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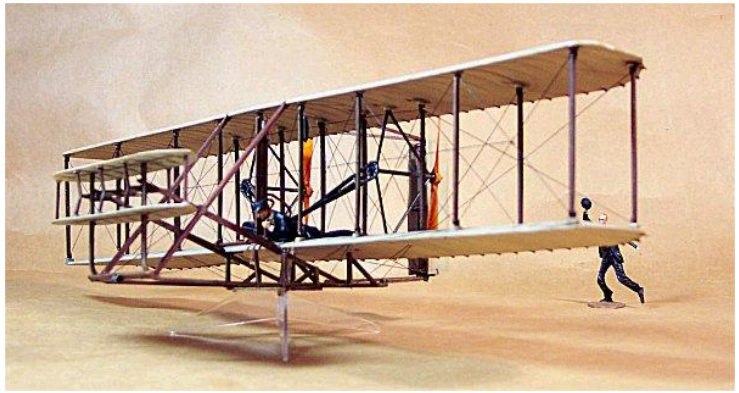
The power of choice.

Unleaded Avgas Transition



The National Academies
Aeronautics and Space Engineering Board Meeting

Irvine, CA
November 8, 2012

Randy Jenson
Principal Engineer
Lycoming Engines

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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**

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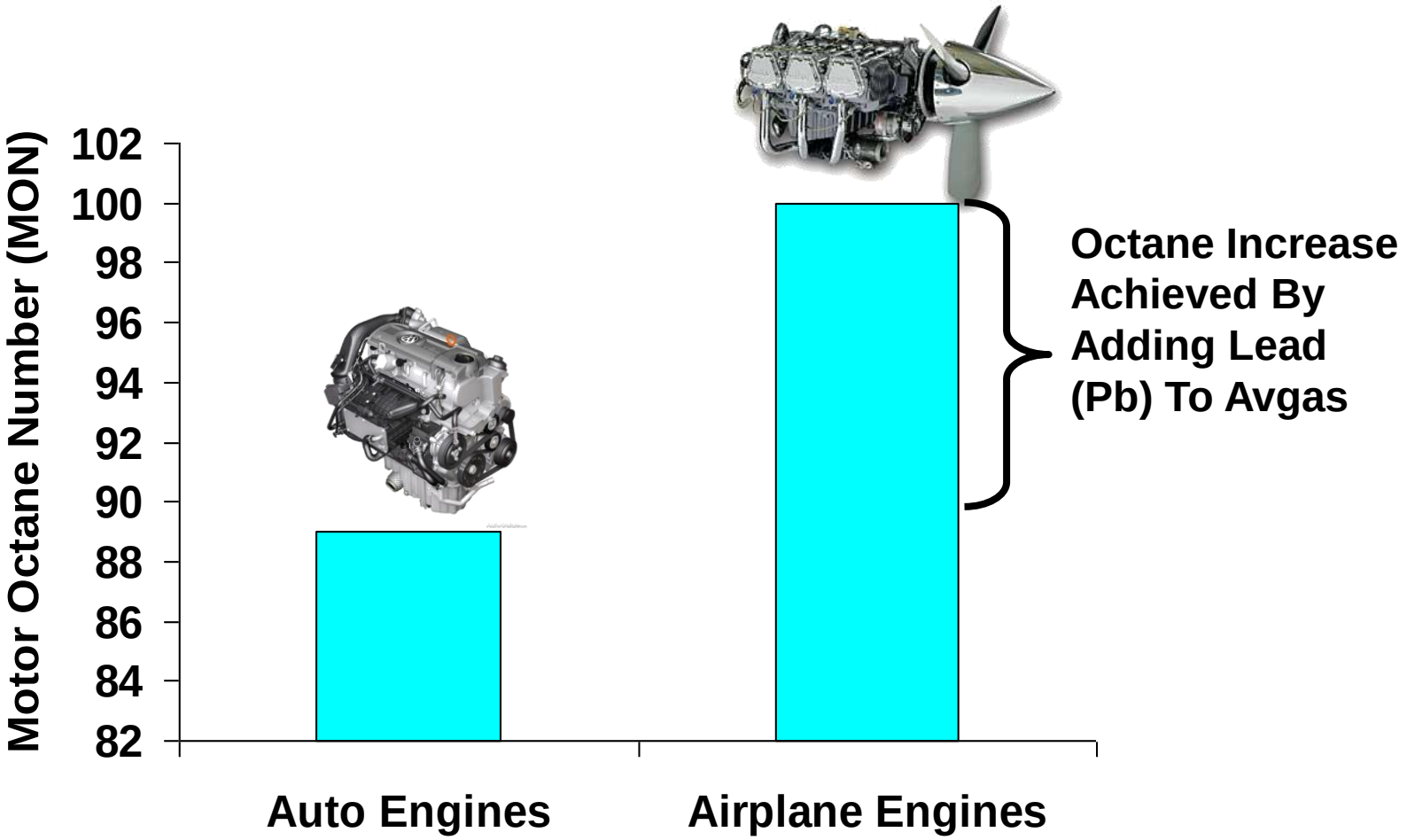
Aircraft Engines Require Higher Octane Fuels



