Boeing CLEEN II Program Update

Structurally Efficient Wing (SEW)

Consortium Plenary Session
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Nov 21, 2019

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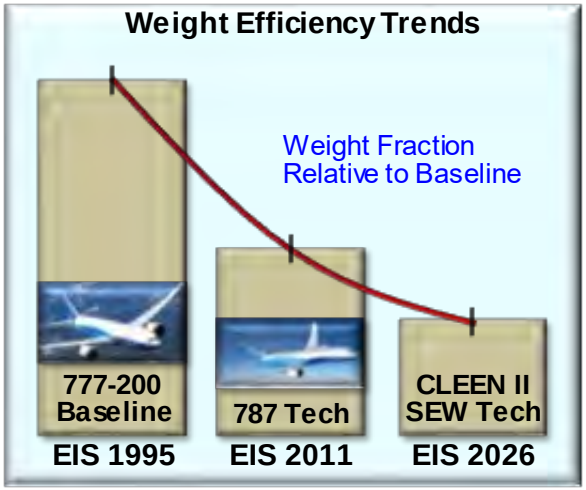
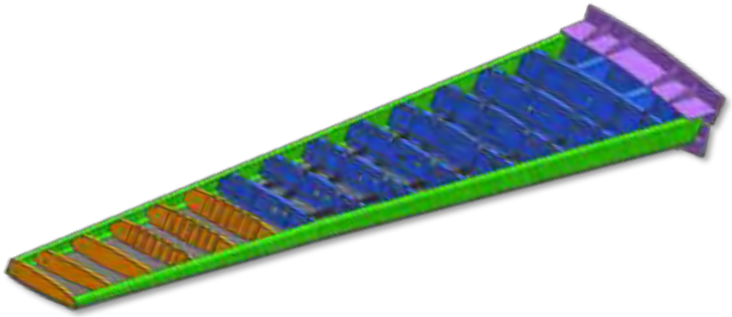
CLEEN II

Structurally Efficient Wing:

- Develop, build, and test a next-generation wing structure that demonstrates significant improvements in structural efficiency
- Show a continued weight reduction as compared to the 777-200 baseline
- Contribute to the FAA CLEEN II goal of reducing fuel burn, potentially reducing fuel consumption up to 3.5% through weight reduction of the wing.





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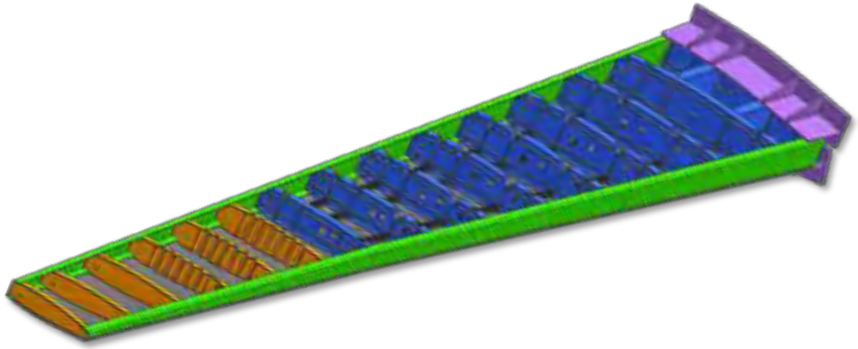
Structurally Efficient Wing (SEW)



Anticipated Benefits: *Cumulative predicted impact over twenty years:*

- *Jet A fuel consumption savings of approximately 200 million tons*
- *CO2 production avoidance of approximately 660 million tons*

Risks/Mitigation Plans:

- *Risks Identified, mitigation plans in place*

Objectives: *Demonstrate a suite of material and structural technologies that will contribute to the FAA's CLEEN II goal of achieving fuel burn reductions by 2026.*

Work Statement: *Boeing's disciplined development and building-block test approach will mature structural wing technologies and will demonstrate via the Wing Component Test Article (WCTA).*

Accomplishments/ Milestones since Boeing initiated this technology/project:

- ✓ *Oct 2015 ATP (completed)*
- ✓ *Mar 2016 CoDR (completed)*
- ✓ *Jan 2017 PDR (completed)*
- ✓ *Jul 2017 DDR (completed)*
- ✓ *Aug 2018 TRR (completed)*
- ✓ *Mar 2019 Full Scale Testing (completed)*
- ✓ *July 2019 Test Report*
- *April 2020 Final Report (Test Opportunity)*
- *June 2020 Final Briefing*

