

# Eliminate Aviation Gasoline Lead Emissions (EAGLE) Initiative Stakeholder Meeting

Thursday, November 17, 2022

10:00 a.m. to 12:00 p.m. EST

*This meeting is an industry-sponsored event. It is not intended to be a forum for providing consensus stakeholder advice or recommendation to the government; rather, we welcome individual perspectives on issues discussed.*

# Disclaimer

It is appropriate with competitors in the room to provide a set of antitrust guidelines. It is in everyone's interest to comply with the antitrust laws. Participants in today's meeting should observe the following guidance:

- No discussion or forecasting of prices for goods or services provided by or received by a company.
- No sharing or discussing any company's confidential or proprietary information.
- No discussion of any company's specific purchasing plans, merger/divestment plans, production information, inventories, or costs.
- No sharing or discussion of specific company compliance costs, unless publicly available.
- No agreement or discussion regarding the purchase or sale of goods or services (such decisions are independent company decisions).
- No discussion of how individual companies intend to respond to potential market/economic scenarios or government action; discussion is limited to generalities.
- No disparaging remarks regarding specific vendors' products or services.
- If a discussion presents an antitrust issue, raise your concern immediately.

# Stakeholder Agenda

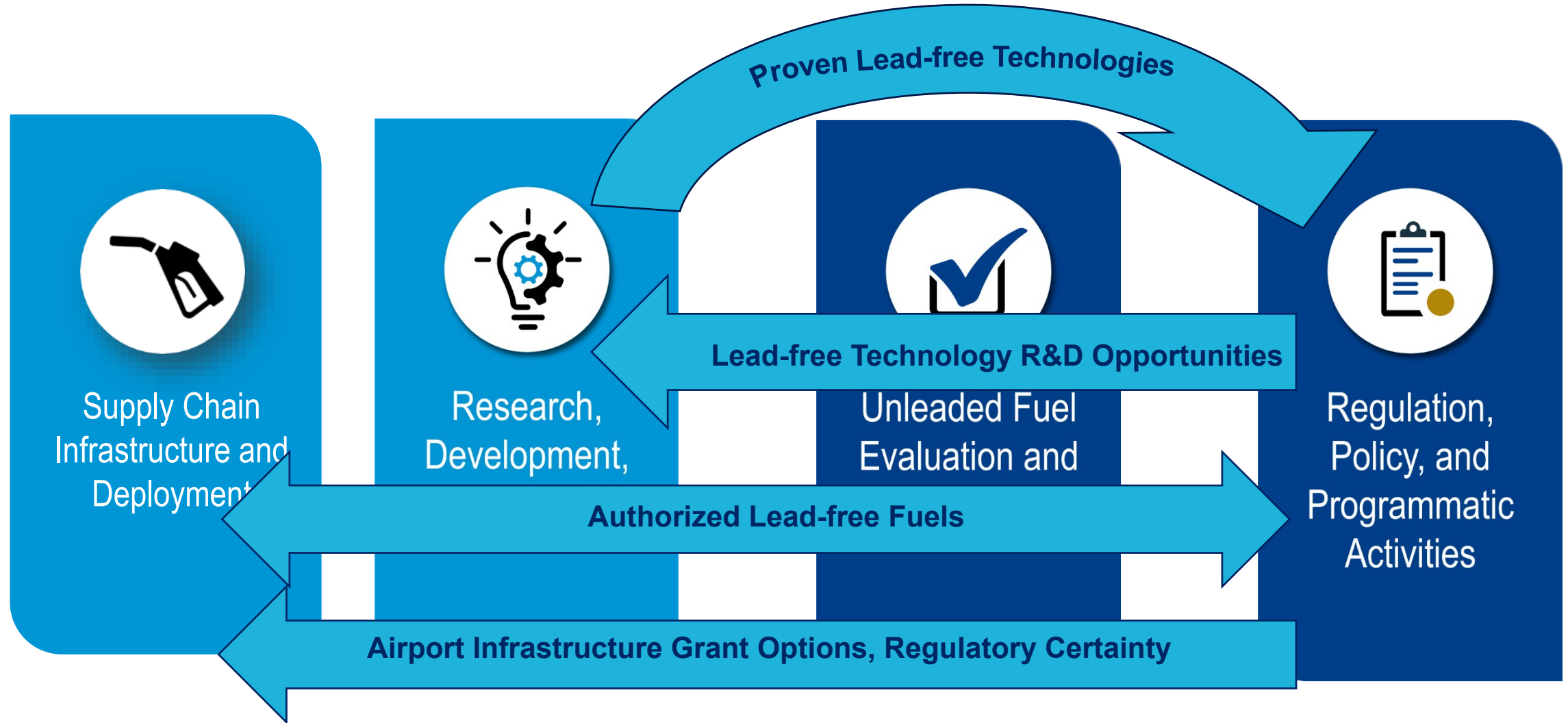
- 10:00 – 10:05** Welcome remarks by EAGLE Co-Chairs
- 10:05 – 10:10** Introductions: EAGLE Senior Coordinator (ESC) and Pillar Leads
- 10:10 – 10:25** EAGLE ESC Report
- 10:25 – 11:05** EAGLE Pillar Lead Reports
- 11:05 – 11:30** Executive Committee Discussion
- 11:30 – 12:00** Stakeholder Q&A
- 12:00** Adjourn