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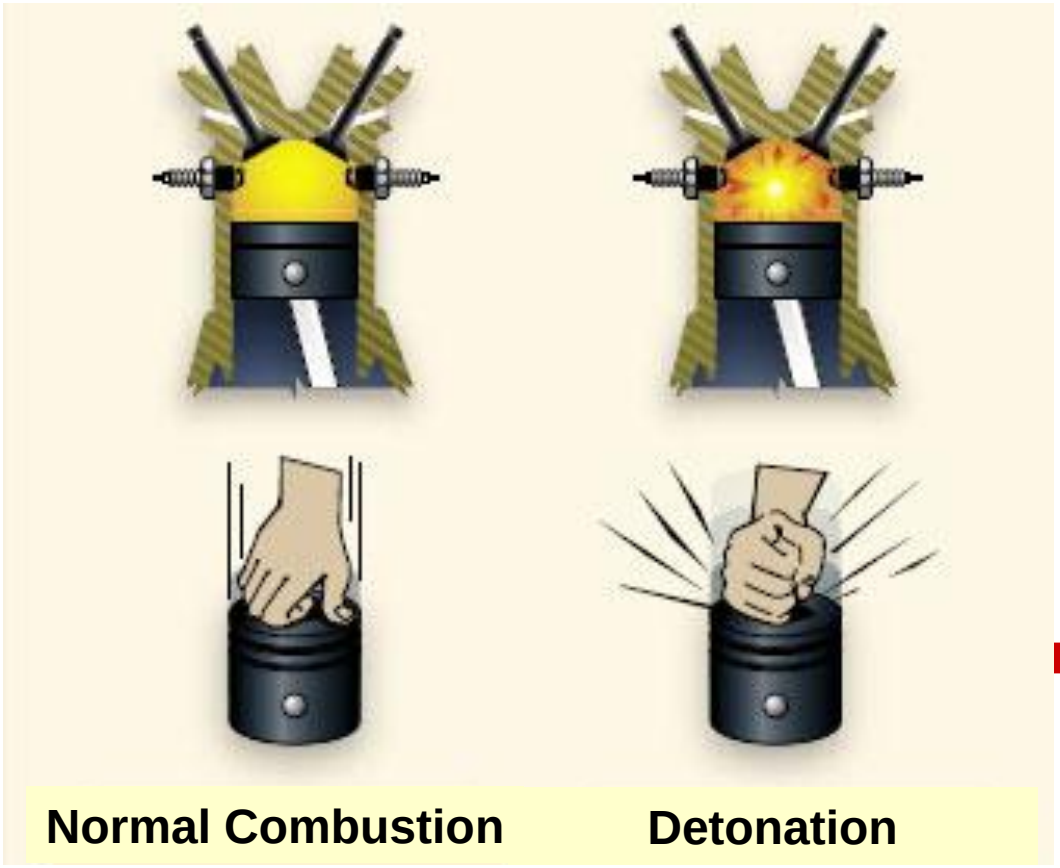
Lead (High Octane) Prevents Damaging Detonation



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But…Lead is a Toxic Chemical

