ICAO ENVIRONMENT

ACT-SAF #3 SERIES

SAF production technologies and certification

Produced and presented by ICAO with support of the following partners:
Airbus
US FAA – Federal Aviation Administration of the United States
Safran

Agenda

1. Opening
2. Introduction of partners
3. Aviation Fuels Terms & Acronyms
4. What is Aviation Turbine Fuel (ATF)?
5. How is Aviation Turbine Fuel Produced & Controlled?
6. Overview of the Aviation Industry Process for Assessing, Controlling & Approving new Feedstocks & Processes for ATF Production
7. Synthetic Aviation Turbine Fuels (SATF) Approval
8. 100% SATF Specification
9. Co-Processing Pathways
10. New SATF Producer Guidance
11. The current challenges of SATF certification
12. Future evolutions of SATF certification processes
13. Open discussion
14. Closing remarks

1. Opening

Jane Hupe, Deputy Director, Environment

Objective

Provide participants with an understanding of the specifications of Aviation Turbine Fuels, and on the process to approve new pathways for its production and use on aircraft.

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ACT-SAF series #3 Partners

AIRBUS

Mr. Ross Walker

FEDERAL AVIATION ADMINISTRATION

Mr. Mark Rumizen

SAFRAN

Mr. Nicolas Jeuland

ACT-SAF updates

ACT-SAF platform provides the most recent information:

- List of Partners constantly updated
- ACT-SAF series material available online

ACT-SAF Series

Coordination with ACT-SAF partners identified that many States need conceptual training on SAF.

To address that, ICAO is developing the **ACT-SAF Series of training sessions**, to be held on a monthly basis. This will allow delivering comprehensive training to ACT-SAF Partners on an array of important SAF-related topics, ranging from sustainability, to policy, economics/financing certification and logistics.

The ACT-SAF Series will empower the ACT-SAF Partners with training material designed with the support of Supporting States and Organisations from the air transport, fuels and finance sectors, as well as academics and actors with niche expertise such as SAF reporting under CORSIA.

Want to participate on the ACT-SAF Series? Join ACT-SAF now (click here to access the ACT-SAF Terms and Conditions). Participation is open to all States and Organizations interested in further action on SAF.

ACT-SAF Series	Date	Topics	Contributor(s)	Abstract	Video and Presentation
#1	25 November 2022	An introduction to SAF	ICAO	• Introduction to ACT-SAF • Basics of SAF	 Download Presentation
#2	25 January 2023	SAF sustainability and reporting under CORSIA	ISCC RSB Verifavia		 Download Presentation

ICAO ACT-SAF Platform

Here you will find more information on our ACT-SAF Participants*

Latest news on ACT-SAF

Date	Latest news	Link
11/17/2022	ICAO launches the ACT-SAF Series of training events on SAF	
10/20/2022	Argentina signs the ACT-SAF Terms and Conditions	
10/7/2022	Equatorial Guinea signs the ACT-SAF Terms and Conditions	
10/4/2022	Brazil signs the ACT-SAF Terms and Conditions	
10/4/2022	Singapore signs the ACT-SAF Terms and Conditions	

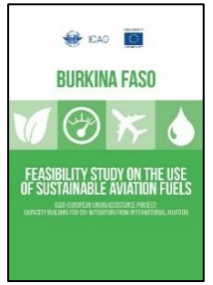
https://www.icao.int/environmental-protection/Pages/act-saf.aspx

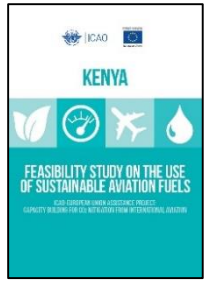
ACT-SAF updates

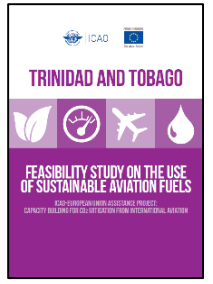
Projects: SAF Production Feasibility Studies:

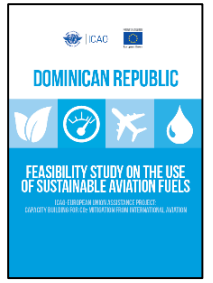
- Many feasibility studies will be developed in ACT-SAF
  - Three new feasibility studies under existing ICAO-EU project (Zimbabwe, Côte d'Ivoire and Cabo Verde)
  - Financial resources provided by Cote D'Ivoire, France, Netherlands and the European Commission will allow several additional feasibility studies
  - ICAO and World Bank project being structured
  - Studies also being pursued by ACT-SAF partners

- ICAO is currently developing a template for SAF Feasibility Studies
  - Allow comparability between results
  - Harmonized structure
  - Facilitate outreach of results









ACT-SAF updates

Projects: Support to policy implementation:

- Many policies are available to support SAF development

Potential Policy Categories*	
Government funding for SAF research, development, demonstration and deployment (RDD&D)	SAF mandates
Targeted incentives and tax relief	Update of existing policies to incorporate SAF
Recognition of SAF environmental benefits	Demonstrate government leadership

ACT-SAF can support States to	
Identify tailored policy solutions	Implement a policy framework

* Reference: ICAO *Guidance on Potential Policies and Coordinated Approaches for the deployment of Sustainable Aviation Fuel (2022),* developed by CAEP

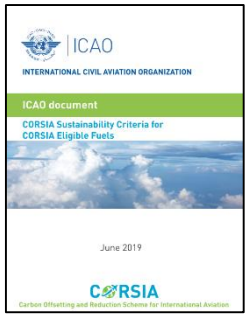
https://www.icao.int/environmental-protection/Pages/saf_guidance_potential_policies.aspx

Projects: Support to certification

All elements of a SAF Supply chain needs to be certified:

- Feedstock production (Farms / Plantations / Waste-producing facilities)
- First Gathering point; collecting point
- SAF production plant
- SAF blend point

Once the potentials are identified, ACT-SAF can support States on the SAF certification processes



Sustainability Certification
ICAO CORSIA Standards

Technical Certification
ASTM Standards

ACT-SAF updates

Key request - conceptual training on SAF

ACT-SAF Series (preliminary list of sessions)
✓ **#1 Introduction to SAF**
✓ **#2 SAF sustainability and reporting under CORSIA**
#3 SAF production technology and certification
#4 SAF market outlook and policies (23rd March)
#5 SAF logistics (April)
#6 SAF economics and financing (May)
#7 Feasibility Assessment (June)

Today's Session

- Future sessions on specific aspects
- Subject to review – **feedback welcome**

https://www.icao.int/environmental-protection/Pages/ACT-SAF-Series.aspx

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3. Aviation Fuels Terms and Acronyms

Aviation Fuels Terms and Acronyms

ATF = **Aviation Turbine Fuel** also known as JET Fuel

SATF = **Synthetic Aviation Turbine Fuel in the context of ATF specifications** *(e.g. ASTM D1655, DEF STAN 91-091)*

- SATF can be either semi-synthetic (e.g. 50%) or fully-synthetic (i.e. 100%)

SBC = **Synthetic (Kerosene) Blend Component used in fuel specification documentation** *(e.g. ASTM D7566, DEF STAN 91-091)*

SAF = **Sustainable Aviation Fuel** is defined as a *"renewable or waste-derived aviation fuel that meets the CORSIA Sustainability Criteria"* *(Ref ICAO SARPs Annex 16 Volume IV)*

SAF = SATF + Sustainability

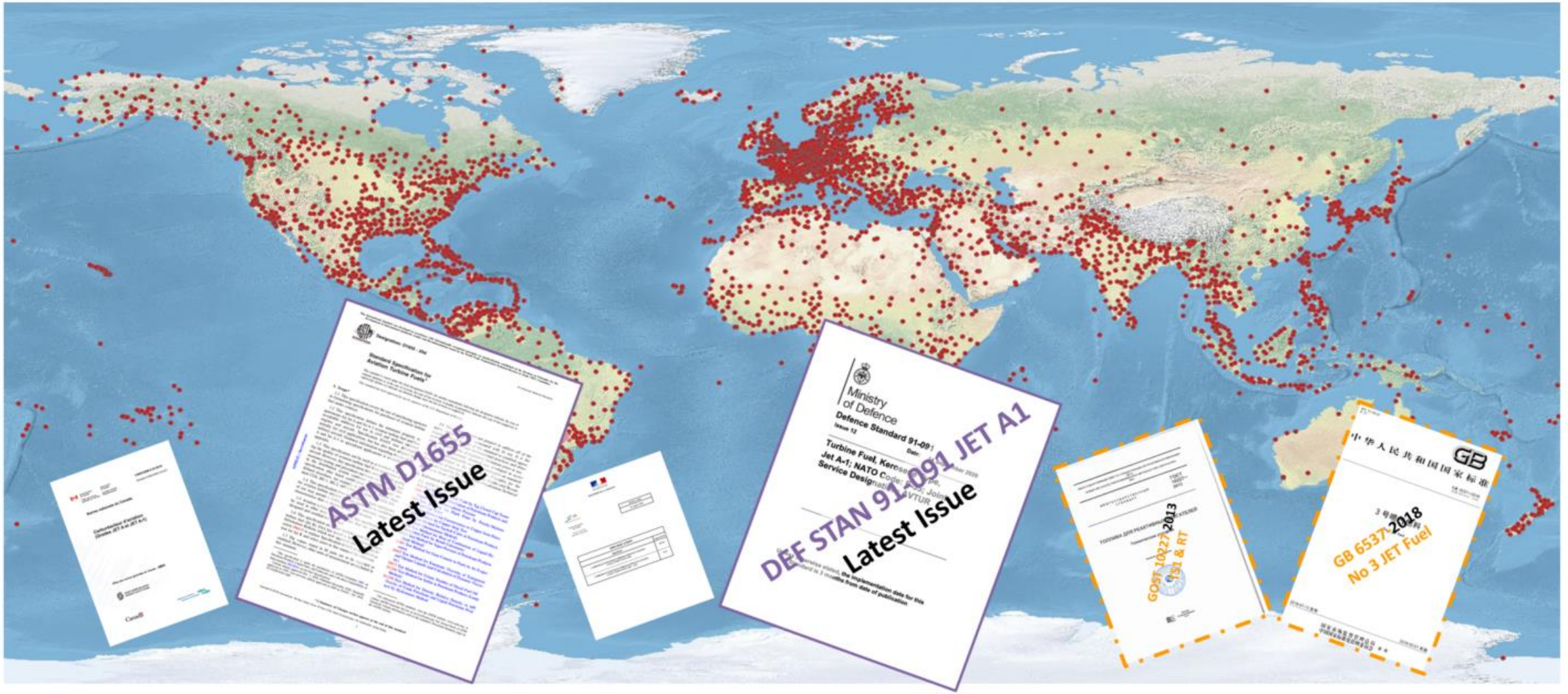
LCAF = **Lower Carbon Aviation Fuel**

- Is defined as *"a fossil based aviation fuel that meets the CORSIA Sustainability Criteria"* *(Ref ICAO SARPs Annex 16 Volume IV)*
- These aviation fuels have the same carbon content as other aviation fuels.

4. What is Aviation Turbine Fuel (ATF)?

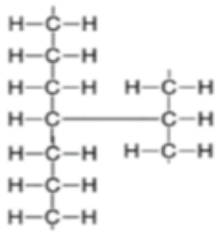
What is ATF

ATF is a commodity traded and used around the world meeting the same minimum requirements ***(i.e. DEF STAN 91-091 / ASTM D1655)***

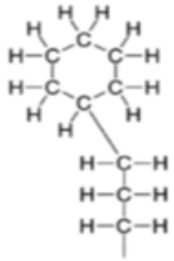


What is Aviation Turbine Fuel?

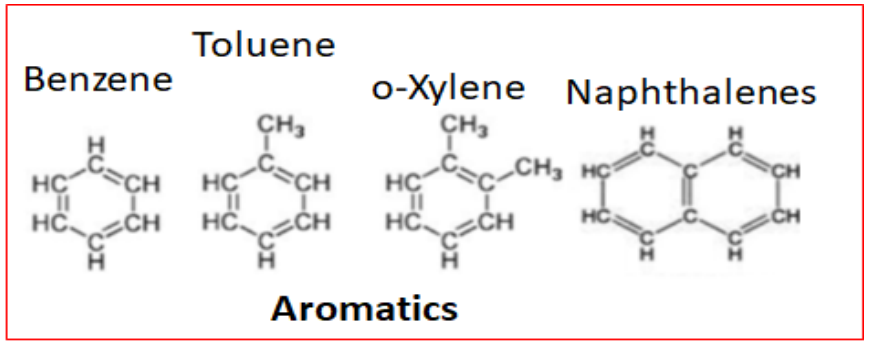
- ATF is a liquid Hydrocarbon in the C_9 to C_{16} range.
- ATF does not have a precise chemical composition but is controlled by property requirements.
- Normally ATF is composed of paraffins, naphthenes & aromatics



Paraffins



Naphthenes



Aromatics

DEF STAN 91-091 Issue 14

Table 1 - Test Requirements

Test	Property	Units	Limits	Method
1	Appearance			
1.1	Visual Appearance		Clear, bright and visually free from solid matter and undissolved water at ambient fuel temperature	Visual (see **Annex F.1**)
1.2	Colour		Report	ASTM D156 or ASTM D6045 (see **Note 1**)
1.3	Particulate Contamination, at point of manufacture	mg/l	Max 1.0	IP423 / ASTM D5452 (see **Note 2**)
or				
1.4	Particulate, at point of manufacture, cumulative channel particle counts	Individual channel counts & ISO Code	Channel Counts ISO Code	IP 565 or IP 577 (see **Notes** and 3)
1.4.1	≥ 4 µm(c)		Report Max	
1.4.2	≥6 µm(c)		Report Max	
1.4.3	≥14 µm(c)		Report Max 14	
1.4.4	≥21 µm(c)		Report Report	
1.4.5	≥25 µm(c)		Report Report	
1.4.6	≥30 µm(c)		Report Max 13	
2	Composition			
2.1	Total Acidity	mg KOH/g	Max 0.0	IP 354 / ASTM D3242
2.2	Aromatic Hydrocarbon Types			
2.2.1	Aromatics	% v/v	Max 25.0	IP 156 / ASTM D1319 (see **Note 4**)
or				
2.2.2	Total Aromatics	% v/v	Max 26.5	IP 436 / ASTM D6379 (see **Note 5**)
2.3	Sulfur, Total	% m/m	Max 0.30	IP336
2.4	Sulfur, Mercaptan	% m/m	Max 0.0030	IP 342 / ASTM D3227 (see **Note 6**)
or				
2.5	Doctor Test		Doctor Negative	IP 30
2.6	Refining Components, at point of manufacture			(see **Note 7**)
2.6.1	Non-Hydroprocessed Components	% v/v	Report	
2.6.2	Severely Hydroprocessed Components	% v/v	Report	
2.6.3	Synthetic Components	% v/v	Report, For limits see **Annex B**	(See **Note 8** and **Annex B**)

