



PAFI

Piston Aviation Fuels Initiative

Future Unleaded Aviation Gasoline

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Presenters

Walter Desrosier

Vice President of Engineering and Maintenance
General Aviation Manufacturers Association (GAMA)

Doug Macnair

Vice President Government Relations
Experimental Aircraft Association (EAA)

Peter White

Manager, Alternative Fuels Program Staff, AIR-20
Federal Aviation Administration (FAA)

David Oord

Senior Director, Government Affairs, Regulatory
Aircraft Owners & Pilots Association



Why Are We Discussing This?

Tetra-Ethyl Lead

Challenges to long-term leaded fuel availability

- Petitions and suits by environmental organizations
 - EPA is being sued to determine if airborne lead emissions from GA A/C endanger public health
- Pending EPA regulation
 - Reduced ambient air quality standards
 - Endangerment finding – lead emissions from GA A/C
- Market forces
 - Single source of Tetra-ethyl lead
 - Lead phased out of most every other product
 - Local areas are putting pressure on airports to eliminate lead



Environmental Considerations

Clean Air Act (CAA)

- 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”

Note.....There are currently no active or planned exhaust gas emission standards applicable to aviation reciprocating engines. Turbine aviation engines, however, are subject to emission standards.



Summary

Environmental Considerations

- The EPA has not proposed to ban leaded AVGAS
- The EPA are 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

The Solution?

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

Funded by congress, FAA and industry in-kind support

Research, Development, Implementation and Transition Must Be a Collaborative Effort

No one can do this alone

Consensus and the marketplace must drive the
solution and yet the marketplace is
broken/constrained

Fuel must be affordable and satisfy the existing
fleet to the greatest degree possible

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 Overview

PAFI is a robust joint government/industry initiative established at the request of a broad cross section of the aviation and petroleum industries and consumer representatives

- Formed in response to the UAT ARC Final Report
- Process for the identification, evaluation and deployment of the most promising unleaded replacements for 100LL
 - technically satisfy the needs of the existing aircraft fleet
 - considers production, distribution, cost, availability, environmental and health impacts
- Goal is data to support FAA **fleetwide authorization** and ASTM specification

PAFI Funding

- President's Budget Request Shows Full Funding for Unleaded Avgas Program through 2018
 - ✓ Annual FY Budget Request Approximately \$6 million
- Congress has authorized ~\$6 million in fiscal years 2014-2016
 - ✓ Funding supports the PAFI test program at the FAA William J. Hughes Technical Center and outside contractors
- Industry In-Kind Support
 - ✓ Fuel development and supply for testing program
 - ✓ Technical expertise for qualification and testing methods
 - ✓ Equipment and services and/or conduct for test program
 - ✓ Program oversight and management

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

PAFI Support Groups

● Technical Advisory Committee (TAC)

- Reports to PAFI Steering Group (PSG)
- Membership represents aviation product and fuel manufacturers
- Venue to provide industry “in-kind” support – technical & equipment

● Technical Evaluation Committee (TEC)