EPA and Global Initiatives to Reduce Lead Contamination

Lead Paint

Leaded Automobile Gasoline

Lead-Acid Batteries

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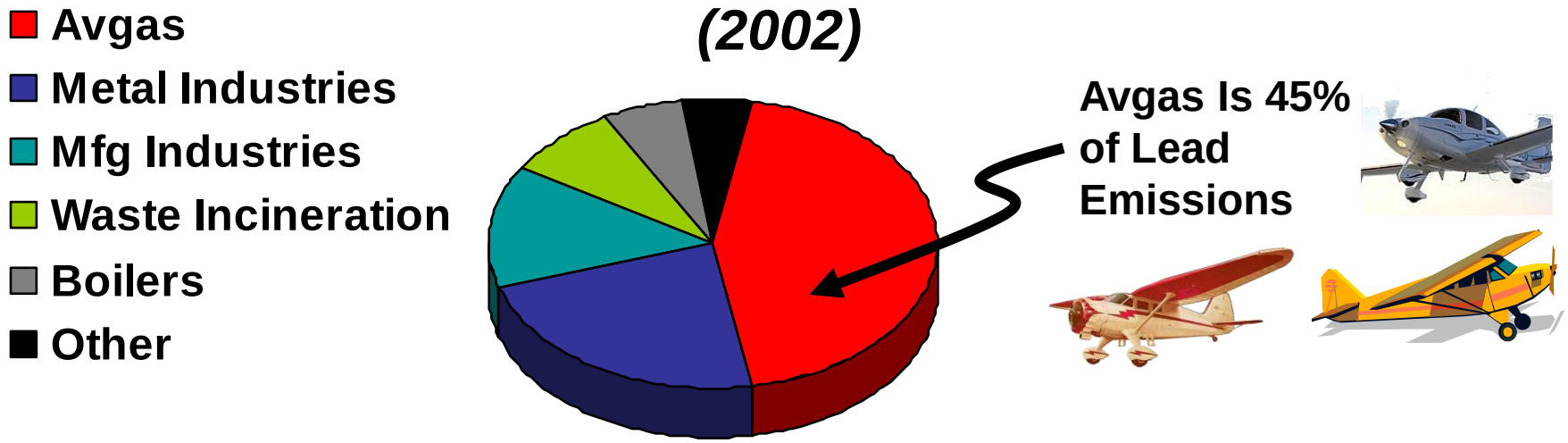
EPA & Environmental Groups Now Focusing On AvGas

EPA Inventory of Lead Emissions (2002)



- **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”

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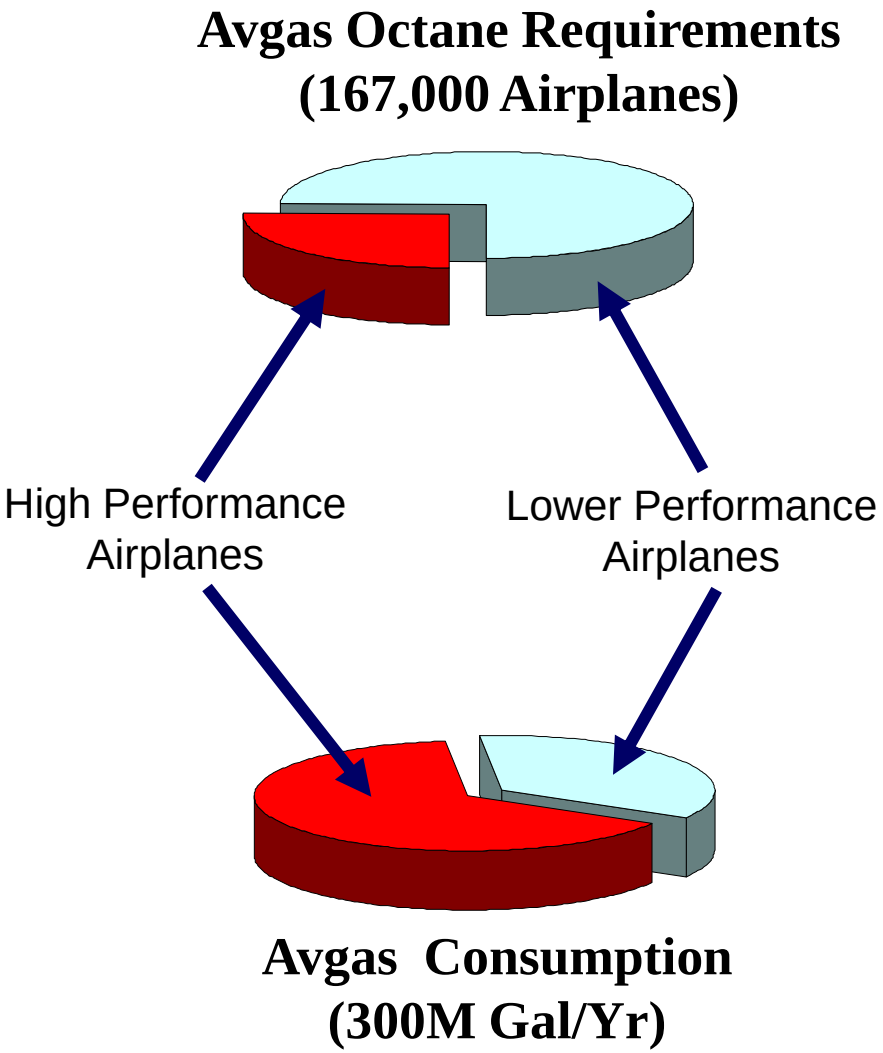
Avgas Octane Requirements and Consumption



