Synthetic Aviation Turbine Fuel (SATF) ASTM Qualification Update

Presented to: CAAFI® Biennial General Meeting

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Date: June 2, 2022
Agenda

- How are SATFs Approved?
- ASTM D4054 Evaluation Process
- FAA D4054 Clearinghouse & Activity
- D4054 Fast Track
- SATF Pre-Screening
- Synthetic Blend Component (SBC) Blend Limits
How are SATFs Approved?

1. **Jet A and Jet A-1 Fuel**
   - FAA Approved Operating Limitations Based on ASTM Fuel Specifications

2. **SAJF Evaluation Process**
   - D4054
   - If New SAF Meets Conventional Jet Fuel Spec & Properties

3. **D7566 Drop-in Jet Fuel Spec**
   - Then New SAF Annex Added to Drop-in Fuel Spec

4. **D1655 = D7566**
   - Conventional Jet Fuel Spec = Drop-In Jet Fuel Spec

- **Blend SBC with Jet Fuel to Make Drop-in SATF**
- **Tested Before Blending with Conventional Jet Fuel**
- **Synthetic Blend Components (SBC)**

**ASTM Specification = Approval to Fly**

- **New SATF Meets Existing Operating Limitations, Therefore Approved to Use on Virtually All Existing Aircraft**
Synthesized Aviation Turbine Fuel Progress

May 24, 2006
CAAFI Established

June 2009
FT-SPK Annex A1

June 2009
ASTM D7566 Issued

FT-SPK Annex A1

July 2011
HEFA-SPK Annex A2

November 2015
FT-SPK/A Annex A4

A1

A2

A4

A6

Commercial Aviation Alternative Fuel Initiative (see www.caafi.org)

A3

A5

A7

Drop-in Fuel Specification

Alternative Jet Fuel Annex

December 2009
ASTM D4054 Issued

December 2009
HEFA-SPK Annex A2

June 2014
SIP Annex A3

April 2016
ATJ-SPK Annex A5
Isobutanol Feedstock Only

A1

A2

A4

A6

Alternative Jet Fuel Evaluation Process

June 2018
Ethanol Feedstock Added

May 2020
HC-HEFA Annex A7

A5

A3

A7

Ethanol Feedstock Added

CHJ Annex A6

Alternative
Jet Fuel
Specification

Commercial Aviation
Alternative Fuel Initiative (see www.caafi.org)
Let’s Look at the ASTM D4054 Evaluation Step

1. FAA Approved Operating Limitations Based on ASTM Fuel Specifications

2. D4054 SAJF Evaluation Process
   If New SAJF Meets Conventional Jet Fuel Spec & Properties

3. D7566 Drop-In Jet Fuel Spec
   Then New SAJF Annex Added to Drop-In Fuel Spec

4. D1655 = D7566
   Conventional Jet Fuel Spec = Drop-In Jet Fuel Spec

5. [Image of airplane and fuel specifications]
D4054 Process Determines “Backwards Compatibility” of SAF
FAA D4054 Clearinghouse

Structured as a Cost Share Arrangement

Coordinates, Manages, and Conducts D4054 Evaluation Process

FAA Funds Under ASCENT Center of Excellence

University of Dayton Research Institute (UDRI)

Candidate SATF In

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Final Research Report Out

Phase 2 ASTM Research Report

Specifications

Phase 1
ASTM Research Report

Tier 1

Tier 2

Tier 3

Tier 4

Component/Reg Testing

Engine/Engineered Testing

Specifications

Tier 1

 Tier 2

 Tier 3

 Tier 4

Phase 1
ASTM Research Report

Final
ASTM Research Report

ASTM specifications

ASTM Balloting

ASTM Review & Ballot

ASTM Specification

As-Is

As-Is Required

Accept

Reject

ASTM Balloting Process

ASTM Review & Ballot

Specifications
D4054 Activity Status

Exploratory Discussions

- Forge?
- Vertimass?
- Prometheus?
- REVO?
- Green Lizard

Tier 1
- Specification Properties
  - Indian CSIR-IIP
  - HFP-HEFA (Green Diesel) (On Hold)
  - ATJ-SKA (Swed Biofuels)
  - Global BioEnergies

Tier 2
- Fit-For-Purpose Properties
  - Global BioEnergies

D1655 Co-processing Activity

- Lipids Co-processing (D1655)
- FT Co-processing (D1655)

ASTM Task Forces

- Inc Lipids co-processing feedstock blend from 5% to 30%
- Co-process pyrolysis oil from used tires
- Co-process hydroprocessed biomass

