PAFI
Piston Aviation Fuels Initiative
Future Unleaded Aviation Gasoline

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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

Implementation of ARC Recommendations

- 2011 - Feb 2012- UAT ARC Final Report & Recommendations Released
- 2012 FAA Creates AIR-20/AIR-21
- 2012 PAFI Steering Group (PSG)
- June 2013 FAA SIR Released
- March 2015 Phase 1 Test Program Started
- Dec 2015 Phase 1 Test Program Completed

ARC Deliberations

- Jan 31 2011- ARC Charter Signed by FAA Administrator
- July 2010– Oshkosh, GA Coalition Asks FAA to take Leadership Role to Form Public-Private Partnership
- 2013 - Feb 2012- UAT ARC Final Report & Recommendations Released
- 2014 PAFI TEC & TAC Implemented
- July 2014 Industry SIR Proposals for UL AVGAS
- Phase 1 Fuels Selected
- Phase 2 Fuels Selected
- Phase 2 Testing Initiated

PAFI Program July 26, 2016
Path To Unleaded Avgas – Where We Are Going

PAFI Phase I

- 2014
  - Phase I Test Program
  - ASTM Lab & Rig Tests

PAFI Phase II

- 2015
  - Select Phase II Fuels
- 2016
  - ASTM Research Report - Production Fuel Specification
- 2017
  - Phase II Engine & Aircraft Test Program
- 2018
  - Final Reports / FAA Authorization
FAA Technical Center’s Role in PAFI Test Program

Pre-Screening Phase

Offeror ➔ Pre-Screening Data ➔ Pre-Screening Committee ➔ PASS ➔ OTA ➔ Selected Offerors

Rejected

Testing at FAA Tech Center

Phase 1 (Fuel Testing)

Rejected ➔ Phase 1 Data ➔ Pre-Screening Committee ➔ PASS ➔ OTA ➔ Selected Offerors

Phase 2 (Equipment Testing)

Tens of thousands of gals of fuel each ➔ Phase 2 Data ➔ Pre-Screening Committee ➔ OTA ➔ Selected Offerors

390 gals of fuel each

PAFI Program July 26, 2016
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 Startibility
  - 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

Questions?