- **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**)**

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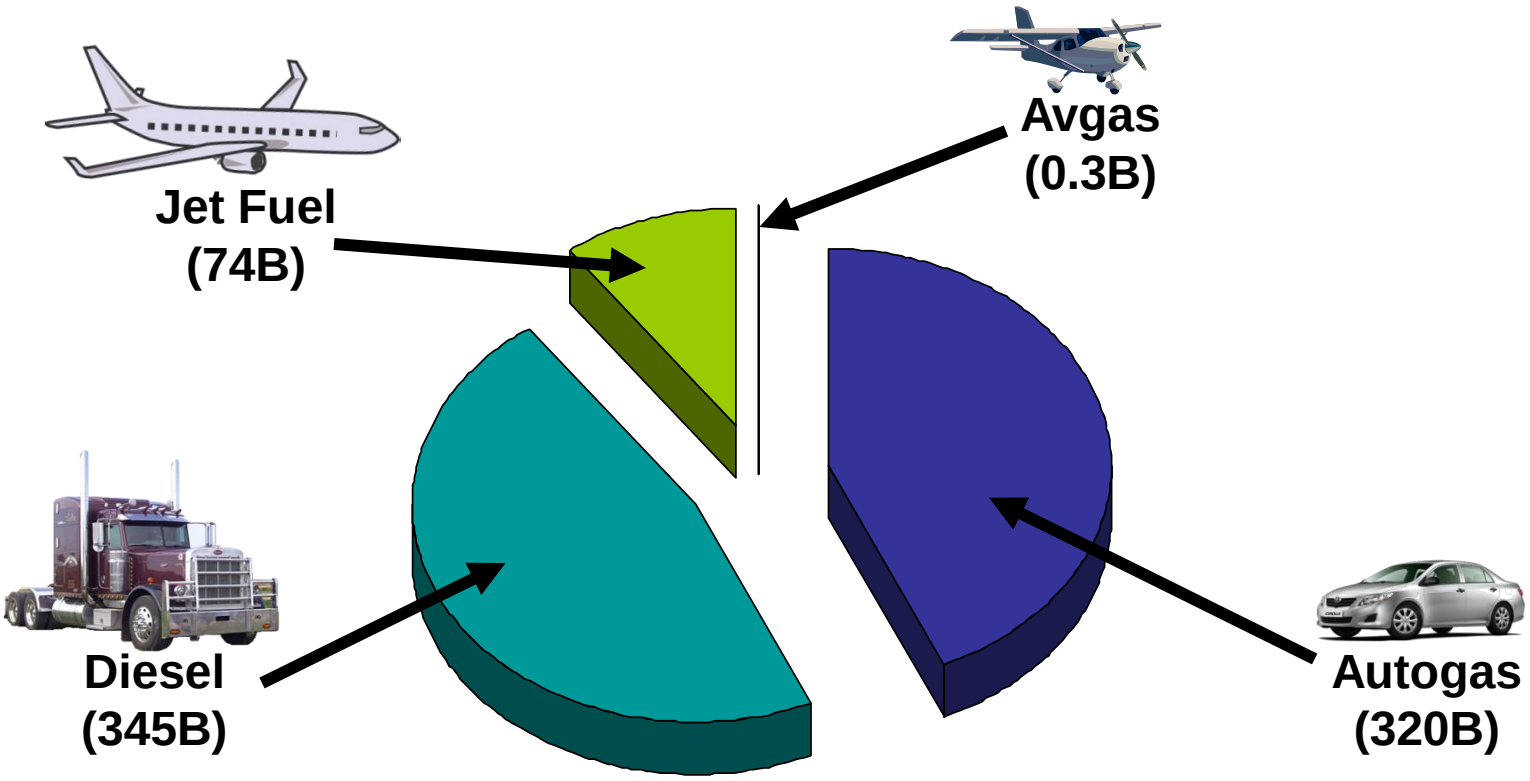
"The Big Picture" - Avgas Has Limited Market Influence

