Collins Aerospace

ACOUSTIC EXHAUST TECHNOLOGY DEMONSTRATOR

CLEEN III Consortium Public Industry Day

November 16, 2022

Raytheon Technologies

Collins Aerospace

NET SALES $19 BILLION

Pratt & Whitney

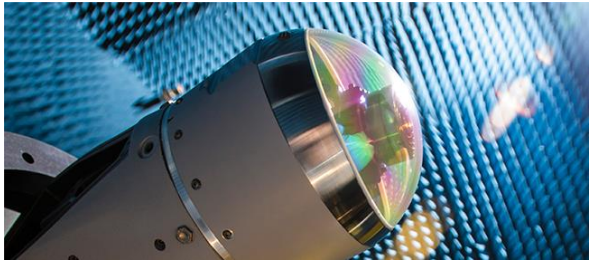
NET SALES $17.2 BILLION

Raytheon Intelligence & Space

NET SALES $15 BILLION

Raytheon Missiles & Defense

NET SALES $15.3 BILLION



COLLINS AEROSPACE BUSINESS UNITS

ADVANCED STRUCTURES

- Actuation
- Landing systems
- Nacelle systems
- Flight controls
- Pilot controls
- Propellers
- Naval composites
- Other highly engineered aerospace structures

AVIONICS

- Aircraft sensors
- Avionics systems
- Cabin management systems
- Fire protection
- Hoist and winch systems

CONNECTED AVIATION SOLUTIONS

- Airport systems
- Applications, analytics & data products
- Business aviation flight support services
- Connectivity & network services
- Passenger & freight rail control systems

INTERIORS

- Aircraft seating
- Cargo systems
- De-icing products
- Evacuation systems
- Galleys and galley inserts
- Interior systems
- Lavatories
- Life rafts
- Lighting
- Potable water systems
- Veneers

MISSION SYSTEMS

- Communication, navigation and guidance
- Electronic warfare
- Ejection seats
- Intelligence, surveillance and reconnaissance
- Missile actuation
- Simulation and training
- Space solutions
- Strategic command and control
- Unmanned aircraft systems

POWER & CONTROLS

- Air management
- Airframe controls
- Electric systems
- Engine controls

SUSTAINABILITY AT COLLINS AEROSPACE

PERSPECTIVE CHANGES EVERYTHING

As one of the largest aerospace companies in the world, we are in a unique position to lead a positive impact on the future.

Sustainability is at the core of how we operate, and now we are committed to doing more.

COLLABORATION

Inspiring our people, communities, customers and industry to work together for a brighter future

RESEARCH AND DEVELOPMENT

Investing in R&D to pioneer more sustainable technologies

PRODUCT SOLUTIONS

Innovating safer, smarter and more resilient solutions

ENVIRONMENTAL IMPACT

Driving resource-efficient practices throughout aviation

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SUSTAINABILITY AT COLLINS AEROSPACE

Environmental impact by the numbers

IMPACT SINCE 2015

- ↓ 18% — LESS GREEN HOUSE GAS (GHG) EMISSIONS (131 MT CO_2)
- ↓ 25% — LESS WATER USE (205 M GAL.)
- ↓ 35% — LESS HAZARDOUS WASTE (13.7 M LBS.)
- ↓ 90% — LESS INSOLVENT AIR EMISSIONS 2015 TO 2019

2025 GOALS

- ↓ 10% — REDUCED GHG EMISSIONS
- ↓ 10% — REDUCED WATER CONSUMPTION
- ↓ 10% — REDUCED WASTE TO LANDFILL & INCINERATION
- 100% — IMPLEMENT WATER, WASTE, GHG & ENERGY BEST PRACTICES

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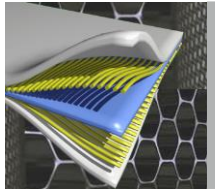
SUSTAINABLE PRODUCT SOLUTIONS

Enabling technologies to decarbonize for current and future aircraft

Emissions Impact

Supporting Sustainable Aviation Fuels (SAF)
- Sustainably produced
- Deliverable at scale
- SAF-ready systems and components

Supporting Hydrogen
- Hydrogen combustion
- Fuel cell propulsion
- Fuel cell emergency power



Lighter-weight, energy-efficient systems and equipment
- Composite materials, thermoplastics, additive manufacturing
- Future Nacelle
- Lightweight cabin

