## Rolls-Royce CLEEN II Program Overview



Brad Belcher

16 November 2022

CLEEN Consortium Public Day Charts, Virtual Meeting

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2

### **CLEEN II Technologies**

	CLEEN Technology Name	Goal Impact	Benefits and Application
Technologies	Alternative Jet Fuel Test and Evaluation (Area A)	Alternative Fuels COMPLETED	Promote the development and introduction of viable, renewable alternative fuels to achieve the NextGen Air Transportation System goals
	Advanced RQL Low NOx Combustion System	NOx Reduction	Demonstrate an RQL combustor with 65% reduced NOx relative to CAEP/8 limits
	Boeing Short Nacelle Flight Demo	Weight and Drag Reduction	Verify characteristics in flight with angle of attack affects
© 2022 Rolls-Royce Non-Technical Data		Tests COMPLETED,	, reports in process



**FAA CLEEN** 

## Flight Demo of Boeing Short Nacelle

- Ground testing conducted under Boeing CLEEN II Contract
  - Boeing baseline and short nacelles
  - Rolls-Royce Trent 1000 Engine
  - Testing at Rolls-Royce outdoor facility at NASA Stennis
  - Successfully completed to TRL 6



## Follow-on flight testing under RRC CLEEN II Contract

- Testing moving to Rolls-Royce
  747 Flying Test Bed to evaluate
  angle of attack effects to TRL 7
- Flight completed on 8 September 2022





# Test hardware and aircraft















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#### **Artwork Installed**





FAA CLEEN II

- Flight Demo of Boeing Short Nacelle
- Back-to-back testing conducted on the Rolls-Royce 747 Flying Test Bed at Tucson, AZ to TRL 7
- Data analysis and final reporting in process
- Thanks for the Boeing, Rolls-Royce, and FAA collaboration team on this fuel burn reduction technology











## Rolls-Royce CLEEN III Program Overview



Steve Mazur

16 November 2022

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#### **CSTAR Gen2 Rig**



## **Rolls-Royce CLEEN III Program**

- Rolls-Royce is developing advanced centrifugal compressor stage technologies to improve the performance of a high overall pressure ratio axial-centrifugal compression system.
- The goal of the work is to improve both component efficiency and surge margin while reducing the physical size of the machine.
  - Combined centrifugal stage efficiency target: 0.3% (~0.3% Fuel Burn)
  - Combined centrifugal surge margin target: +2%
  - Engine performance model will be used to calculate engine and fleet level impact
- The effort includes design, fabrication, and assessment of candidate technologies, including testing in the Centrifugal Stage for Aerodynamic Research (CSTAR) rig at Purdue University.
- Through this approach, concepts are progressed from TRL3 to TRL5.



### **CSTAR GEN2.5 CF Compressor Rig**

- Rig allows for inexpensive printing of downstream diffuser and deswirler geometries
- Sectors are printed from high temperature capable polymer
- Enables optimization of the diffuser and deswirler as a system
- Diffuser technologies to be studied include injection holes and end wall contouring
- Deswirl technologies to be studied include vane configuration and 3D geometry





#### CSTAR Gen2.5 Rig



### **CLEEN III CSTAR Test Sequence**

#### Testing planned from 2022 Qtr 4 through Qtr 2 2024



Aerodynamic technologies which are successful will be considered TRL5 at program conclusion.