Gallons of Fuel Per Year



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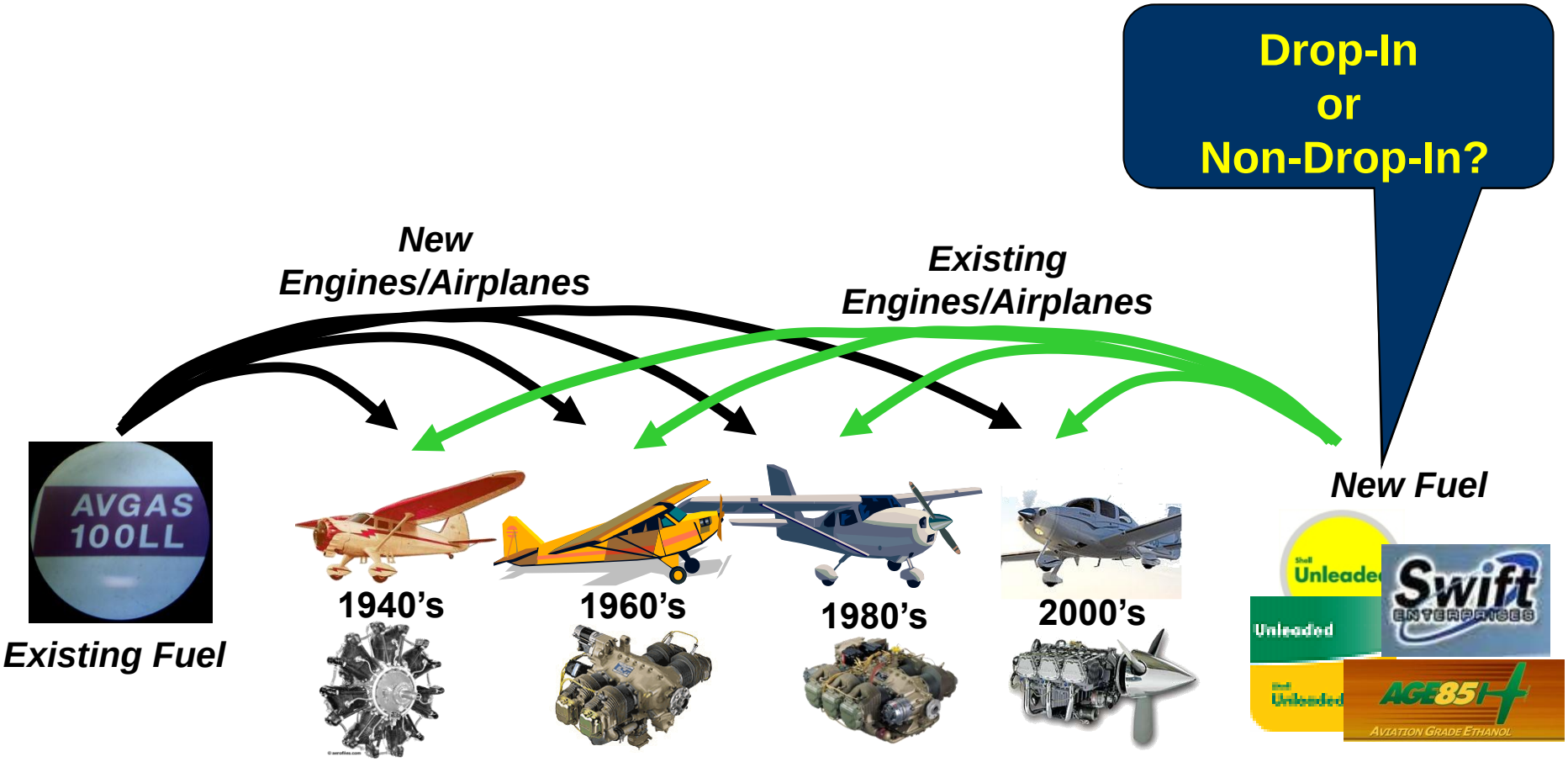
Today's Challenge



