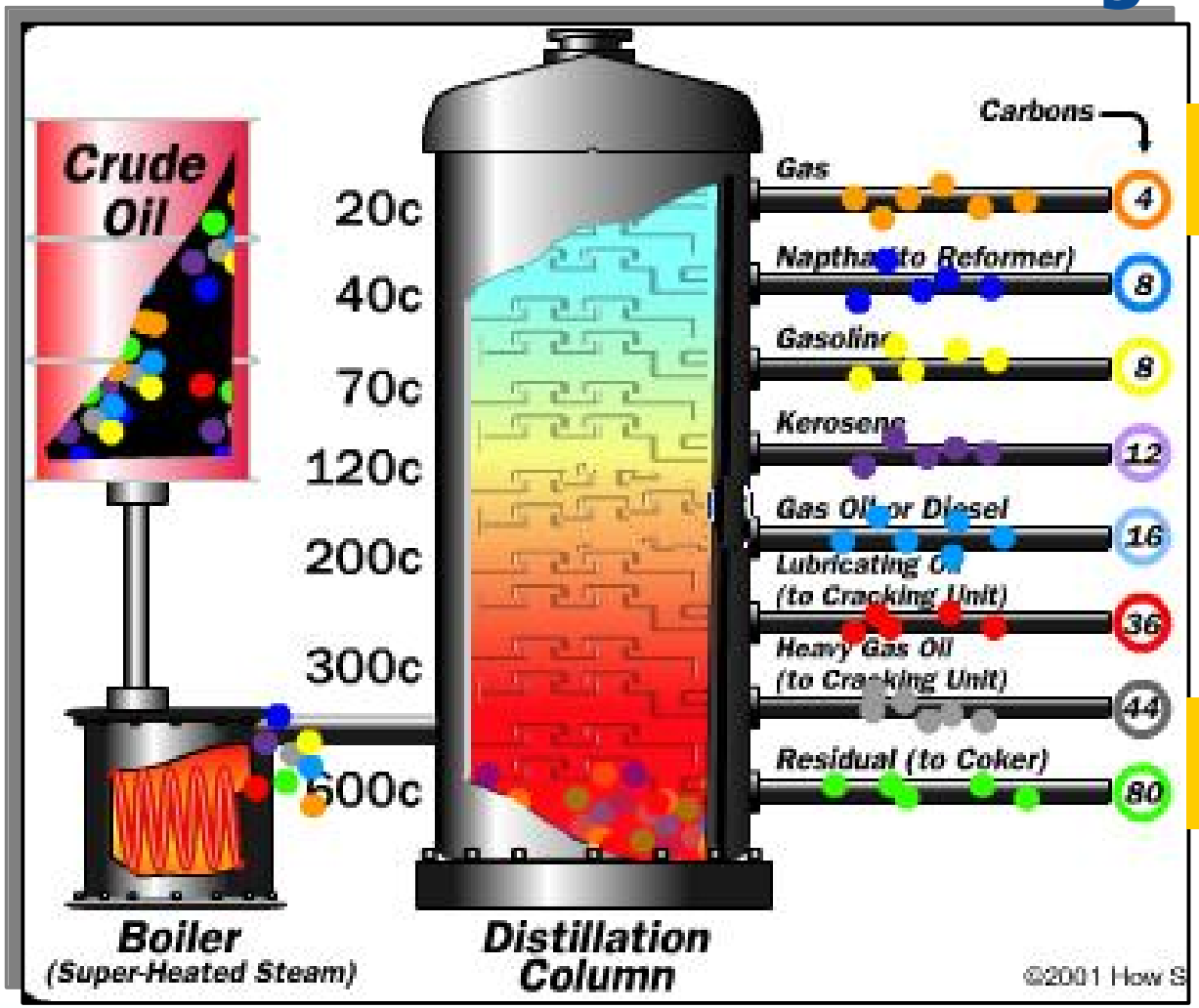
**Avgas (Alkylate)**

| Engine | Fuel |
|---|---|

Past | Present | Future?