## **EAGLE Senior Coordinator Robert Olislagers**

Eliminate the use of leaded aviation fuels for piston-engine aircraft in the United States by the end of 2030 without adversely impacting the safe and efficient operation of the existing GA fleet

# Pillar Interdependencies – Example (not exhaustive)





# Unleaded Fuel Evaluation and Authorization

Presented by: Maria DiPasquantonio and Tim Owen

# EAGLE Pillars – Unleaded Fuel Evaluation and Authorization



Supply Chain  
Infrastructure  
and Deployment



Research,  
Development,  
and Innovation



Unleaded Fuel  
Evaluation and  
Authorization



Regulation,  
Policy, and  
Programmatic  
Activities



# Unleaded Fuel Evaluation and Authorization Pillar Objectives



- **Complete test and evaluation** of candidate replacement fuels for 100 Low Lead (100LL) aviation fuel
- **Identify at least one unleaded fuel** acceptable for widespread use
- **Institutionalize fleet authorization process** for unleaded fuels
- **Include education, training, awareness, and outreach** responsibilities

## Cornerstones

- Transparency / Accountability
- Stakeholder Participation / Collaboration
- Technical Excellence / Objectivity

## Key Considerations

- Fuel Quality
- Safety
- Fleet Impact
- Mitigations
- Research and Development

## Deliverables

- Fleet Authorization Process
- Authorizations for Fuels / Eligible Models
- Test & Evaluation Process / Test Plans
- Lessons Learned / FAQs
- Data and Reports → R&D Efforts (Pillar B)

## Pillar Interdependencies

- Business (Fuel) Infrastructure and Implementation (Pillar A)
- Research, Development, and Innovation (Pillar B)
- Regulation, Policy, and Programmatic Activities (Pillar D)

# EAGLE Supports Two Paths to Fuel Authorization



## Fleet Authorization

Process other than traditional means of certification

Fuel Testing	Fuel Evaluation & Approval
Fuel Authorization (other than traditional means)	

PAFI (FAA & Industry Consensus)

Fleet Approvals

## TC, ATC or STC

Existing, normal certification processes



STC (Applicant proprietary)

Engine/Aircraft Approvals

# PAFI / EAGLE UL Fuel Testing – Summary of Schedule Acceleration Efforts



- Leverage in-kind and outsource testing/support to maximum extent possible
- Re-evaluate Test Protocols
  - Engine Test Protocol
    - Eliminate testing of UL91 capable engines with candidate fuels
  - Aircraft Test Protocol
    - Eliminate testing of UL91 capable aircraft
    - Reduce / eliminate 100LL fuel comparison testing
  - Propeller Vibration Test Protocol
    - Proposed elimination of Test Requirement by analysis
  - Outcome: Expected six month schedule reduction
    - **Original plan:** October 2024 | **Accelerated plan:** April 2024
    - Additional efforts being explored
    - Assumes (2) PAFI fuel candidates

## Acceleration Efforts

- ✓ 10 aircraft → 7 aircraft
- ✓ Decreased flight time by 50%
- ✓ Expected 6 month schedule reduction



## PAFI Entry Requirement Testing

### **Mini-Materials Compatibility**

Subset of full materials compatibility testing involving articles representative of sealants, fuel bladders, and elastomers, performed by fuel developer

### **Engine Performance/Fuel Properties**

Rated power check of TIO-540-J2BD to compare engine operational parameters and CoA to 100LL

### **Performance & Detonation**

Comparative testing between minimum specification 100LL and test fuel performed in altitude test cell on TIO-540-J2BD engine

### **Mini-Durability**

Engine test to evaluate the deposit forming characteristics and effects of the fuel during a § 33.49 150 hour endurance test, TIO-540-J2BD engine

## Full Scale PAFI Testing

### **Materials Compatibility**

Full materials compatibility lab and bench tests

- **Rig Testing:** Storage stability, cold soak storage, hot surface ignition temperature, low temperature flow ability

### **Performance & Detonation**

Testing of multiple engine models at simulated altitude, hot day conditions

### **Durability**

- 1) § 33.49 150 hour endurance engine test followed by
- 2) 200 hour flight duty cycle durability test per AC 33.19-1 to characterize effects on engine durability and TBO on multiple engine models

