Engineering, Operations & Technology
Boeing Research & Technology

CLEEN II –
Structurally Efficient Wing (SEW)

Presented to: CLEEN II Consortium Public Session

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Boeing -Structurally Efficient Wing (SEW) Elevator Speech

Boeing will develop, build, and test a next-generation wing structure that demonstrates significant improvements in structural efficiency.

SEW could potentially reduce fuel consumption up to 3.5% through weight reduction of the wing.

SEW contributes to the FAA's CLEEN II goal of reducing fuel burn.

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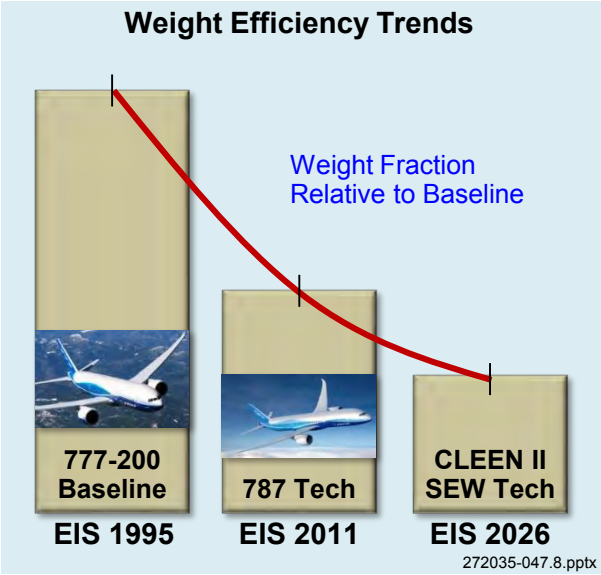
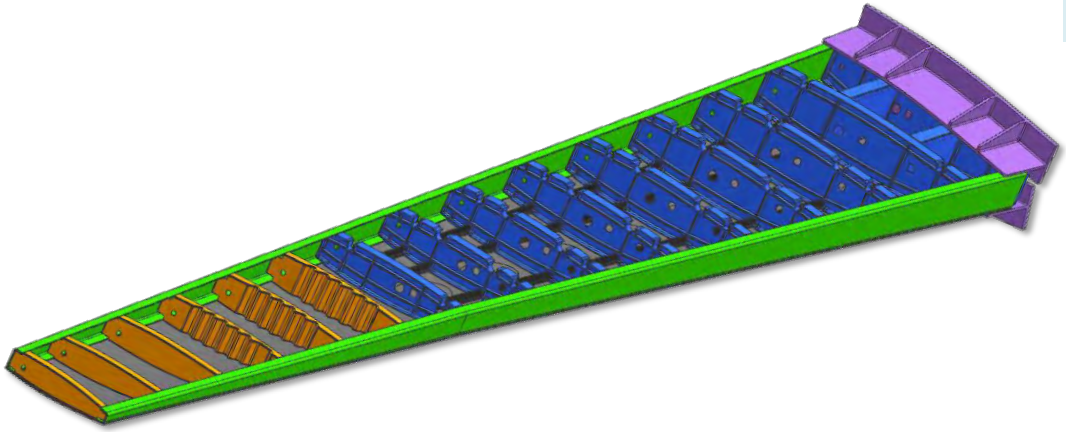
Boeing -Structurally Efficient Wing (SEW)

Under CLEEN II, the goal of the Boeing project is to develop and demonstrate advanced aircraft wing technologies that show a continued weight reduction as compared to the 777-200 baseline





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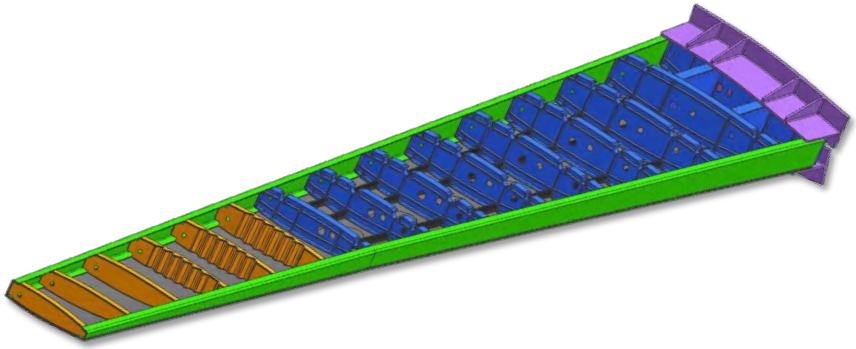
Boeing Structurally Efficient Wing (SEW)



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:

- *OTA Signed Oct 2015*
- *CoDR completed Mar 2016*
- *PDR completed Jan 2017*

Schedule:

- *Oct 2015 ATP (completed)*
- *Mar 2016 CoDR (completed)*
- *Jan 2017 PDR (completed)*
- *Jul 2017 DDR*
- *Jun 2018 TRR*
- *Jun 2019 Program End*

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CLEEN II SEW Technologies

New technologies enable changes in the wing architecture:	Goal Impact	Benefits and Application
• Advancing manufacturing technologies • Modeling- Rapid finite element modeling configuration optimization • Advanced prepreg composites • Resin-infused stitched blade stringers • Resin-infused hat stringers • Advanced alloy metallic ribs • Resin-infused sine wave rib • Stamped thermoplastic ribs	Fuel burn reduction	Lower weight, higher performance wing

All of these technologies are contributing to the fuel consumption reduction goal by reducing structural weight

