NATIONAL INSTITUTE FOR AVIATION RESEARCH

WICHITA STATE UNIVERSITY

Material Qualification Testing of Resin Infused Tejin Tenax™ Dry Reinforcements using Syensqo (Solvay) PRISM™ EP2400 Infusion Resin.

John Tomblin, Rachael Andrulonis, Royal Lovingfoss, Michelle Man, Caleb Saathoff & Tomas Lorik

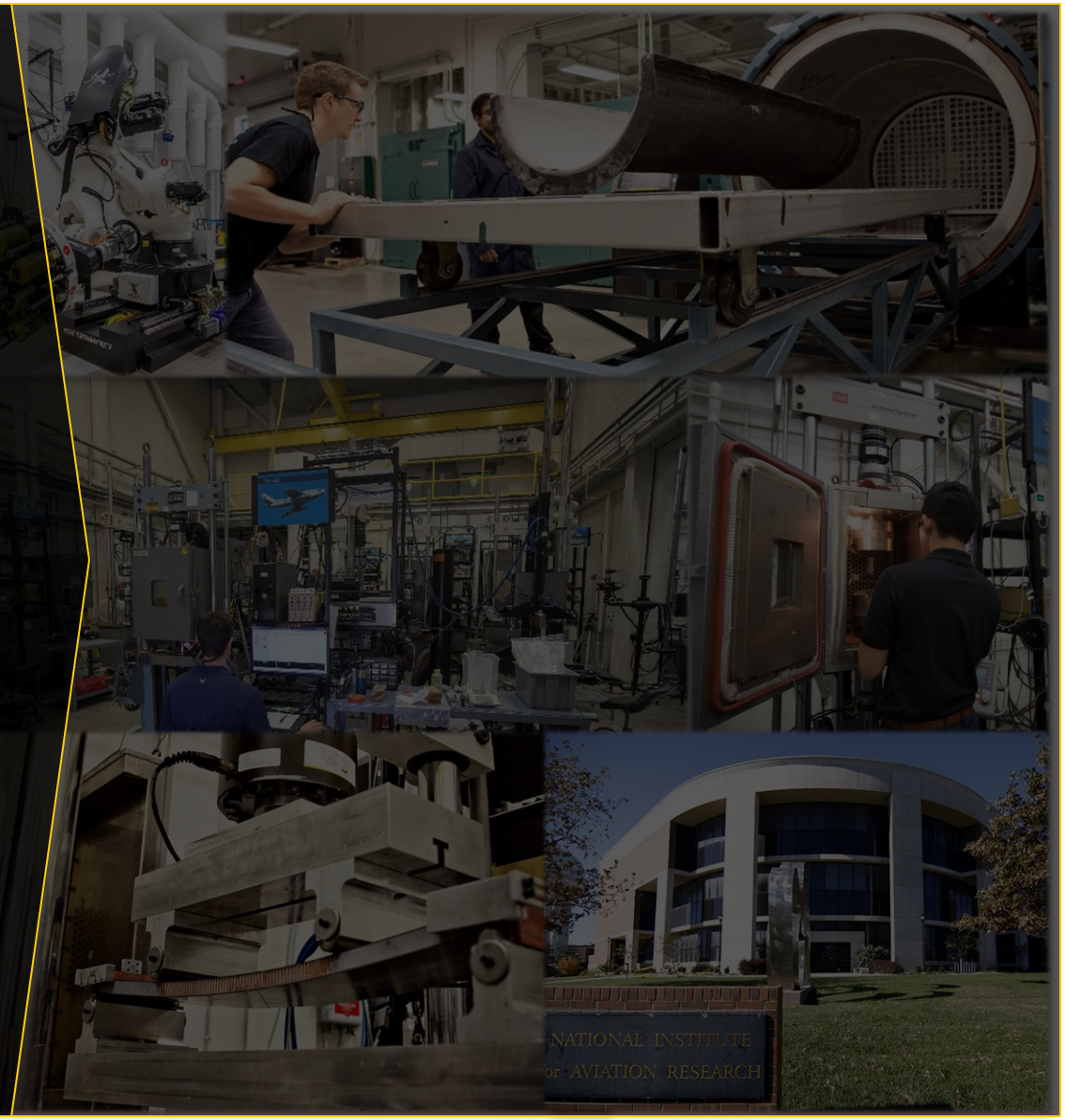
CECAM center of excellence for composites and advanced materials