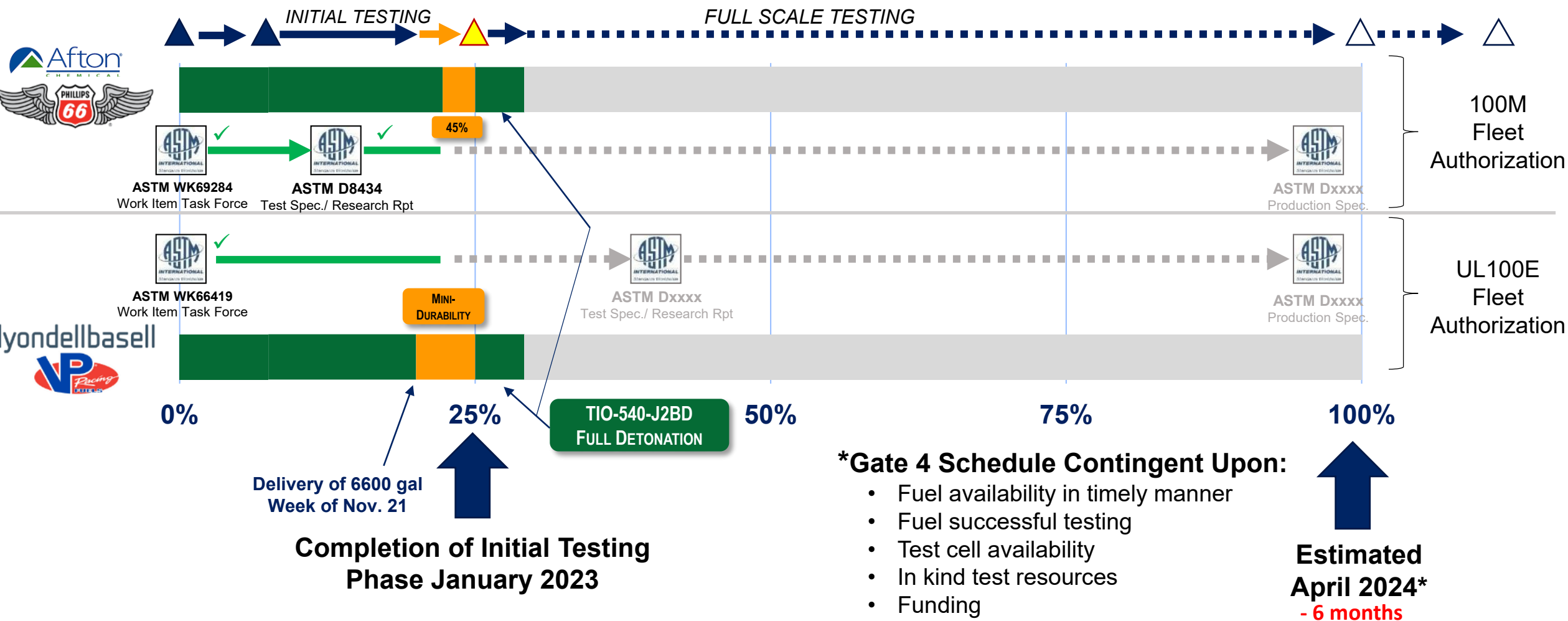
### **Propeller Vibration**

Evaluate propeller stress levels compared to 100LL for multiple engine / propeller combinations

### **Aircraft**

Ground and flight testing on multiple aircraft to evaluate engine and aircraft operability, handling, cooling, and fuel system hot weather conditions

# Status of Candidate UL Fuels – PAFI



- PAFI Test & Evaluation Program for Fleet Authorization of Unleaded Avgas
  - 6 Materials Compatibility
  - 4 Durability and Performance
  - 3 Engine Propeller Vibration
  - 11 Aircraft Engine Cooling Climb
  - 2 Referenced Fuels Handling Plans
  - 6 Performance and Detonation
  - 6 Engine / Propeller Operability
  - 11 Aircraft Engine Handling Ground / Flight
  - 11 Aircraft Fuel System Hot Weather Flight

- ## EAGLE – Stakeholder Meeting November 17, 2022

# EAGLE UL Fuel Evaluation and Authorization Current Accomplishments



- OEM Technical Advisory Committee (TAC) meeting held on Sept. 27, 2022
  - Full TAC meeting tentatively scheduled for Dec. 5, 2022 in coordination with ASTM Meeting, Orlando FL
- Additional TAC working groups being established
  - Test Plan Release Group
  - Detonation Methodology Group
  - Research & Development Group
- Revisions to FAA Handbooks submitted to address Health, Safety, and Environmental concerns
  - Address NASEM Recommendation 4.2 to ensure information on lead risks and mitigation practices are included in relevant manuals, training materials and handbooks.
    - Airplane Flying Handbook and Pilots Handbook of Aeronautical Knowledge to include statement on the proper disposal of fuel sumped from aircraft tanks.
    - Aviation Maintenance Technician – Powerplant Handbook to include updated guidance on spark plug lead fouling and mitigation during engine operation.



