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

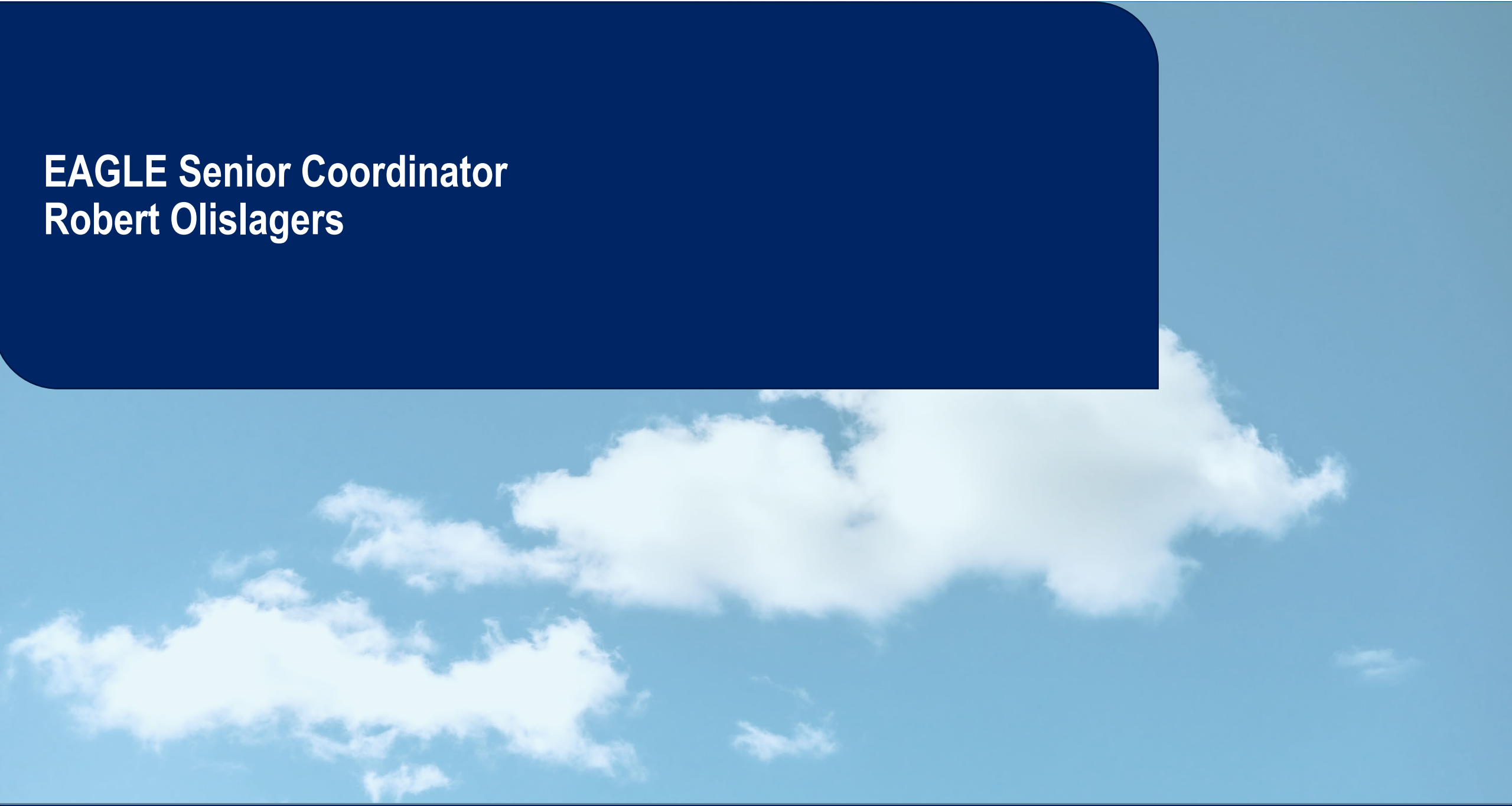
It is appropriate with competitors in the room to provide a set of antitrust guidelines. It is in everyone's interest to comply with the antitrust laws. Participants in today's meeting should observe the following guidance:

- 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

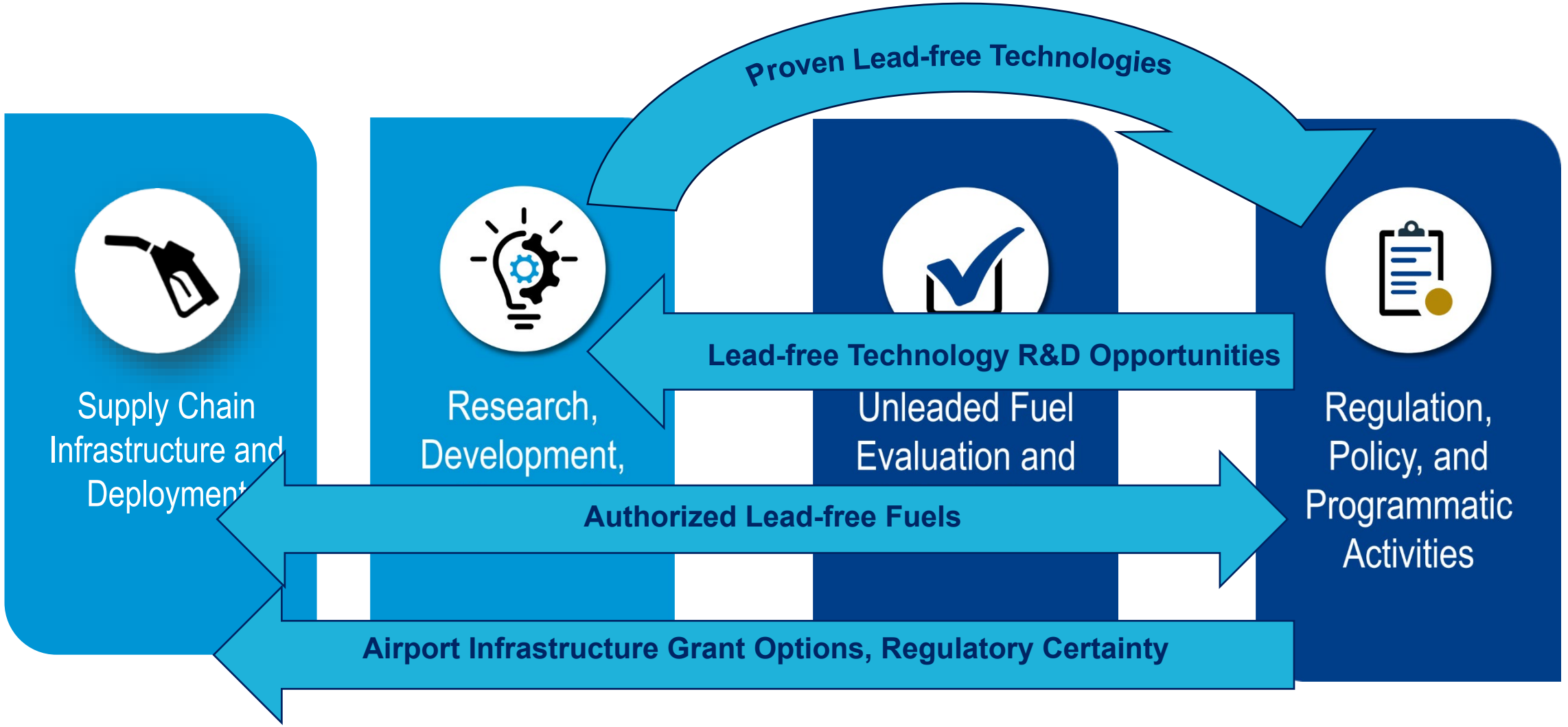
EAGLE Senior Coordinator
Robert Olislagers



EAGLE Goal

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)

Afton CHEMICAL

lyondellbasell

PHILLIPS 66

VP Racing FUELS

Fleet Approvals

TC, ATC or STC

Existing, normal certification processes

Supplemental Type Certificate

STC (Applicant proprietary)

Swift FUELS

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 Unleaded Fuel Testing Protocols