High performance aviation engines were made possible because of the concurrent development of high performance aviation fuels.

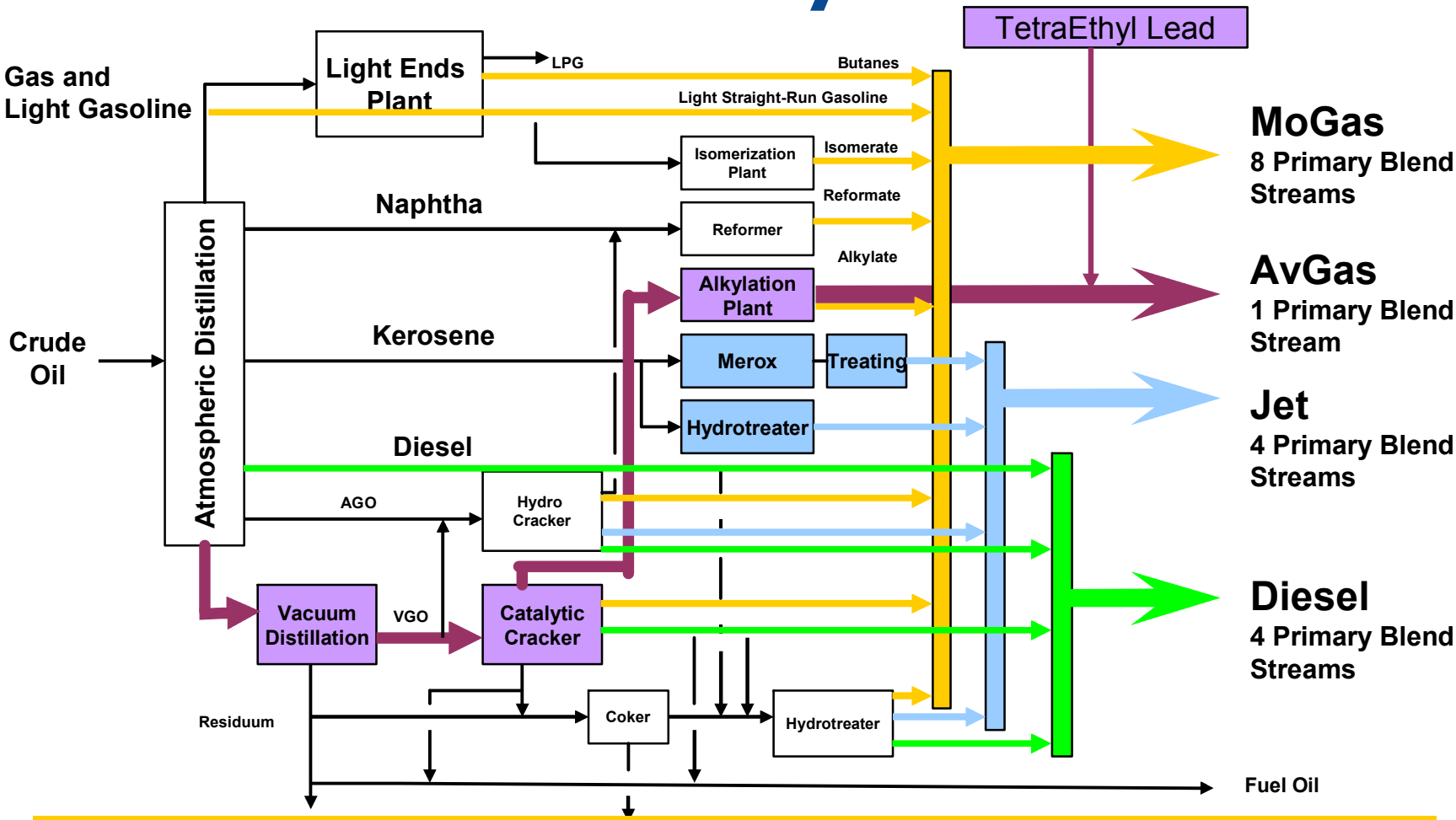