# Unleaded Fuel Evaluation & Authorization Pillar Accomplishments (Cont.)

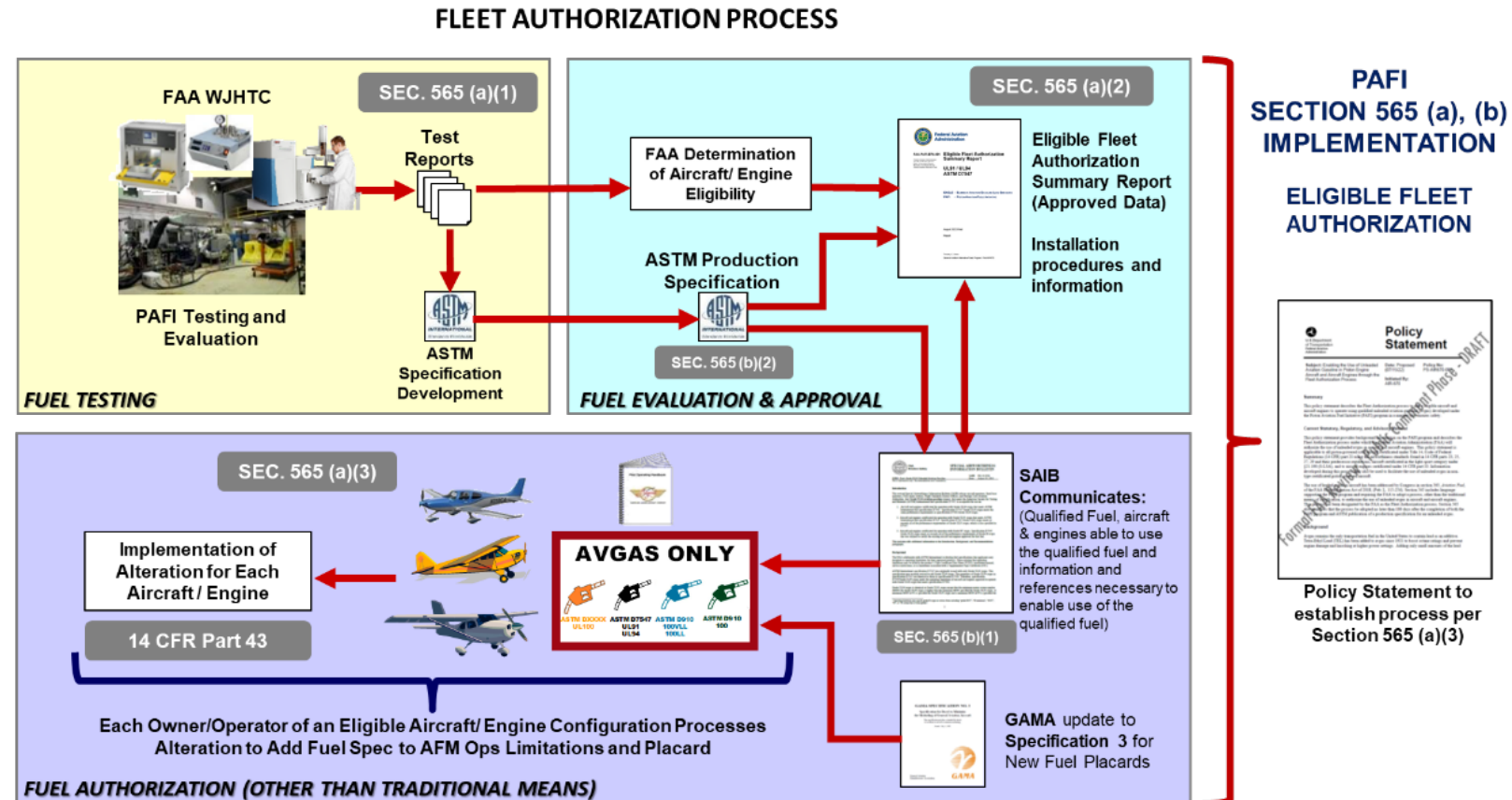


## Fleet Authorization Process

- PS-AIR-20-2000 Policy Statement

- NOTICE published in Federal Register for public comment 10/5/2022
- 60-day public comment period ends 12/5/2022
- Upon comment disposition, Final Notice to be published in Federal Register (est. 1/31/2023)

- UL91 Fleet Authorization to follow (est. 3/29/2023)