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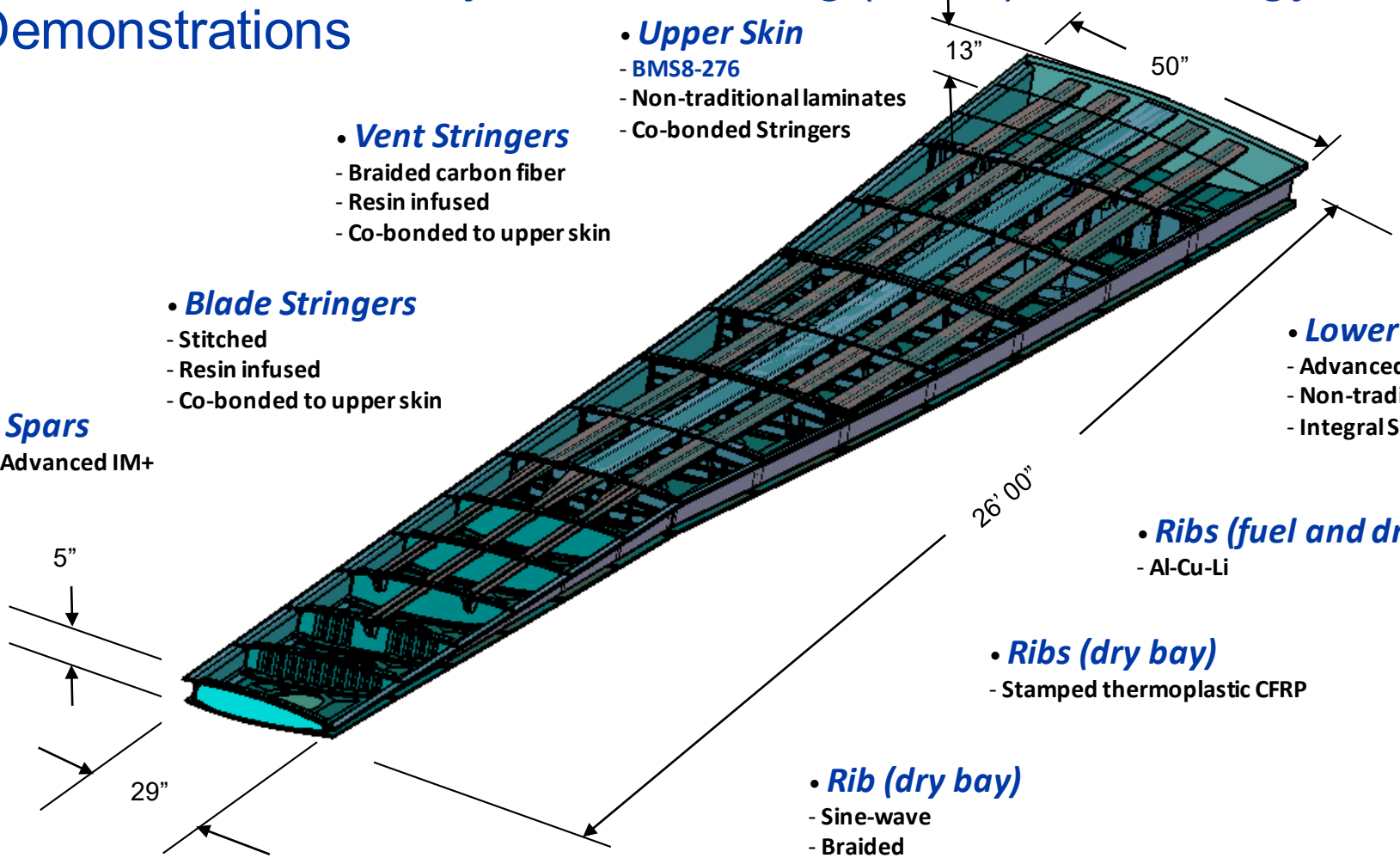
CLEEN II Structurally Efficient Wing (SEW) Technology Demonstrations



- ***Upper Skin***
  - BMS8-276
  - Non-traditional laminates
  - Co-bonded Stringers
- ***Vent Stringers***
  - Braided carbon fiber
  - Resin infused
  - Co-bonded to upper skin
- ***Blade Stringers***
  - Stitched
  - Resin infused
  - Co-bonded to upper skin
- ***Spars***
  - Advanced IM+
- ***Lower Skin***
  - Advanced IM+
  - Non-traditional laminates
  - Integral Stringers
- ***Ribs (fuel and dry bay)***
  - Al-Cu-Li
- ***Ribs (dry bay)***
  - Stamped thermoplastic CFRP
- ***Rib (dry bay)***
  - Sine-wave
  - Braided
  - Resin infused