TABLE 1 Test Requirements

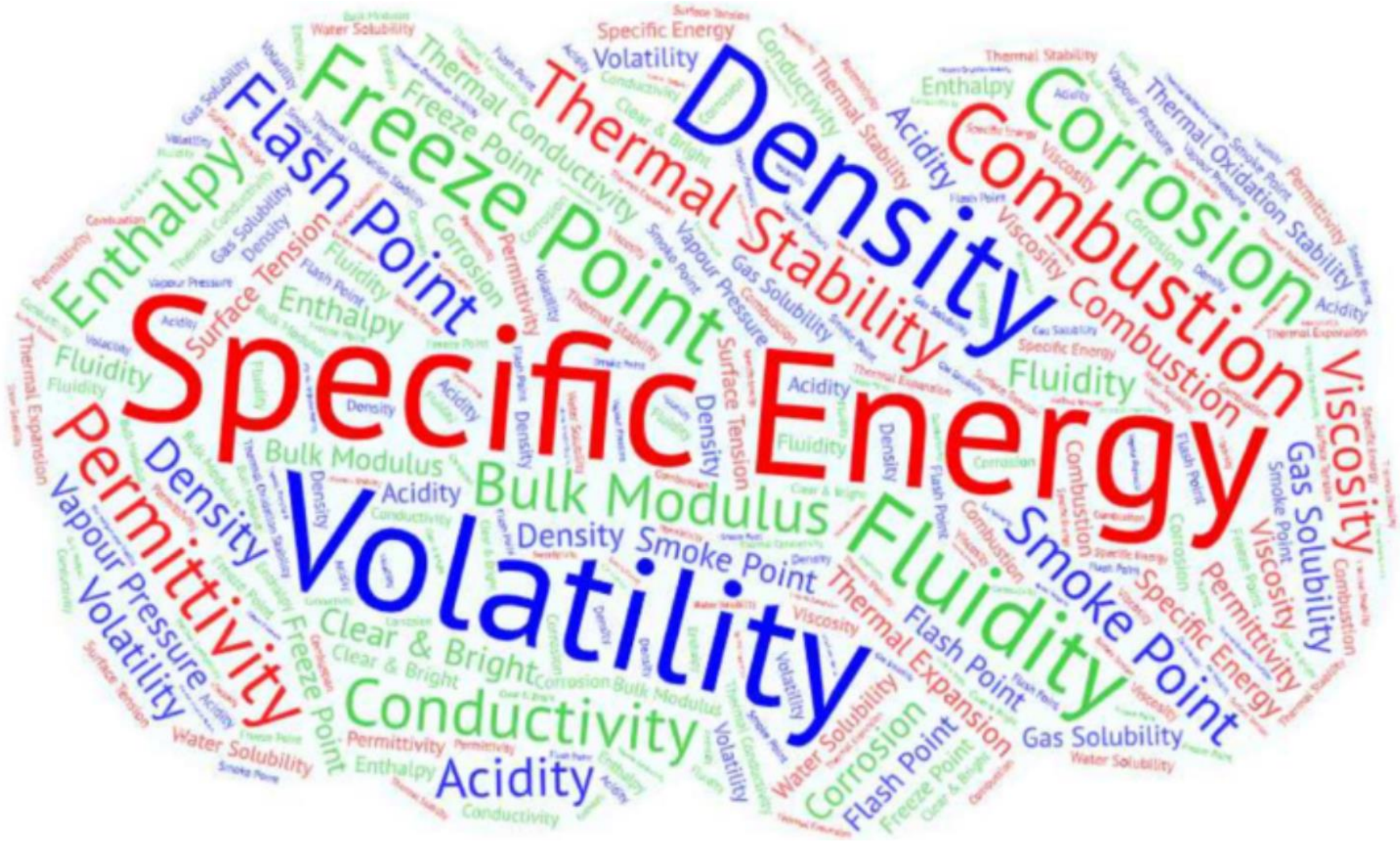
Continued on page 2-7

What is ATF

ATF is:

Beyond being a liquid Hydrocarbon in the C_9 to C_{16} range, ATF must meet the user requirements to ensure the safe operation of aircraft in all phases of flight.

Some properties are tested, others are considered as inherent.



5. How is Aviation Turbine Fuel (ATF) produced & controlled?

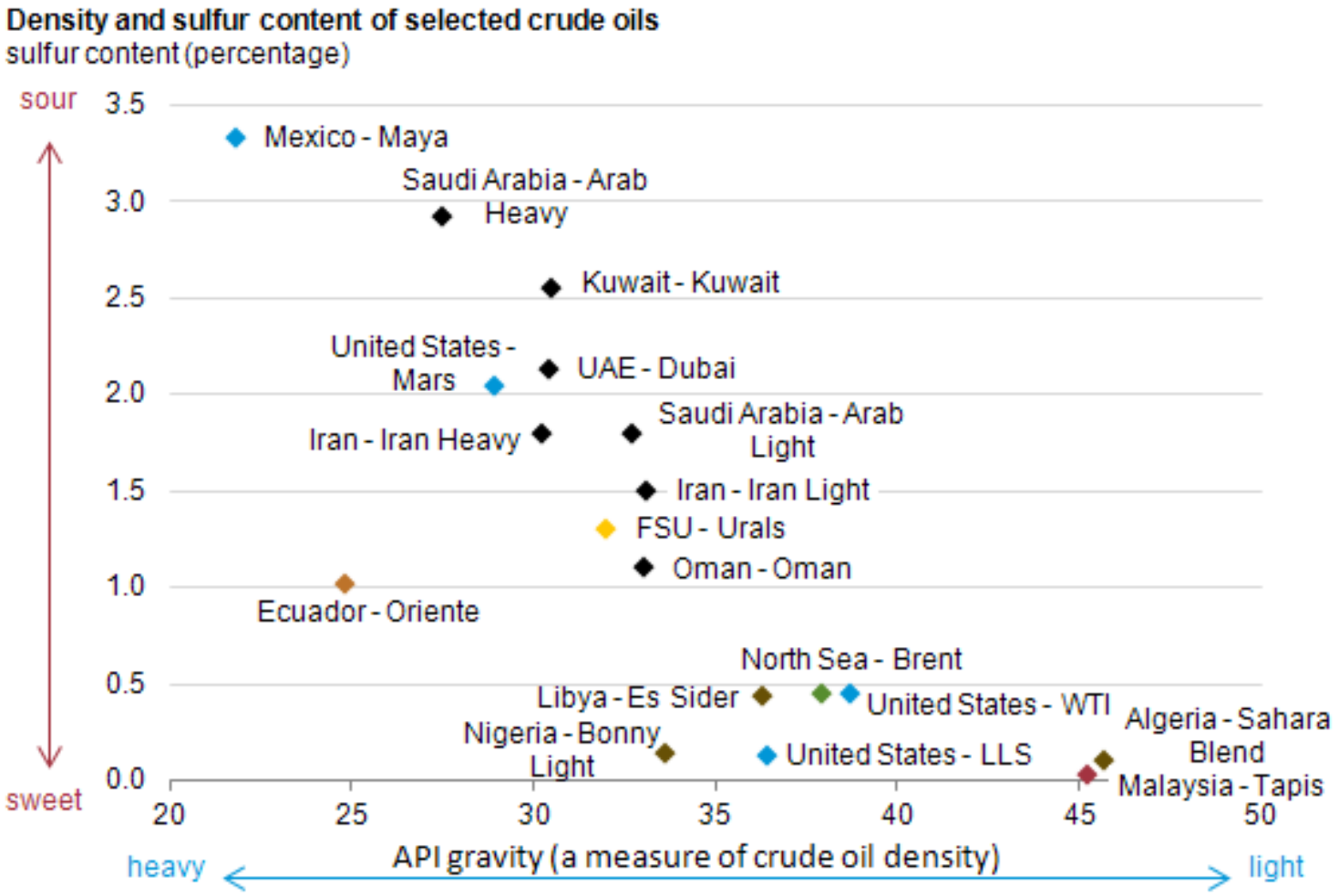
How is ATF produced and controlled

Aviation Turbine Fuel has traditionally been produced from petroleum crude oils

A selection of various crude oils that can be transformed into JET Fuel

How is ATF produced and controlled

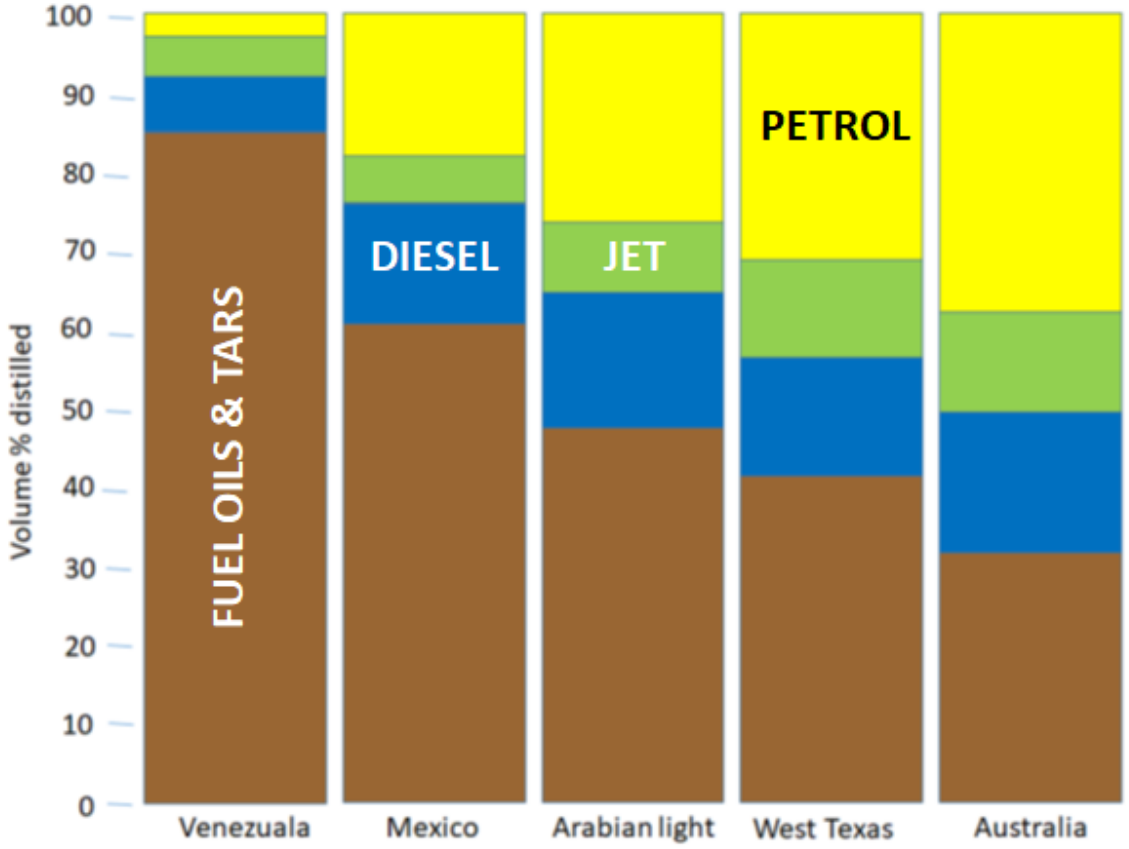
ATF is produced from various different feedstocks and transformed by numerous chemical processes.