# Initial Fleet Authorization of UL91 Will Enable Unleaded Operation by 68% of Fleet



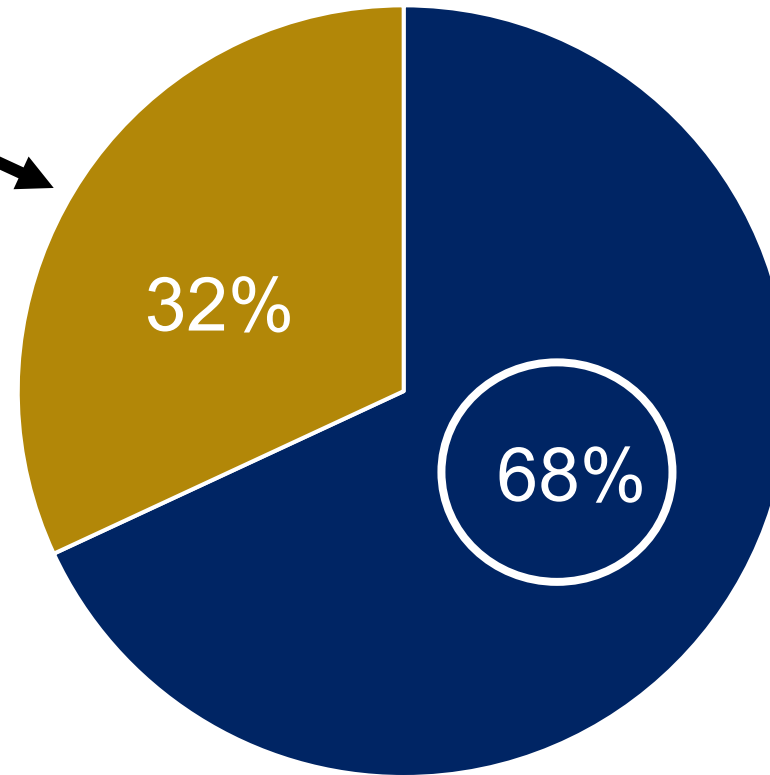
% of US General Aviation Fleet

## PAFI Target → 100LL Fleet

High Octane Unleaded

32% of Fleet

2022 thru 2025



■ UL91/UL94 ■ 100LL

## Fleet Authorization 1

ASTM D7547 (UL91, UL94)

68% of Fleet by end of second Qtr. FY23

ASTM D7547 is 100LL without the lead

## Objectives:

- To support near term availability of UL options
- To exercise FAA's new fleet authorization process



# Education, Training, Awareness, and Outreach

## Upcoming Outreach and Engagement Opportunities

- Stakeholder Pillar C meetings
- PAFI Technical Advisory Committee (TAC) meeting – December 2022
- Working Group Meetings – Test Plans, R&D, Detonation Methodology
- EAGLE Steering Group (ESG) Meetings – Weekly
- Meetings with PAFI Fuel Candidates – Bi-weekly

## Resources

- Fuel Development and Testing: [Lessons Learned](#) | [Best Practices](#) | [Considerations](#)
- [Unleaded Fuel Development FAQs and Definitions](#)
- [Piston Engine Aviation Fuels Initiative \(PAFI\) Background and Program Update](#)
- [PAFI Test Plan Index](#)

## For Additional Information

[Aviation Gasoline | Federal Aviation Administration \(faa.gov\)](#)



# Supply Chain Infrastructure and Deployment

Presented by: Ryan Manor



# Supply Chain Infrastructure & Deployment

## OBJECTIVES

- **Support** policy and regulatory proposals for **maintaining 100LL availability** and airport access to **ensure safety** during the transition across the country for use by general aviation aircraft
- **Evaluate** and support program(s) that **incentivize** fuel producers and distributors, aircraft and engine manufacturers, and GA operators **to accelerate development, qualification, deployment, and use of unleaded fuels**
- **Facilitate** policy proposals at the Federal and State level **to increase production and distribution** – as well as **enable** and encourage **greater use** – of commercially viable replacement unleaded fuel
- **Facilitate** government policy, regulatory proposals and voluntary consensus standards that will support a **commercially viable supply chain and quality-focused infrastructure** for the deployment of unleaded fuel, including the promotion of free-market competition
- **Evaluate Environmental, Social, and Governance (ESG)** commitments to help engage additional organizations and investors in this effort

## GUIDING PRINCIPLES

### **Approach**

- Systematic | Data Driven | Coordinated

### **Cornerstones**

- Safety
- Fuel Quality: Clean, Dry & On Spec
- Transparency
- Stakeholder Participation
- Diversity of Thought
- Collaboration
- Accountability
- Outreach, Education & Training

### **Key Considerations**

- Mitigations
- Cost/Benefit
  - Public Health Risks
  - Environmental Impact
  - Business Impact
- 2nd and 3rd Order Impacts

### **Pillar Interdependencies**

- Research, Development, and Innovation (Pillar B)
- Unleaded Fuel Evaluation and Authorization (Pillar C)
- Regulation, Policy, and Programmatic Activities (Pillar D)



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## PROGRESS & NEXT STEPS

### **Pillar A Team Member Outreach**

- Teams Formed
  - Refining (10)
  - Logistics (18)
  - Airports (23)
  - Pilots (13)
  - Environmental, Social & Governance (13)

### **Build Out Work Streams**

- Approach
  - Survey stakeholders
  - Education and awareness campaigns
  - Tools
- Output of team work will help inform government policy and regulatory proposals

### **Level setting documents (in progress)**

### **Metrics (TBD)**



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# Supply Chain Infrastructure and Deployment

**Gap Analysis** – Identify technical issues and propose actions to successfully introduce an unleaded fuel into the aviation marketplace.