# Basic Fossil Fuel Processing




**Higher Flammability**
**Lower Density**

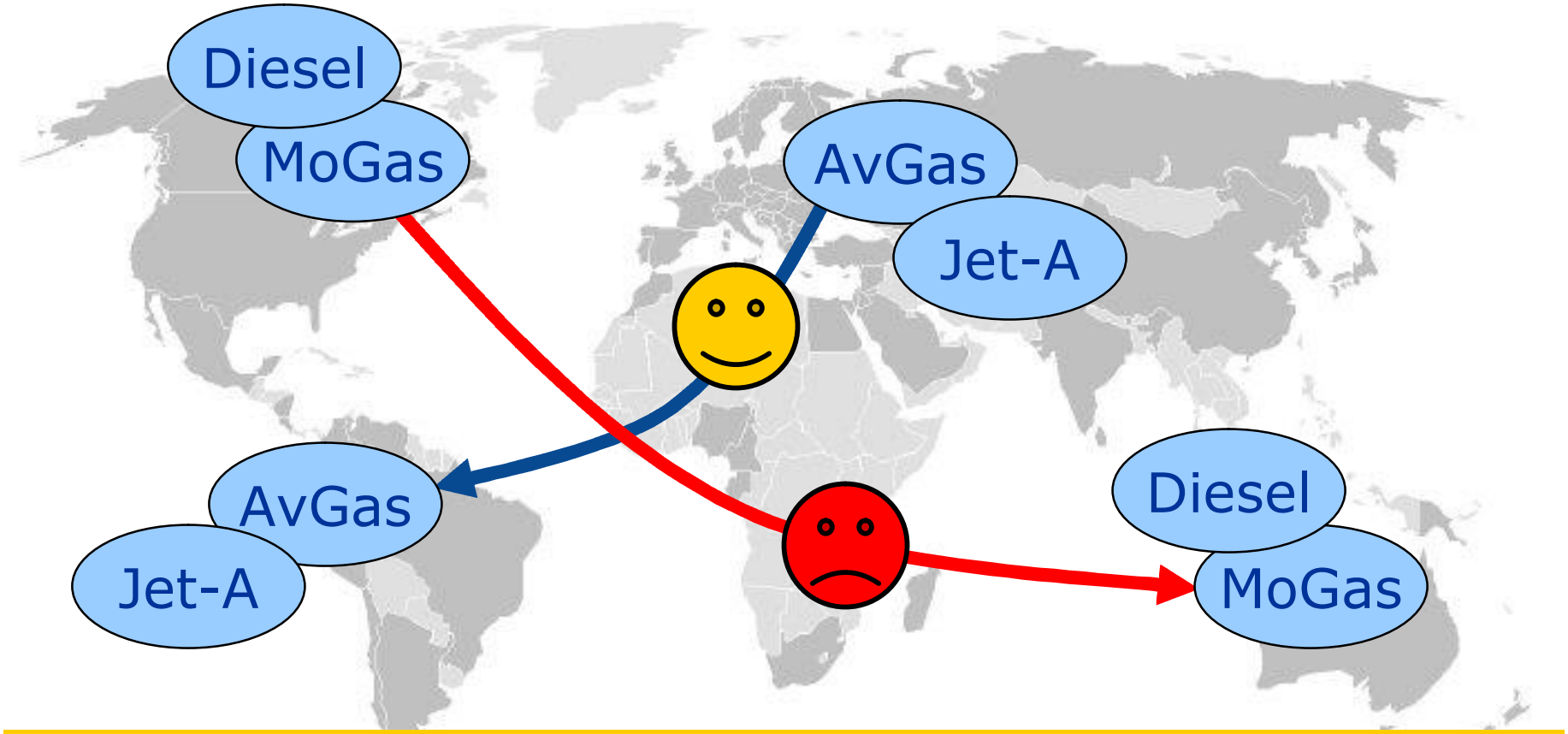
**Lower Flammability**
**Higher Density**