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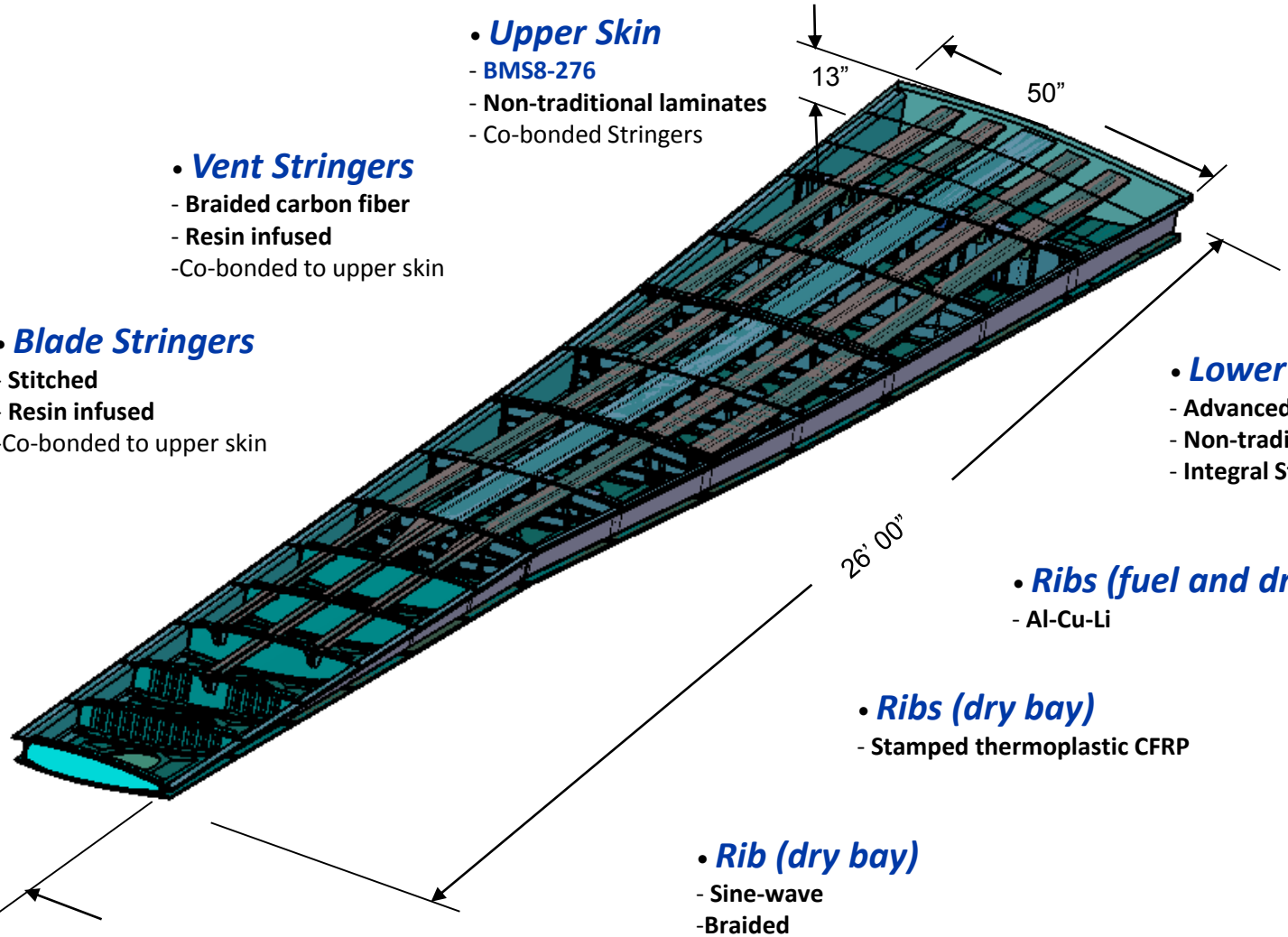
CLEEN II Structurally Efficient Wing (SEW) Technology Demonstrations

The Goal of the Structurally Efficient Wing is reduce wing weight up to 28% as compared to the 777-200



- ***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**

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Project Year 1-2 Major Achievements
CLEEN II - Boeing - Structurally Efficient Wing

- ***OTA signed Oct 7, 2015***
- ***Concept of Design Review (CoDR) completed early***
- ***Assembly Layout (ALO) completed***
- ***Preliminary Design Review (PDR) completed early***