JAMS JOINT ADVANCED MATERIALS & STRUCTURES CENTER OF EXCELLENCE

Federal Aviation Administration

TARGETED OUTCOMES FROM PRESENTATION

1. Provide an understanding of NIARs material qualification of Resin Infused Tejin Tenax™ Dry Reinforcements using Syensqo (Solvay) PRISM™ EP2400 Infusion Resin.
2. Highlight lessons learned during prequalification activities and how these influenced the framework for material qualification activities.
3. Demonstrate use of the developed qualification framework for resin infused dry reinforced materials through generation of material properties.



RESEARCH TEAM & OBJECTIVES

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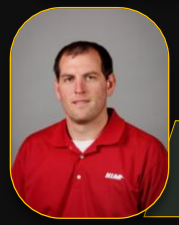
Director of Advanced Materials Research



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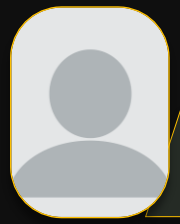

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Senior Technical Specialist for Advanced Composite Materials

TEIJIN SYENSQO FIBER DYNAMICS

PROJECT OVERVIEW

PROJECT OBJECTIVES

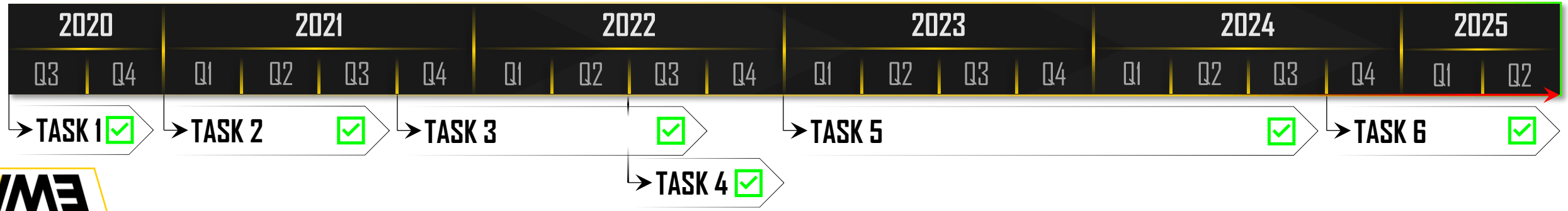
- To develop a framework for the qualification of resin infused fiber reinforced materials including guidelines and recommendations for their characterization and testing using the National Center for Advanced Materials Performance (NCAMP) process.
- Transition of the test data and guidelines generated into shared databases such as Composite Materials Handbook-17 (CMH-17).

RESEARCH OUTCOMES

- Vacuum Assisted Resin Transfer Molding (VARTM) trial test data and analysis published in FAA technical report.
- VARTM qualification material property test data, overview of results, and lessons learned published in an FAA technical report.
- Resin infusion material specification guidelines published in FAA technical report.
- VARTM material allowables submitted to CMH-17 and posted on the NCAMP Portal along with material and process specifications.

