100% SAF
- initial reflections

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CAAFI R&D Team

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Why 100% SAF?

Many in the aviation industry, from manufacturers to airlines, have announced "zero-emission" goals and plans. A reduced carbon (down to zero and even to negative) fuel is central to the discussion.

Current major needs regarding SAF:

- ramp-up SAF production (availability)
- establish SAF price parity with conventional jet (cost)
- level playing field with ground transportation for aviation (regulatory framework)

100% SAF is not an immediate need, however, this is the time to start the process to get ready for it

- technological & operational readiness
- standardization

Today, we will introduce the topic and raise relevant questions…a follow-on R&D team session is being considered to further the discussion in more detail.

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What is SAF & SAF blend?

What many think:

~~Synthetic Jet Fuel~~ + Conventional Blend Component = SAF Blend

(SAF) (Jet A/A-1) (Jet A/A-1)

What really is the case:

Synthetic Blend Component* + Conventional Blend Component = SAF Blend

(SAF*) (Jet A/A-1) (Jet A/A-1)

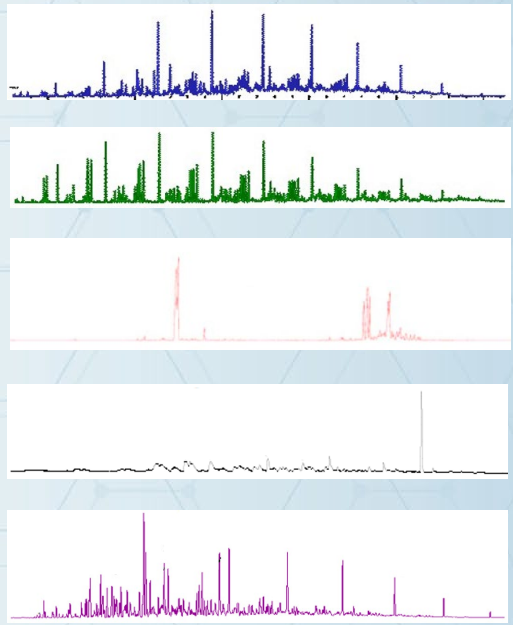
Multiple ways to produce the synthetic blend component today;
some like-jet, some similar to jet, some nothing like jet…

* Not all synthetic blend components are sustainable. For the purposes of this presentation the term SAF will be used.

QUIZ

Which one is conventional jet fuel? (carbon distribution)

Which ones are SAF?



1st one is petro-jet fuel, all others are SAF!!!

Synthetic blend component, by itself, is not necessarily a finished aviation fuel that could be used in aircraft

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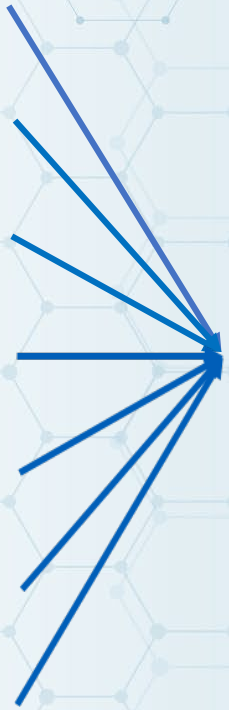
SAF blends are all the same product…

FT-SPK synth. blend comp't (sbc)	+ Jet A/A-1 conv. blend comp't (cbc)
HEFA-SPK sbc	+ cbc
HFS-SIP sbc	+ cbc
FT-SKA sbc	+ cbc
ATJ-SPK sbc	+ cbc
CHJ sbc	+ cbc
HC-HEFA-SPK sbc	+ cbc



Partially synthetic Jet A/A-1 (drop-in, fleet-wide compatible)

When blended they all result in the one and the same product: Jet A/A-1

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Unblended SAF (neat, 100%)…is it  ?

100%

FT-SPK sbc → 

HEFA-SPK sbc → 

HFS-SIP sbc → 

FT-SKA sbc → 

ATJ-SPK sbc →   (depends on the producer)

CHJ sbc → 

HC-HEFA-SPK sbc → 

 Identical to Jet A/A-1 (fleetwide compatible, drop-in)

 Like Jet A/A-1 (limited fleet compatible, non-drop-in)

 Not-like Jet A/A-1 (not acceptable as a stand-alone jet fuel)

		
aromatics	~17%	~0%
energy cont.	~43.2MJ/kg	+ 0-3%
density	~800kg/m^3	- 0-8%
Cetane #	~45	± 20-30%
Sulfur	~500-800ppm	~0ppm

Variation of composition among pathways and even among producers for a pathway
When unblended they do not all result in one and the same product
A specification is needed to define 100% SAF (in progress; early stages)

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Pathways in the pipeline (no pun intended!)

