

# Rolls-Royce CLEEN II Sustainable Aviation Fuels

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CLEEN II Consortium-Public Day, Virtual



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## CLEEN Technologies

CLEEN Technology Name	Goal Impact	Benefits and Application
Alternative Jet Fuel Test and Evaluation (Area A)	Alternative Fuels	Promotes the development and introduction of viable, renewable alternative fuels to achieve the NextGen Air Transportation System goals. Data will be shared with the ASTM Aviation Fuel Community to support international approval of a fully synthetic jet fuel.



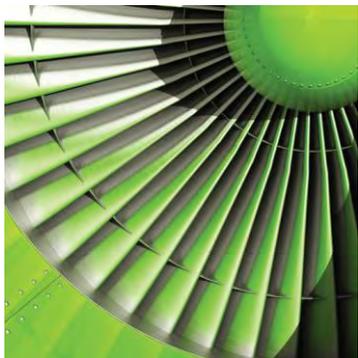
## Rolls-Royce Sustainable Aviation Fuel Program

## Elevator Speech

The Rolls-Royce Sustainable Aviation Fuel Program is promoting alternative jet fuel development, approval & deployment, which contributes to the attainment of FAA NextGen Air Transportation System goals. This robust evaluation program is characterizing a novel fully-synthetic fuel's performance under representative engine conditions. This goal is being accomplished through a series of “back-to-back” rig tests with conventional Jet A fuel to assess the fuel's impact on combustor performance and emissions. Elastomeric seal performance is also being assessed using the innovative Elastocon rig capability developed and demonstrated under CLEEN I. The data generated will be compared to prior work, assessed, and shared with the ASTM Aviation Fuel Community to support the International approval of a fully synthetic jet fuel.



## Rolls-Royce Sustainable Aviation Fuel Program



istockphoto

## Program Scope

- Promotes the development and introduction of viable renewable alternative fuels to meet NextGen Air Transportation system goals
- A robust evaluation program that is characterizing a fully synthetic fuel's performance under representative engine conditions
- Accomplished through a series of “back-to-back” rig tests with conventional Jet A fuel
- Fuel chemistry/properties relationship upon fuel spray, combustor performance, operability, and emissions
- Elastomeric seal performance due to cyclic fuel switching under more realistic engine conditions
- Data generated can be shared with ASTM Aviation Fuel Community and aid in fuel certification process



## Rolls-Royce Sustainable Aviation Fuel Program

### Benefits

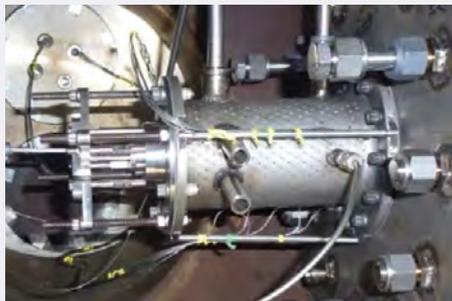
- The data generated will support the international approval of a fully synthetic jet fuel
- Enhanced methods for predicting fuel performance on engine systems to support reduced cost and timescale of approvals
- Greater data and test capability to support environmental benefits (i.e., local air quality, increasing regulations)
- Renewable, synthetic alternative jet fuel for aerospace gas turbine engine applications should provide reduced aerospace environmental impact and increased energy security



**The purpose of the Test Program is to ensure the candidate fuel will have no negative impact on engine Safety, Durability, or Performance**

## Approach

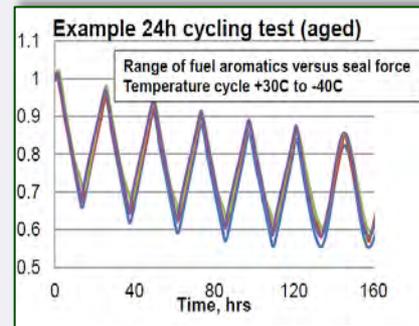
- Proven sequential test program (“back-to-back” with Jet A)
  - Fuel requirements: 2200 gallons
  - Conduct laboratory and fit-for-purpose evaluation
  - Characterize fuel spray behavior
  - Utilize combustion rigs to assess fuel impact upon performance, operability, and emissions
  - Assess elastomeric seal performance using the innovative Elastocon rig
- Data generated will be compared to prior work, assessed and reported