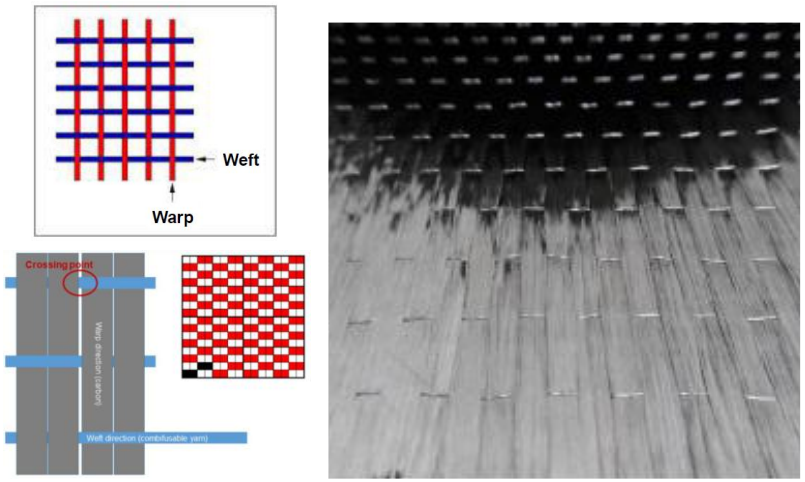
PROJECT PLAN & TIMELINE

1. **COORDINATION** — Establishment of an Industry Steering Committee (ISC).
2. **MATERIAL & PROCESS SELECTION** — Finalize resin and reinforcement materials and resin infusion method through manufacturing trials.
3. **QUAL. FRAMEWORK DEVELOPMENT** — Development of qualification framework leveraging lessons learned ensuring challenges and critical process parameters established on Task 2 are reflected and evaluated via trial testing.
4. **MATERIAL & PROCESS SPECs** — Development of base fabric, base resin, and base laminate material specifications and process specification for VARTM processing of test panels for qualification program.
5. **MATERIAL QUALIFICATION** — Performance of material qualification using framework established.
6. **MATERIAL DATA & STATISTICS** — Statistical analysis overview and guidelines.



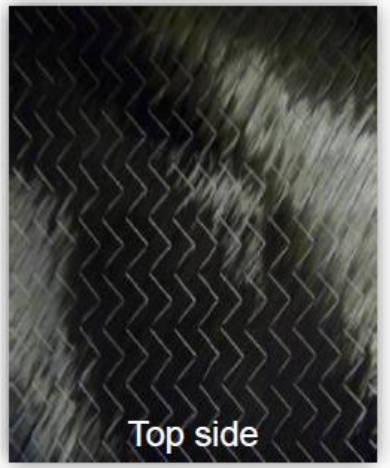
- **REINFORCEMENT OVERVIEW**
  - Tenax™-E IMS65 Non-Crimp Reinforcement
  - Material Forms:
    1. Unidirectional (UD): Woven with yarn
    2. Bidiagonal (BD): Carbon fibers in +45°/-45° or -45°/+45° (also in ±30° and ±60°)
    3. Biaxial (BA): Carbon fibers in 0°/90° or 90°/0°

1. UNIDIRECTIONAL WOVEN



2. BIDIAGONAL NCF: PILLAR STITCH

3. BIAXIAL NCF: TRICOT LOOP



TASK 2: MATERIALS & PROCESSING

- **REINFORCEMENT OVERVIEW**
  - Toughening Veil: TA1903s (polyamide veil) to improve material toughness.
  - Powder Binder: Hexion EP05311 binder.
  - Stitching Yarns:
    - NCF: K-203 (EP1390) 33 dtex a co-polyamide yarn
    - UD Woven: polyester and co-polyamide Z-85 combi-fuseable bonding yarn
- **RESIN OVERVIEW**
  - Solvay PRISM™ EP 2400: One-part toughened epoxy resin
  - Superior toughness, low viscosity, and extended pot-life
  - Intended service temp >250°F
- **RESIN INFUSION PROCESS OPTIONS**
  - RTM: Resin Transfer Molding
  - VARTM: Vacuum Assisted Resin Transfer Molding
  - SCRIMP: Seeman Composite Resin Transfer Molding
  - CAPRI: Controlled Atmospheric Pressure Resin Infusion

NON-CRIMP FABRIC: BIDIAGONAL EXAMPLE SHOWN

Veil (V) – Top layer
Carbon fiber (+45°)
Veil (V)
Carbon fiber (-45°)
Powder Binder (PB) – Bottom/first layer

