



**P**ISTON

**A**VIATION

**F**UELS

**I**NIATIVE



Future Unleaded Aviation Gasoline

EAA AirVenture

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# Presenters

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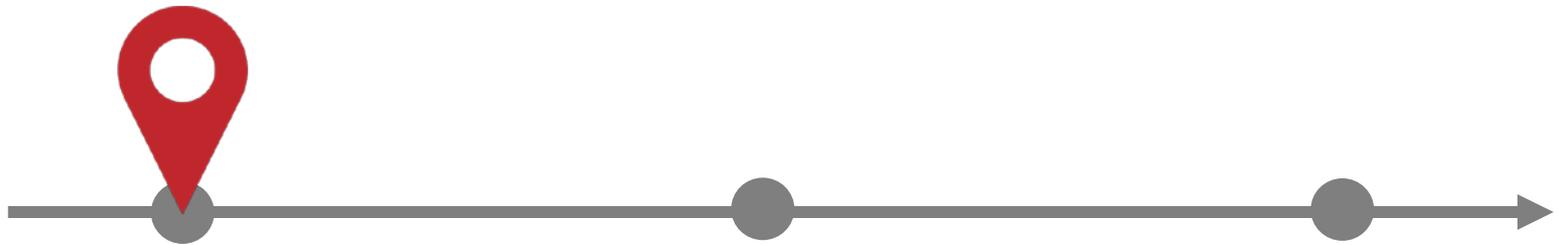
Senior Director, Government Affairs, Regulatory  
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# How we got here





# Tetra-Ethyl Lead

## Challenges to long-term leaded fuel availability

- Past and future petitions and suits by environmental organizations
  - EPA has and will continue to be sued to determine if airborne lead emissions from GA aircraft endanger public health
- Federal - Pending EPA regulation
  - Reduced ambient air quality standards (NAAQS) for lead
  - Endangerment finding – lead emissions from GA aircraft
- Local / Market forces
  - Single source of Tetra-ethyl lead world-wide
  - States and local governments pressure



# Endangerment Finding - Regulations

## Clean Air Act

- 42 U.S. Code § 7571 (Clean Air Act) gives the EPA authority to establish emissions standards on any pollution/source determined to endanger public health
- EPA must consult with the FAA in establishing these standards
  - Standards should take into account technological feasibility and must not significantly increase noise or adversely affect safety
- The FAA is compelled by 49 USC 44714 to “prescribe standards for the composition ...of an aircraft fuel... to eliminate aircraft emissions (that the EPA) decides...endanger the public health”
- A positive EPA Endangerment Finding will result in the establishment of regulations to mandate the use of unleaded fuels



# Environmental Considerations

- The EPA has not completed their assessment of endangerment regarding lead emissions from GA aircraft
- The EPA is at the first step of a long process and have made no decisions
- EPA is committed to working closely with FAA, States, Industry and user groups to keep piston-engine aircraft flying in an environmentally acceptable and safe manner throughout the U.S.
- The EPA cannot take unilateral action to ban lead without FAA and public involvement



# Proactive Approach

- The industry/government collaborative effort known as the Piston Aviation Fuels Initiative (PAFI)



# PAFI Overview

- Industry and Government Collaboration
- Funded by Congress, FAA, and Industry in-kind support
- Collaborative effort to manage
- Key parameters and criteria to determine viable fuel and market acceptance



# PAFI Mission

- The mission of PAFI is to evaluate candidate unleaded replacement fuels and identify those fuels best able to technically satisfy the needs of the existing aircraft fleet while also considering the production, distribution, cost, availability, environmental and health impacts of those fuels.



# PAFI Goal

- The output of the PAFI R&D program will be test data that can be used...
  - By the offeror, to obtain an ASTM Production Specification
  - By the FAA, to authorize engines and aircraft to operate on the unleaded fuels



# Where we are





# PAFI Steering Group (PSG)

## Purpose

- Facilitates, coordinates, expedites, promotes, and oversees the PAFI program
- Coordinates resources and support necessary to execute the program
- Engages industry stakeholders for allocation of expertise and resources to support task groups and the PAFI test program