Crude oils have different properties depending on where they are from

How is ATF produced and controlled

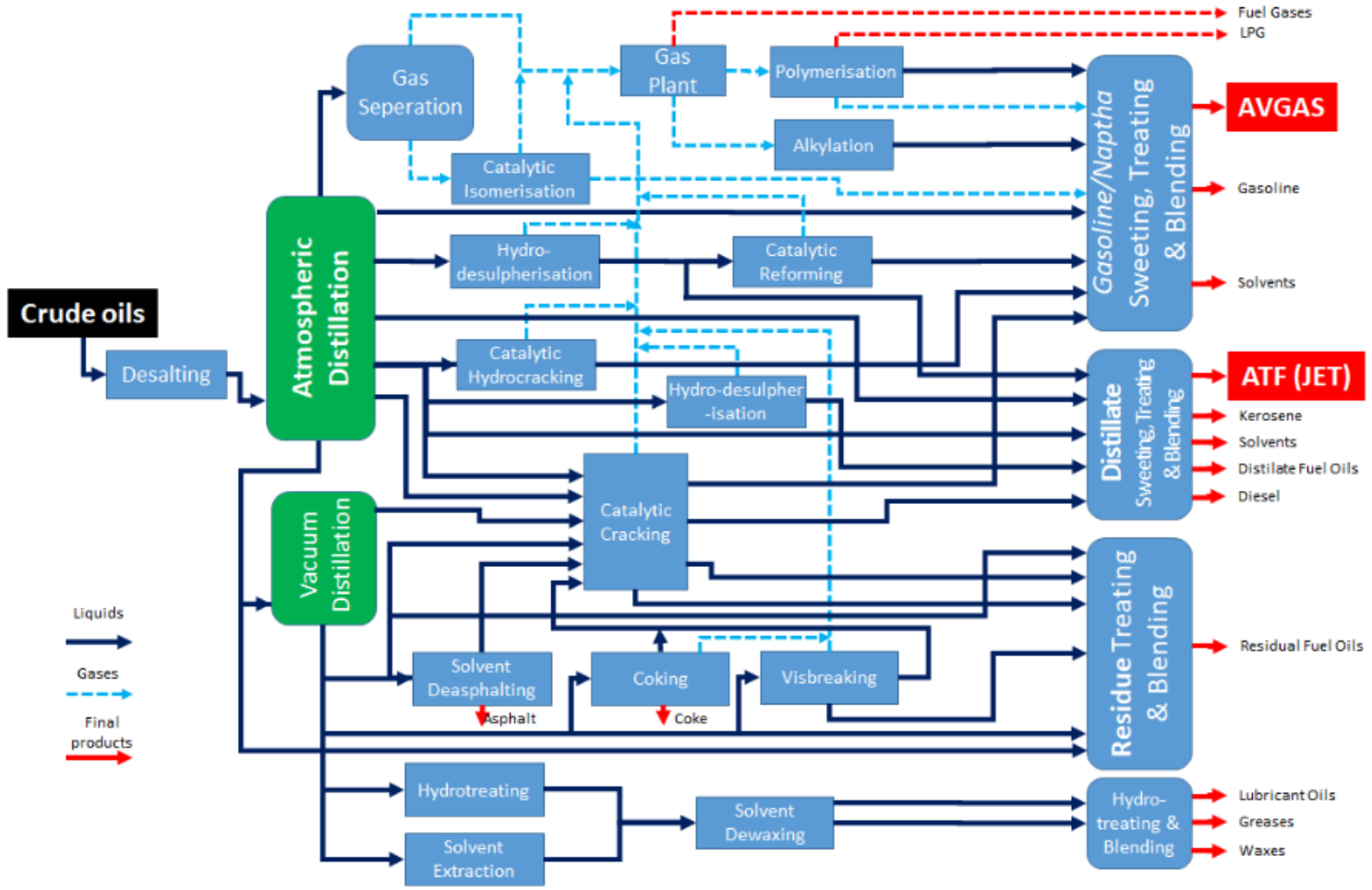
Straight or atmospheric distillation is not sufficient to transform crude oils into the required end products



To optimise production and obtain the desired range and quantities of end products various other processes must be applied

How is ATF produced and controlled

ATF is produced from various different feedstocks and transformed by numerous chemical processes.

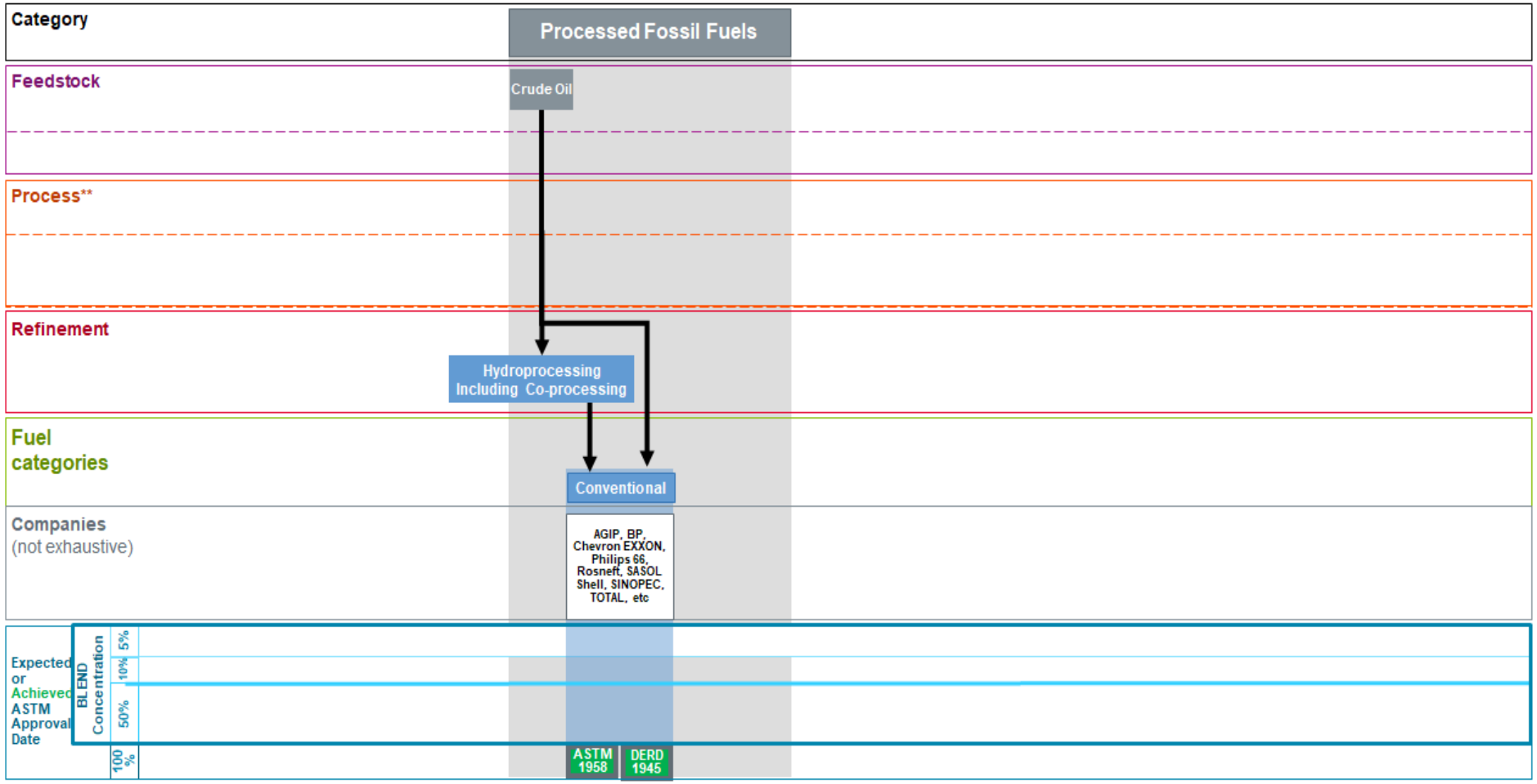


(Example of what refinery processes look like)

Feedstocks are transformed by numerous different processes to achieve the required distribution and volumes of end products.

How is ATF produced and controlled

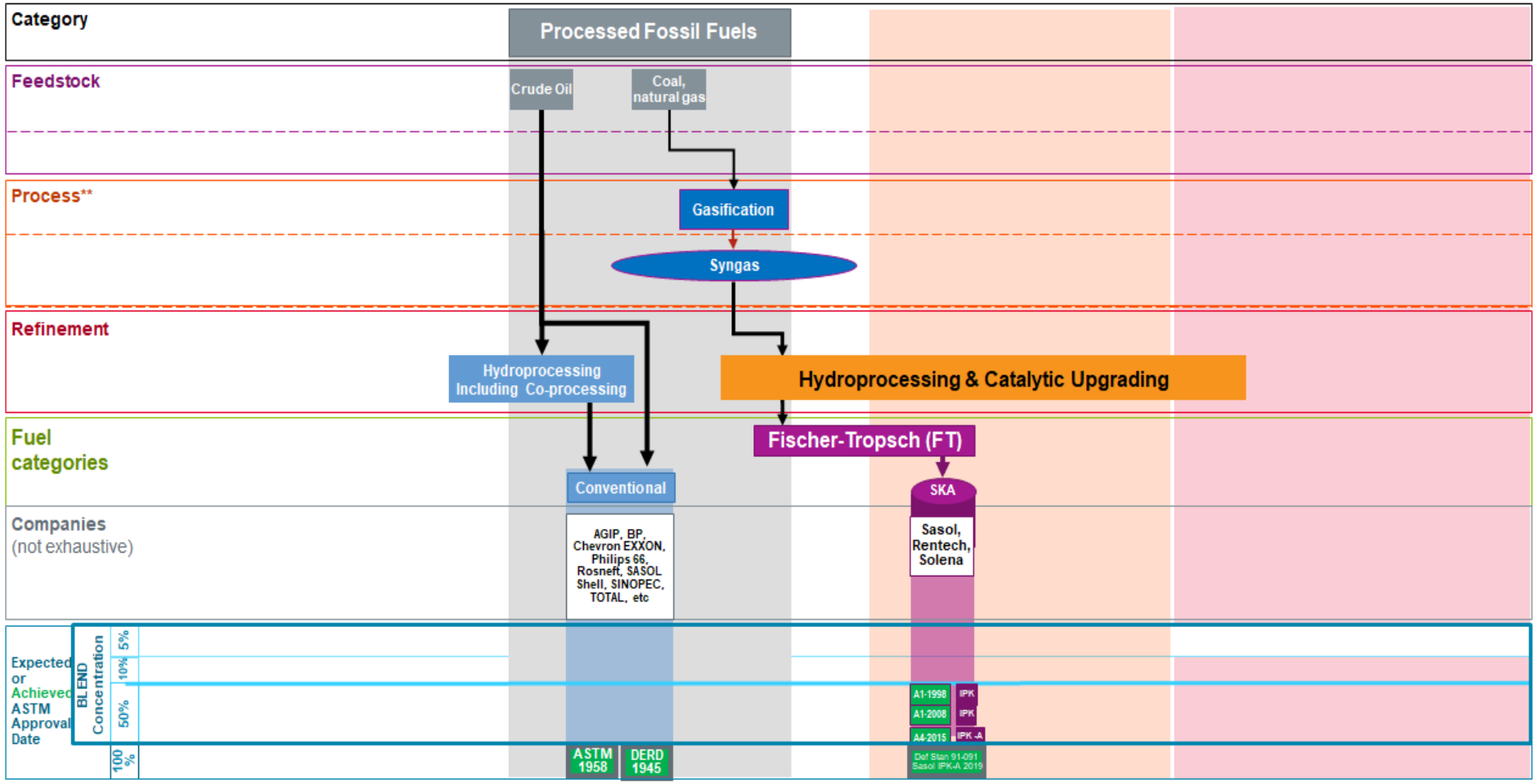
Aviation Fuel Production Pathways (1945 to 1999)



For over half a century the production of ATF was restricted to transforming crude oils. Early petroleum production was via atmospheric distillation but this was soon supplemented by various chemical transformation technologies to optimise the range & yield of products including ATF

How is ATF produced and controlled

Aviation Fuel Production Pathways (1999)

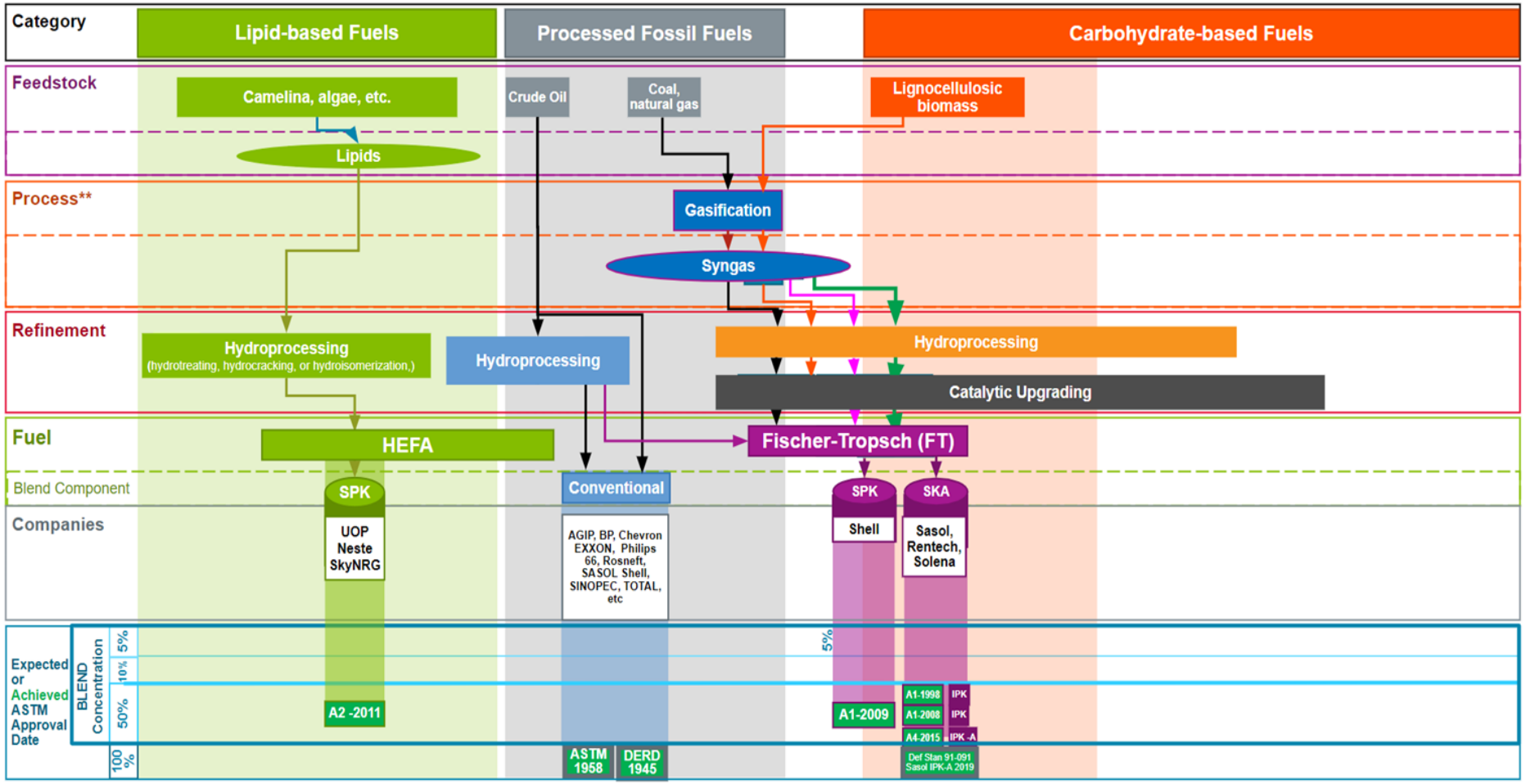


** *Process / information is shown for diagrammatic purposes only*
*** *A1, A2, A3, A4, A5, A6, A7 refer to ASTM D7566 annexes*