Identify the following:

- Any additional technical issues and gain further performance understanding of the GAMI 100UL fuel formulation that was STC approved
- Technologies we can have ready to close the performance gap for aircraft engines
- Technical issues and propose solutions to support the EAA diversity of aircraft engines and aircraft types/operations (e.g., experimental engines, vintage and antique aircraft, war birds)
- Any other issues as we work toward a successful introduction and transition



# Research, Development and Innovation

Presented by: Tim Smyth



Supply Chain  
Infrastructure  
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Unleaded Fuel  
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Research,  
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## Mitigate Impacts on Existing Fleet – Based on Properties and Authorization of an Unleaded Fuel

- Address safety and technical challenges associated with high-performance engine use of unleaded fuels such as:
  - Octane detonation protection
  - Materials compatibility
  - Operational procedures
  - Engine monitoring
- Where necessary, potentially enable existing engines and aircraft to safely operate using unleaded replacement fuel



Research,  
Development,  
and Innovation

## Mitigate Impacts on Existing Fleet – Initial R&D Focus

- Aircraft / engine modifications to improve detonation protection (i.e. octane) to allow safe use of UL fuel – such as
  - Retarded / staggered ignition timing
  - Electronic ignition / extended spark duration
  - Higher pressure fuel injection systems
  - Anti-detonation injection (ADI) systems (water/methanol)
  - Manifold air temperature reduction methods
  - Cylinder head temperature reduction methods
- Review and possible update to FAA certification guidance for detonation testing means of compliance

### **R&D effort to determine:**

1. Quantify effective Motor Octane Number (MON) benefits
2. Assess fleet impacts
3. Assess safety aspects



## R&D Pillar Stakeholder Discussion Meeting – December 5, 2022

- Update on status of current UL fuel evaluation and potential issues
- Review current and proposed engine and aircraft R&D technology activities and certification process areas
  - Initial focus on detonation protection (i.e., octane)
- FAA briefing on alternate propulsion technology R&D activities
  - Electric/hybrid electric propulsion
  - Compression ignition/jet fuel propulsion



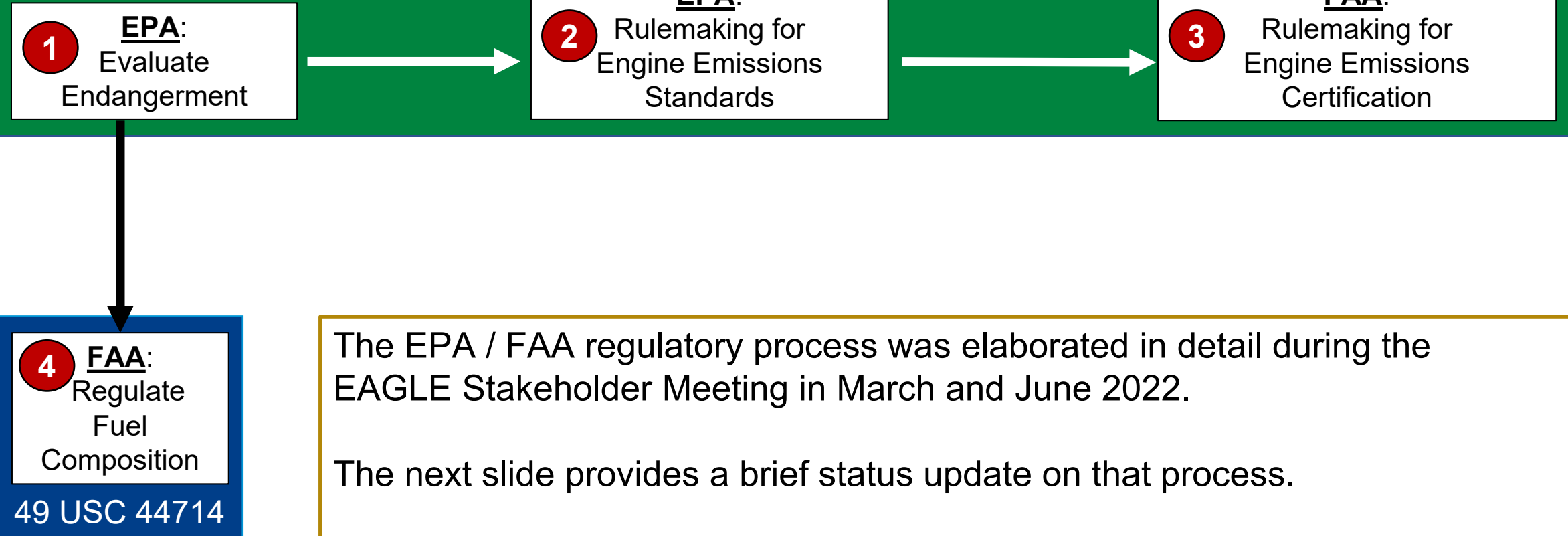
# Regulation, Policy, and Programmatic Activities