# The Modern Refinery…




Aviations Fuels = Optimized for Aviation Engines

# Global Consistency of Fuels




Aviation Fuels = Optimized for Global Transportation

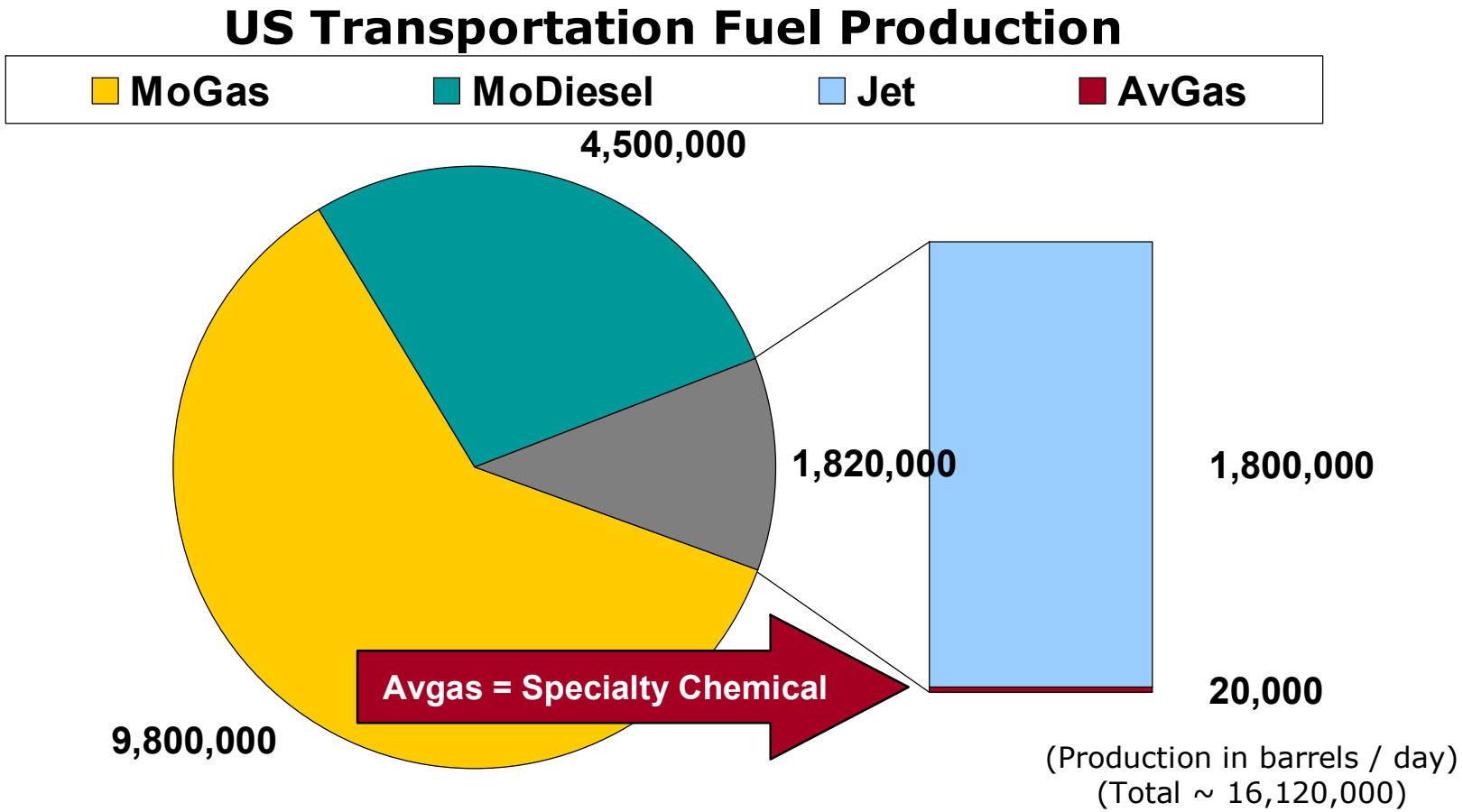
# Key Facts – Part 1

1. **Aviation fuels and Aviation engines were jointly optimized to arrive at today's high performance solutions**