In 1999 the first non petroleum Synthetic Blending Component (SBC) production pathway was approved to be used in the production of ATF. Coal was transformed using the Fischer Tropsch (FT) Process & the SBC was blended with ATF to make the first SATF known as Coal-To-Liquids (CTL). SATF-CTL has been safely used in South Africa for over 20 years

How is ATF produced and controlled

Aviation Fuel Production Pathways (2009-2011)



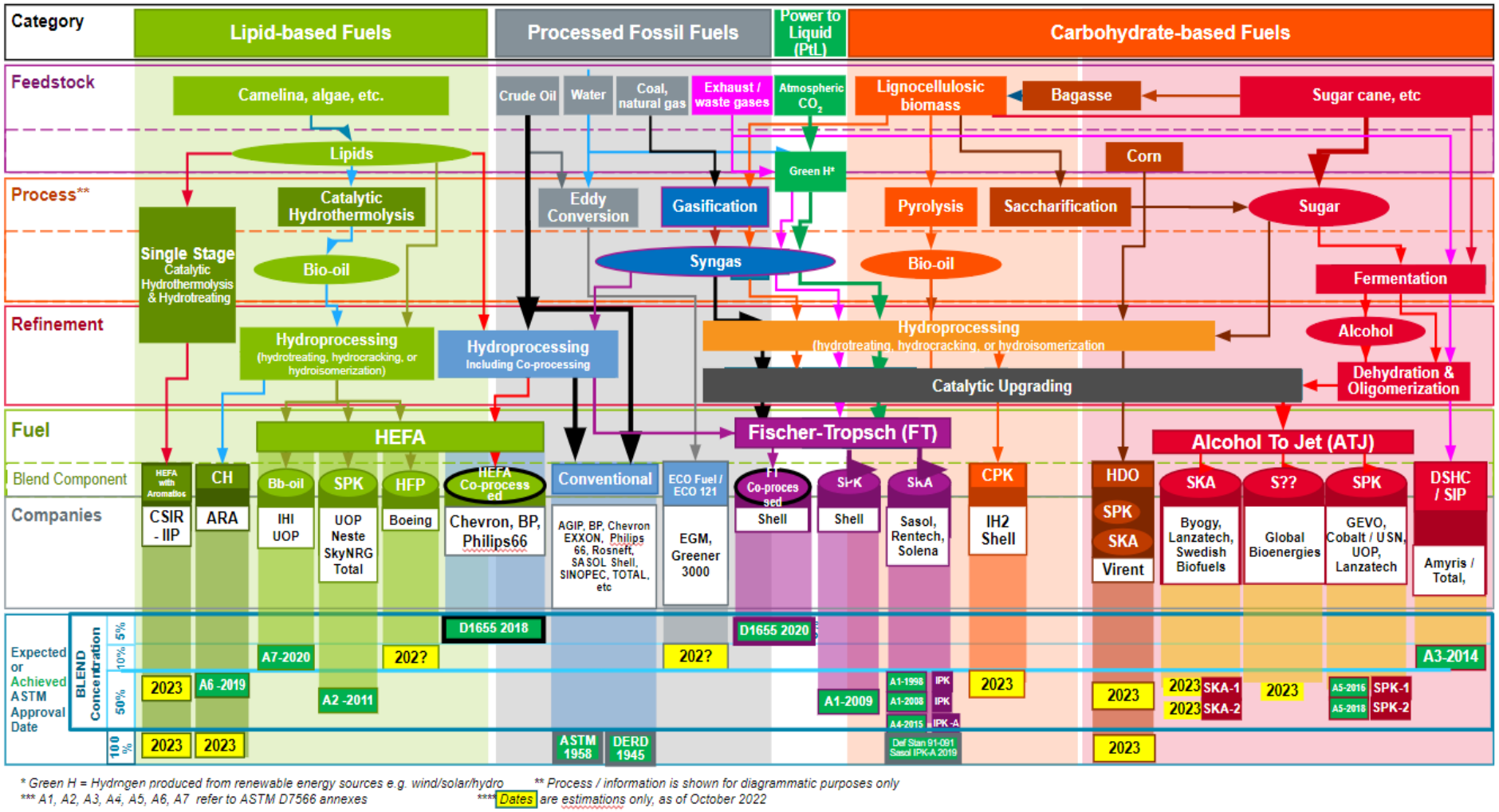
** Process / information is shown for diagrammatic purposes only
*** A1, A2, A3, A4, A5, A6, A7 refer to ASTM D7566 annexes

In 2009 the use of other non petroleum feedstocks, i.e. natural gas & biomass using the FT process were permitted to produce SBC and new fuel specification (ASTM D7566 was created to capture and control the more stringent requirements when producing ATF with SBC.

(The SATF-CTL pathway had been an annex in DEF STAN 91-091)

How is ATF produced and controlled

Aviation Fuel Production Pathways



* Green H = Hydrogen produced from renewable energy sources e.g. wind/solar/hydro ** Process / information is shown for diagrammatic purposes only
*** A1, A2, A3, A4, A5, A6, A7 refer to ASTM D7566 annexes **** Dates are estimations only, as of October 2022

Since 2011 the number of SBC pathways in ASTM D7566 has been expanded and the number of approved feedstocks and processes to produce ATF by blending SBC is now seven.

In addition, two distinct processes where by non petroleum oils can be co-processed with crude oil to directly produce ATF without the need of blending an SBC.

ASTM D7566 Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons

- Covers the manufacture of ATF that consists of conventional ATF blended with SBC.
- Identifies Materials and Manufacturing processes in 7 annexes

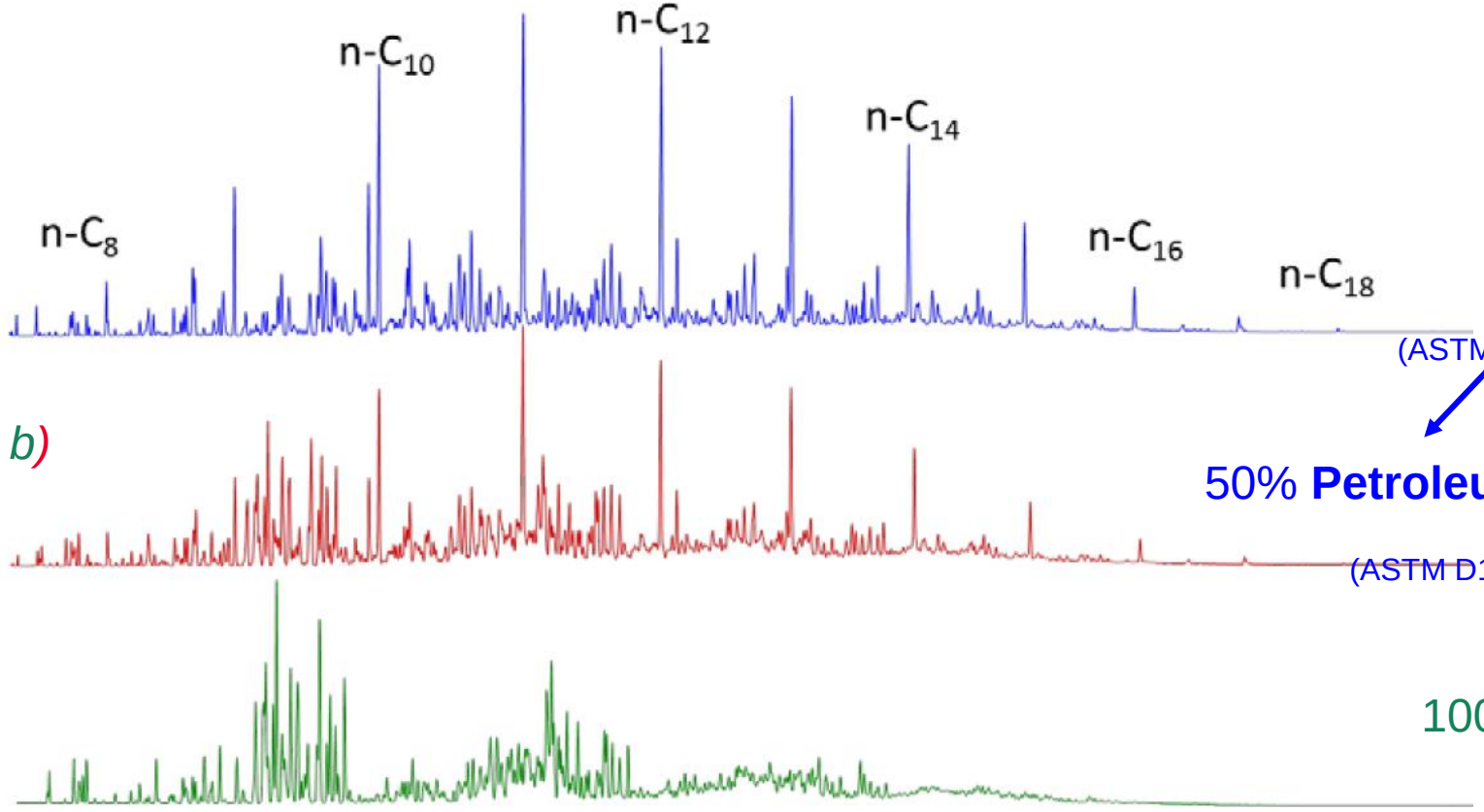
1. Fischer-Tropsch Hydroprocessed Synthesised Paraffinic Kerosine (**SPK**)
2. Synthesised Paraffinic Kerosine from Hydroprocessed Esters & Fatty Acids (**HEFA SPK**)
3. Synthesised Iso-Paraffins from Hydroprocessed Fermented Sugars (**SIP**)
4. Synthesised Kerosine with Aromatics derived by Alkylation of Light Aromatics from Non-Petroleum Sources (**SPK-A)**
5. Alcohol-To Jet Synthetic Paraffinic Kerosene (**ATJ-SPK**)
6. Synthesised Kerosine from Hydrothermal conversion of Fatty Acid Esters & Fatty Acids (**CHJ**)
7. Synthesised Paraffinic Kerosine from Hydroprocessed Hydrocarbons, Esters & Fatty Acids (**HC-HEFA SPK**)

- ATF manufactured, certified, & released to all the requirements of Table 1 of D7566, meets the requirements of Specification D1655 & **shall be regarded as Specification ASTM D1655 ATF.**
  - It also meets the requirements of and is regarded as **Def Stan 91-091, CGSB 3.23-2020, DCSEA 134 E & other specifications**
  - **By meeting the requirements of ASTM D1655, DEF STAN 91-091 etc the ATF is approved for flight**
  - *(ASTM D7566 is not approved for flight unless recertified as one of the approved fuel specifications).*

How is ATF produced and controlled

Why blending is required

N.B. The Theoretical Maximum SBC blending ratio depends on ASTM D7566 Annex



JET A1
100% Petroleum
(ASTM D1655 – Approved for flight) **ATF**

JET A1
50% **Petroleum** / 50% **SBC** – **blended**
(ASTM D1655 – Approved for flight) **SATF**

100% SBC *(example)*
(ASTM D7566 - Not approved for flight) *SBC*

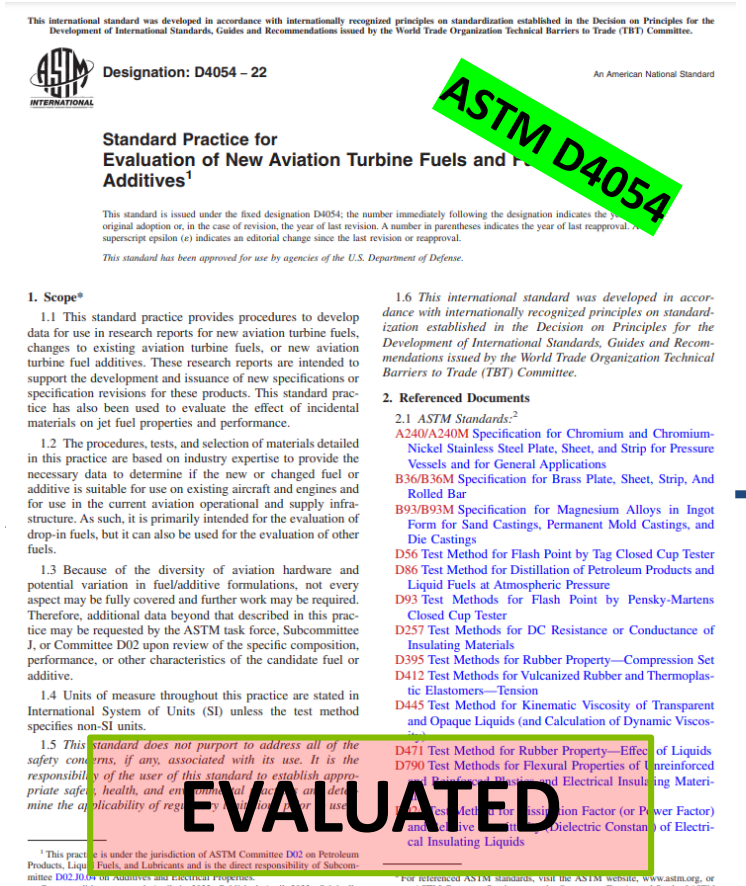
D7566 Table 1 Extended Requirements includes:

Composition			
Aromatics: One of the following requirements shall be met:	**Min**	Max	*Test Methods*
1. Aromatics, volume percent Min[R,S]	**8**	25	D1319 or IP 156 or D8305[X]
2. Aromatics, volume percent Min[R,S]	**8.4**	26.5	D6379/IP 436

6. Overview of the Aviation Industry Process for Assessing, Controlling & Approving new Feedstocks & Processes for ATF Production

Approval process for new feedstocks

What is the process for approving new feedstocks and production processes into the ATF/JET fuel specifications?



This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: D4054 – 22

An American National Standard

ASTM D4054

Standard Practice for Evaluation of New Aviation Turbine Fuels and F… Additives[1]

This standard is issued under the fixed designation D4054; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This standard practice provides procedures to develop data for use in research reports for new aviation turbine fuels, changes to existing aviation turbine fuels, or new aviation turbine fuel additives. These research reports are intended to support the development and issuance of new specifications or specification revisions for these products. This standard practice has also been used to evaluate the effect of incidental materials on jet fuel properties and performance.