Presented by: Ralph Iovinelli

# EPA & FAA Authorities Regarding Aircraft Lead (Pb) Emissions



## Clean Air Act Sections 231 and 232

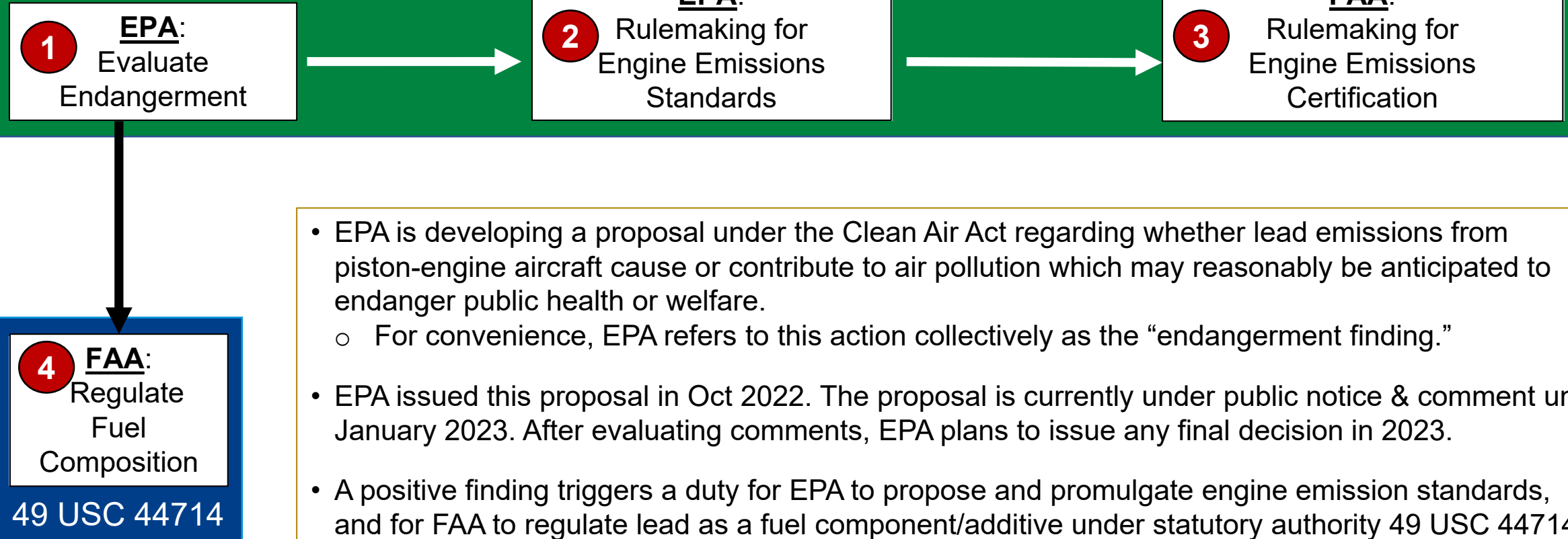




# EPA & FAA Authorities Regarding Aircraft Lead (Pb) Emissions (cont.)



## Clean Air Act Sections 231 and 232



- EPA is developing a proposal under the Clean Air Act regarding whether lead emissions from piston-engine aircraft cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare.
  - For convenience, EPA refers to this action collectively as the “endangerment finding.”
- EPA issued this proposal in Oct 2022. The proposal is currently under public notice & comment until January 2023. After evaluating comments, EPA plans to issue any final decision in 2023.
- A positive finding triggers a duty for EPA to propose and promulgate engine emission standards, and for FAA to regulate lead as a fuel component/additive under statutory authority 49 USC 44714.

Any subsequent regulatory action would involve EPA and FAA working together and carefully considering technology, safety, noise, and economic impacts (**2** & **4**).

# Timeline of EPA Endangerment Finding

- ✓ October 7, 2022 – EPA issued a "*Proposed Finding That Lead Emissions From Aircraft Engines That Operate on Leaded Fuel Cause or Contribute to Air Pollution That May Reasonably Be Anticipated To Endanger Public Health and Welfare*" (referred to as an "[Endangerment Finding](#)") on their website.
- ✓ October 17, 2022 – [Federal Register Notice](#)
- ✓ November 1, 2022 – Public Hearing
- January 17, 2023 – Public Comment Period Closes
- TBD 2023 – EPA releases final Endangerment Finding

[EPA Docket](#)



# Regulation, Policy, and Programmatic Activities

Presented by: William Reinhardt

Additional Context – ACRP Project and Airports



# Airport Guidance through ACRP Research

1. **ACRP – *Airport Guide for Transitioning to Unleaded Aviation Gasoline***
2. **Objective:** What can we learn from airports transitioning to unleaded aviation gasoline and working to reduce lead emissions?
3. **Timeframe:**
  - [The RFP](#) was posted 10/24/22 and will close 12/13/22
  - Contractor selection in January
  - Kick-off Spring 2023
4. **Outcome: Guidance to help airports transition.**  
**Will include the following key components:**
  - A primer (high-level overview of the issue and state of the industry)
  - Guide for airports transitioning
  - Tools and resources