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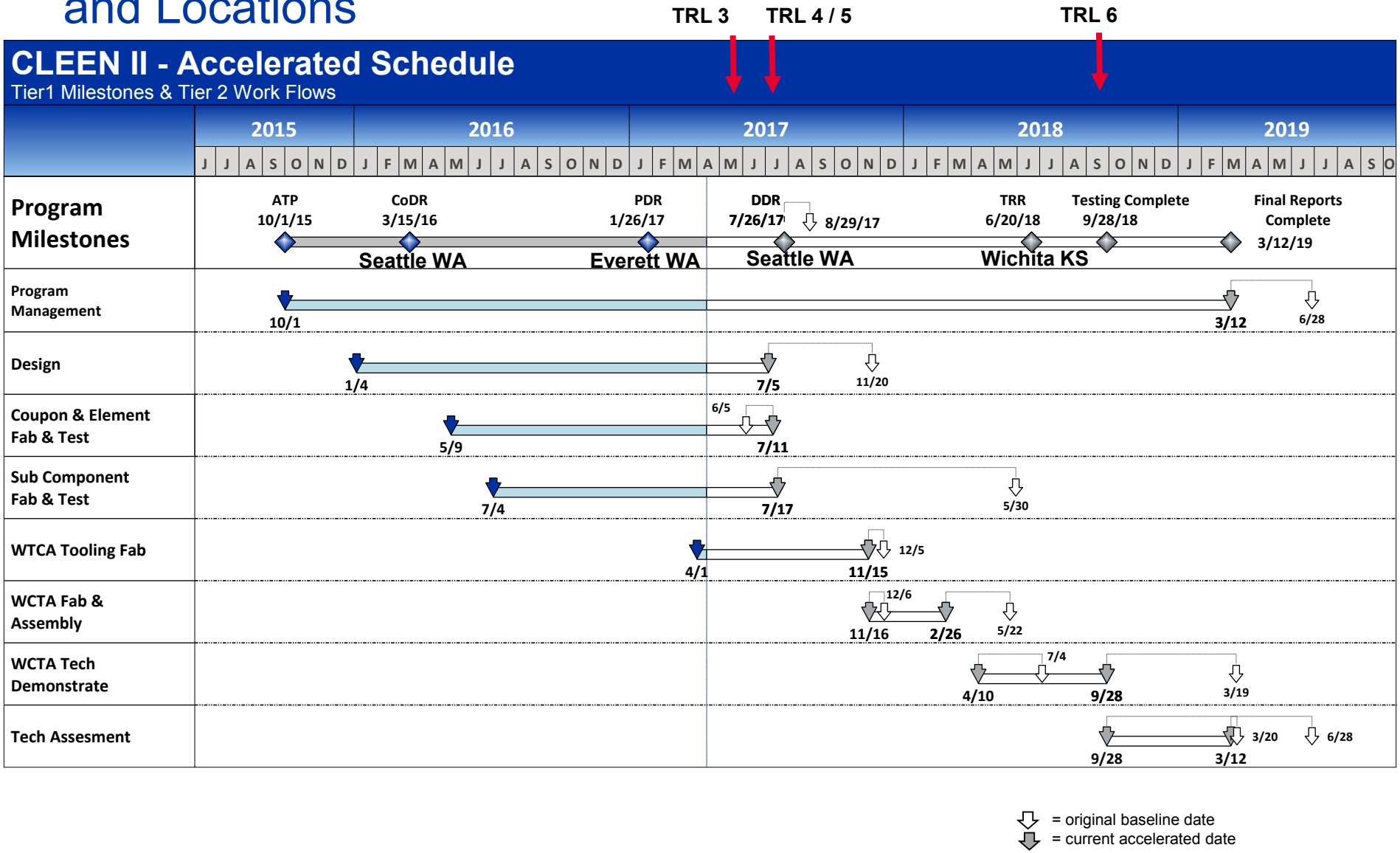
CLEEN II Boeing SEW – Accelerated Schedule with TRL and Locations



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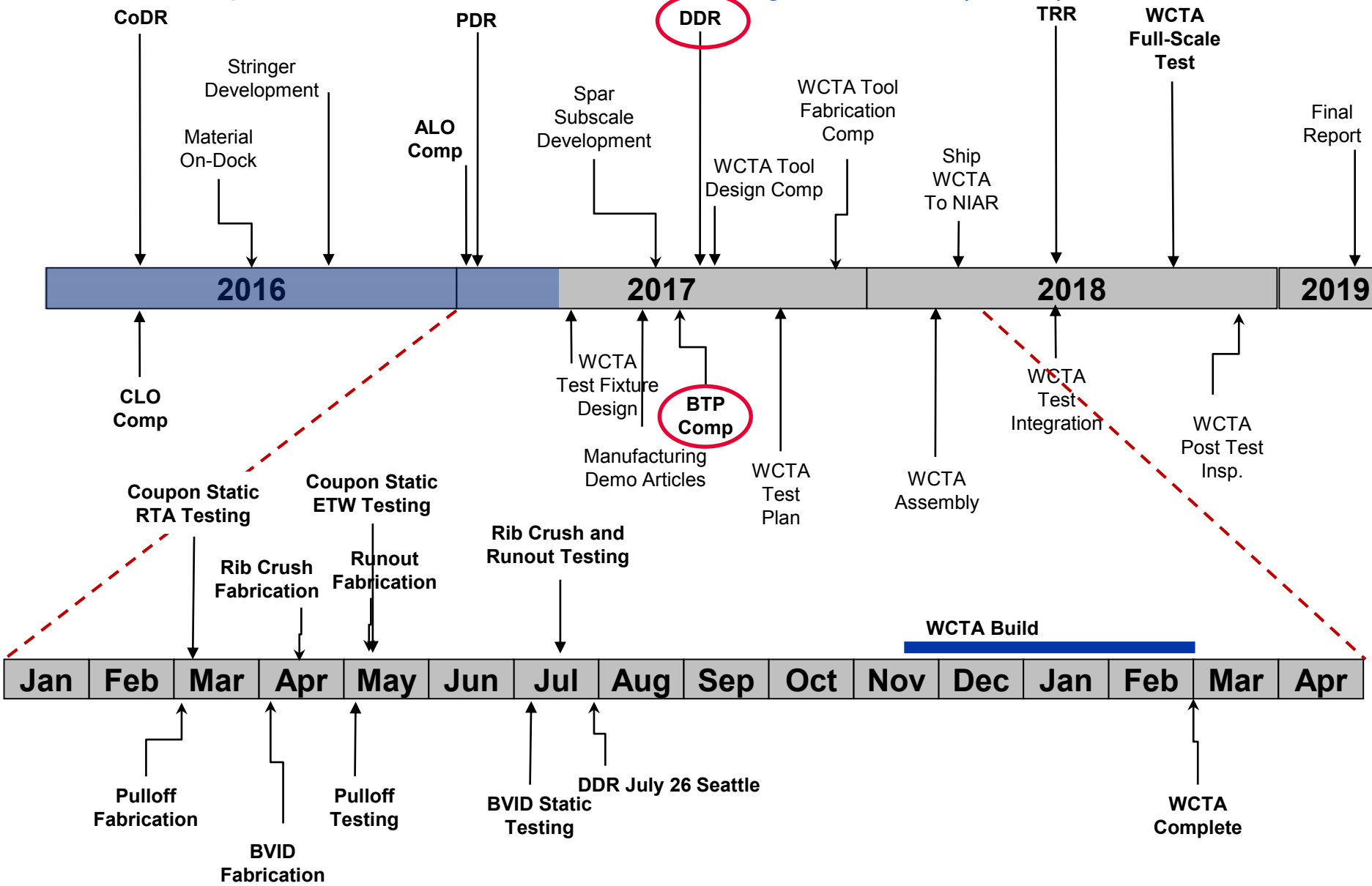
SEW – Top View Schedule to Detail Design Review (DDR)