2. **Aviation fuels are designed to be globally consistent**

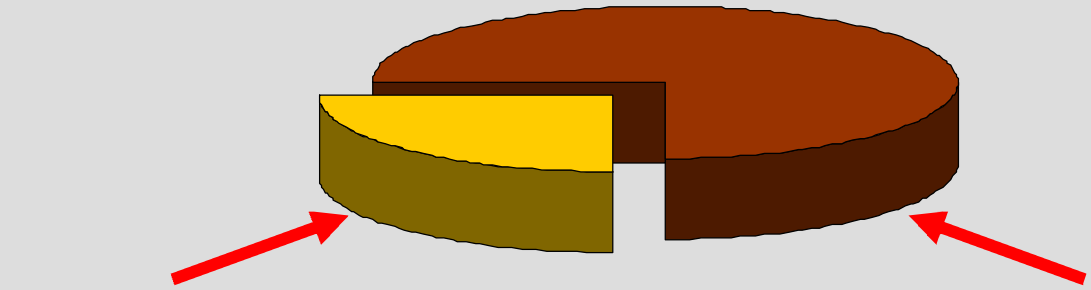
# Fuel Usage & Production

# Total Fuel Consumption




**"AvGas" stopped being a high volume commercial fuel in the early 1960's**

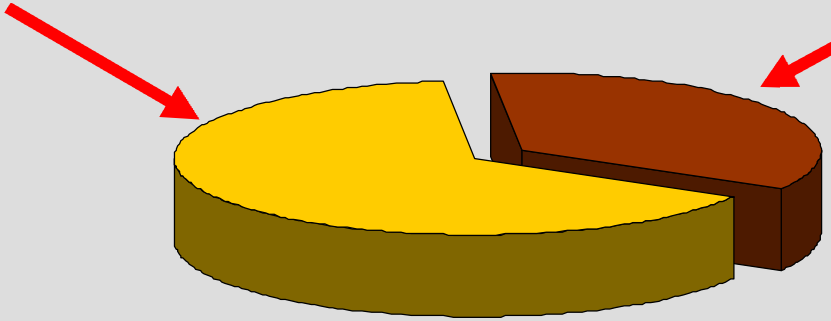
# AvGas Consumption



**Fuel Requirements**
**(167,000 Airplanes)**

Higher Performance
Airplanes (~100LL)

Lower Performance
Airplanes (<100LL)