# Airport Activities

## 1. Transition-Enabling Infrastructure

- The FAA is authorized to provide limited grant funding for aircraft fueling systems (fuel farms)
  - Help certain Non-Primary (General Aviation) airports become self-sufficient through fuel sales
  - Increase efficiency at certain commercial service airports and reduce fuel truck emissions
- Need to support multiple fuel types to implement EAGLE and transition to a lead free future

## 2. Immediate Actions (in alignment with NAS recommendations)

- Airport owners / operators and pilots can implement simple mitigation measures
  - Work to offer additional fuel types to facilitate transition
  - Include transition to unleaded fuels in airport planning initiatives and identify in Airport Capital Improvement Plan (ACIP)
  - Increase distance between pre-flight / maintenance run-up locations and people on and off airport
  - Consider wind direction in run-up area choice
  - Minimize engine idle time and run-up time
  - Post “exhaust fume” warning signs
  - Promote airport and pilot awareness

# Thank you!

Email: [info@flyeagle.org](mailto:info@flyeagle.org)

# Details of Schedule Acceleration Efforts



- Outsource portions of engine Durability Testing
  - Teardown inspection, measurements
  - IO-360-C1F Durability Testing  
(Outsource/in-kind - 4,200 test hours)
- Delete O-360-A1A Durability Testing  
(Eliminates 550 engine test hours)
  - Engine is UL91 capable
  - Replace with single § 33.49 150 hour endurance test with UL91 fuel
    - Potentially outsourced / in-kind

## Acceleration Efforts

- ✓ Outsource/in-kind 4200 test hours
- ✓ Eliminates 550 engine test hours

# Details of Schedule Acceleration Efforts (Continued)



- Modify Flight Test Regimen
  - Remove 100LL Comparison testing (decreases flight test by ~ 50%)
  - Eliminate flight testing for UL91 capable aircraft
    - Piper PA-28-181
    - Harvard T-6
  - Replace Cessna 150 with Cessna 182Q to provide carbureted ops test
  - Eliminate testing of Piper PA-31-350 aircraft
- Eliminate Propeller Vibration Testing
  - Testing based on analysis/report of combustion parameters

**Note: Requires concurrence from Hartzell, McCauley, Lycoming, and Continental**

## Acceleration Efforts

- ✓ Decreases flight test by ~ 50%)
- ✓ Eliminates some testing



# Proposed Test Article and Test Facility (Subject to TAC Concurrence)



## • Detonation & Performance

- |                           |              |
|---------------------------|--------------|
| • Continental TSIO-520-VB | WJHTC Cell 2 |
| • Continental IO-550-D    | WJHTC Cell 3 |
| • Lycoming IO-540-K1A5    | WJHTC Cell 3 |
| • Continental O-470-U     | WJHTC Cell 2 |

Includes carburetor icing tests

## • Durability & Performance (150 Hr. § 33.49 + 200 Hr. flight duty cycles)

- |                          |                  |
|--------------------------|------------------|
| • Continental TSIO-550-K | WJHTC Prop Stand |
|--------------------------|------------------|

- |                      |     |
|----------------------|-----|
| • Lycoming O-360-A1A | TBD |
|----------------------|-----|

150 Hr. § 33.49 only, UL91

## • Aircraft Testing (Engine Handling, Engine Ops, Cooling Climb, Hot Fuel)

### Legend

❖ In-kind request

☐ Outsourced

✓ Complete



# Test Plans Overview – Status and Plan Forward

May 2021: Provided to GAMI and Afton Chemical

- PAFI-ETP-009 Rev C *TSIO-550-K PAFI Phase II Durability & Performance Test*
- PAFI-ETP-019 Rev A *TIO-540-AJ1A Engine/Propeller Operability Test*

Phillips 66/Afton Chemical and Lyondell/VP Racing received latest revisions to test plans prior to testing

- PAFI-ETP-005 *TIO-540-J2BD PAFI Phase II Performance and Detonation Tests*

Current intensive effort underway to revise all test plans to remove any proprietary information and/or obtain permission for the use of copyrighted material prior to public release

- Materials: (2) PAFI-MTP-001,-002; (4) PAFI-RTP-002,-004,-005,-006
- Detonation: (6) PAFI-ETP-001,-002,-003,-004,-005,-006
- Durability: (4) PAFI-ETP-007,-008,-009,-010
- Operation: (6) PAFI-ETP-011,-012,-013,-014,-018,-019
- Prop Vibration: (3) PAFI-ETP-015,-016,-017
- Other: (5) PAFI-FHP-001; Fuel Aging Test Plan; PAFI-FSP-001,-002,-003

Aircraft Test Plans in revision to include aspects of engine operations test, remove 100LL testing where not required, and add optional propeller vibration testing