WOVEN FABRIC

Veil (V) – Top layer
Carbon fiber (0°) – Bottom/first layer

TASK 3: QUALIFICATION FRAMEWORK DEVELOPMENT

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- **TRIAL TESTING OBJECTIVES & MATRICIES**
  - Panel Fabrication
    - 26 Panels fabricated at Fiber Dynamics
  - Properties Evaluated
    - Mechanical: *Tension, Compression, Flex, And Shear Testing*
    - Physical: *Fiber Volumes, Resin Contents, Voids, etc.*
  - General Processing Challenges
    - Identifying variables that need to be controlled.
  - Manufacturing Process Differences
    - VARTM vs RTM
    - Qualification Vs. Equivalency: *Challenges, Feasibility*

PREQUALIFICATION TESTING: LAMINATE TEST MATRIX

Manufacturing Process	Type of Fabric	Stacking Sequence	Target Thickness (in)	# of Fabric Layers	Test Type	ASTM Method Description	# of Specimens
RTM	DRNF -BD & BA	[45/-45,0/90]2s	0.116	8	OHC	D6484	5
					OHT	D5766	5
					CAI	D7136/D7137	5
VARTM	DRNF -BD & BA	[45/-45,0/90]2s	0.116	8	OHC	D6484	5
					OHT	D5766	5
					CAI	D7136/D7137	5

PREQUALIFICATION TESTING: LAMINA TEST MATRIX

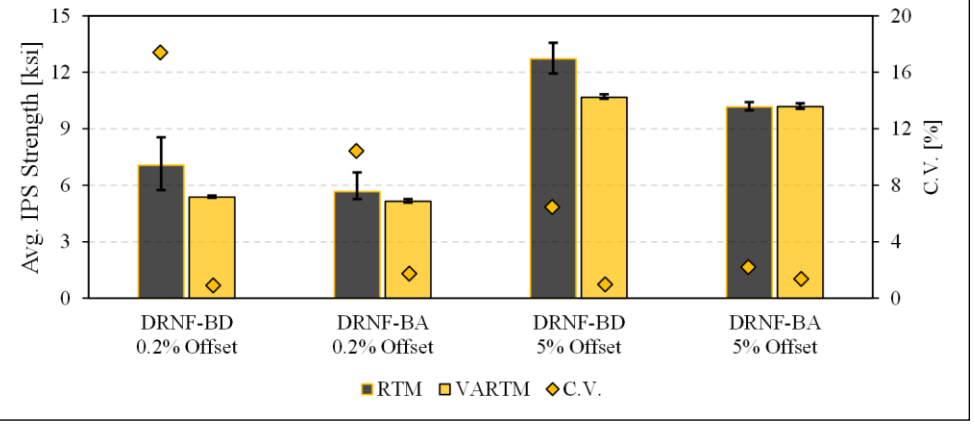
Manufacturing Process	Type of Fabric	Stacking Sequence	Target Thickness (in)	# of Fabric Layers	Test Type	ASTM Method Description	Specimen Orientation*	# of Specimens
RTM	DRNF-BD	[45/-45]3s	0.087-0.090	6	UNT	D3039	45º	5
					CLC	D6641	45º	5
					CLC	D695	45º	5
					IPS	D3518	0º	5
					Flexural	D7264	0º	5
VARTM	DRNF-BD	[45/-45]3s	0.087-0.090	6	UNT	D3039	45º	5
					CLC	D6641	45º	5
					CLC	D695	45º	5
					IPS	D3518	0º	5
					Flexural	D7264	0º	5
RTM	DRNF-BA	[0/90]3s	0.087-0.090	6	UNT	D3039	0º	5
					CLC	D695	0º	5
					CLC	D695	90º	5
					IPS	D3518	0º	5
					Flexural	D7264	0º	5
VARTM	DRNF-BA	[0/90]3s	0.087-0.090	6	UNT	D3039	0º	5
					CLC	D695	0º	5
					CLC	D695	90º	5
					IPS	D3518	0º	5
					Flexural	D7264	0º	5
RTM	DRNF-BD	[45/-45]6s	0.174-0.181	12	SBS	D2344	0º	5
VARTM	DRNF-BD	[45/-45]6s	0.174-0.181	12	SBS	D2344	0º	5
RTM	DRNF-BA	[0/90]6s	0.174-0.181	12	SBS	D2344	0º	5
VARTM	DRNF-BA	[0/90]6s	0.174-0.181	12	SBS	D2344	0º	5
VARTM	DRWF-UD	[45/-45]3s	.087-.090	12	IPS	D3518	0º	5
		[0/90]3s	0.087-0.090	12	UNT	D3039	0º	5
					CLC	D6641	0º	5
		[0]12	0.087-0.090	12	UNT	D3039	0º	5
					CLC	D6641	0º	5