**Fuel Usage**
**(349 M gal/yr)**

**(1,325M liter/yr)**

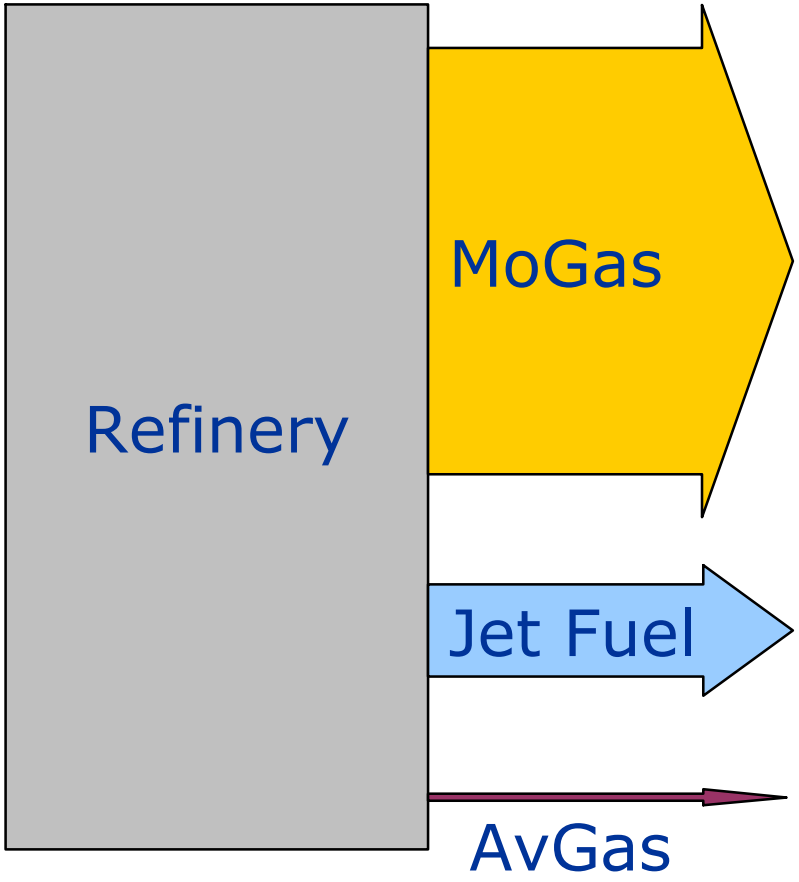
# Key Facts – Part 2

1. **~25% of all Aviation Piston Engines need 100LL which consume ~60% of the AvGas**
   - **These "60% Consumers" are predominantly revenue applications (business aircraft)**
2. **Any "custom" aviation piston fuel will be a boutique fuel or specialty chemical**

# Aviation Engine Fuel Options

## A World without 100LL

# Options for Piston Aviation?

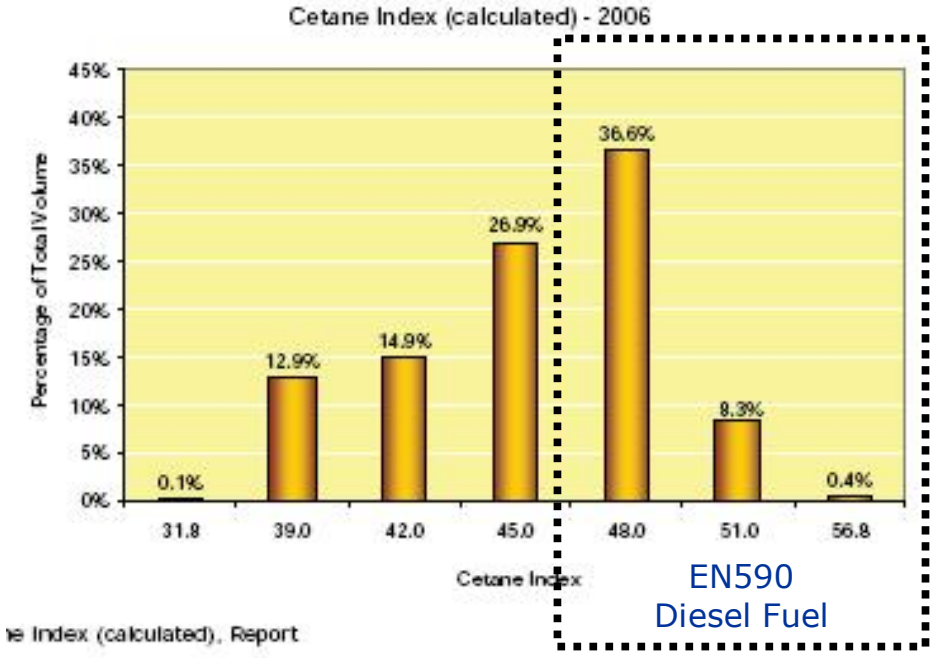



**SI Piston Engines (Otto Cycle)**
**Ground Transportation**
**Local Geography Emissions**

**Turbine Engines (Brayton Cycle)**
**Aviation Transportation**
**Global Consistency**
**CI Piston Engines (Diesel Cycle)**