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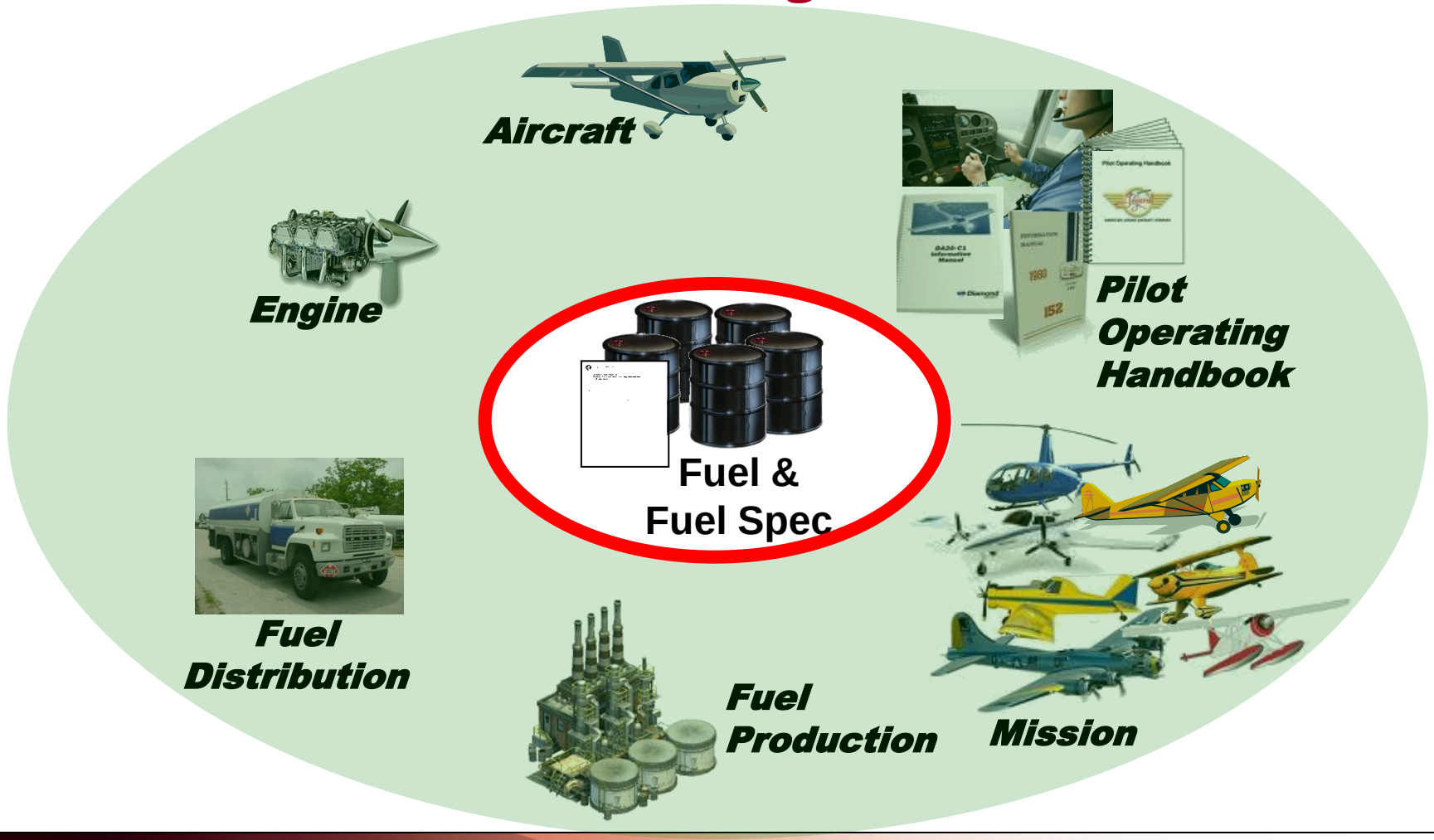
Drop-In Fuel

Plugs Into Existing Aviation Safety Infrastructure
Focus on Evaluating ONLY the Fuel