Reduce Weight up to 28% as Compared to the 777-200

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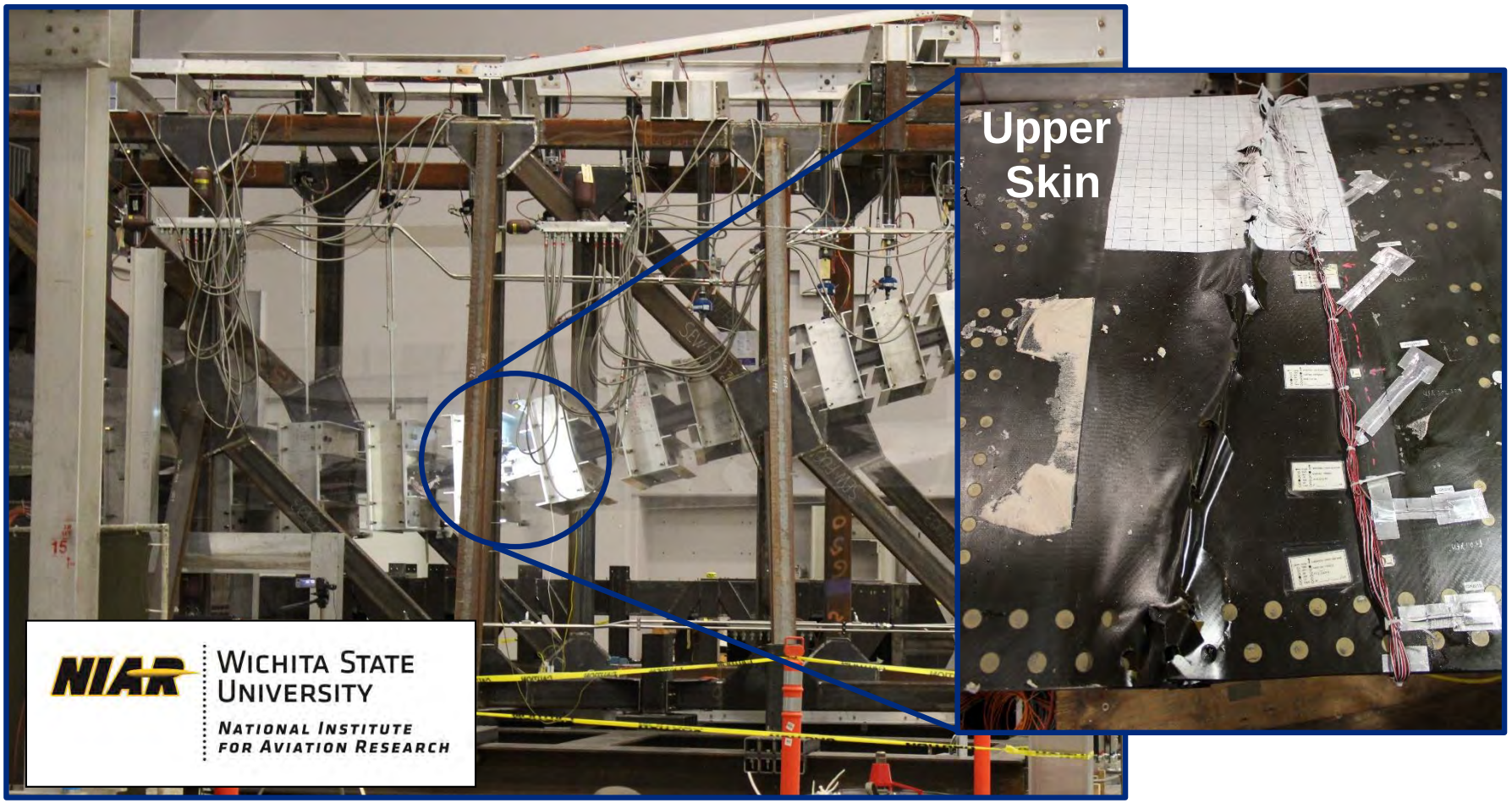
SEW WCTA Residual Strength Test