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DDR Exit Criteria

Criteria	ECD
Coupon Testing RTA Complete	3/10/2017
Element Testing Complete Excluding BVID	5/05/2017
Coupon Testing ETW Complete	5/12/2017
Manufacturing Demonstration Articles Complete	6/28/2017
Build-to-Packages (BTP) Complete	7/05/2017
WCTA Tool Design Complete	7/10/2017
Subcomponent Testing Complete	7/18/2017
Detailed Design Review (DDR) Complete	7/26/2017

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Critical Path to Detail Design Review (DDR)

Project: CLEEN II Critical Path Network Gantt Chart
Project:CLEEN II
A2.4 (Detailed Design Review (DDR)) Needed : 07/18/2017 Projected : 07/18/2017

Based on: Early Dates
Date: 04/19/2017
Time Now: 04/13/2017

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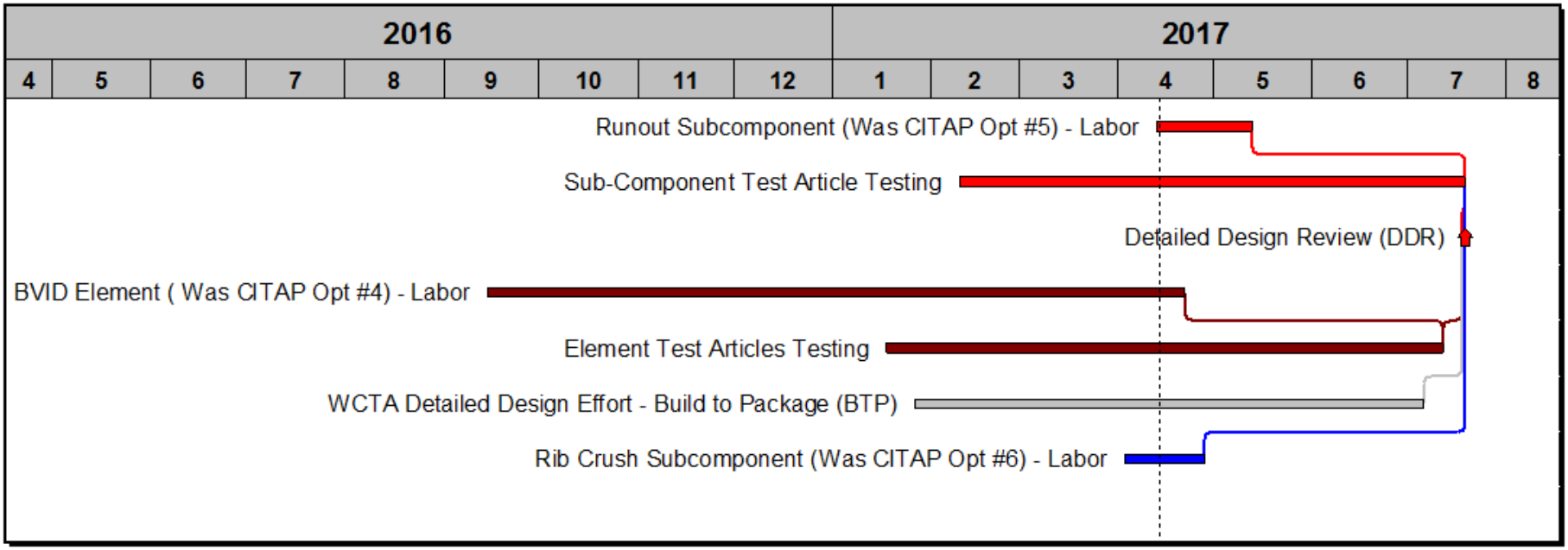

Path 1
Min. TF = 0d

Path 2
Min. TF = 5d

Path 3
Min. TF = 9d

Path 4
Min. TF = 11d

BTP and Fabrication and Testing of the Subcomponents and Elements Receiving “Critical Path” Attention

