

# Integration and Coordination of the National Jet Fuels Combustion Program

## University of Dayton

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Cost Share Partner: DLR Germany, University of Dayton, NRC Canada

## Research Approach:

Evaluate the **operability impacts of alternative aviation fuels** across NJFCP institutions and allied partners

Test fuels were designed to stress several **key property effects in engines**

**Diverse rigs** evaluate test fuels at **varying conditions** and compare results to **OEM experience**

Model chemical kinetics and operability limits of fuels

## Objective:

**Streamline the evaluation and qualification process** of novel Sustainable Aviation Fuel candidates

## Project Benefits:

Development of **focused tests** to minimize operability impacts of SAFs *with prescreening*  
Proposed testing to reduce and eventual elimination Tier 3 and 4 operability tests *with Referee Rig*

## Major Accomplishments (to date):

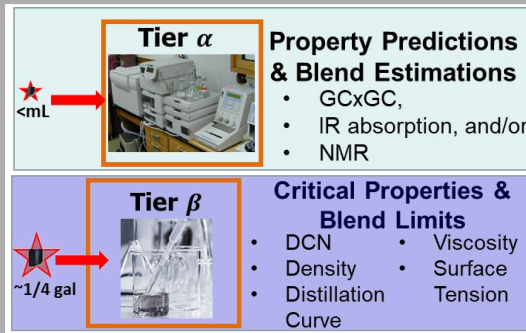
Evaluation of ~12 fuels across dozens of experimental devices  
Analysis suggests bounding of **~8 properties** can account for **~90% of all observed variance**  
Referee Rig operability limits at relevant conditions match all known OEM hardware trends  
CFD matches operability trends for several fuels conditions  
Process for custom chemical kinetics developed

## Future Work / Schedule:

June 2021 - Completion of the AIAA book  
TBD – Additional testing of CPK-0

# NJFCP Outcomes and Learnings

## Prescreening

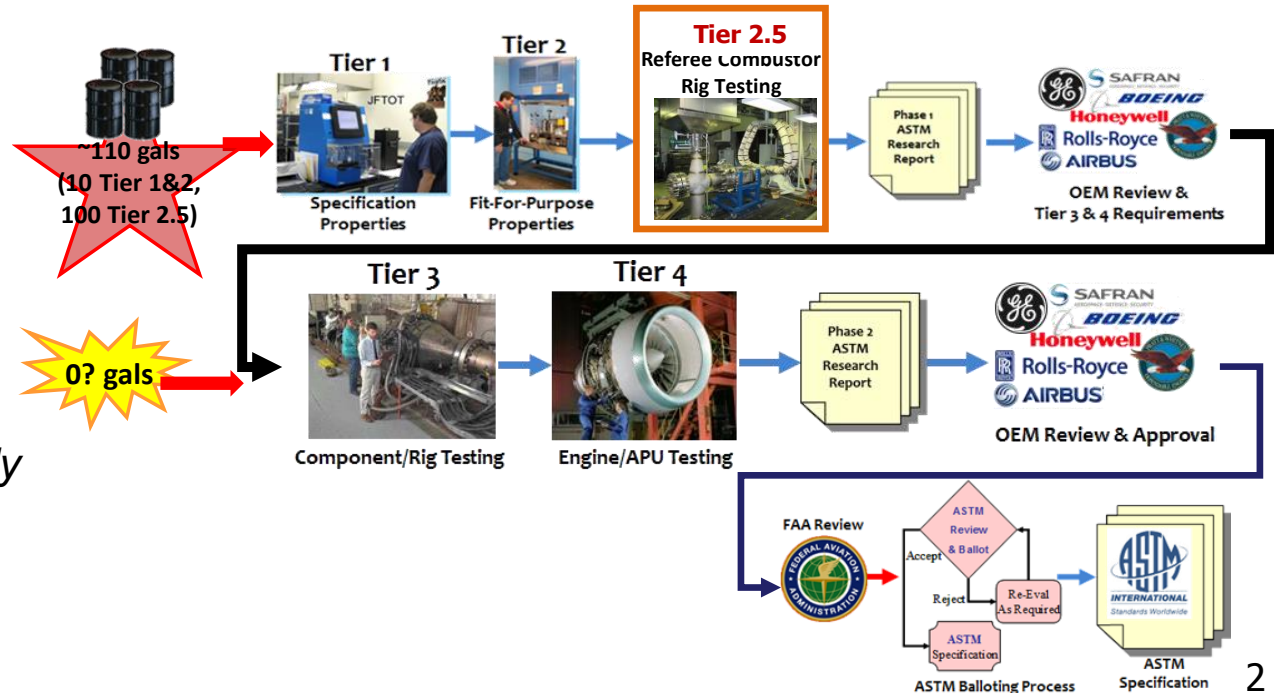


Guide compositions to meet properties most likely to eclipse Tier 3 and 4 operability tests with minimal volume requirements

Volumes needed for various testing Tiers

Tier	$\theta$ (gal)	Notes
$\alpha$	$\sim 10^{-6}$	P65a prescreening
$\beta$	$\sim 10^{-1}$	
$\gamma$	$\sim 10$	P65b prescreening
1 & 2	$\sim 10^2$	Referee Rig
2.5	$\sim 10^2$	
3 & 4	$\sim 10^3$	

## Proposed ASTM D4054



- Elimination and/or minimization of operability tests (Tier 3 and 4)
- Data from a GE CLEEN program (05/2020) strongly validates the Referee Rig trends of fuel impacts

# Impact and follow-on activities



1. P025 – Tier  $\alpha$  prescreening methods with mid-IR
2. P065a – Tier  $\alpha$  and  $\beta$  prescreening methods with multidimensional gas chromatography, ultraviolet light, and low volume property tests
3. P065b – Tier  $\gamma$  for low volume operability tests
4. P066 – Evaluation of alternative fuels for reducing fuel burn
5. P067 – Impact of Fuel Heating on Combustion and Emissions
6. P073 – Combustor Durability Evaluation with Use of Alternative Jet Fuels

- **All** chapters/sections completed and submitted to AIAA in early December!
  - 13 Chapters
  - 3 Appendices
- Current major tasks:
  1. Currently iterating on a book cover
  - 2. AIAA delivered first proofs! (15 April)**
    - **17 May proofs with addressed queries are due to AIAA**

# AIAA book table of contents



Chapter	Title		
1	Introduction		
2	Historical perspective on fuel effects		
3	Fuel selection		
4	Description of referee rig	<b>Other contributions</b>	
5	Lean blowout		Preface
6	Ignition		Executive Summary
7	Emissions	Appendix 1	Statistical analysis of fuel properties
8	Kinetics		
9	Sprays	Appendix 2	Property data for category A and category C fuels
10	Computational fluid dynamics		
11	Impact on approval of new fuels		
12	Prescreening of novel sustainable aviation fuels		
13	Conclusions		