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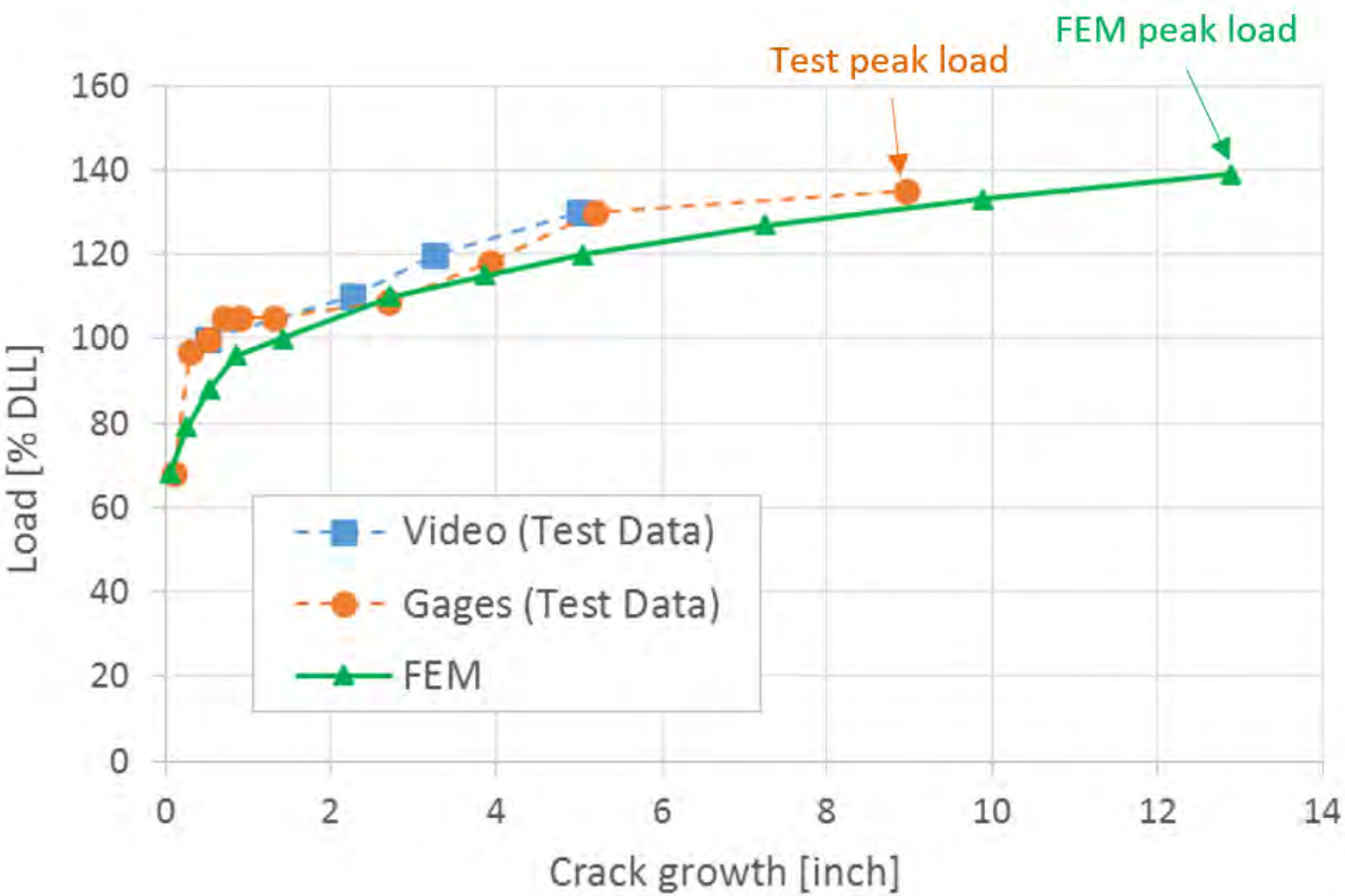
Residual Strength Test Analysis