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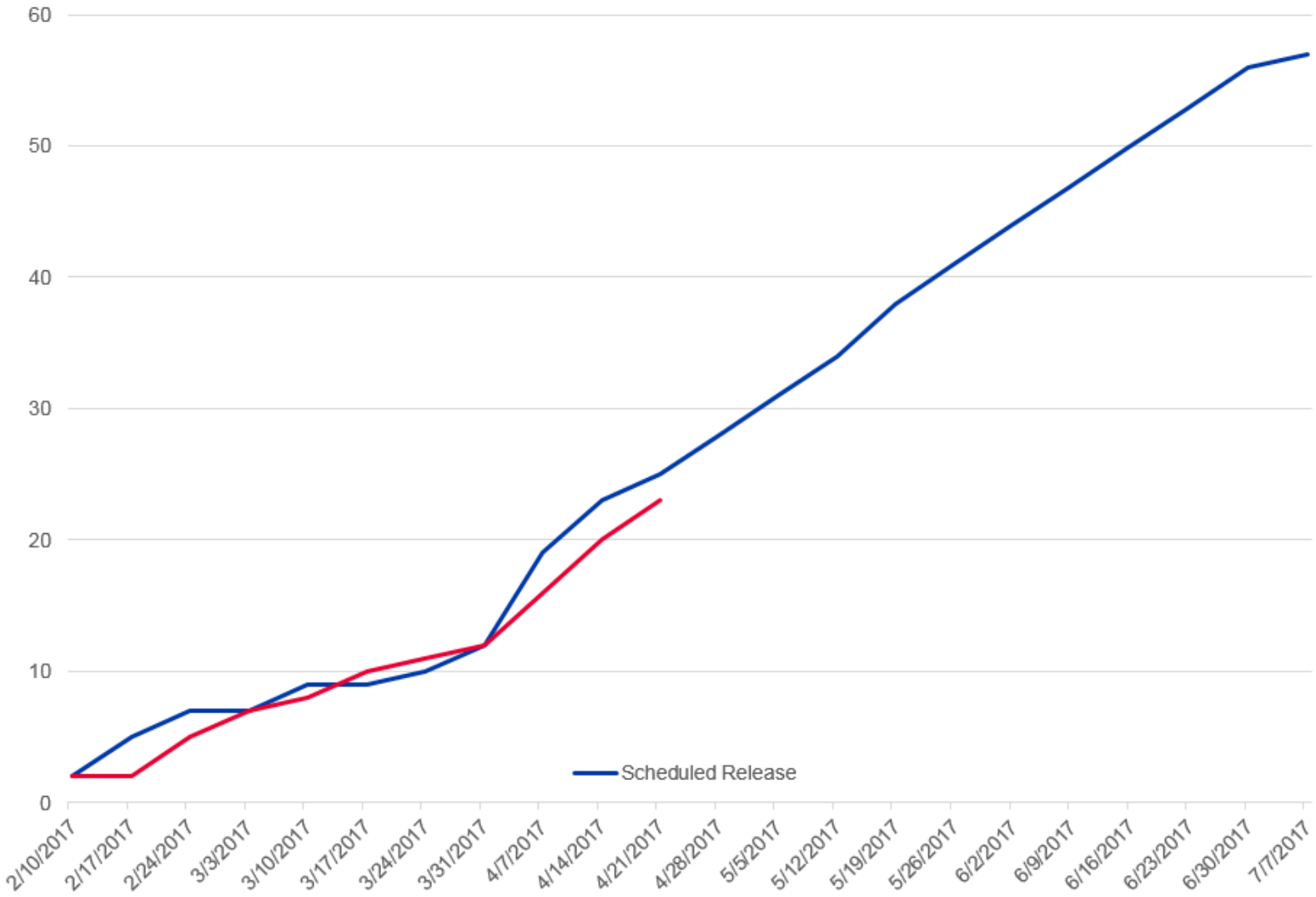
Build-to-Package Release Progress



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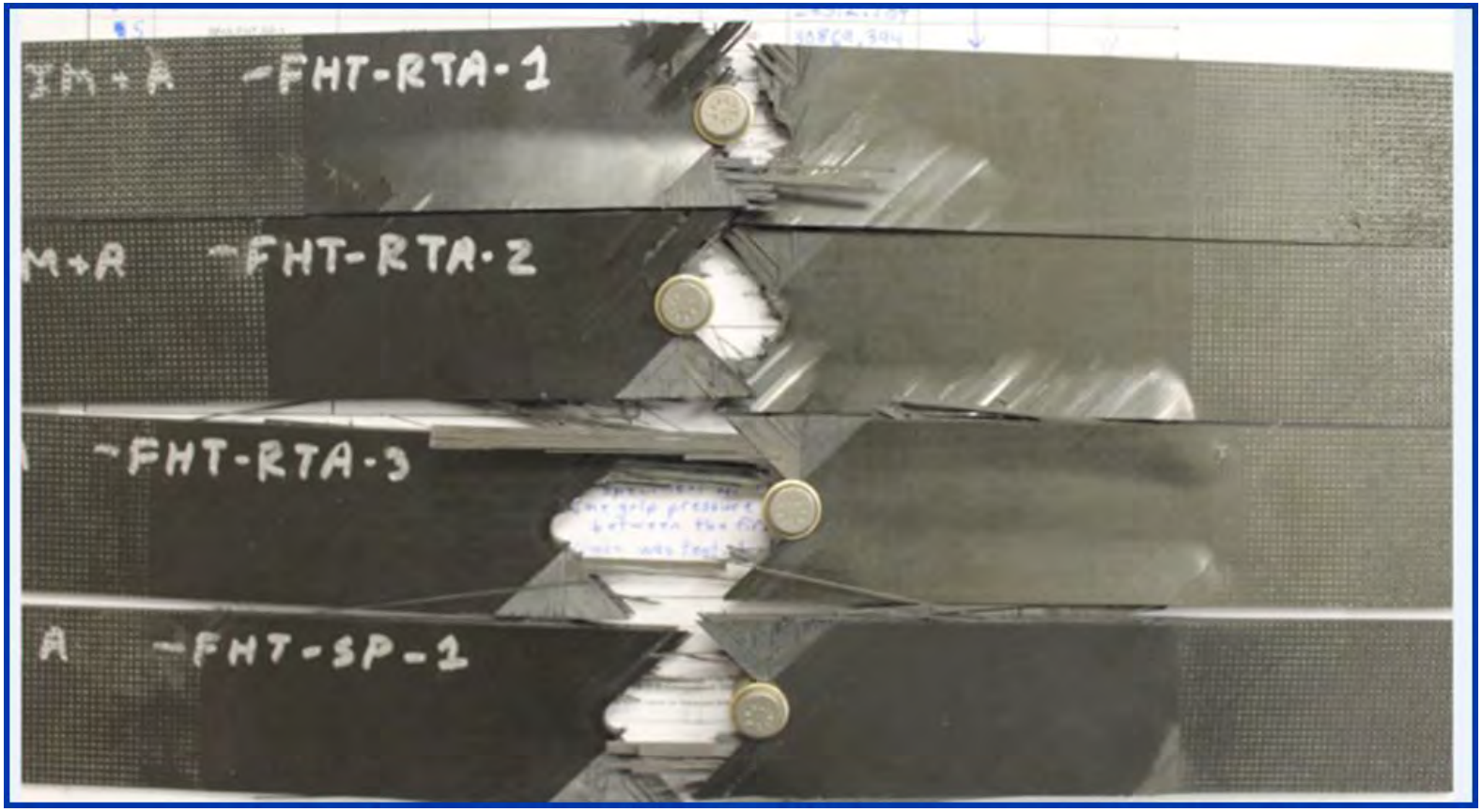
SEW Coupon Testing