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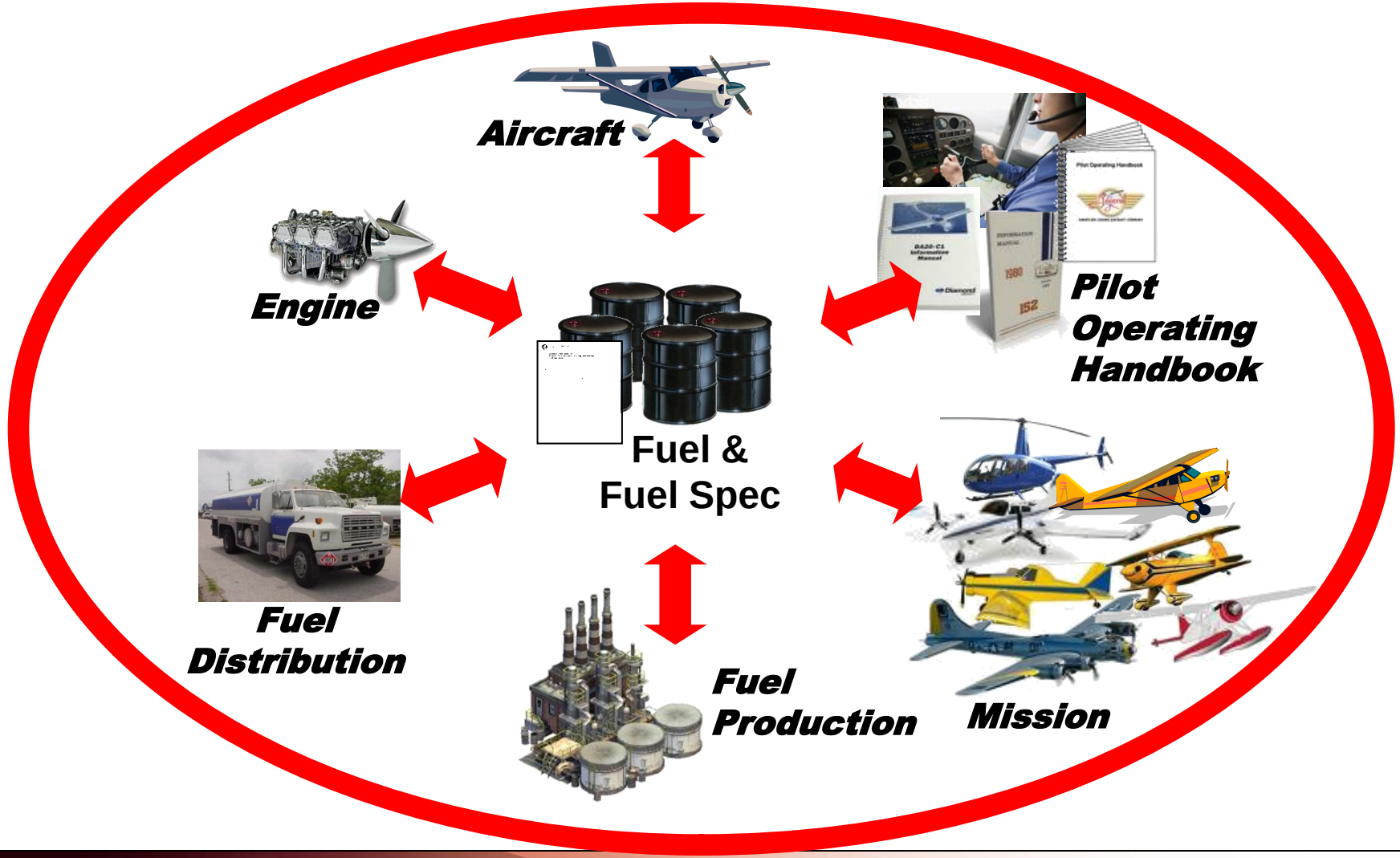
Non-Drop-In Fuel

Must Consider Entire Aviation Safety Infrastructure



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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

Combustion Deposits
Distillation, Trace Metals

Durability
Lubricity, Aromatics Potential Gum

Corrosion
Water Reaction, Water Separation, Sulfur Content

Oil Dilution
Distillation

Aircraft Range
Net Heat of Combustion, Density

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

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

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Current Initiatives

Expensive Retrofit or New Airplane

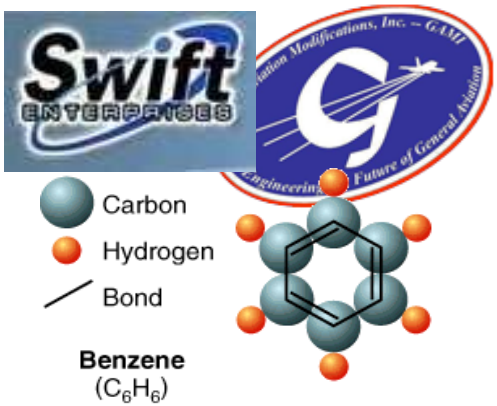
Not Completely Drop-In, Expensive, Under Development

