Rolls-Royce CLEEN II Program Overview

Brad Belcher

8 November 2023

CLEEN Consortium Public Day Charts, Virtual Meeting

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USAF Strategic Bomber

US Army Future Long-Range Assault Aircraft (FLRAA)

Ready To Deliver.

Who We Are

Rolls-Royce is a leading power & propulsion systems company.

We pioneer cutting-edge technologies that deliver clean, safe and competitive solutions to meet our planet's vital power needs.

World-Class Engineers & Manufacturers

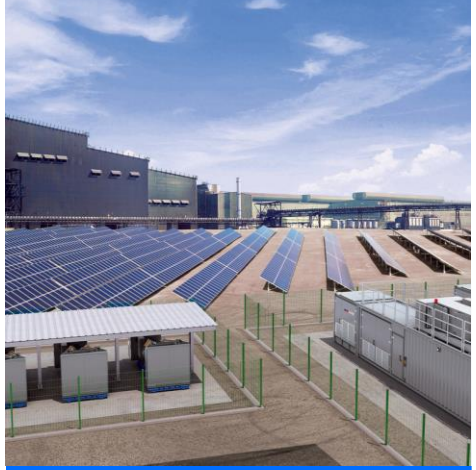
Innovators

Digital Pioneers

What We Do

Rolls-Royce is tightly focused into **three operating businesses.**

Civil Aerospace



Power Solutions

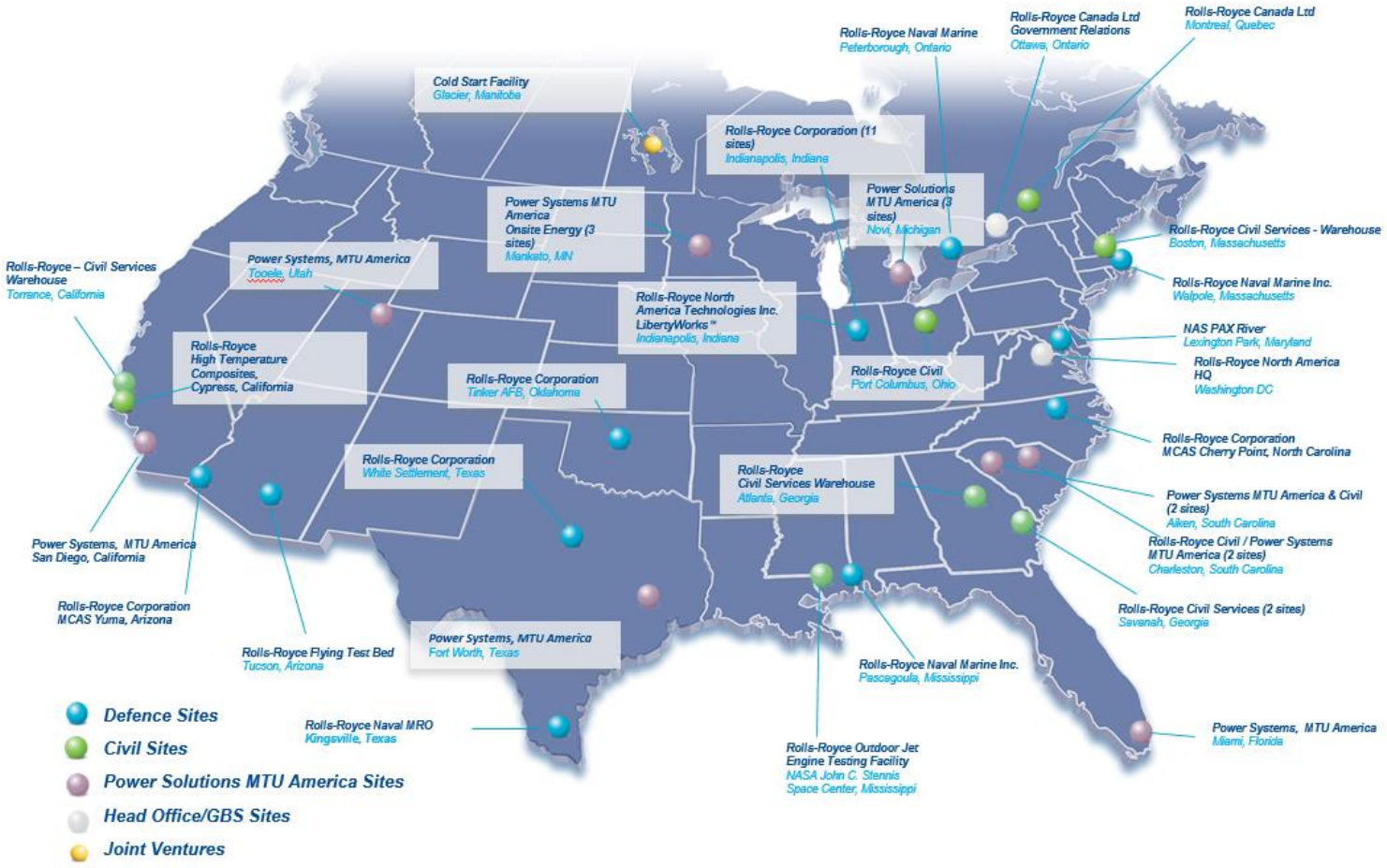
Defense

Our Footprint

Rolls-Royce directly employs more than **5,200 diverse high-skill US teammates** and supports tens of thousands of jobs across our downstream network ($1.6B Annual US Supplier Spend).