Hybrid-electric propulsion
- Next generation propeller systems
- Motor / control and battery systems
- More electric aircraft systems

Aircraft trajectory & ground operations improvements
- Advancing trajectory-based operations (TBO)
- Airport and airline operations
- Artificial intelligence

2050

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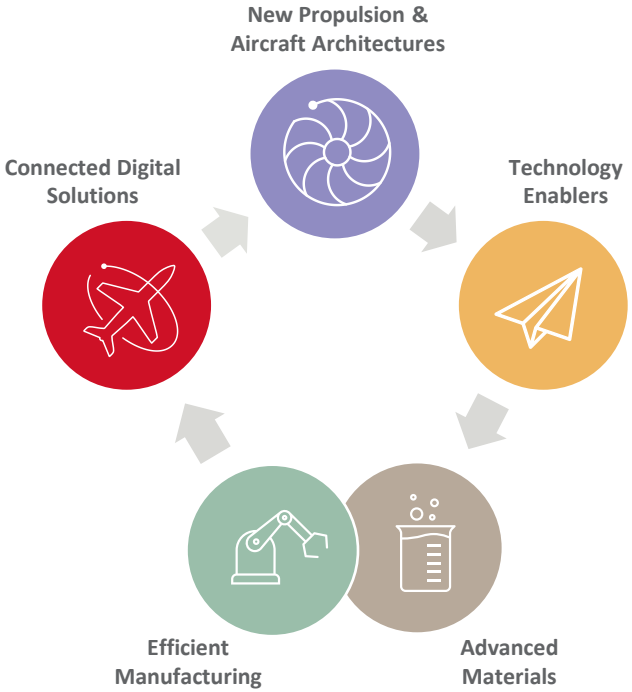
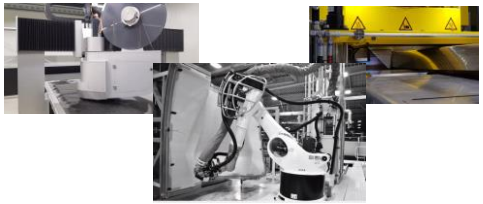
ADVANCED STRUCTURES

Leading the sustainability transformation

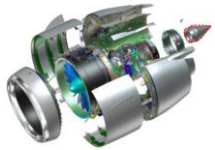


Thermoplastics Structures



Out of autoclave…**60% energy reduction**
Durable materials…**100% recyclable**
Welded designs…**10% lighter**

Next-Gen Acoustics



Next gen acoustic exhaust…**1.5 EPNdB**
UHBR/Short Inlet Enabler
Lower Acoustic Area without Noise Penalty

Next Gen Aircraft Architectures

Thin wing… **8-10% lower fuel burn**
Propulsion… **2-3% lower fuel burn**

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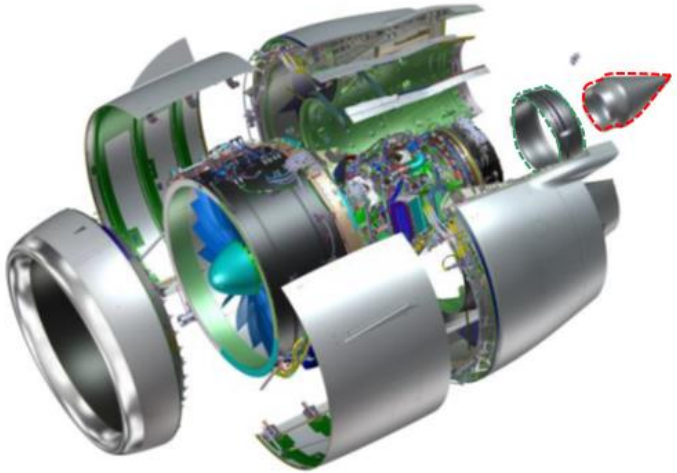
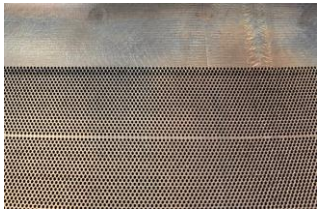
ACOUSTIC EXHAUST TECHNOLOGIES

Technology	Goal Impact	Benefits and Application
Advanced Acoustic Exhaust	Noise Reduction	0.9 – 1.5 EPNdB



Acoustic Chamber….