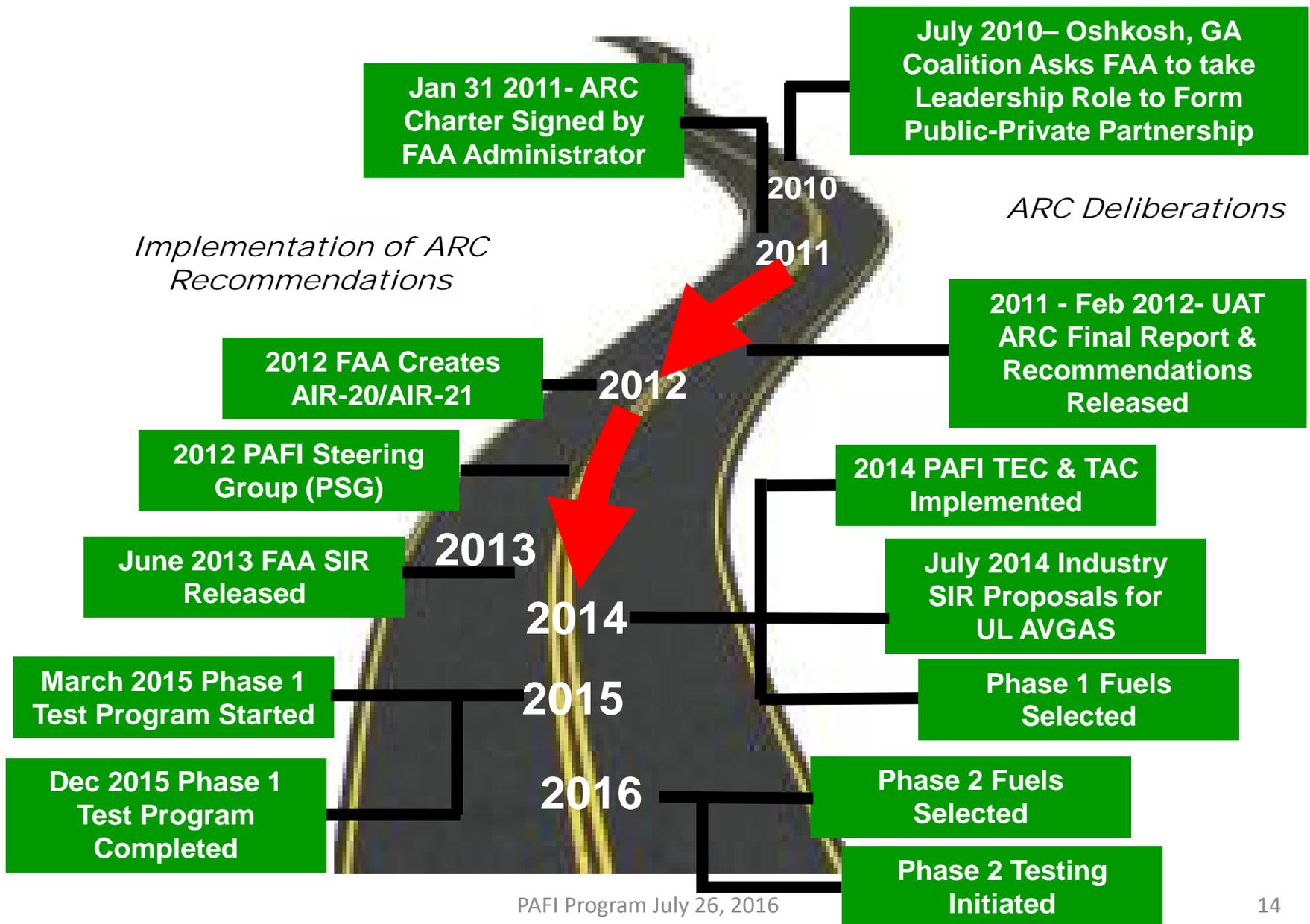
- Reports to FAA
- FAA consultants and employees vetted for COI within areas of expertise necessary to evaluate fuels to criteria
- Responsible for Phase I and Phase 2 fuel evaluation & selection
- TEC Mission is now complete – *no more downselects*