Tier 3
- Component/Rig Testing
- Tier 4
- Engine/APU Testing

- Shell H2
- Virent SAK
- IHI HC-HEFA
- Global BioEnergies

OMV Re-Oil?
- Forge?
- Vertimass?
- Alder Energy?
- REVO?
D4054 Fast Track Annex

Jet A Property and Compositional Range

D4054 Property and Compositional Objectives

Fast Track Target Values

Lite Testing Program For SATFs with Nominal Jet Fuel Properties and Compositions

Limited to a 10% Blend Percentage
SATF Pre-Screening

**Pre-Screening Phase**

**Tier α**
- Property/Performance Predictions
  - GCxGC,
  - IR absorption, and/or
  - NMR

**Critical Properties**
- DCN
- Density
- Distillation Curve
- Viscosity
- Surface Tension

**ml's of test fuel**
- Optimize/Refine Conversion Process/Composition

**Tier β**

**ASTM D4054 Evaluation Phase**

- 100's to 1000's of gallons of test fuel
Let’s Take a Closer Look at Synthetic Blend Component (SBC) Blend Limits

1. FAA Approved Operating Limitations Based on ASTM Fuel Specifications
2. D4054 SAJF Evaluation Process
   - If New SAJF Meets Conventional Jet Fuel Spec & Properties
3. D7566 Drop-In Jet Fuel Spec
   - Then New SAJF Annex Added to Drop-In Fuel Spec
4. D1655 = D7566
   - Convention Fuel Spec
   - Drop-In Jet Fuel Spec
SBC Composition Compared to Jet A Fuel

Compositional Subset

Annex A1 FT-SPK

Annex A2 HEFA-SPK

Annex A3 SIP

Annex A4 FT-SPK/A

Annex A5 ATJ-SPK

Annex A6 CHJ

Annex A7 HC-HEFA

Jet A Fuel

Isoparaffins

Cycloparaffins

Aromatics

Naphthalenes

Normal Paraffins

Fully Formulated

Compositional Subset
Max Allowable Blend % in Conventional Jet Fuel

- 50% Compositional Subset
- 50% Annex A1 FT-SPK
- 10% Compositional Subset
- 50% Annex A2 HEFA-SPK
- 10% Annex A3 SIP
- 50% Fully Formulated
- 50% Annex A4 FT-SPK/A
- 10% Compositional Subset
- 50% Annex A7 HC-HEFA
- 50% Fully Formulated
- 50% Annex A6 CHJ
- 50% Annex A5 ATJ-SPK
- 50% Compositional Subset

Jet A Fuel

- Naphthalenes
- Aromatics
- Isoparaffins
- Cycloparaffins
- Normal Paraffins
What Determines the Maximum Blend Percentage?

- **To Meet Jet Fuel Property Requirements**
  - 50% Compositional Subset
  - Annex A1 HEFA-SPK
  - Annex A2 HEFA-SPK
  - Annex A3 SIP
  - Annex A4 FT-SPK/A

- **Conservatism, Until Service Experience Gained**
  - 50% Fully Formulated

- **Approved Under Streamlined “Fast Track” Process**
  - 10% Compositional Subset
  - Annex A7 HC-HEFA
  - Annex A6 CHJ
  - Annex A5 ATJ-SPK

- **To Meet Jet Fuel Property Requirements**
  - 50% Compositional Subset
  - Annex A1 HEFA-SPK
  - Annex A2 HEFA-SPK
  - Annex A3 SIP
  - Annex A4 FT-SPK/A

- **Conservatism, Until Service Experience Gained**
  - 50% Fully Formulated

- **To Meet Jet Fuel Property Requirements**
  - 50% Compositional Subset
  - Annex A1 HEFA-SPK
  - Annex A2 HEFA-SPK
  - Annex A3 SIP
  - Annex A4 FT-SPK/A

- **Conservatism, Until Service Experience Gained**
  - 50% Fully Formulated

- **To Meet Jet Fuel Property Requirements**
  - 50% Compositional Subset
  - Annex A1 HEFA-SPK
  - Annex A2 HEFA-SPK
  - Annex A3 SIP
  - Annex A4 FT-SPK/A

- **Conservatism, Until Service Experience Gained**
  - 50% Fully Formulated

- **To Meet Jet Fuel Property Requirements**
  - 50% Compositional Subset
  - Annex A1 HEFA-SPK
  - Annex A2 HEFA-SPK
  - Annex A3 SIP
  - Annex A4 FT-SPK/A
Thank You

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Questions?