100%

ATJ-SKA sbc → 

HEFA-SKA sbc → 

HDO-SAK sbc → 

CPK-0 sbc →  or  (TBD)

HTL sbc → 

SAK sbc + SPK sbc → 

 Identical to Jet A/A-1 (fleetwide compatible, drop-in)

 Like Jet A/A-1 (limited fleet compatible, non-drop-in)

 Not-like Jet A/A-1 (not acceptable as a stand-alone jet fuel)

Blending of *approved* blend components will open a door to get to drop-in 100% SAF by blending non-drop-in blend components

More pathways on the way…initially most, if not all, will be approved at 50% but could meet 100% drop-in SAF requirements when defined
Blending of *approved* blending components is an important path

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Drop-in vs non-drop-in SAF

		
Description:	Fully formulated Jet A/A-1 composition	Compositional subset of Jet A/A-1 composition
Applicability:	Fleet Wide drop-in	Targeted or Limited for designated aircraft/engines only, not fleet-wide compatible
Example pathways:	CHJ (D7566 Annex A6), FT-SKA (D7566 Annex 4), future: ATJ-SKA, HEFA-SKA, blending of blend components	FT-SPK (D7566 Annex A1), HEFA-SPK (D7566 Annex A2), certain type ATJ-SPK (D7566 Annex A5)
Specification:	ASTM D7566	New standard needed
FAA Certification:	Not required	Required for each intended aircraft/engine model
Supply chain/handling/storage:	Separate supply chain/handling/storage not required	Separate supply chain/handling/storage required

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Examples of OEM experience with 100% SAF

Swedish MoD Gripen flight with GKN RM12 engine (GE F404 derivative) – 100% CHJ.

Boeing 777 EcoDemonstrator flight with GE90 engines. On-wing engine tests – 100% HEFA-SPK.

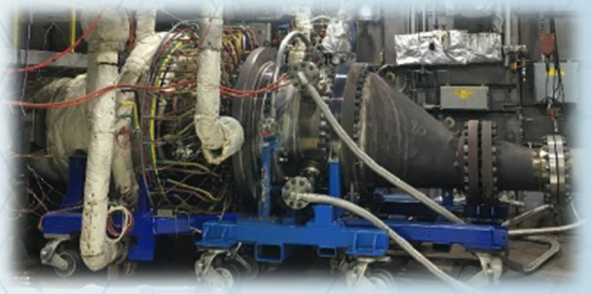
Multiple engine tests with Rolls-Royce Trent & Pearl engines – 100% HEFA-SPK.

NRC Canada Falcon 20 flights with GE CF700 engines – 100% HEFA-SPK/HDO-SAK blend & CHJ.

Multiple ground/on-wing GE F414 engine tests – 100% CHJ.

Bell Ranger helicopters frequent flights with Pratt & Whitney engines in 80s – 100% FT-SPK.

Boeing EA-18G Growler flight (Secretary of NAVY) with GE F414 engines – 100% CHJ.



Many combustor rig tests by OEMs – 100% HEFA-SPK, ATJ-SPK, ATJ-SKA, blends of blend components, others…

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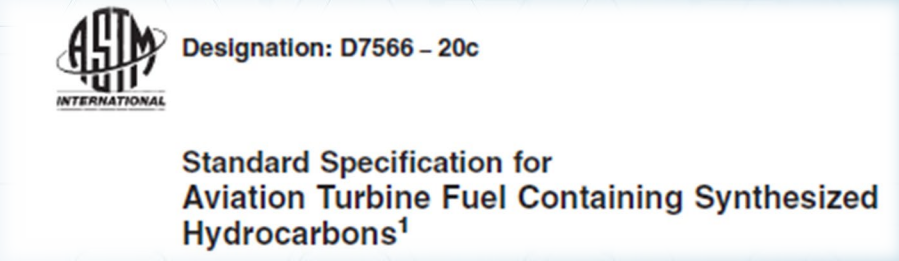
Additional flights/tests among OEMs/airlines in work – 100% drop-in & non-drop-in SAF

ASTM Standardization

Specify 100% SAF* via a standard

ASTM Task Force formed in Q1 '21:

- Main effort: Modify ASTM D7566 drop-in standard to allow 100% SAF
  - Establish a new set of requirements for 100% SAF (e.g., new Table)
  - 1st step: approval of CHJ at 100%
  - Next: other pathways & blending of blend components (only already approved blend components allowed)
  - Effort is approval of 100% SAF as Jet A/A-1
- Possible secondary (later) effort: Establish another standard ASTM Dxxxx for 100% non-drop-in SAF
  - Effort is for establishing a standard defining a particular synthetic fuel
  - Not approval of 100% non-drop-in SAF, but development for it a standard that could be used by the OEMs to certify their equipment with if they so desire
- Multi-year effort (2-5 years for both)


Designation: D7566 – 20c

Standard Specification for
Aviation Turbine Fuel Containing Synthesized Hydrocarbons[1]

* Standard is for synthetic fuels, sustainable or not. For the purposes of this presentation the term SAF is used synonymously with synthetic fuel.

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100% SAF White Paper and Webinar

Intent: Frame stakeholder discussions on key issues concerning 100% SAF

Questions/ Issues to Discuss:

- Why 100% SAF – reasons for pursuing (GHG, LCA, nvPM)
- Approaches to achieve 100% SAF (single fuels, blends)
- Approach to Drop-In/Fungibility (100% drop-in, relax certain properties)
- Desired production, sustainability, environmental characteristics
- Critical safety, operability, performance characteristics
- Potential changes to certification and qualification
- Milestones, next steps, timelines
- Possible unknown unknowns

Webinar: More details on questions, solicit feedback

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Thank You!

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