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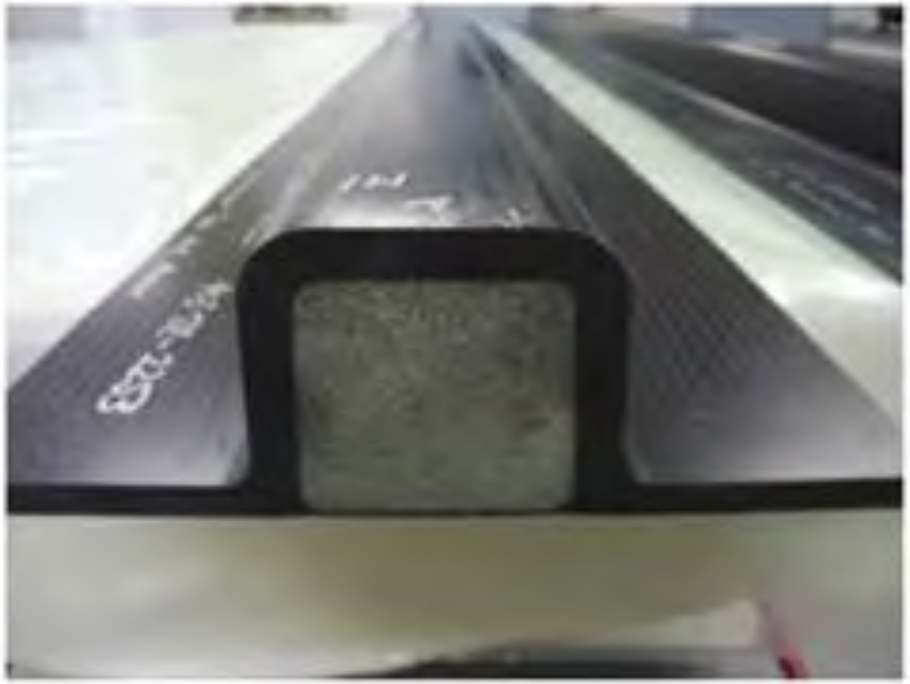
SEW Hat Stringers



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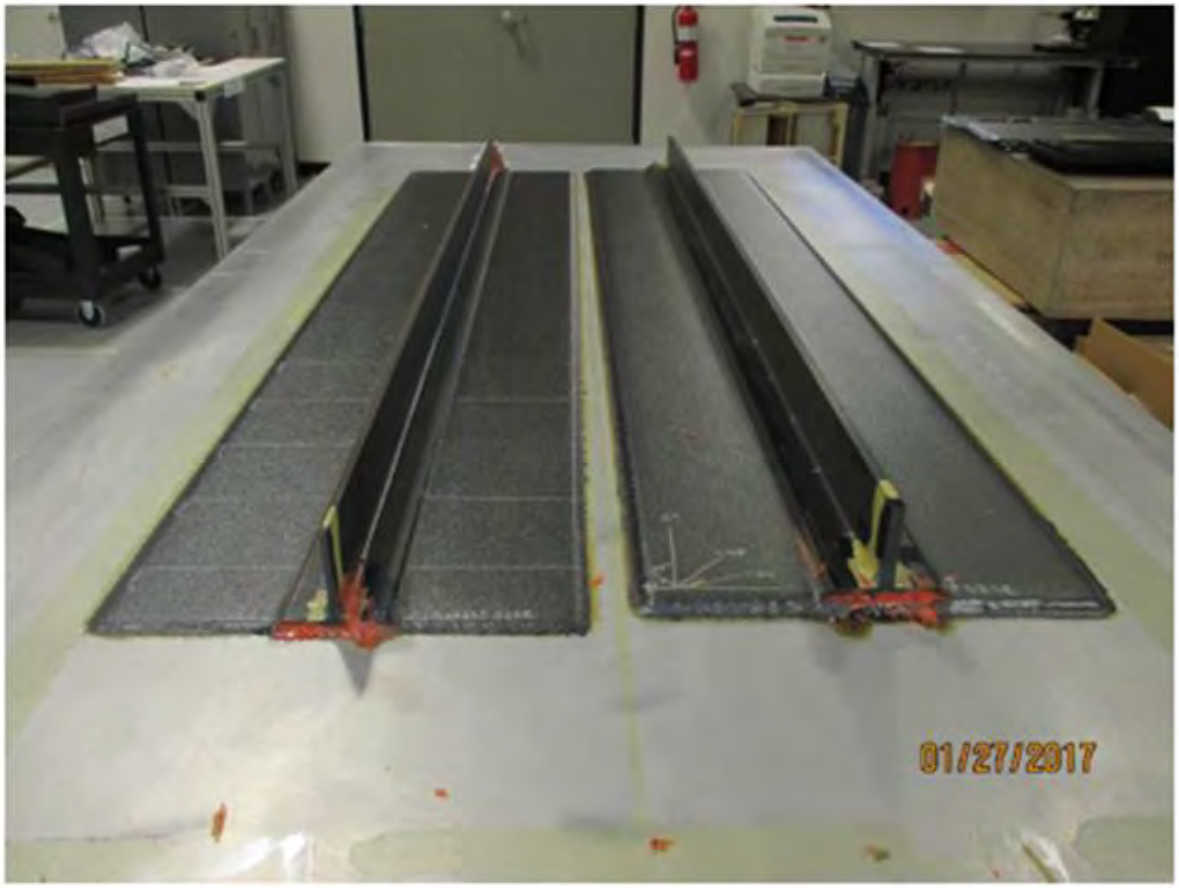
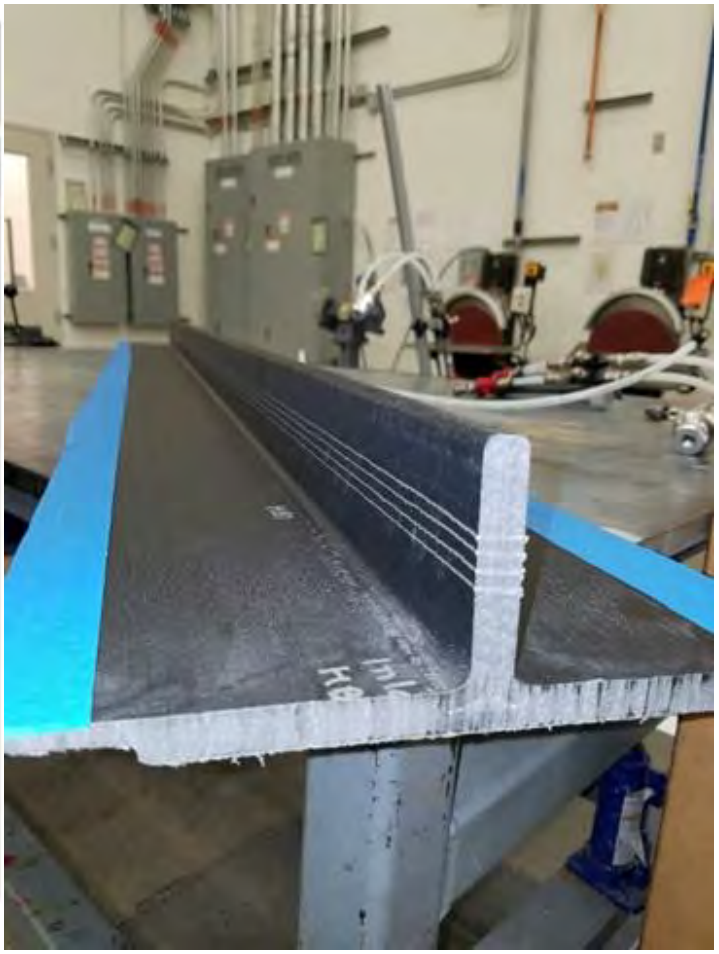
SEW Blade Stringers