**Flame Tube**



**Full Annular Combustor**



**Seal Performance**



## Fuel Selected

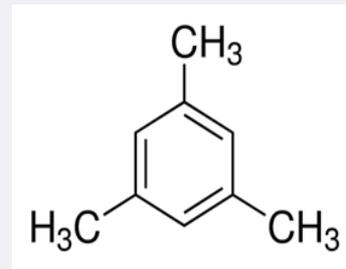
# “LanzaTech Alcohol to Jet Synthetic Kerosene with Aromatics”

87%

**Alcohol to Jet**



13%



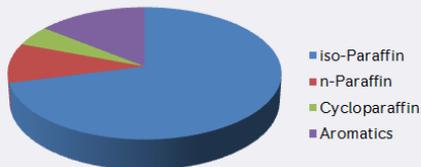
**Mesitylene**

- ✓ Fully synthetic kerosene fuel
- ✓ Allows for proper atomization and fuel system performance
- ✓ Acceptable combustion performance anticipated
- ✓ Acceptable elastomer seal performance

# Summary of ATJ-SKA Back to Back Test Results

- Laboratory characterization:
  - Primarily iso-paraffinic composition
  - Acceptable volatility, fluidity, and thermal stability
- Overall spray performance similar to Jet A fuel, with only minor differences noted
- Combustion flame tube:
  - Lean stability deteriorated slightly
  - Emissions – NO<sub>x</sub> similar, but CO and UHC emissions are higher at certain conditions, leading to lower combustion efficiency
  - Combustion liner wall temperatures are similar

### ATJ-SKA



### Chemistry



### Fuel Spray



### Combustion



## Schedule

# CLEEN II Sustainable Aviation Fuel Schedule

Rolls-Royce Sustainable Aviation Fuel Program	2016				2017				2018				2019				2020		
	Q1	Q2	Q3	Q4	Q1	Q2	Q3												
Fuel Selection & Delivery	█				█				█				█				█		
Test Program	█								█				█				█		
Draft Final Report	█															█			

Program on track to finish Q3 2020



## Sustainable Aviation Fuel Program

# Achievements

- **Completed Objectives:**
  - Laboratory and fit for purpose
  - Spray characterization
  - Elastocon compression stress relaxation data for five seal materials
  - Flame tube testing
  
- **Wrapping up:**
  - FANN rig test
  - Deliver full draft technical report 3Q2020

Program on track to deliver objectives



## Quad Chart

# Sustainable Aviation Fuel Test and Evaluation



## Benefits:

- The data generated will support the international approval of a fully-synthetic jet fuel
- Enhanced methods for predicting fuel performance on engine systems to support reduced cost and timescale of approvals
- Greater data and test capability to support environmental benefits (i.e., local air quality, increasing regulations)
- Renewable, synthetic alternative jet fuel for aerospace gas turbine engine applications should provide reduced aerospace environmental impact and increased energy security

## Objectives:

- Promote the development and introduction of viable renewable alternative fuels - NextGen Air Transportation systems goals
- Improved tools for predicting fuel performance and scientific understanding
- Data generated will aid in ASTM fuel certification process

## Work Statement:

- Assess a fully synthetic jet fuel using low NOx combustion systems to determine fuel impact on performance, operability, and emissions
- Assess elastomeric seal performance using the innovative Elastocon rig

## Accomplishments/Milestones:

- Objectives Completed: Laboratory, fit for purpose, spray characterization, Elastocon, and flame tube testing
- Wrapping up: FANN rig test and draft technical report

## Schedule:

Rolls-Royce Sustainable Aviation Fuel Program	2016			2017			2018			2019			2020		
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Fuel Selection & Delivery	[Green bar]														
Test Program									[Green bar]						
Draft Final Report															[Blue bar]