* Specimen orientation: orientation of the specimen in reference to the fabricated panel 0º direction

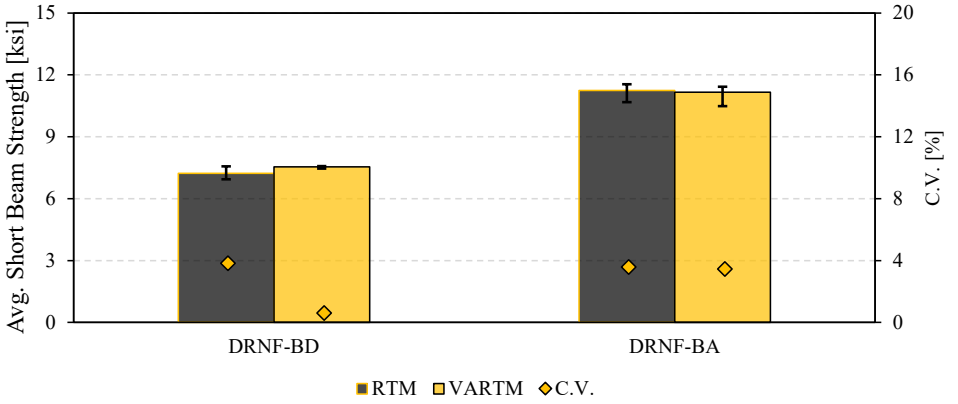
TASK 3: QUALIFICATION FRAMEWORK DEVELOPMENT

- **DOWNSELECTION OF PROCESS**
  - Focused on RTM and VARTM due to simplicity and maturity (steering committee recommendation).
  - Evaluated both processes via nondestructive testing (NDT) and mechanical performance.
- **DECISION**
  - VARTM panels were more consistent and reproducible provided that proper steps were followed.
  - Increased coefficient of variation (C.V.) in strength results for specimens manufactured with RTM when compared to VARTM
    - UNT, UNC, IPS exhibited this phenomenon
    - FLEX, SBS, OHT, OHC, CAI did not exhibit this phenomenon
  - **VARTM Selected**: Improved consistency, process control, and panel quality with comparable results to RTM.