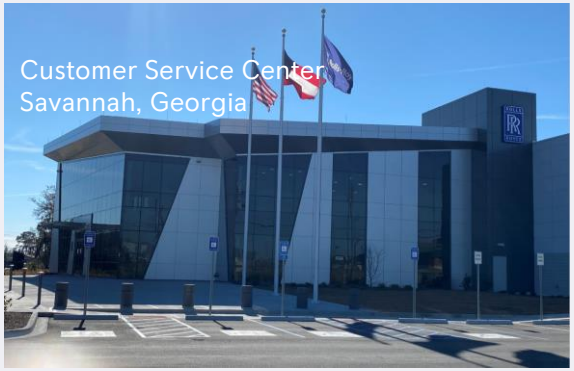
Since 2015, we have invested more than **$1B in our US facilities**.

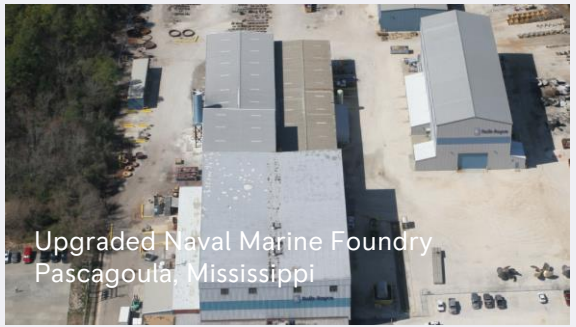
We also operate a number of University Technology Centers (UTCs) in the US, and support several apprentice and workforce development programs at our flagship sites.



We’re investing in our US facilities

More than $1B invested in US facilities and capabilities since 2015 to serve the future needs of our customers.





NetZero

We are committed to achieving **NetZero carbon** across our value chain, while still delivering leading technologies to our civilian and defense customers.

Rolls-Royce Will:

- ✓ Reach NetZero carbon from our operations by 2030
- ✓ Reach 75%+ of R&D spending invested in NetZero technology by 2025
- ✓ Reach NetZero carbon across our value chain by 2050

Electric Flight

Sustainable Fuels


Small Modular Reactors


Microgrids


Industry-Leading Battery Technology

Civil Aerospace

Our Civil Aerospace group is a major manufacturer of high-performance aircraft engines.

Our Civil Aerospace group is a major manufacturer of aircraft engines, **leading the wide body commercial and business jet propulsion markets**.

All-in production Civil Aero engines will be certified 100% Sustainable Aviation Fuel Compatible by 2023.

385+ Million

Flight Hours on Rolls-Royce Engines

Defense

We are the **engine market leader** in **transport and patrol aircraft**, and power a broad range of engines for **combat aircraft** and **helicopters.**

Rolls-Royce is the only fielded **tilt-rotor** and **STOVL** aircraft propulsion provider for the US military.

Rolls-Royce is also the **primary propeller supplier for the US Navy** and a pioneer aero-derivative marine engines for the DoD.

Rolls-Royce CLEEN III Program Overview

Stephen Krautheim

8 November, 2023

CLEEN Consortium Public Day Charts

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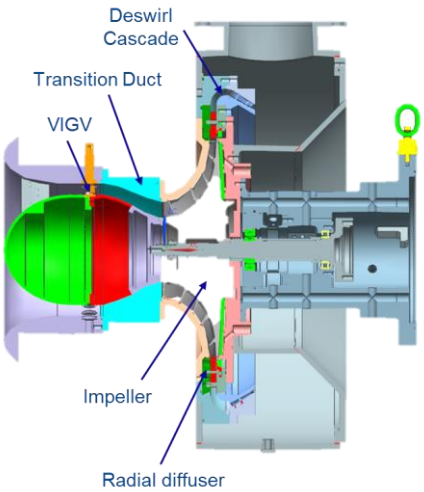
Rolls-Royce CLEEN III Program