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SEW Thermoplastic Rib

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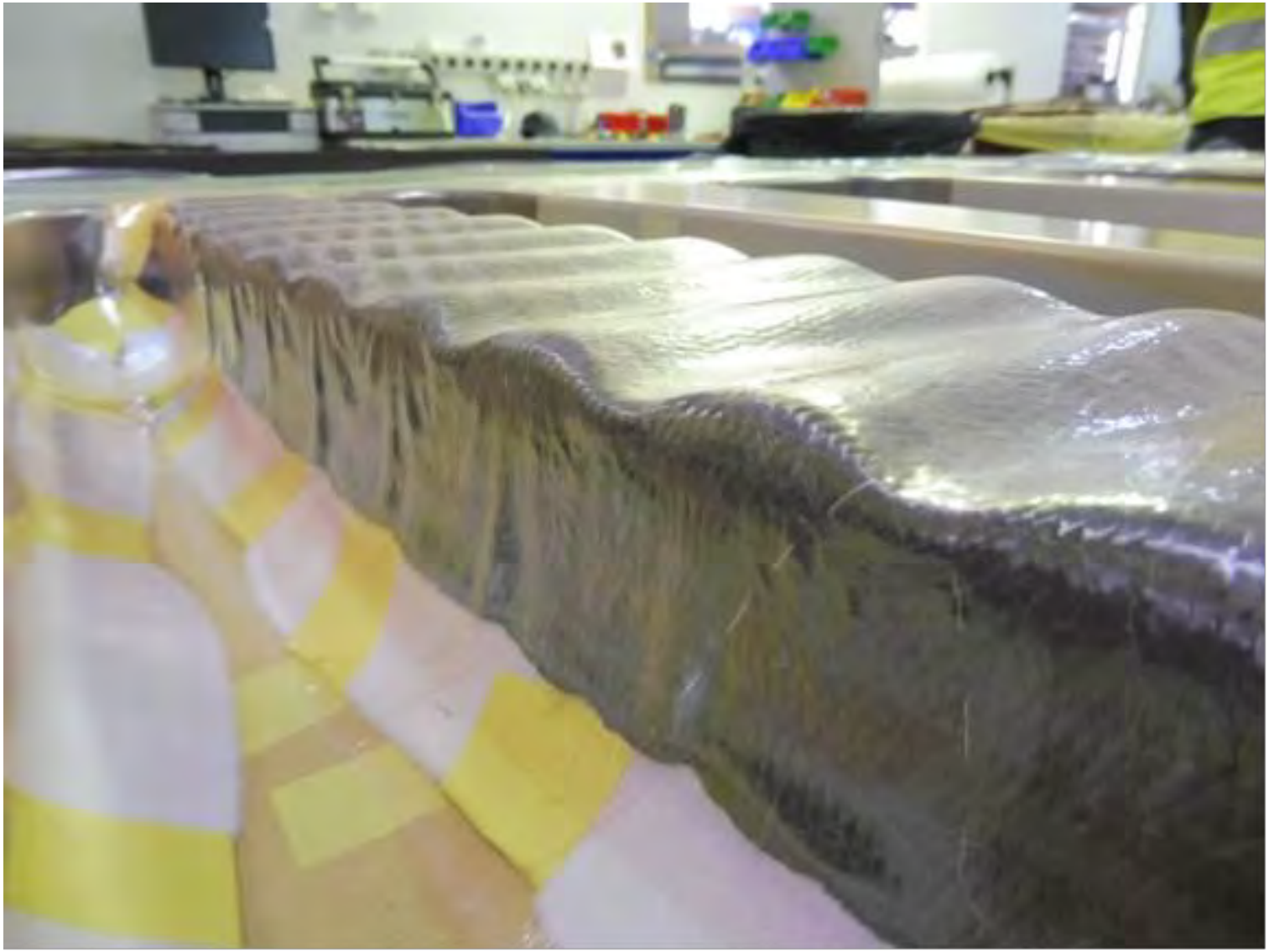
SEW Resin-Infused Sine Wave Rib