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

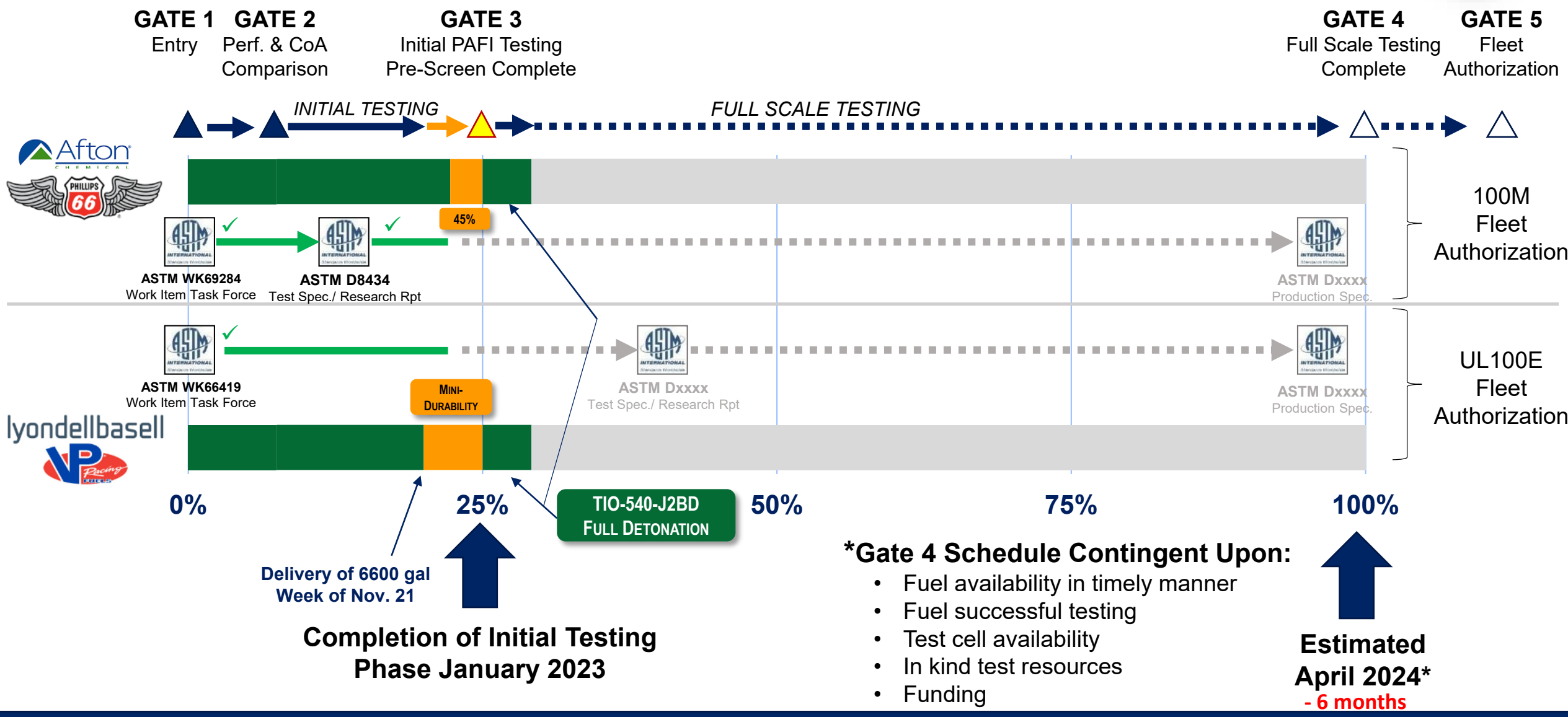
Performance & Detonation
Testing of multiple engine models at simulated altitude, hot day conditions

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 Public Release of Test Plans

- Once approved for release by the TAC, the following 60 PAFI Test Plans will be released to the public via the EAGLE and PAFI websites:

- PAFI Test & Evaluation Program for Fleet Authorization of Unleaded Avgas

6	Materials Compatibility	6	Performance and Detonation
4	Durability and Performance	6	Engine / Propeller Operability
3	Engine Propeller Vibration	11	Aircraft Engine Handling Ground / Flight
11	Aircraft Engine Cooling Climb	11	Aircraft Fuel System Hot Weather Flight
2	Referenced Fuels Handling Plans		

- An Index of PAFI Test Plans with Revision Level and actual/planned Public Release Dates has been posted to the website – www.faa.gov/about/initiatives/avgas/pafi-test-plan-index
- 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
  - Full Technical Advisory Committee (TAC) meeting planned for December 2022
  - Public release is contingent upon industry concurrence by the TAC for release
- Test Data and Test Reports contain proprietary information and cannot be released at this time

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.