Distinct and Separate Support Groups with **NO**
interconnections

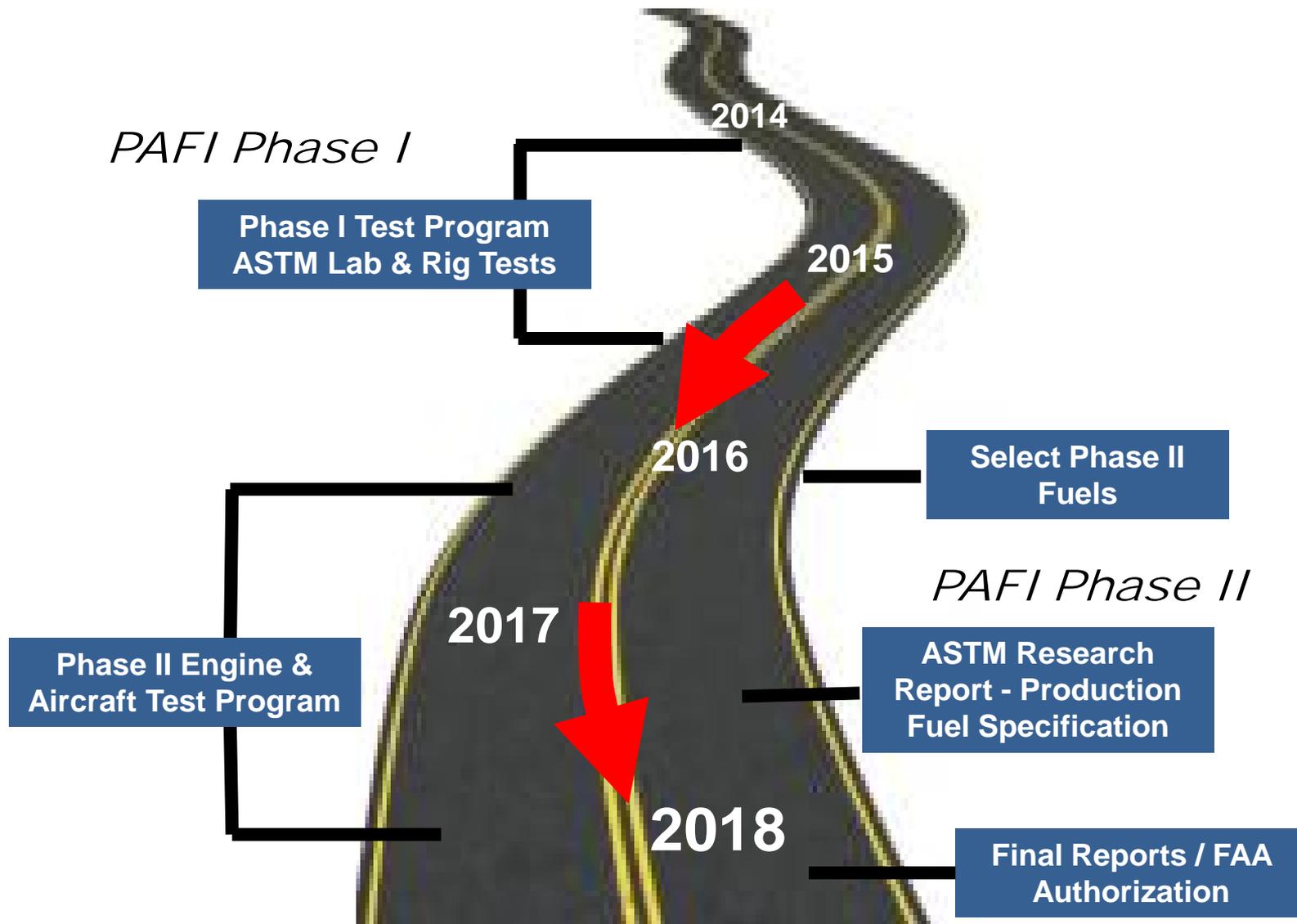
Key Takeaways

- Piston Aviation Fuels Initiative (PAFI)
 - Implemented, funded and in process
 - Fleet-wide approval is the primary goal
 - Two phase test program – Phase 1 completed earlier this year
 - Completion of PAFI - 2018
 - Supported and funded by Congress and FAA
 - PAFI is not “picking” a fuel but rather qualifying the best fuels for use
- Supply of current leaded avgas remains stable