1.2 The procedures, tests, and selection of materials detailed in this practice are based on industry expertise to provide the necessary data to determine if the new or changed fuel or additive is suitable for use on existing aircraft and engines and for use in the current aviation operational and supply infrastructure. As such, it is primarily intended for the evaluation of drop-in fuels, but it can also be used for the evaluation of other fuels.

1.3 Because of the diversity of aviation hardware and potential variation in fuel/additive formulations, not every aspect may be fully covered and further work may be required. Therefore, additional data beyond that described in this practice may be requested by the ASTM task force, Subcommittee J, or Committee D02 upon review of the specific composition, performance, or other characteristics of the candidate fuel or additive.

1.4 Units of measure throughout this practice are stated in International System of Units (SI) unless the test method specifies non-SI units.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A240/A240M Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

B36/B36M Specification for Brass Plate, Sheet, Strip, And Rolled Bar

B93/B93M Specification for Magnesium Alloys in Ingot Form for Sand Castings, Permanent Mold Castings, and Die Castings

D56 Test Method for Flash Point by Tag Closed Cup Tester

D86 Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure

D93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester

D257 Test Methods for DC Resistance or Conductance of Insulating Materials

D395 Test Methods for Rubber Property—Compression Set

D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension

D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscos…

D471 Test Method for Rubber Property—Effec… of Liquids

D790 Test Methods for Flexural Properties of U…nreinforced …Reinforced Plastics and Electrical Insulating Materi…

D…Test Method for …ssipation Factor (or Power Factor) …and Relative …Permittivity (Dielectric Constant) of Electrical Insulating Liquids

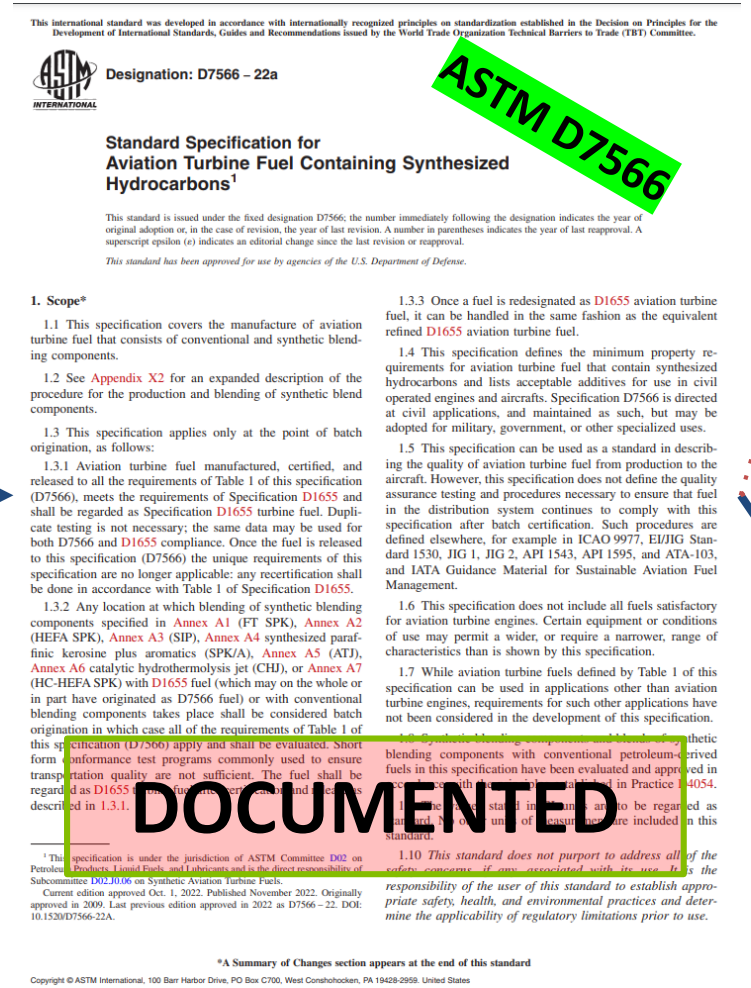
[1] This practice is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.J0.04 on Additives and Electrical Properties.

Current edition approved April 1, 2022. Published April 2022. Originally approved in 1981. Last previous edition approved in 2021 as D4054 – 21a. DOI:10.1520/D4054-22.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard**

EVALUATED



This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: D7566 – 22a

ASTM D7566

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

This standard is issued under the fixed designation D7566; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This specification covers the manufacture of aviation turbine fuel that consists of conventional and synthetic blending components.

1.2 See Appendix X2 for an expanded description of the procedure for the production and blending of synthetic blend components.

1.3 This specification applies only at the point of batch origination, as follows:

1.3.1 Aviation turbine fuel manufactured, certified, and released to all the requirements of Table 1 of this specification (D7566), meets the requirements of Specification D1655 and shall be regarded as Specification D1655 turbine fuel. Duplicate testing is not necessary; the same data may be used for both D7566 and D1655 compliance. Once the fuel is released to this specification (D7566) the unique requirements of this specification are no longer applicable: any recertification shall be done in accordance with Table 1 of Specification D1655.

1.3.2 Any location at which blending of synthetic blending components specified in Annex A1 (FT SPK), Annex A2 (HEFA SPK), Annex A3 (SIP), Annex A4 synthesized paraffinic kerosine plus aromatics (SPK/A), Annex A5 (ATJ), Annex A6 catalytic hydrothermolysis jet (CHJ), or Annex A7 (HC-HEFA SPK) with D1655 fuel (which may on the whole or in part have originated as D7566 fuel) or with conventional blending components takes place shall be considered batch origination in which case all of the requirements of Table 1 of this specification (D7566) apply and shall be evaluated. Short form performance test programs commonly used to ensure transportation quality are not sufficient. The fuel shall be regarded as D1655 …fuel only after …and delivery as described in 1.3.1.

1.3.3 Once a fuel is redesignated as D1655 aviation turbine fuel, it can be handled in the same fashion as the equivalent refined D1655 aviation turbine fuel.

1.4 This specification defines the minimum property requirements for aviation turbine fuel that contain synthesized hydrocarbons and lists acceptable additives for use in civil operated engines and aircrafts. Specification D7566 is directed at civil applications, and maintained as such, but may be adopted for military, government, or other specialized uses.

1.5 This specification can be used as a standard in describing the quality of aviation turbine fuel from production to the aircraft. However, this specification does not define the quality assurance testing and procedures necessary to ensure that fuel in the distribution system continues to comply with this specification after batch certification. Such procedures are defined elsewhere, for example in ICAO 9977, EI/JIG Standard 1530, JIG 1, JIG 2, API 1543, API 1595, and ATA-103, and IATA Guidance Material for Sustainable Aviation Fuel Management.

1.6 This specification does not include all fuels satisfactory for aviation turbine engines. Certain equipment or conditions of use may permit a wider, or require a narrower, range of characteristics than is shown by this specification.

1.7 While aviation turbine fuels defined by Table 1 of this specification can be used in applications other than aviation turbine engines, requirements for such other applications have not been considered in the development of this specification.

…blending components with conventional petroleum-derived fuels in this specification have been evaluated and approved in accordance with the …described in Practice D4054.

…stated in …are to be regarded as …of …are included in this standard.

1.10 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

[1] This specification is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.J0.06 on Synthetic Aviation Turbine Fuels.

Current edition approved Oct. 1, 2022. Published November 2022. Originally approved in 2009. Last previous edition approved in 2022 as D7566 – 22. DOI: 10.1520/D7566-22A.

***A Summary of Changes section appears at the end of this standard**

DOCUMENTED

Def Stan 91-091

Ministry of Defence

Defence Standard 91-091

Issue 14 Date: 07 March 202…

…Turbine Fuel, Kerosene Type, Jet A-1; NATO Code: F-35; Joint Service Designation: AVTUR

CAN/CGSB-3.23-2020 Corrigendum No. 1, January 2021

CGSB 3.23-2020

…viation turbine fuel (Grades JET A and JET A-1)

DCSEA 134 E

Unless otherwise stated, the implementation date for this Standard is 2 months from date of publication

ASTM D1655

MIL DTL 83133

Designation: D1655 – 22

Standard Specification for Aviation Turbine Fuels[1]

APPROVED FOR FLIGHT

Verify aircraft documentation for any restrictions and or limitations

Questions?

Topics to be covered:

3. Aviation Fuels Terms & Acronyms
4. What is Aviation Turbine Fuel (ATF)?
5. How is Aviation Turbine Fuel Produced & Controlled?
6. Overview of the Aviation Industry Process for Assessing, Controlling & Approving new Feedstocks & Processes for ATF Production

Agenda

1. Opening
2. Introduction of partners
3. Aviation Fuels Terms & Acronyms
4. What is Aviation Turbine Fuel (ATF)?
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6. Overview of the Aviation Industry Process for Assessing, Controlling & Approving new Feedstocks & Processes for ATF Production
7. Synthetic Aviation Turbine Fuels (SATF) Approval
8. 100% SATF Specification
9. Co-Processing Pathways
10. New SATF Producer Guidance
11. The current challenges of SATF certification
12. Future evolutions of SATF certification processes
13. Open discussion
14. Closing remarks

7. Synthetic Aviation Turbine Fuels (SATF) Approval

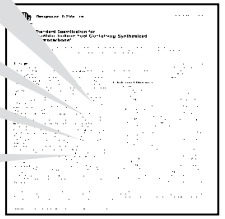
Airworthiness Authority Approval of Aviation Fuel

The Airworthiness Authority does not certify fuel,

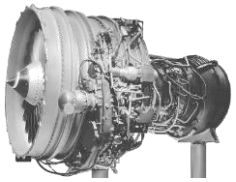
they certify airplanes and engines to operate on specified fuel

Jet A/A-1

- DEF STAN 91-091
- ASTM D1655
- OEM Specifications
- MIL-DTL 83133



Fuel Specification



Engine Ratings and Operating Limitations

Powerplant Limitations

- Fuel Specification

Operating Limitations

- Powerplant limitations in Airplane Flight Manual

Aircraft Flight Manual

- no person may operate a civil aircraft without complying with the operating limitations specified in the approved AFM

Airlines May Only Use the Fuel Specified by the OEM

This Must Control the Fuel Composition and Properties to Ensure a Consistent Product

Fuel is Evaluated During Aircraft and Engine Certification

Here is Where the Airworthiness Authorities Apply Regulatory Oversight in Operations

SATF Approval

SATF Approval For Use on Aircraft

New SATF Meets Existing Operating Limitations, Therefore Approved to Use on Virtually All Existing Aircraft

4 D1655 = D7566

Conventional Jet Fuel Spec = Drop-In Jet Fuel Spec

ASTM Specification = Approval to Fly

Blend SBC with Jet Fuel to Make Drop-in SATF

1

FAA Approved Operating Limitations Based on ASTM Fuel Specifications

Jet A and Jet A-1 Fuel

3 D7566 Drop-In Jet Fuel Spec

Then New SATF Annex Added to Drop-In Fuel Spec

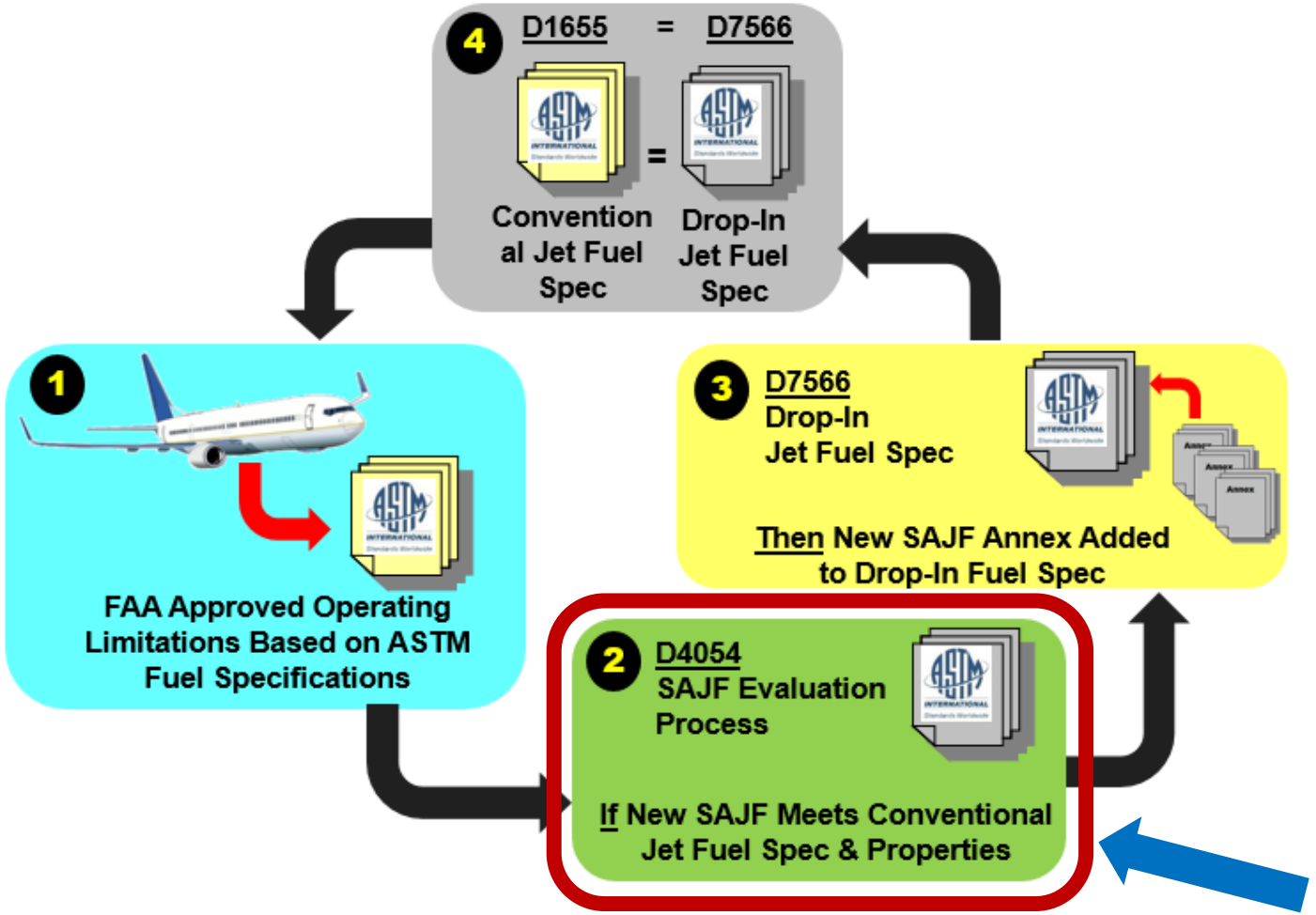
Tested Before Blending with Conventional Jet Fuel