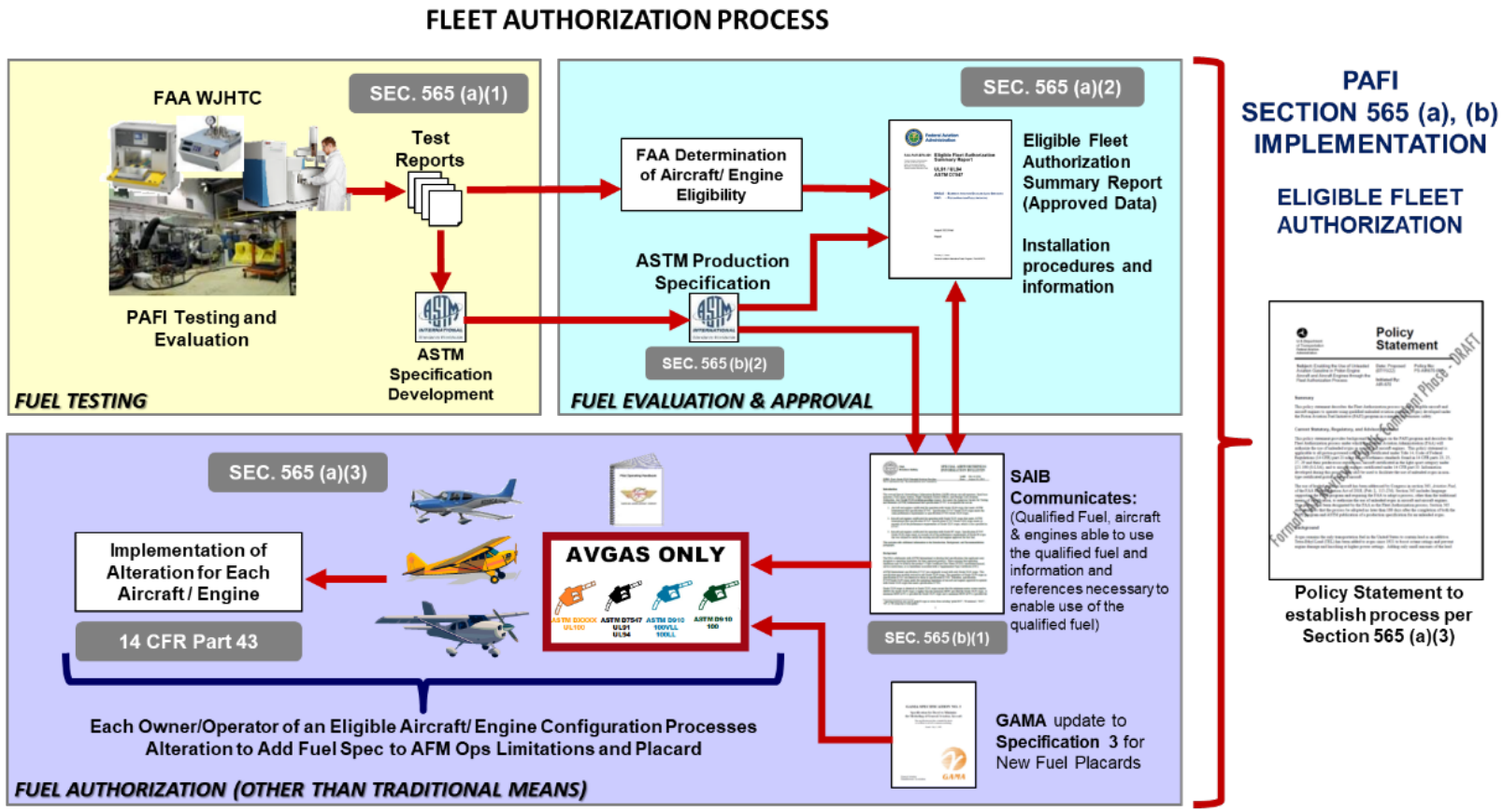
Unleaded Fuel Evaluation & Authorization Pillar Accomplishments (Cont.)