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SEW WCTA Assembly Planning

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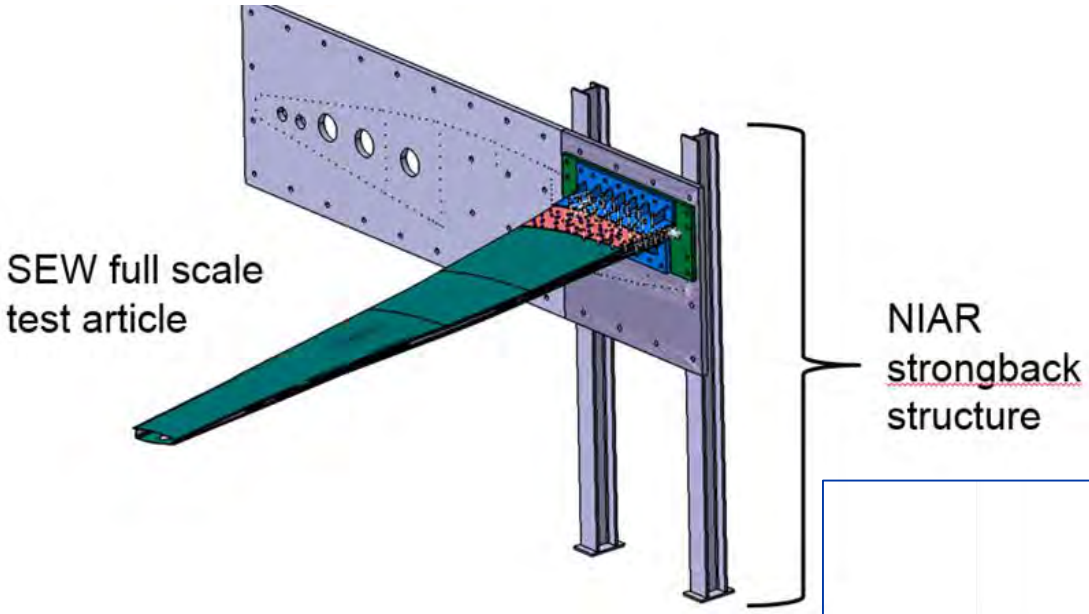
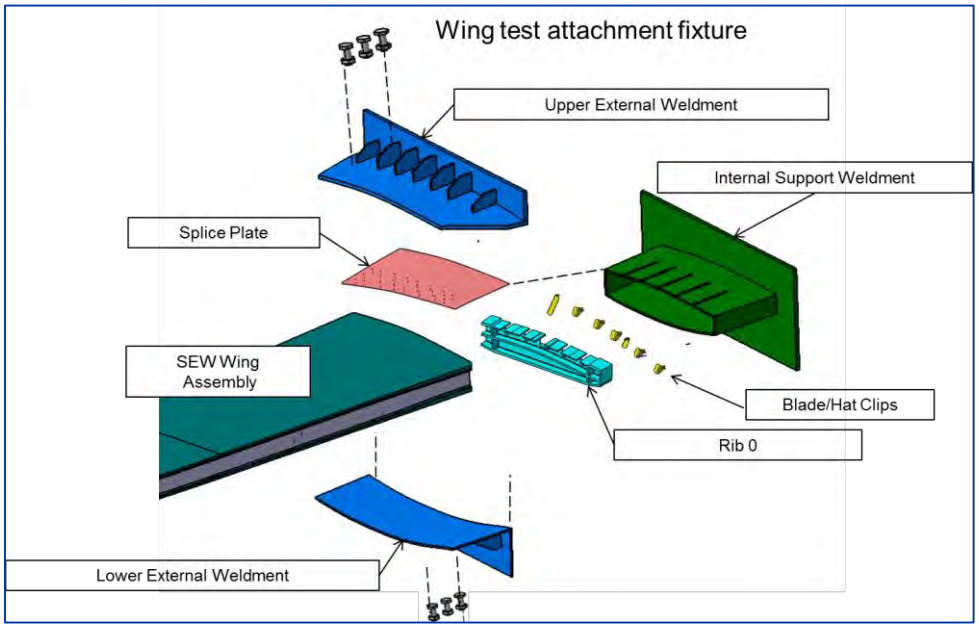
SEW Strongback Connections





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Summary

The SEW technologies selected represent Boeing's highest potential structural concepts that have a clear path to certification and implementation.

The building-block test approach on SEW will develop the selected technologies along the TRL scale, resulting in a TRL 6 demonstration when the Wing Component Test Article (WCTA) test is complete.

The SEW contributes to the FAA's CLEEN II goal of reducing fuel burn.

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Acronyms

ATP	Authority to Proceed
CoDR	Concept Design Review
DDR	Detailed Design Review
PDR	Preliminary Design Review
RR	Rolls Royce
SEW	Structurally Efficient Wing
TRL	Technology Readiness Level
TRR	Test Readiness Review
WCTA	Wing Component Test Article

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