Synthetic Blend Components (SBC)

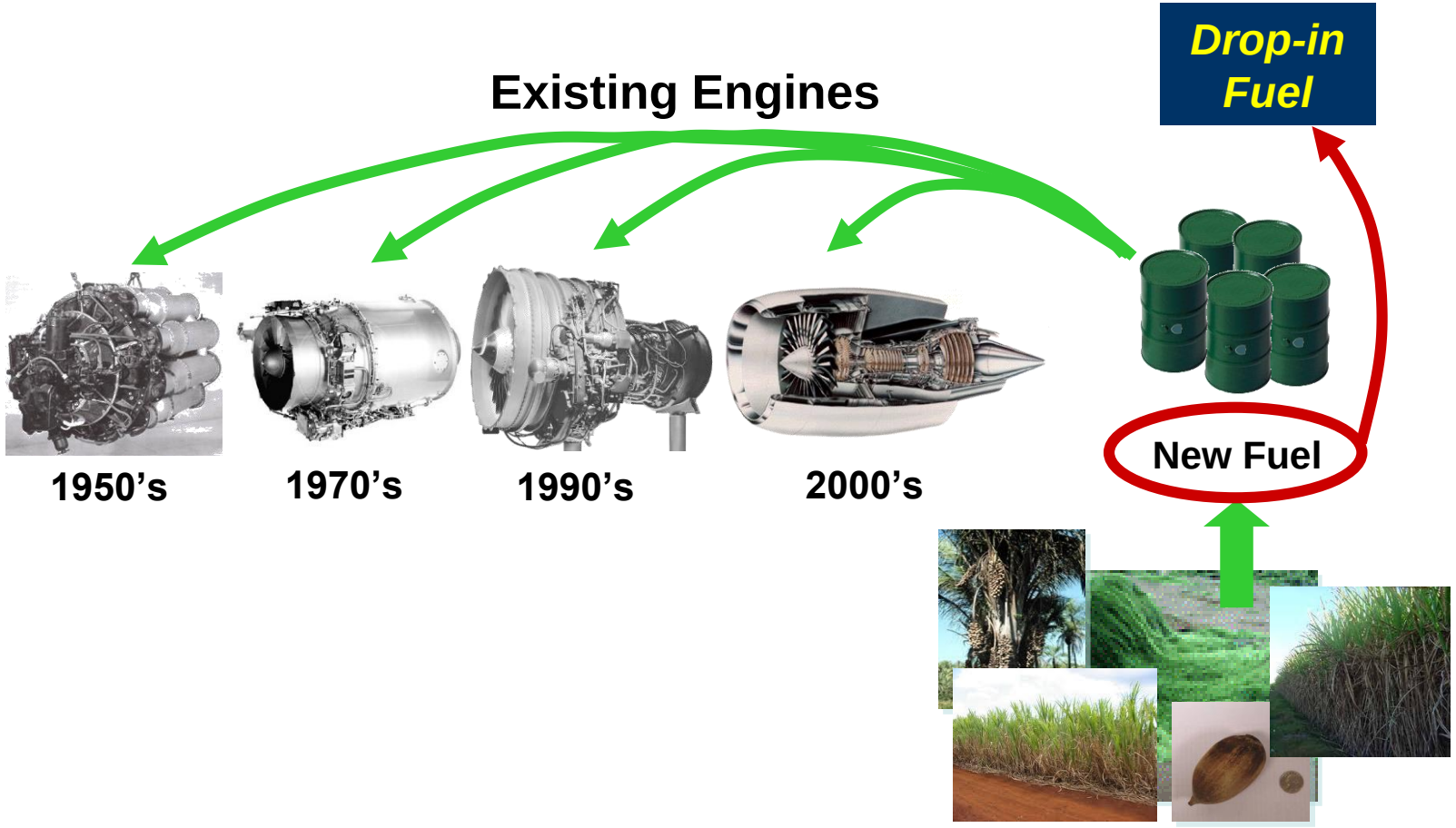
2 D4054 SATF Evaluation Process

If New SATF Meets Conventional Jet Fuel Spec & Properties

Let's Look at the ASTM D4054 Evaluation Step



D4054 Process Determines "Backwards Compatibility" of SATF



ASTM D4054 Evaluation Process

Tier 1

Specification Properties

Tier 2

Fit-For-Purpose Properties

Phase 1 ASTM Research Report

SAFRAN BOEING Honeywell Rolls-Royce AIRBUS

OEM Review & Tier 3 & 4 Requirements

Tier 3

Component/Rig Testing

Tier 4

Engine/APU Testing

Phase 2 ASTM Research Report

ASTM Balloting Process

SAFRAN BOEING Honeywell Rolls-Royce AIRBUS

OEM Review & Approval

ASTM Review & Ballot

Accept

Reject

Re-Eval As Required

ASTM Specification

ASTM D7566 Specification Annex

Review by National Airworthiness Authority

SATF Approval

FAA D4054 Clearinghouse

FAA Funds Under ASCENT Center of Excellence

Structured as a Cost Share Arrangement

Coordinates, Manages, and Conducts D4054 Evaluation Process

Final Research Report Out

Tier 1

Specification Properties

Tier 2

Fit-For-Purpose Properties

Phase 1 ASTM Research Report

SAFRAN BOEING Honeywell Rolls-Royce AIRBUS

OEM Review & Tier 3 & 4 Requirements

Tier 3

Component/Rig Testing

Tier 4

Engine/APU Testing

Phase 2 ASTM Research Report

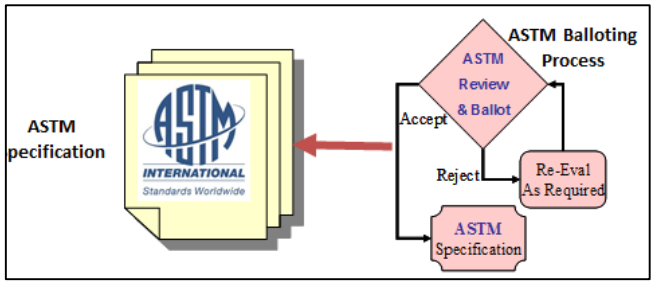
SAFRAN BOEING Honeywell Rolls-Royce AIRBUS

OEM/FAA Review & Approval

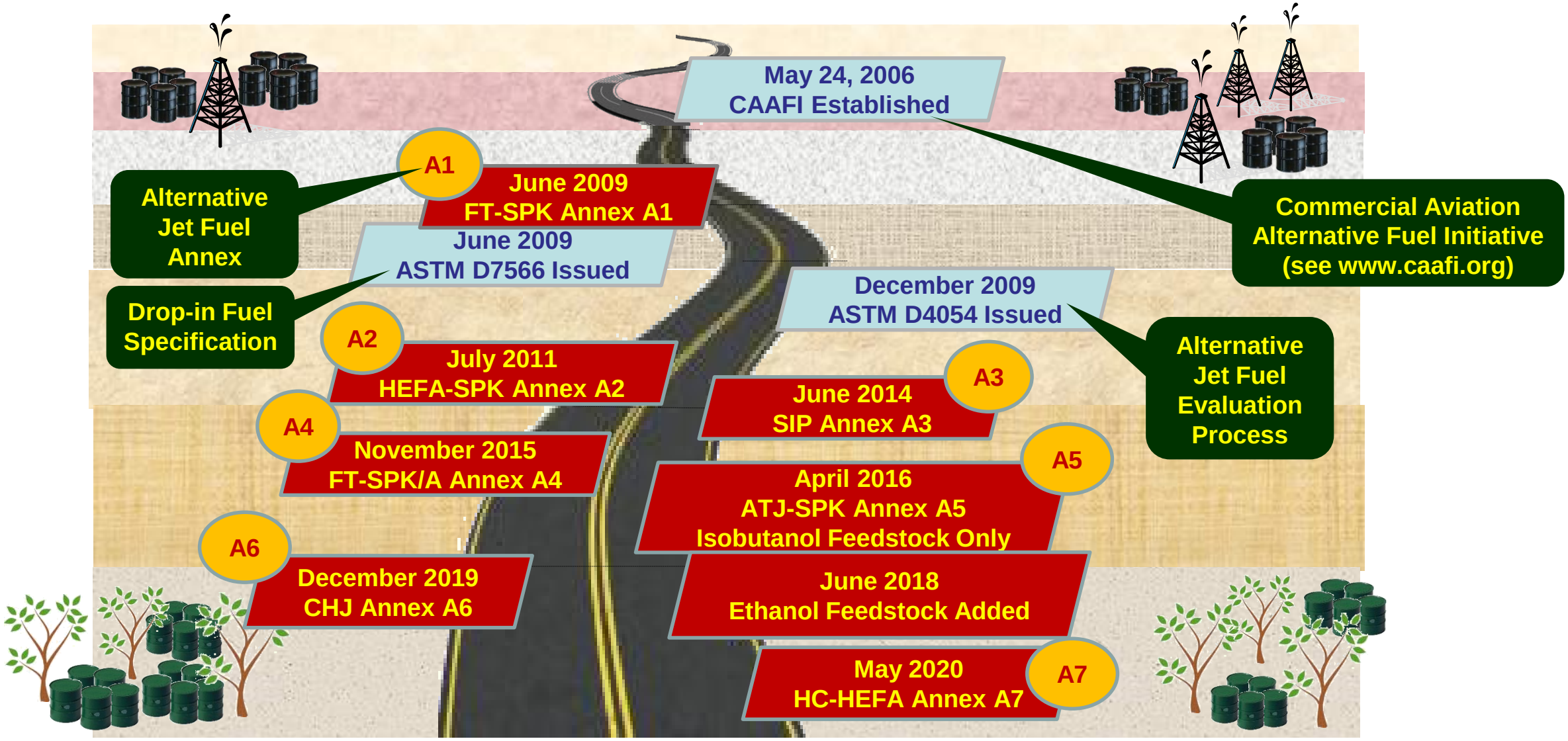
University of Dayton Research Institute (UDRI)

Candidate SATF In

Phase 2 ASTM Research Report



SATF Progress to Date



8. 100% SATF Specification

100% SATF Specification

ACT SAF

Current D7566 SATF Production Concept

This IS Jet A/Jet A-1 Fuel

ASTM D1655 Conventional Aviation Turbine (Jet) Fuel

Crude Oil

Refinery

Conventional Jet Fuel (ASTM D1655)

ASTM D7566 Synthetic Aviation Turbine Fuel (SATF)

Blend

Synthetic Aviation Turbine Fuel (up to 50% renewable)

ASTM D7566 Annex Ax Synthetic Blend Component (SBC)

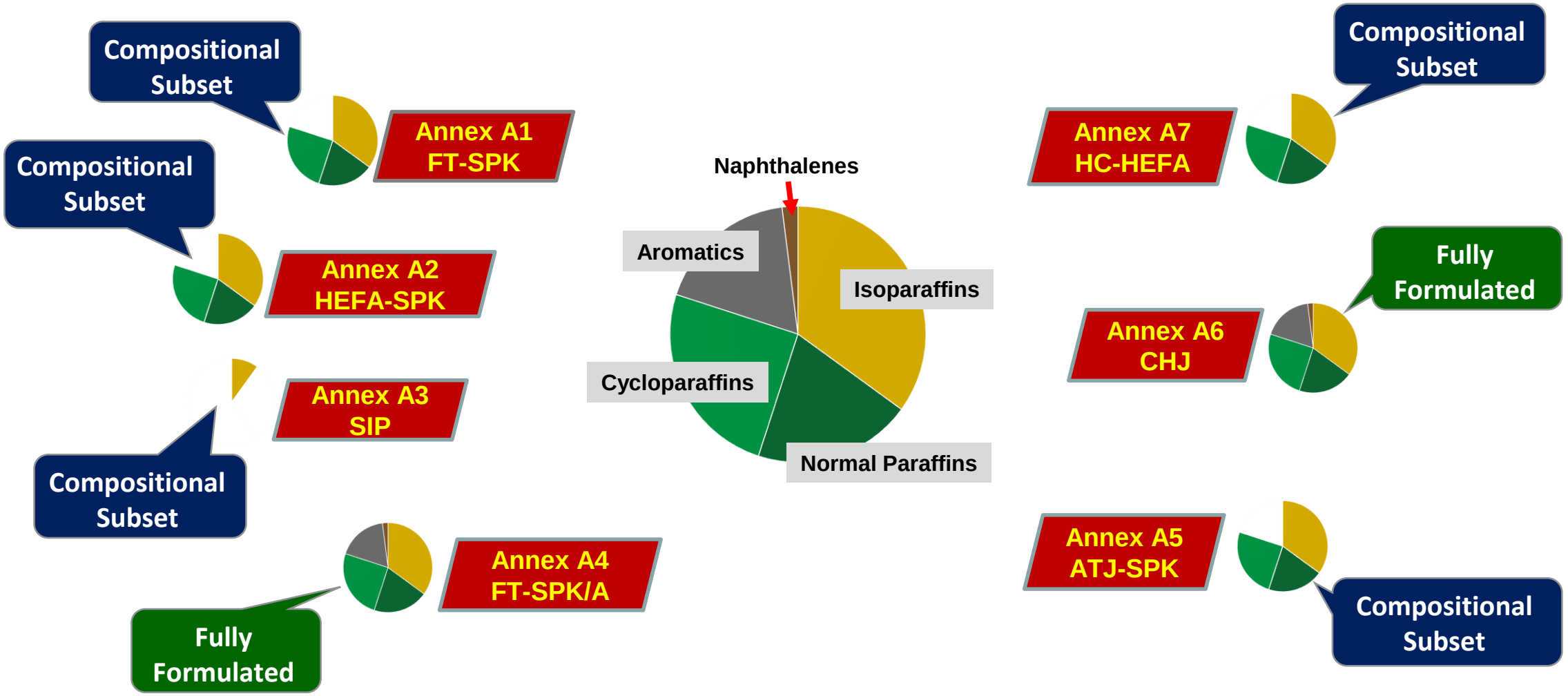
Renewable Feed Stocks

Conversion Process

Synthetic Blend Component (ASTM D7566)