Fleet Authorization Process

- PS-AIR-20-2000 Policy Statement

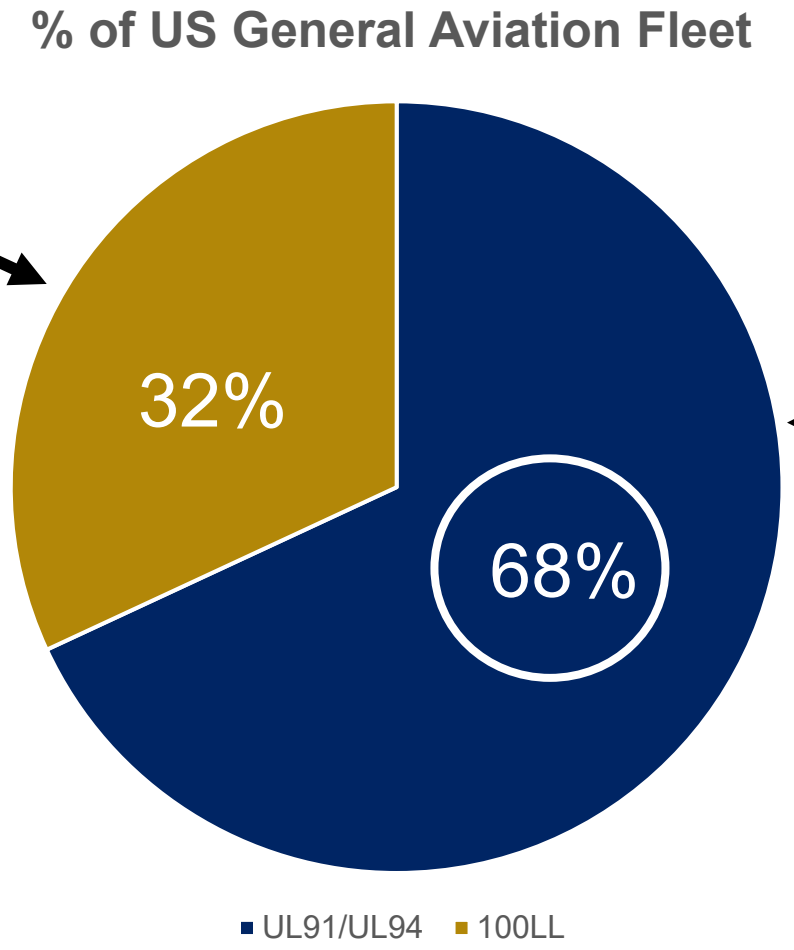
  - NOTICE published in Federal Register for public comment 10/5/2022
  - 60-day public comment period ends 12/5/2022
  - Upon comment disposition, Final Notice to be published in Federal Register (est. 1/31/2023)

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



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

PAFI Target → 100LL Fleet
High Octane Unleaded
32% of Fleet
2022 thru 2025



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)

Supply Chain Infrastructure & Deployment (cont)

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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)

Supply Chain Infrastructure & Deployment (continued)

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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

EAGLE Pillars

Supply Chain Infrastructure and Deployment

Research, Development, and Innovation

Unleaded Fuel Evaluation and Authorization

Regulation, Policy, and Programmatic Activities

Objective: Facilitate Transition to Unleaded Replacement Fuel

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

Facilitate Transition to Unleaded Replacement Fuel (Continued)

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

Next Steps

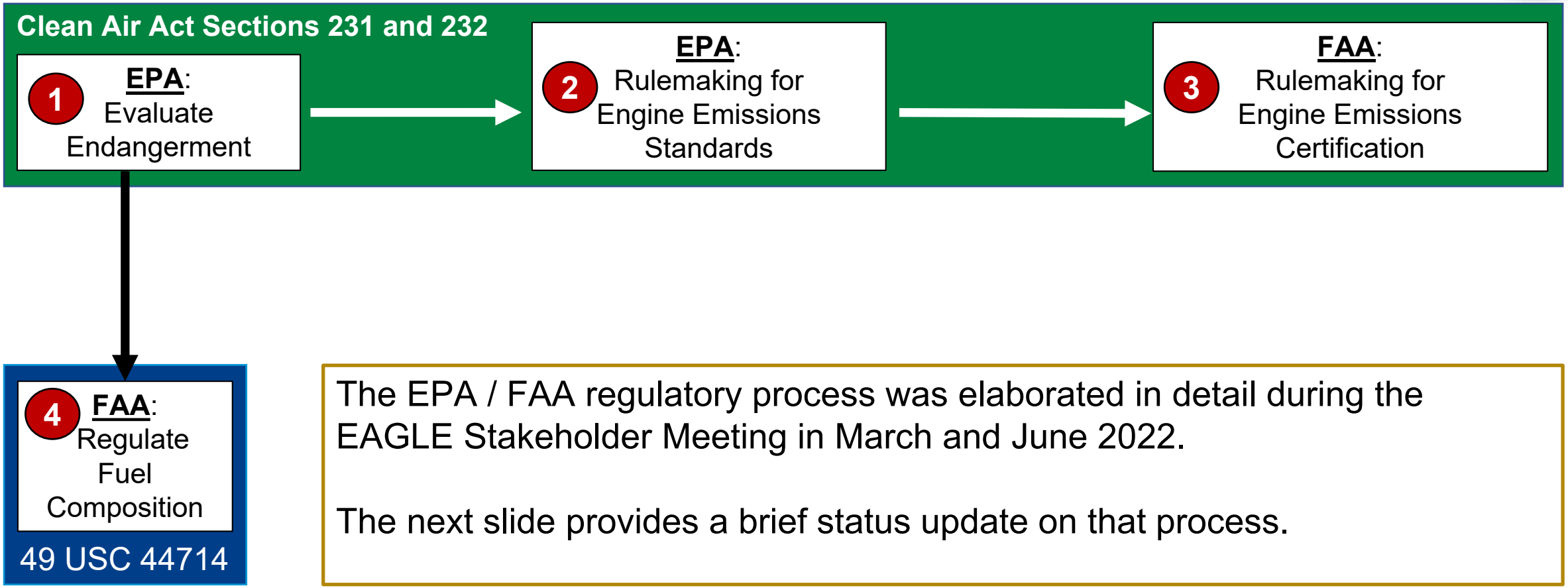
R&D Pillar Stakeholder Discussion Meeting – December 5, 2022

