Unleaded Avgas Transition

The National Academies
Aeronautics and Space Engineering Board Meeting

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Why is this topic so critically important?

• The “Status Quo” has changed
• The clock is ticking and we need to take action
• We need to understand the complexities of the current situation so that we can effectively develop a solution and execute a plan
Aircraft Engines Require Higher Octane Fuels

Motor Octane Number (MON)

Auto Engines

Airplane Engines

Octane Increase Achieved By Adding Lead (Pb) To Avgas
Lead (High Octane) Prevents Damaging Detonation

Normal Combustion  Detonation
But...Lead is a Toxic Chemical

EPA and Global Initiatives to Reduce Lead Contamination

Lead Paint

Leaded Automobile Gasoline

Lead-Acid Batteries
EPA & Environmental Groups Now Focusing On AvGas

**EPA Inventory of Lead Emissions (2002)**

- Avgas
- Metal Industries
- Mfg Industries
- Waste Incineration
- Boilers
- Other

Avgas Is 45% of Lead Emissions

- **Friends of the Earth**
  - 2006 Petition to EPA
  - 2012 Law Suit Regarding EPA Lack of Action
- **Center for Environmental Health (CEH)**
  - May 2011 Law Suit in California Against FBOs
  - Proposition 65 “Warning Requirement”
Avgas Octane Requirements and Consumption

Avgas Octane Requirements
(167,000 Airplanes)

- High Performance Aircraft Require High Octane Fuels
- High Performance Aircraft Use Most of the Fuel
- Majority of Demand Driven by Need for High Octane Fuels
- Lower Performance Aircraft Can Use Lower Octane Fuels
  (Autogas-But Without Ethanol)
“The Big Picture” - Avgas Has Limited Market Influence

Gallons of Fuel Per Year

- Jet Fuel (74B)
- Avgas (0.3B)
- Diesel (345B)
- Autogas (320B)
Today’s Challenge

Existing Fuel

New
Engines/Airplanes

Existing
Engines/Airplanes

New Fuel

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Drop-In Fuel

Plugs Into Existing Aviation Safety Infrastructure
Focus on Evaluating ONLY the Fuel
Non-Drop-In Fuel

Must Consider Entire Aviation Safety Infrastructure
Fuel Affects Many Engine Design Elements

Detonation
Motor Octane Number, Performance Number, Distillation, Aromatics

All-Weather Operability
Distillation, Vapor Pressure, Freezing Point

Vapor Lock
Distillation, vapor pressure

Fuel Gauging
Dialetric Constant

Durability
Lubricity, Aromatics Potential Gum

Corrosion
Water Reaction, Water Separation, Sulfur Content

Oil Dilution
Distillation

Material Compatibility
Aromatics, freezing pt. Acidity, Copper Strip, Trace Elements

Combustion Deposits
Distillation, Trace Metals

Aircraft Range
Net Heat of Combustion, Density

Carburetor Icing
Distillation, vapor/liquid ratio, Enthalpy

Cold Start
Distillation, Vapor Pressure

Mixture Distribution
Freezing Pt., viscosity Distillation

Fuel Metering
Density

Combustion Performance
Distillation, Flame Speed, Net Heat of Combustion

Emissions
Lead Content, Aromatics, distillation

Deposits/Valve Sticking
Potential Gum

Fuel Pumping
Freezing Pt., viscosity Distillation

Fuel Gauging
Dialetric Constant

Lycoming

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Current Initiatives

- Expensive Retrofit or New Airplane
- Diesel Aircraft Engines
- High-Aromatic Fuels
- Ethanol Fuels
- Automobile Gasoline
- Not Completely Drop-In, Expensive, Under Development
- Not Completely Drop-In, Not Commercially Successful

Higher Performance Airplanes Left On Ground
Thank You
Fuel Octane Scales

Ground Fuels

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Aviation Fuels

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AVGAS 100LL
AVGAS UL 91
Mogas 91 AKI
AVGAS 80

AKI = [RON + MON]/2

Note: Scales are approximate and for illustration only