100% SATF Specification

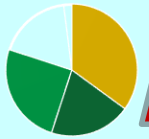
SATF Composition Compared to Jet A Fuel



100% SATF Specification

ASTM Task Group Working on Revision to D7566 to Allow Blending of Annex Synthetic Blend Components to Allow 100% SATF

Blend A Compositional Subset Annex with a Fully Formulated Annex



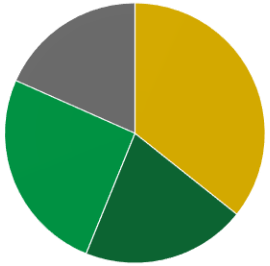
Annex A2 HEFA-SPK + Annex A6 CHJ =

Blend A Compositional Subset Annex with a Different Compositional Subset Annex

Annex A2 HEFA-SPK + TBD 2023 SAK* Annex A? =

Allow Use of a Fully Formulated Annex Without Blending

Annex A6 CHJ =



Fully Formulated SATF (a Jet A or Jet A-1 Fuel)

*SAK: Synthetic Aromatics Kerosene

9. Co-Processing Pathways

Co-Processing Pathways

ASTM D1655
Annex A1
Co-Processing

Renewable
Feed Stocks

Currently Limited to <5% of feed to refinery

Co-Processed Jet Fuel
(ASTM D1655 Annex A1)
(>= 95% petroleum/=<5% renewable)

ASTM D1655
Conventional Aviation
Turbine (Jet) Fuel

Crude Oil

Refinery

Conventional
Jet Fuel
(ASTM D1655)

ASTM D7566
Synthetic Aviation
Turbine Fuel (SATF)

Blend

Synthetic Aviation
Turbine Fuel
(ASTM D7566 & D1655)
(up to 50% renewable)

ASTM D7566 Annex Ax
Synthetic Blend
Component (SBC)

Renewable
Feed Stocks

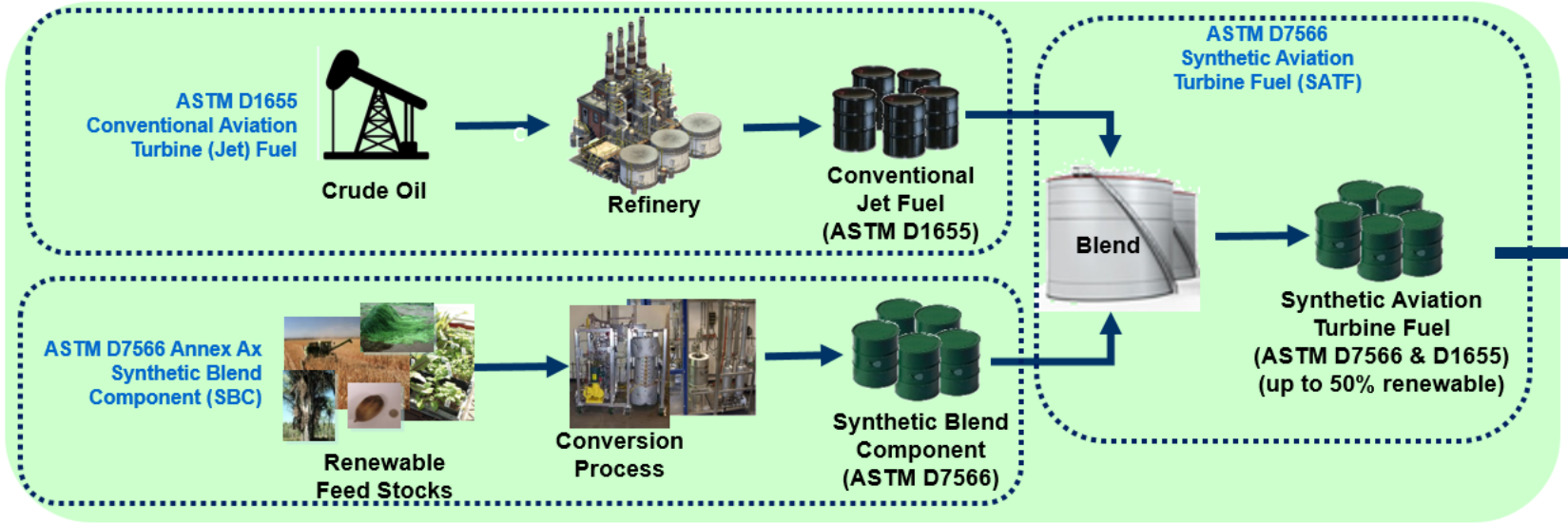
Conversion
Process

Synthetic Blend
Component
(ASTM D7566)

10. New SATF Producer Guidance

New SATF Producer Guidance

Industry Oversight



There is no requirement from the Airworthiness Authority Certification to produce SATF. However:

- An Airline customer may require “due diligence” testing after consulting with their aircraft and engine manufacturers
- The SATF producer may need to obtain sustainability certification, which do not include flight safety aspects covered by ASTM.

Airworthiness Authority Oversight

There is no requirement for an Airline to Obtain Approval from their Airworthiness Authority

- SATF is Jet A or Jet A-1 Fuel and is already approved

Break for discussion

Questions?

Topics to be covered:

7. Synthetic Aviation Turbine Fuels (SATF) Approval
8. 100% SATF Specification
9. Co-Processing Pathways
10. New SATF Producer Guidance

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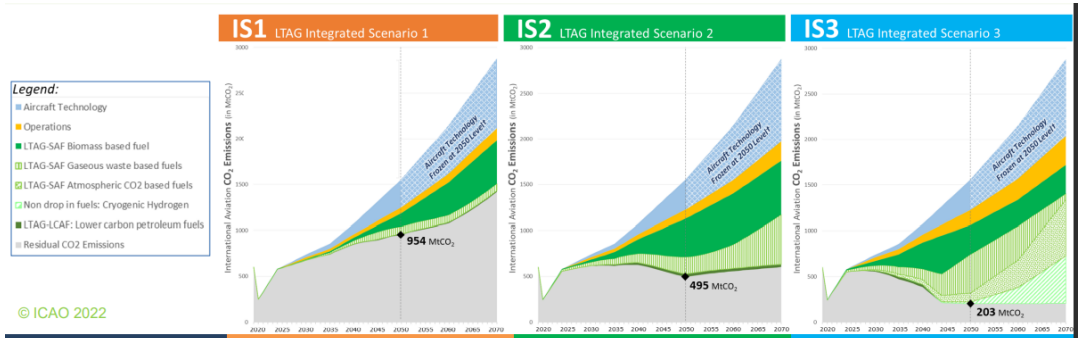
- ICAO LTAG (Long Term Aspirational Goal) have been adopted in late 2022
- All LTAG scenarios rely on a massive ramp-up of SAF
- Such ramp-up implies:
  - Continuous qualification of new SATF pathways
  - Allow SATF use at high blending ratio (up to 100%)

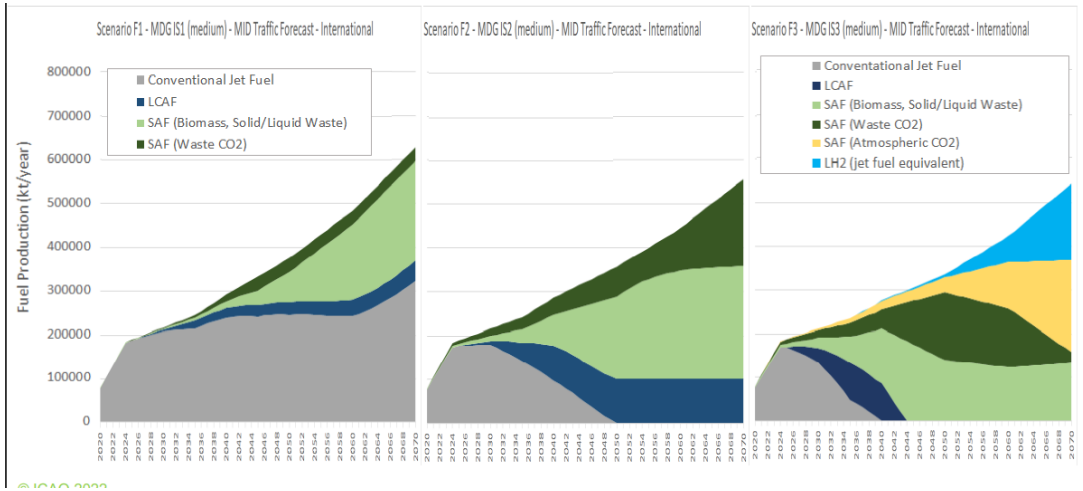
Ongoing work on ASTM process efficiency increase

Towards a 100% SATF grade



Metrics	IS1	IS2	IS3
CO_2 Emissions in 2050 after Reductions	≈**950 MtCO$_2$** in 2050 *(**160%** of 2019 CO_2 emissions)*	≈**500 MtCO$_2$** in 2050 *(**80%** of 2019 CO_2 emissions)*	≈**200 MtCO$_2$** in 2050 *(**35%** of 2019 CO_2 emissions)*
Reduction in 2050 from the Baseline	**39% total** through: Technologies - 20%, Operations - 4%, Fuels - 15%	**68% total** through: Technologies - 21%, Operations - 6%, Fuels - 41%)	**87% total** through: Technologies - 21%, Operations - 11%, Fuels - 55%
Cumulative residual Emissions from 2020 to 2070	23 GtCO$_2$ (2020 to 2050) 23 GtCO$_2$ (2051 to 2070)	17 GtCO$_2$ (2020 to 2050) 11 GtCO$_2$ (2051 to 2070)	12 GtCO$_2$ (2020 to 2050) 4 GtCO$_2$ (2051 to 2070)

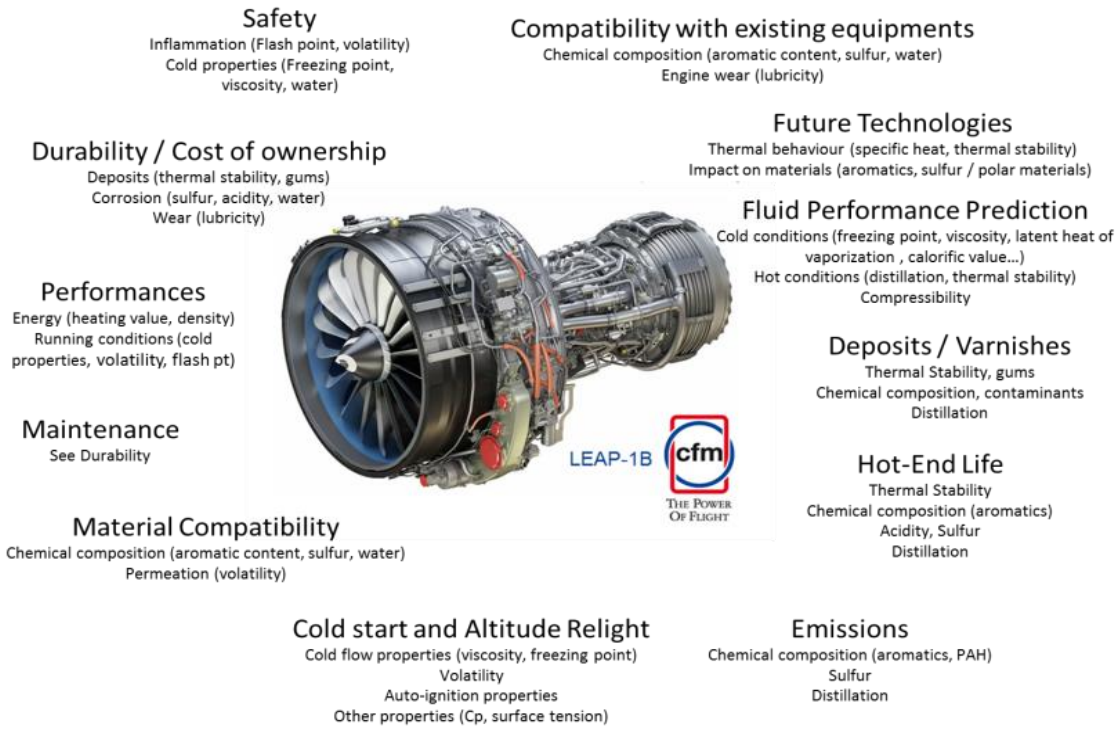
15

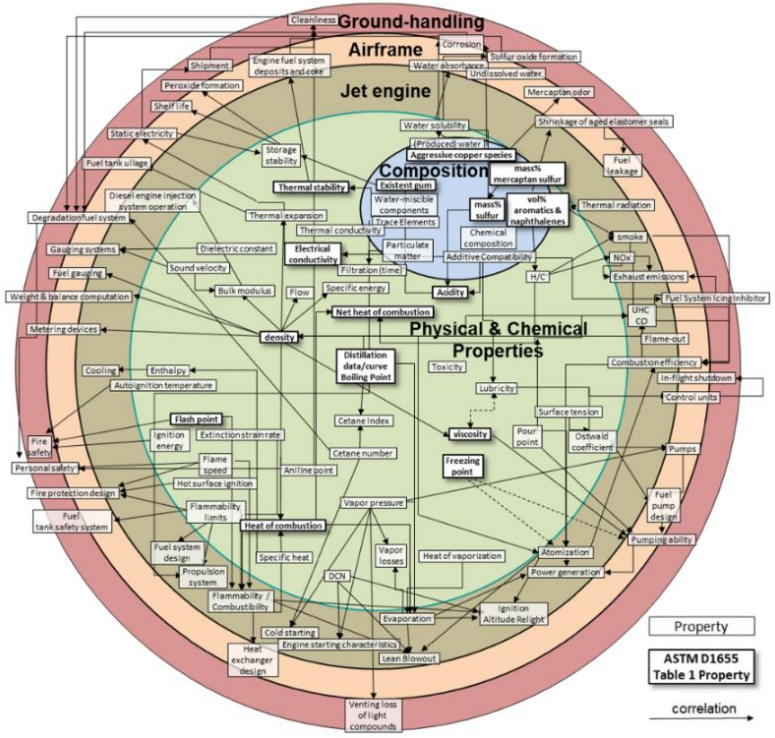


Current challenges of SATF certification

- ASTM process efficiency increase

- Disclaimer: increase of efficiency does NOT mean simplification or reduction of requirements
- ASTM process often seen as costly and complex, but compulsory in order to ensure the highest safety levels