## Members

AOPA – Aircraft Owners and Pilots Association

EAA – Experimental Aircraft Association

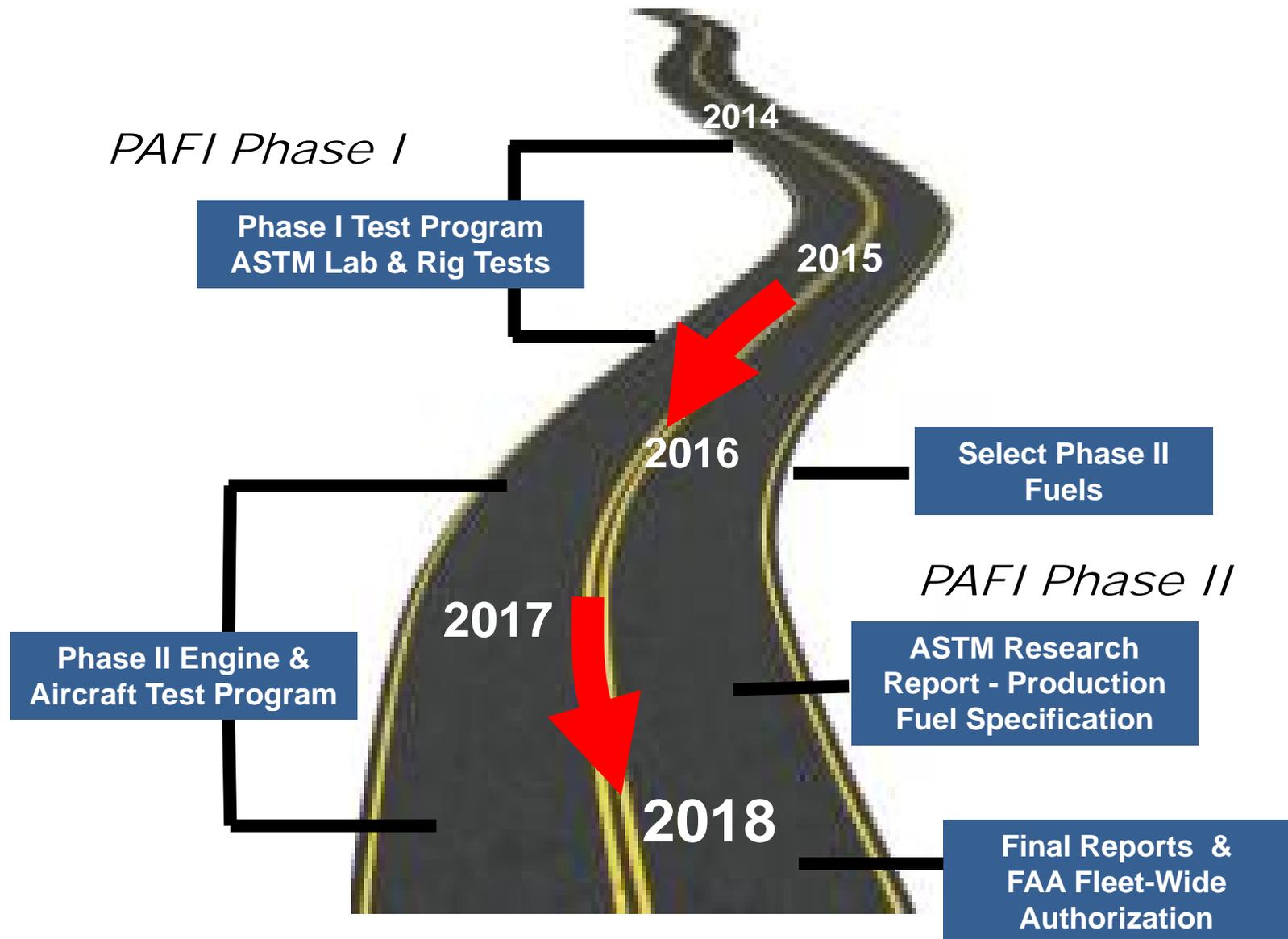
GAMA – General Aviation Manufacturers Association

NATA – National Air Transportation Association

NBAA – National Business Aviation Association

FAA - Federal Aviation Administration

# Path To Unleaded Avgas





# Think This Is Just About Octane?

- Octane requirement is just the tip of the iceberg
  - Avgas has many qualities necessary to control adverse outcomes in our aircraft and engines
  - Evaluating the impact of completely new fuel chemistry on the full history of aircraft production is an immensely complicated undertaking



# FAA Technical Center Test Program

- Phase I – Lab, Rig, Engine and Environmental/Toxicity Assessment
  - Laboratory Testing
  - Materials Compatibility Testing
  - Limited engine testing – performance, detonation, emissions, starting
  - Environmental and Toxicology research and report
  - Fit-for-Purpose Rig Testing
    - Rig #1, Low Temperature Flow Ability
    - Rig #2, Carburetor Icing
    - Rig #3, Dynamic Fuel System
    - Rig #4, Storage Stability
    - Rig #5, Cold Storage
    - Rig #6, Hot Surface



# Phase 1 Data Evaluation

- Test Data Evaluated in 9 Performance Categories
  - Cold Fuel Performance
  - Hot Fuel Performance
  - Anti-Detonation Performance
  - Fuel Systems Compatibility
  - Engine Power and Performance
  - Engine Start ability
  - Environmental Risk Assessment
  - Fuel Property Lab Tests
  - Cost, Producibility, Infrastructure Impact



# FAA Technical Center Test

- Phase II – Full Scale Engine & Aircraft Testing
  - Work Product – Data packages from full scale engine & aircraft testing which support ASTM & FAA Approval
    - Fuels are being tested at the engine and aircraft level to evaluate their suitability across as much of the existing fleet as possible - multiple fuels in multiple engines and multiple aircraft
  - Data from Phase I and Phase II will be used to support
    - Fleet wide authorization of aircraft and engines to operate on the replacement unleaded fuels
    - ASTM Production Specification