Excellent Correlation of Test Data and Analysis

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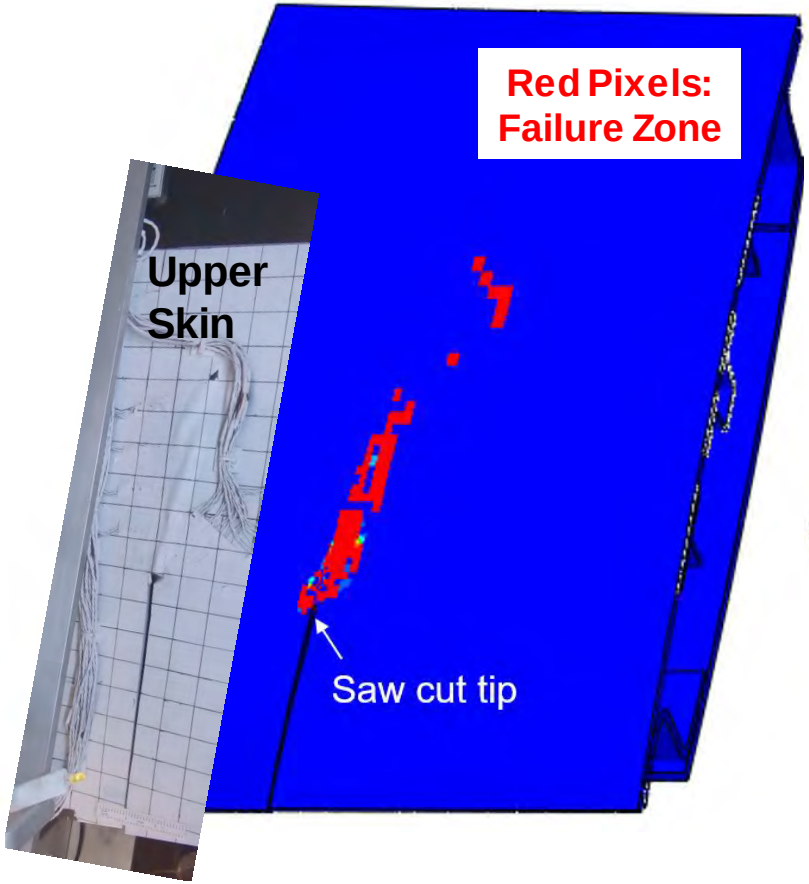
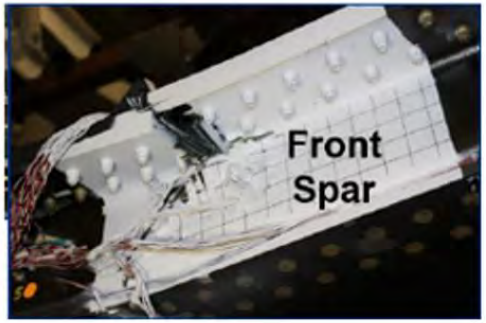
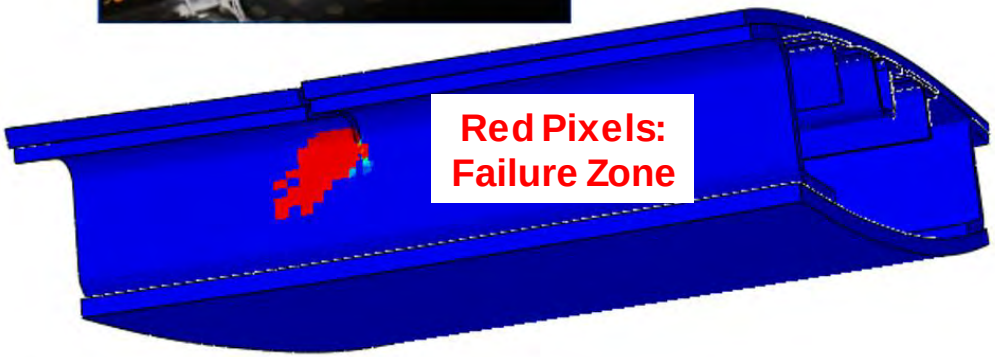
Residual Strength Model Behavior







Excellent Correlation of Model Behavior

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Opportunity for Additional Panel Test and NTL Data Correlation

Notched Panel Test:

- Existing Test Article
- Risk Reduction for High Modulus Light Weight Lower Skins

NTL Data Correlation

- Correlate SEW coupon and WCTA test data with current methods
- Risk Reduction for NTL Skins

SEW Final Report Updated in April 2020 with Final Briefing in June 2020

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SEW Summary

Boeings CLEEN II technologies represent some of our highest impact concepts with a clear path to certification and implementation.

- SEW contributes to the FAA's CLEEN II goal of reducing fuel burn
- FAA & Industry benefit from continued CLEEN program investment and collaboration.
- The building-block test approach on SEW developed the selected technologies along the TRL scale, resulting in a TRL 6 demonstration with the completion of the Wing Component Test Article (WCTA) full scale test series

WCTA Test Results Support the Transition of SEW Technologies to Commercial Transport and Military Applications

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Acronyms

ATP	Authority to Proceed
CoDR	Concept Design Review
DDR	Detailed Design Review
DLL	Design Limit Load
EIS	Entry into Service
NIAR	National Institute for Aviation Research
PDR	Preliminary Design Review
SEW	Structurally Efficient Wing
TRL	Technology Readiness Level
TRR	Test Readiness Review
WCTA	Wing Component Test Article

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