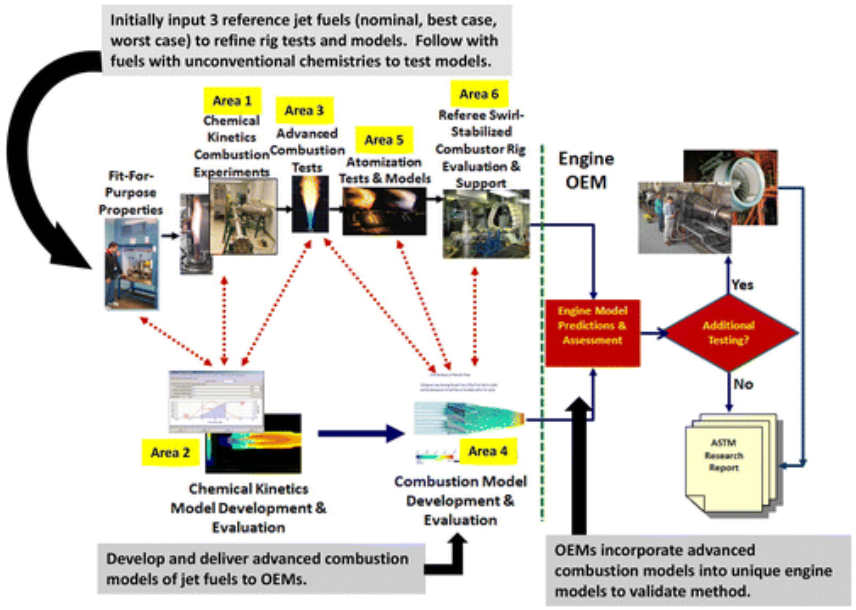


Fuel properties inter-correlations and impact on aircraft (EU Jetscreen project)

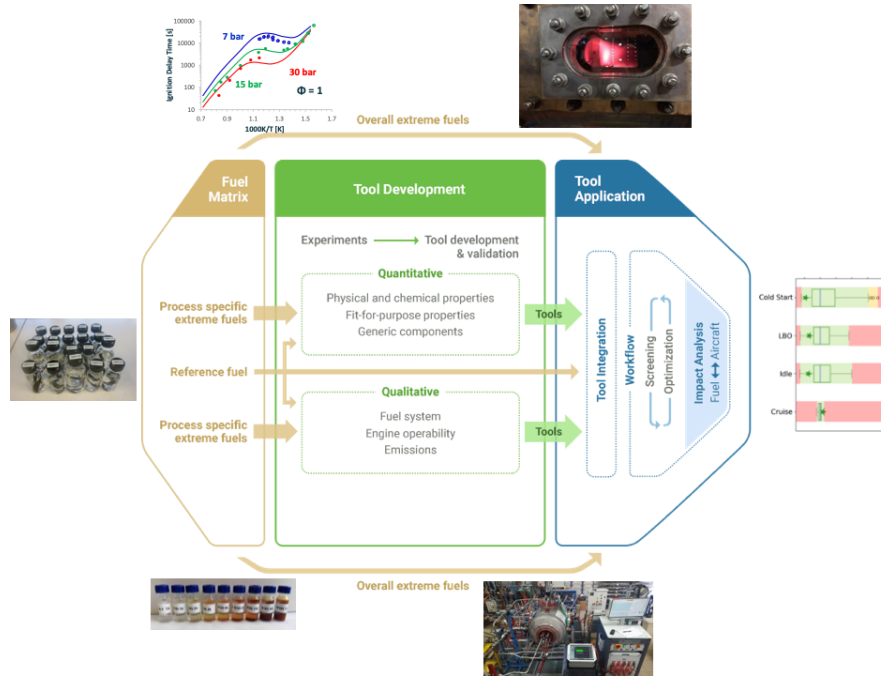
Current challenges of SATF certification

- ASTM process efficiency increase
  - Through R&T

- Better understanding of fuel / aircraft interactions
- Development of modelling tools allowing a more efficient « prescreening » of fuels



FAA ASCENT NJFCP (National Jet Fuel combustion Program)



EU Jetscreen project

Current challenges of SATF certification

- **ASTM process efficiency increase**
  - **Through increased coordination**

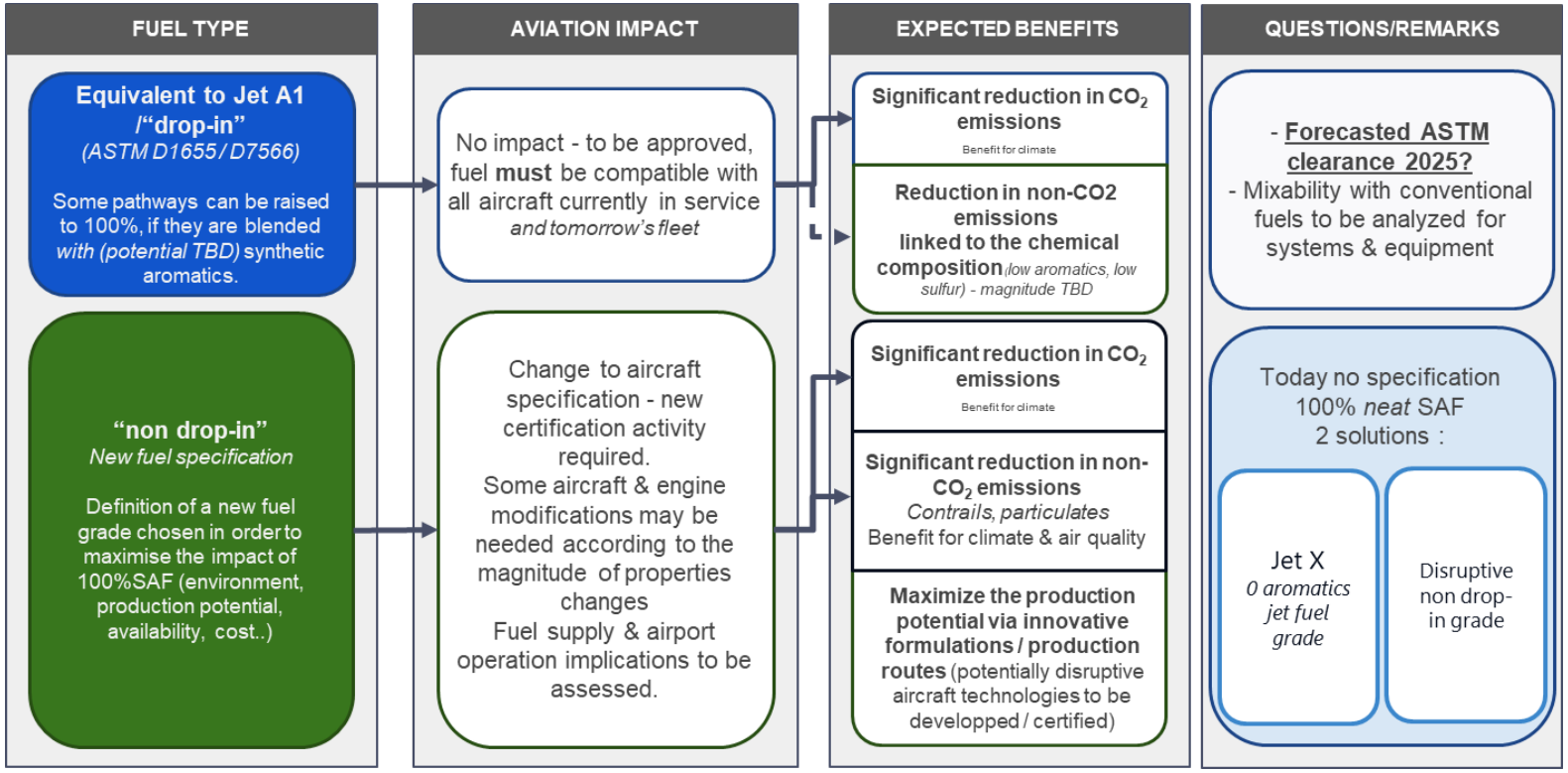
- **Creation of local « Clearinghouses »**
  - **UK clearing house**
  - **EU clearing house (EASA)**
- **Goal of EU clearinghouse :**
  - **Providing expert advice to prospective SATF producers** on SATF approval process and guiding producers who wish to enter the process.
  - **Funding and carrying out early testing.** This would include arranging tests with the appropriate testing facilities, collecting/interpreting results and assisting in the production of research reports.
  - **Process simplification by acting as a 'one-stop shop' for fuel producers**, guiding communication with key stakeholders, particularly OEMs, and providing access to testing facilities and skilled staff.

The goal of a Clearinghouse is not to replace ASTM, but to support fuel producers wishing to qualify a fuel to ASTM standards

Evolutions of SATF certification

- **Development of 100% SATF grade**

- **Current pathways limited to 50% incorporation, in order to ensure fleet compatibility (material compatibility, injection, combustion…)**
- **2 ways can be envisaged in order to remove this limit :**



Evolutions of SATF certification

- **Development of 100% SATF grade**

- **Current pathways can serve as a basis for future 100% SATF grade, allowing to target a specification at near term**

Process Pathway	Qualified Today	Blend Limit (%)	Future 100% Drop-In
FT-SPK, Fischer-Tropsch Synthetic Paraffinic Kerosene	√	50	NO
HEFA-SPK, Hydrogrocessed (Fatty) Esters and Fatty Acids Synthetic Paraffinic Kerosene	√	50	NO
HFS-SIP, Hydroprocessed Fermented Sugars Synthesized iso-Paraffins	√	10	NO
FT-SKA, Fisher-Tropsch Synthetic Kerosene with Aromatics	√	50	YES
ATJ-SPK, Alcohol-to-Jet Synthetic Paraffinic Kerosene	√	50	NO and
CHJ, Catalytic Hydrothermolysis Jet	√	50	YES
HHC-SPK, Hydroprocessed Hydrocarbon Synthetic Paraffinic Kerosene	√	10	NO
ATJ-SKA, Alcohol-to-Jet Synthetic Kerosene with Aromatics	X	50	YES
HEFA-SKA, Hydroprocessed (Fatty) Esters and Fatty Acids Synthetic Kerosene with Aromatics	X	50	YES
HDO-SAK, Hydrodeoxygenated Aromatic Kerosene	X	25	NO
CPK-0, Cycloparaffinic Kerosene	X	50	TBD or
HTL, Hydrothermal Liquefaction	X	50	YES
HFP-HEFA-SPK, High Freeze Point Hydroprocessed (Fatty) Esters and Fatty Acids Synthetic Paraffinic Kerosene	X	15-30 (TBD)	NO

Current pathways can yield product at 100% which is:

- Identical to Jet A/A-1 – fleet-wide & infrastructure-wide compatible
- Close to Jet A/A-1 but not identical – not fleet-wide & infrastructure-wide compatible
- Nothing like Jet A/A-1 – not viable jet fuel

Another path to 100% drop-in SAF:

Blending of blend components (+ =)

Drop-in 100% SAF: will need specification ASTM D7566 updated - short/medium term

Non-Drop-in 100% SAF: will need new specification, and separate infrastructure - medium/long term (if pursued)

Source : G. Andac (GE), S.Kremer (P&W), CAAFI biennal general meeting 2022

Evolutions of SATF certification

- **Development of 100% SATF grade**

- **2 ASTM task forces already created**

vs - ASTM Task Forces

Drop-in: not just compatible with particular engine and/or aircraft, but fleet-wide and infrastructure-wide compatible

	or (100% / A + B)	
Composition:	Fully formulated Jet A/A-1	**Subset** of Jet A/A-1
Applicability:	Fleet Wide drop-in	**Designated** aircraft/engines only
Example pathways:	CHJ (D7566 Annex A6), FT-SKA (D7566 Annex A4), future: ATJ-SKA, HEFA-SKA, blending of blend components	FT-SPK (D7566 Annex A1) HEFA-SPK (D7566 Annex A2) ATJ-SPK (D7566 Annex A5) *certain types*
Specification:	ASTM D7566	**New standard** needed
Substantiation/Certification:	Not required	**Required** for each intended aircraft/engine model
Infrastructure:	No impact	**Separate** supply chain/handling/storage required

CAAFI

ASTM Task Force est. Apr '21
G. Andac (GE), Vice-Chair: M. Rumizen (FAA)
Approval of use of conforming 100% synthetic fuel as Jet A/A-1

ASTM Task Force recently formed
Establishing specification of 100% SPK
NOT approval of use as Jet A/A-1 or as a new fuel; only to be used for substantiation and certification[9]

Source : G. Andac (GE), S. Kremer (P&W), CAAFI biennal general meeting 2022

Break for discussion

Questions?

Topics to be covered:

11. The current challenges of SATF certification
12. Future evolutions of SATF certification processes

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13. Open discussion

Break for discussion

Open discussion

14. Closing Remarks

ACT-SAF updates

Key request - conceptual training on SAF

ACT-SAF Series (preliminary list of sessions)
✓ #1 Introduction to SAF
✓ #2 SAF sustainability and reporting under CORSIA
✓ #3 SAF technology and certification
#4 SAF market outlook and policies
#5 SAF logistics (April)
#6 SAF economics and financing (May)
#7 Feasibility Assessment (June)

NEXT: 23rd March 8-10 AM EST

- Future sessions on specific aspects
- Subject to review – **feedback welcome**

https://www.icao.int/environmental-protection/Pages/ACT-SAF-Series.aspx

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Eastern and Southern African (ESAF) Office
Nairobi
Asia and Pacific (APAC) Sub-office
Beijing
Asia and Pacific (APAC) Office
Bangkok
THANK YOU