# “Cloud” GA Recip Powered Fleet





# PAFI Phase 2 Testing

## Aircraft Test Articles:

- Cessna 150/T206H/402C
- Beech - G36
- Cirrus – SR22T
- North American – Harvard
- Piper – PA28-181/PA31-350/PA46-350P
- Robinson – R44



# PAFI Phase 2 Testing

## Engine Test Articles:

- Engine Range, from Carbureted Four Cylinder to Turbocharged/Fuel Injected Six Cylinders - Includes Representative Radial Engines
  - CMI – IO550D/O470U/TSIO520VB/O200A/IO550B/W6706N/TSIO550K
  - Lycoming – IO540J2BD/IO540K1A5/IO360C1C/TIO540AJ1A/O360A1A/IO360C1F
  - Rotax – 912ULS/912iS/914UL
  - P&W – R1830

## Engine Test Matrix:

- Detonation Testing
- Durability Testing
- Performance Testing/Mapping
- Operations Testing, Propeller Test Stand
- Propeller/Crankshaft Vibration Testing, Propeller Test Stand



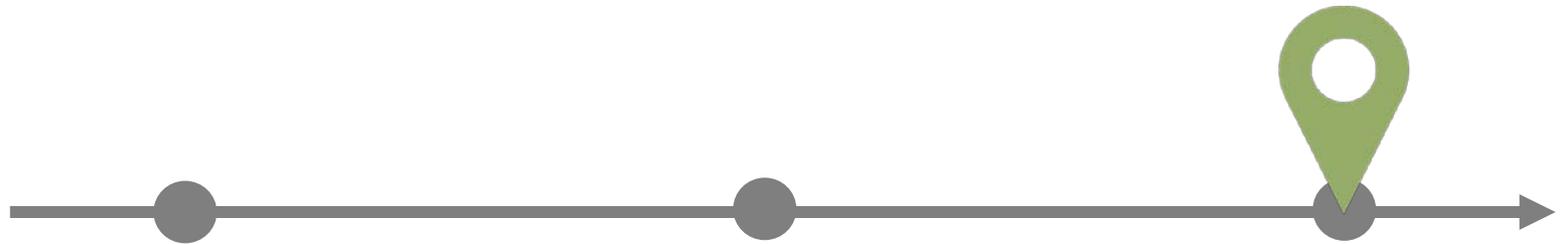
# PAFI Phase 2 Testing

## Aircraft Test Matrix:

- Hot Fuel/Weather
- Cooling Climb
- Inflight Restarts
- Engine Handling Characteristics
- Carburetor Icing/Deicing
- Continued Airworthiness/AFM Procedures
- Function and Reliability



# Where are we headed





# Fleet Wide Authorization

- PRIMARY GOAL OF PAFI
  - Approach will not result in classic engine/airframe specific approvals, as there will be no applicant, and no certificate issued
  - Plan to determine and publish eligibility lists of engines/aircraft that can utilize the new unleaded AVGAS formulation(s)
  - FAA and industry are currently working with Congress to expand or creating new statutory authorization for fleet wide transition
- Approach and implementation is fuel dependent
  - Fuel properties & composition
  - Impact on engine and aircraft models
- Plan to publish eligibility lists in the Federal Register



# Program Status & Milestones

- 5-Year Program Under Way and Funded by Congress and Industry In-Kind Contributions
- July 2014: 17 candidate fuels from 6 offerors entered the program
- Sept. 2014: 4 fuels from 3 offerors accepted into Phase 1
- December 2014 - November 2015 – Phase 1 test program
- March 2016: 2 fuels selected for Phase 2 evaluation
- Dec. 2018: Fuels complete PAFI testing to support fleet-wide “approval”



# Phase 2 Testing Status

- PAFI is evaluating Phase 2 test data as it becomes available
- PAFI fuels are exhibiting some differences with potential impacts compared to 100LL
- The differences are being documented, impacts are being assessed, and mitigations options are being explored and evaluated
- PAFI's goal is to identify the most effective mitigations and authorize the largest portion of the fleet to operate on each PAFI fuel
  - With the lowest possible impact
- Each fuel is different and will have different impacts, different authorized fleets, and different mitigations



# Next Few Years

- PAFI working an aggressive and ambitious timeline
  - Some tests are being delayed – overall schedule still achievable
- Unknown impact of Regulatory Reform on EPA Endangerment Finding/Follow on Regulatory activities
- FAA must respond to EPA action if a positive finding of endangerment is determined
- Availability of leaded avgas remains stable and is projected to be so through the transition
  - Industry working closely with existing lead supplier and fuel industry to coordinate orderly transition from leaded to unleaded fuel
- AIR-20 continues to support applicants that approach the FAA directly for approvals of alternative fuels outside of the PAFI program



# Conclusion

“Ultimately it is everyone’s goal that the piston aviation fleet moves efficiently and economically to a viable and safe unleaded future. The PAFI program provides a sound process to ensure that this goal is achieved with a minimum of disruption to the general aviation industry and with the greatest likelihood of marketplace success.”

Reference: PAFI Whitepaper Nov 2013