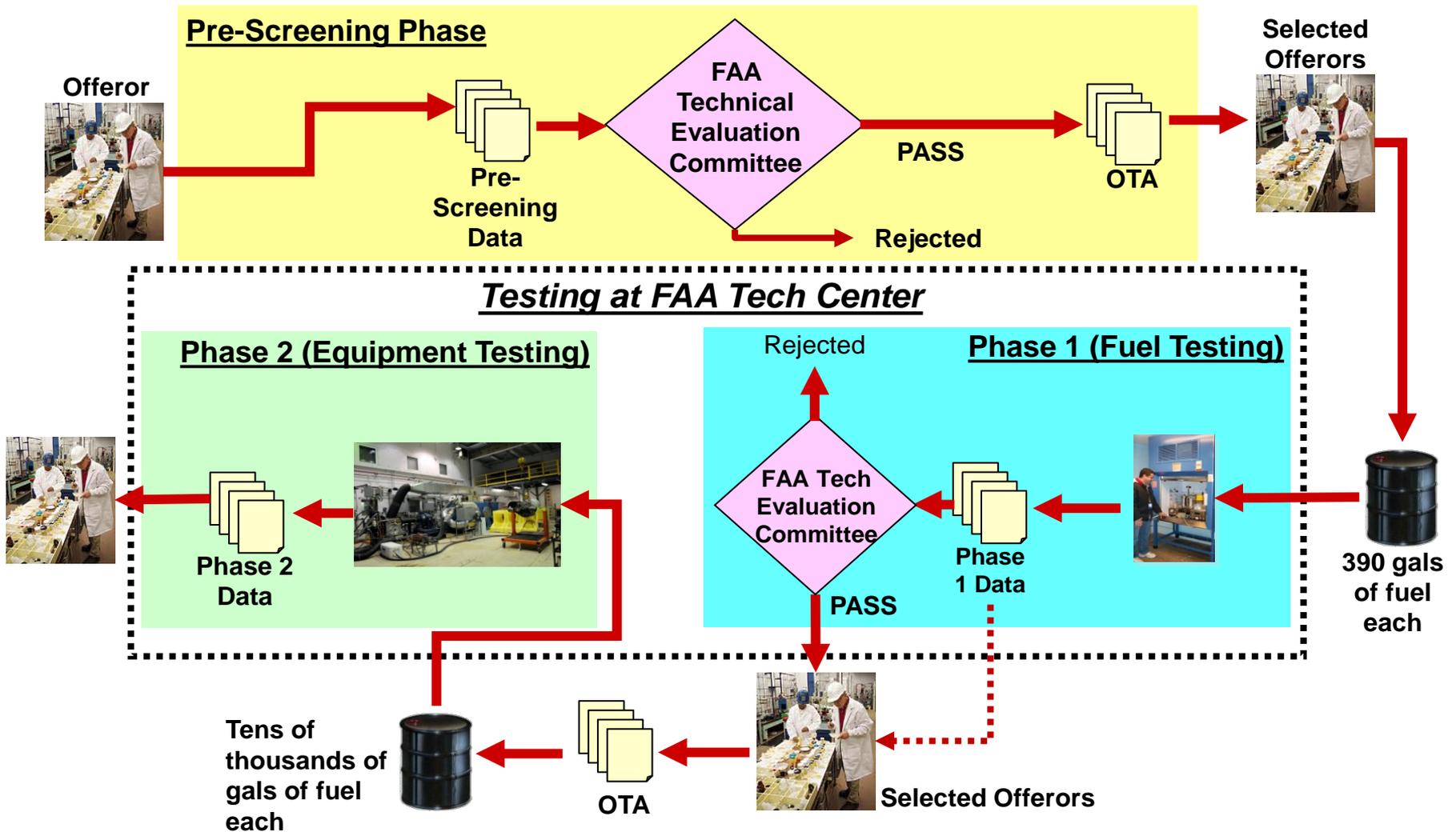
Path To Unleaded Avgas – Where we Are



Path To Unleaded Avgas – Where We Are Going



FAA Technical Center's Role in PAFI Test Program



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 Startability
 - Environmental Risk Assessment
 - Fuel Property Lab Tests
 - Cost, Producibility, Infrastructure Impact

Phase 1 Results

- Conclusions
 - Use of available unleaded fuel (UL91/94) would have a high/costly impact on the high-performance segment of the fleet
 - Introduction of PAFI fuels should have less impact on a much wider segment of the fleet
 - Preliminary results indicate overall impacts of the PAFI unleaded fuel(s) should be less or comparable to UL91/94
- PAFI fuels Selected for further evaluation in Phase 2:
 - Shell UL100
 - Unleaded Aviation Gasoline Test Fuel
 - Based on ASTM Test Specification D7960
 - Swift UL102
 - High Aromatic Content Unleaded Hydrocarbon Aviation Gasoline
 - ASTM Specification D7719

FAA Technical Center Test Program

Phase II – Full Scale Engine & Aircraft Testing

Work Product – Data packages from full scale engine & aircraft testing which support ASTM & FAA Approval

- Fuels will be 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 collected from this testing will generate data that can be used to support the fleet wide authorization of aircraft and engines to operate on the replacement unleaded fuels
- Data from the Phase I and Phase II testing will support ASTM Production Specification

“Cloud” GA Recip Powered Fleet



PAFI Phase 2 Testing

Engine Test Articles:

- Engine Range, from Carbureted Four Cylinder to Turbocharged/Fuel Injected Six Cylinders
- Includes Representative Radial Engines

Engine Test Matrix:

- Detonation Testing
 - Naturally Aspirated and Turbocharged Engines
 - Includes Fuel Mixes, to Evaluate Phased Deployment
 - Altitude Simulation
- Durability Testing
 - Standard Part 33 Block Test
 - Mission Profile Test
- Performance Testing/Mapping
- Operations Testing, Propeller Test Stand
- Propeller/Crankshaft Vibration Testing, Propeller Test Stand

PAFI Phase 2 Testing

Aircraft Test Articles:

- Aircraft Range; Two Place Light Trainers to High Performance Twins and Rotorcraft
- Includes Breadth of Engine Test Articles

Aircraft Test Matrix:

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

Fleet Wide Authorization

- Fleet-wide authorization is the 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

Key Takeaways

- FAA/Industry Piston Aviation Fuels Initiative (PAFI)
 - Purpose:
 - Facilitate transition to unleaded replacement Avgas with least impact on existing fleet
 - Primary objective is FAA fleetwide authorization of GA aircraft to operate on the PAFI unleaded fuels
 - 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; Fuel complete PAFI testing to support fleet-wide “approval”
- PAFI is a robust industry-government collaborative initiative
 - Crucial to establishing viable marketplace for unleaded fuel
- Program is on schedule and anticipated to stay that way

Next Few Years

- PAFI working an aggressive and ambitious timeline
- EPA timing regulatory actions in harmony with PAFI timelines
 - EPA Endangerment Finding – NPRM 2017, Final Rule 2018
- 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 on specified models of engines and aircraft

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

Piston Aviation Fuel Initiative Links

FAA PAFI Website

<http://www.faa.gov/about/initiatives/avgas/>

FAA Contracts SIR Link

<https://faaco.faa.gov/index.cfm/announcement/view/15840>

FAA Press Release, March 29, 2016

http://www.faa.gov/news/press_releases/news_story.cfm?newsId=20154

Questions?