**SI Piston Engines (Otto Cycle)**
**Aviation Transportation**
**Global Consistency**

# Jet Fuel Considerations…




- Cetane controls the delay time for ignition in Diesel cycle piston engines
- Jet fuel specifications and production methods do not control cetane number
- Fuel with lower cetane than engine calibration can impact power, starting, and reliability

- Cetane variation of Jet Fuel is one of the main reasons behind ExxonMobil conditions for supplying jet fuel to aircraft with piston Diesel Cycle engines

# MoGas Considerations…

**PLUS**

- High volume production / competitively priced commodity
- High availability worldwide

**DELTA**

- Lower octane
- Higher vapor pressure
- Geographical and seasonal variation
- No "Aviation" influence on specification

Attractive for its availability - however - increases complexity for newly designed, high performance applications and problematic for legacy aircraft.

# Conclusions, Recommendations and Actions

## Lycoming's Perspective

# Conclusions

- **There is no "magic bullet" for the existing installed base of engines / aircraft that require 100LL**
  - **The economic impact in North America of "no supply" of 100LL or equivalent would be severe**
- ***Newly Developed* engines need to anticipate the alternate and lower performance fuels that will be available in the future**
  - **Broader cut lower octane unleaded gasoline**
  - **Jet-A, Jet-A1, JP-8 and Synthetic Jet Fuels**
- **More sophisticated technology to maintain piston engine performance on lower performance fuels will be required**
  - **Lower power/weight ratio is sometimes the compromise**

Advanced Electronic Controls become a Necessity

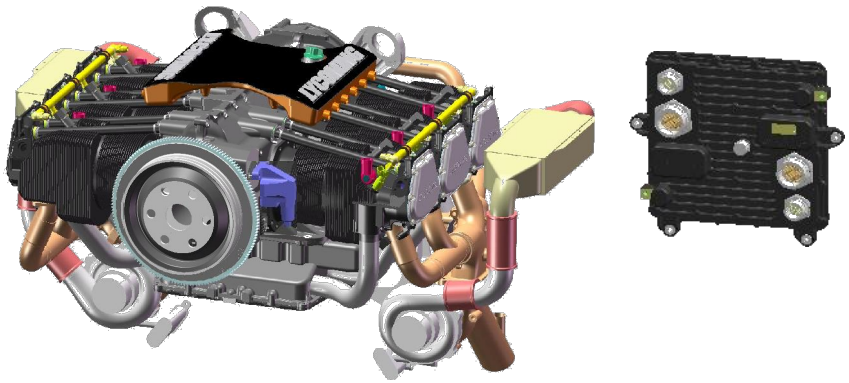
# Recommendations

1. **Aggressively pursue synthesized high octane unleaded aviation grade 100LL substitute fuel (100UL)**
   - **FAA Technical Center testing to date of SWIFT fuel shows strong promise for this approach**
2. **Aggressively pursue a universal aviation fuel based on current Jet Fuel formulations**
   - **Include minimum cetane as a parameter in specification and production**
   - **Accept the trade-off impacts to the airframe and engine capability**

These two actions must be pursued collectively by regulatory agencies and industry.

# Lycoming Engines Actions

1. **Public Information and Education Campaign**
2. **Direct participation with industry and regulators to evaluate technology options and alternative fuels**
3. **Alternate fuel approval for existing engines**
4. **Closed loop feedback adaptive electronic engine controls (iE²)**