Not Completely Drop-In, Not Commercially Successful

Diesel Aircraft Engines

High-Aromatic Fuels

Swift Enterprises



Ethanol Fuels

Automobile Gasoline

Higher Performance Airplanes Left On Ground

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Thank You

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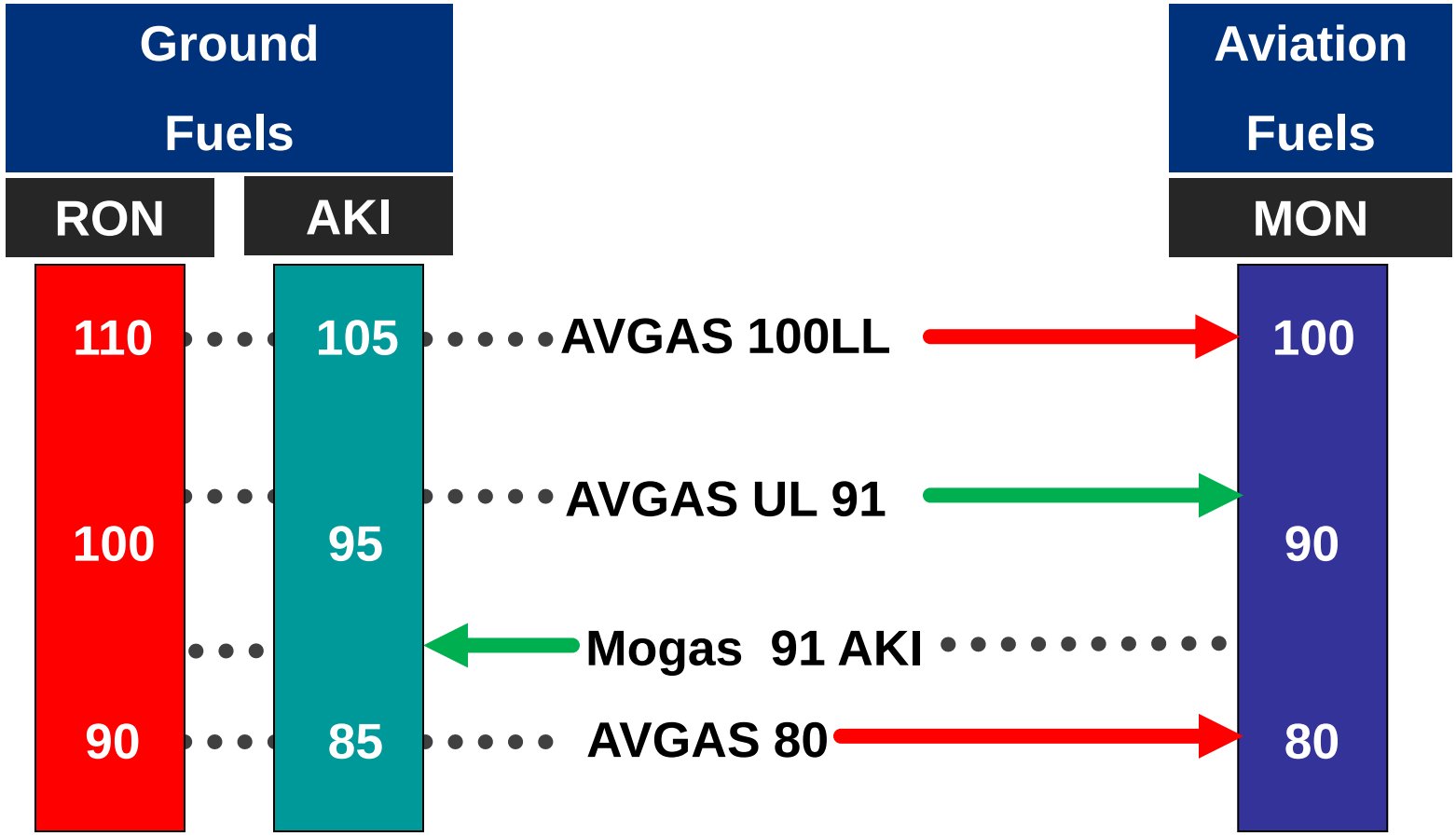
Fuel Octane Scales

AKI = [RON + MON]/2



Note: Scales are approximate and for illustration only

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