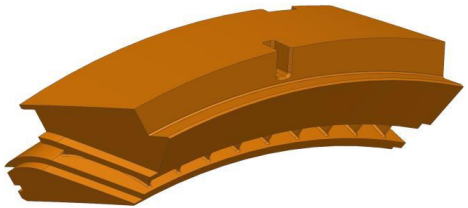
CSTAR Gen2 Rig

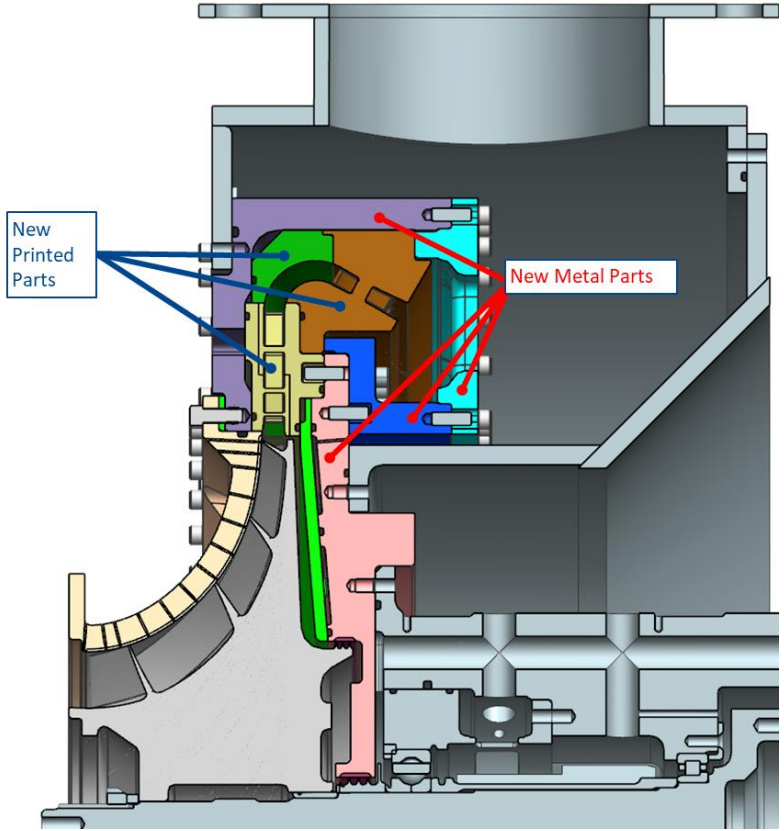


- Rolls-Royce is developing advanced centrifugal compressor stage technologies to improve the performance of a high overall pressure ratio axial-centrifugal compression system.
- The goal of the work is to improve both component efficiency and surge margin while reducing the physical size of the machine.
  - 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



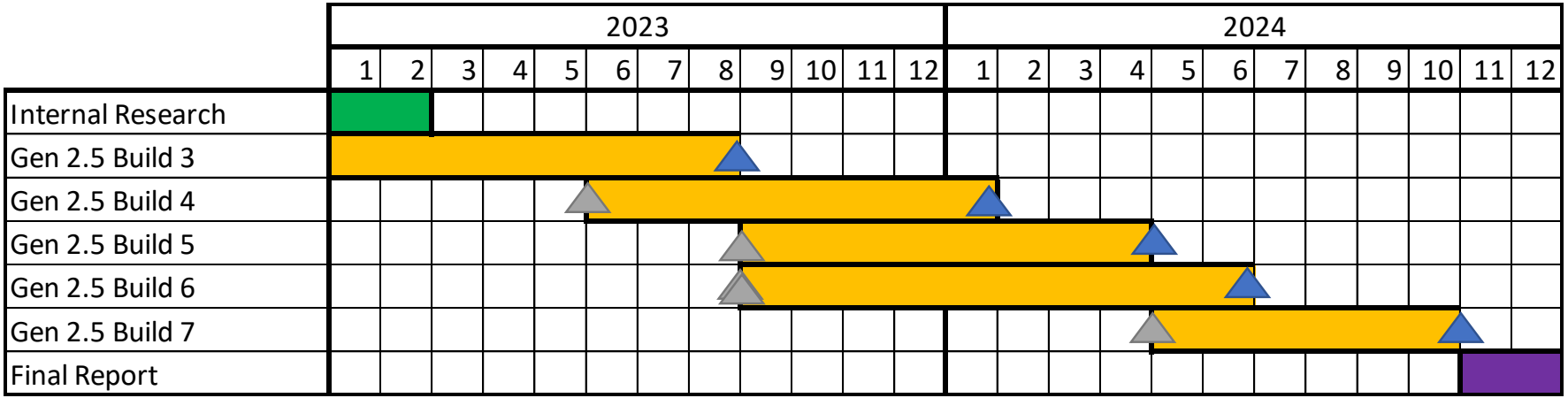


CSTAR Gen2.5 Rig

CLEEN III CSTAR Test Sequence

Testing will continue through end of 2024

Rolls-Royce Baseline	
CLEEN III Funding	
TRL 3	
TRL 5	



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