….combined with novel liners

Large Cell Acoustic Liners In Work
IP Sensitive

INNOVATIVE
PRODUCIBLE ✓ COST EFFECTIVE

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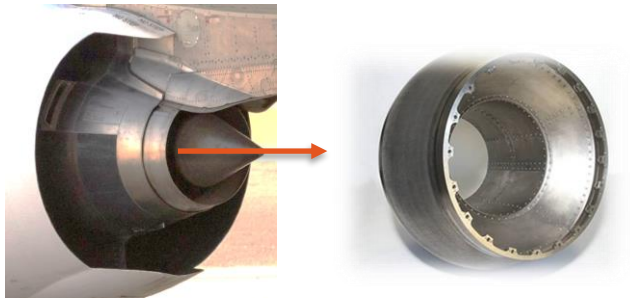
ADVANCED ACOUSTIC EXHAUST



Benefits:

- Noise Reduction: 0.9 - 1.5 EPNdB
- Fuel Burn Improvement: Neutral

Risks/Mitigations:

- Novel core producibility with exhaust relevant materials is unknown / Perform fabrication trials
- Close tolerances of bonding skins / Assess build repeatability

Objectives:

- Develop and demonstrate an advanced acoustic exhaust
- Advance manufacturing maturity/producibility of novel cores

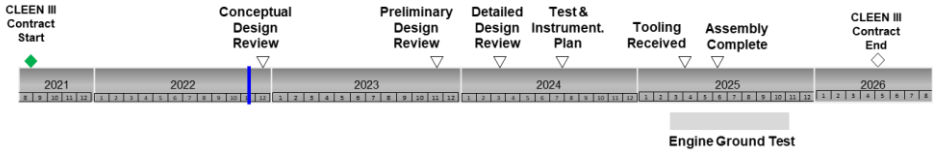
Work Statement:

- Novel core geometries tuned to exhaust tones
- Manufacturing feasibility studies with relevant alloys
- Flat panel mechanical and acoustic property tests
- Demonstrator design, fabrication, and acoustic testing

Progress Update:

- Acoustic conceptual configuration defined
- Producibility trials (1st material assessed, 2nd material ongoing)
- MRL 3 on schedule
- On schedule for CDR

Schedule:



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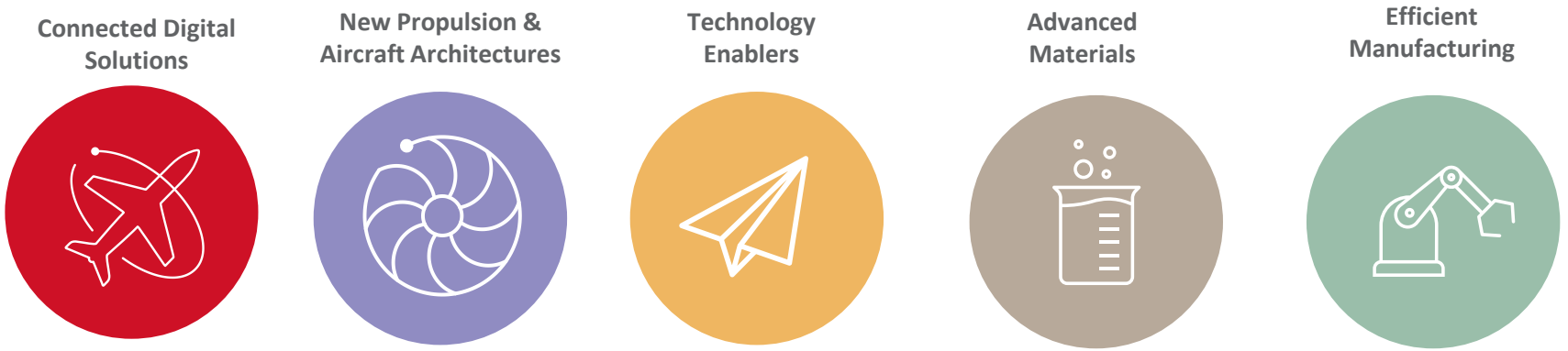
SUMMARY

- Advanced acoustic exhaust technology, noise reduction 0.9 – 1.5 EPNdB
- Acoustic evaluations underway
- Novel core geometry finalized
- Fabrication evaluations with relevant materials in work



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THANK YOU!