- 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

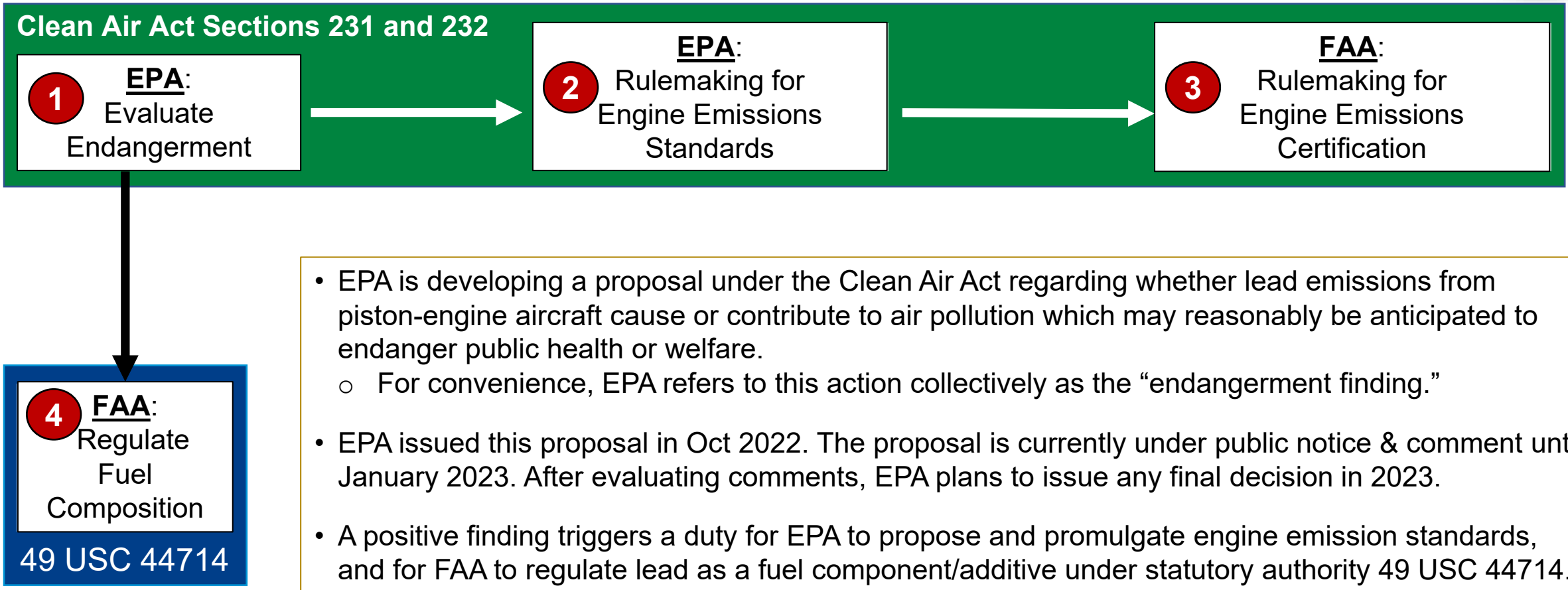
EPA & FAA Authorities Regarding Aircraft Lead (Pb) Emissions



The EPA / FAA regulatory process was elaborated in detail during the EAGLE Stakeholder Meeting in March and June 2022.

The next slide provides a brief status update on that process.

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



- 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

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