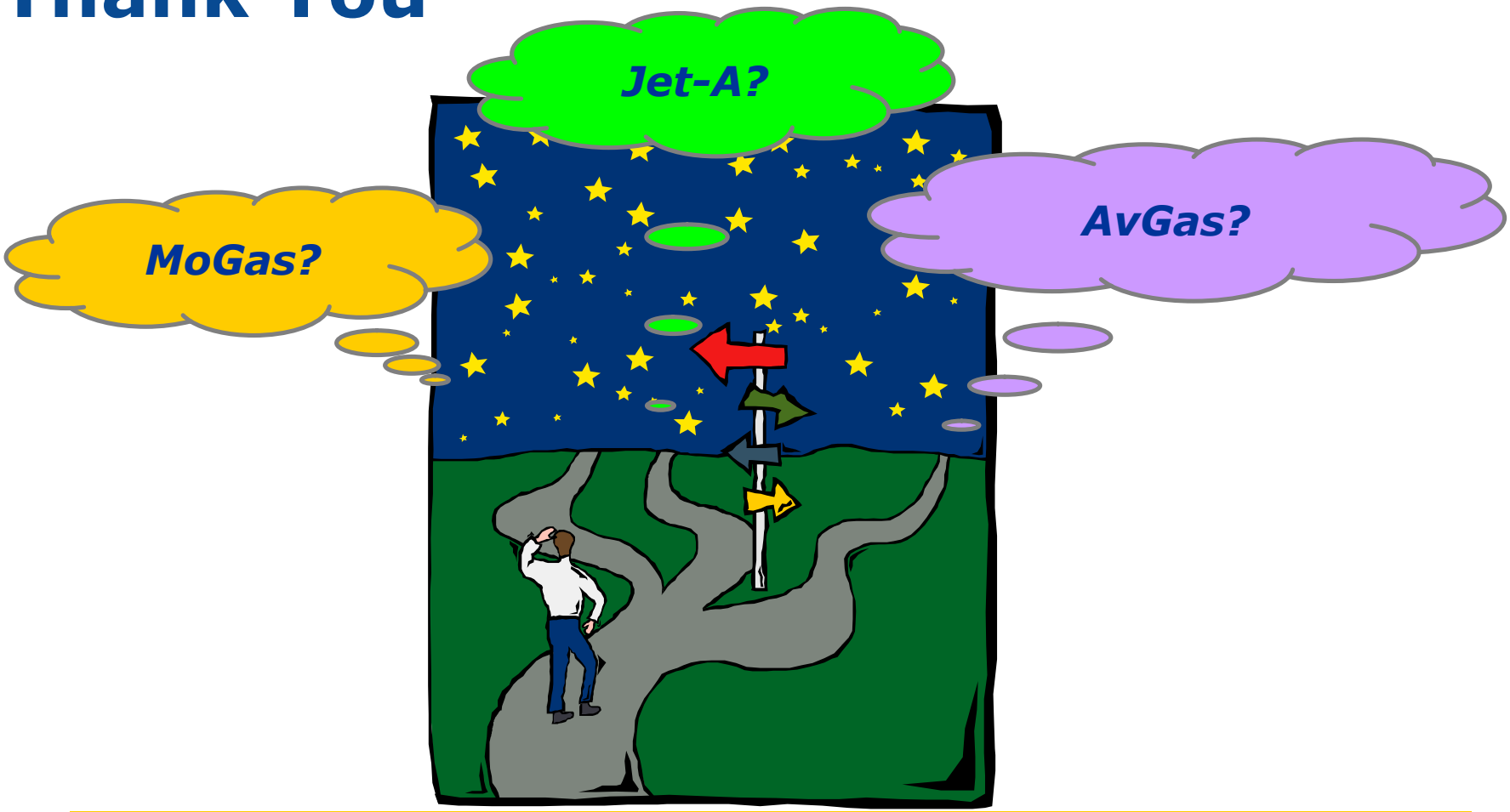


# The Reality

- **In the eyes of the EPA, the clock is ticking on TEL.**
- **The EPA wants a plan:**
  - **What are we going to do?**
  - **When are we going to do it?**

GAMA Transition Plan to be Released in 2009

# Thank You




Solution = Technology + Policy + Public Demand