ASTM D3518: IN-PLANE SHEAR STRENGTH



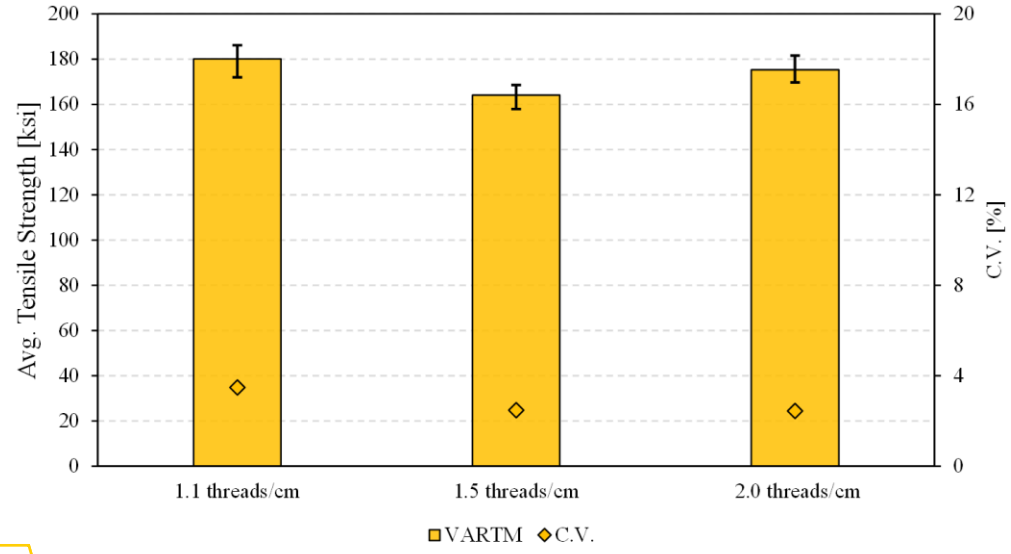
ASTM D2344: SHORT BEAM STRENGTH



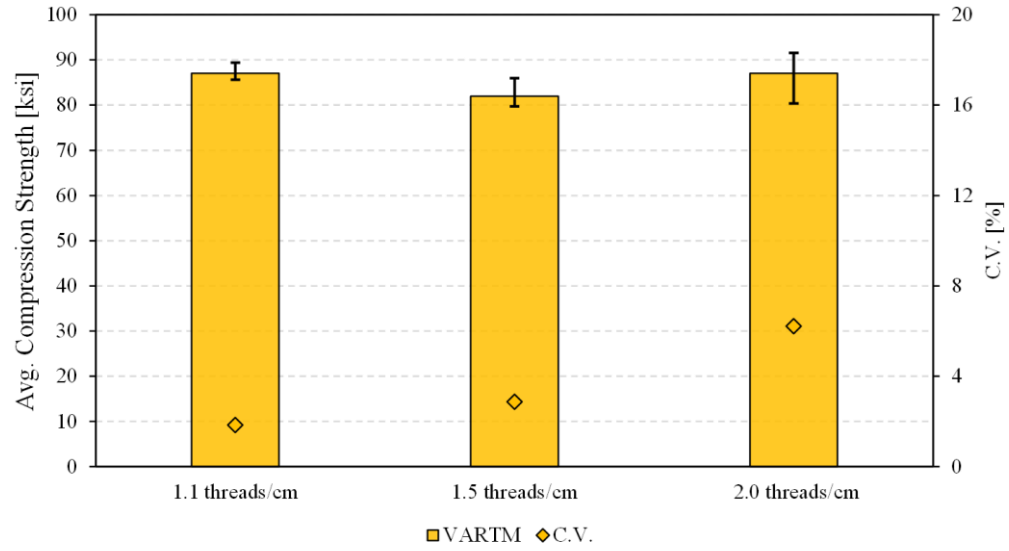
TASK 3: QUALIFICATION FRAMEWORK DEVELOPMENT

- **WEFT DENSITY SELECTION**
  - The first batch of UD woven fabric panels were fabricated using the same parameter set as the DRNF panels with limited success.
    - Cause thought to be Weft Density: Challenges with permeability ➔ Porosity and high processing time
    - Teijin provided three material forms with varying weft densities: 1.1-threads/cm, 1.5-threads/cm, and 2.0-threads/cm
  - **1.5-threads/cm Selected**: Balance between infusion time and panel quality.

ASTM D3039: TENSILE STRENGTH



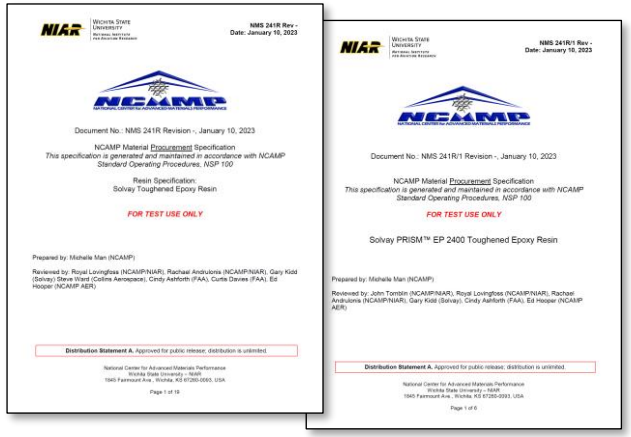
ASTM D6641: COMPRESSIVE STRENGTH



TASK 4: MATERIAL AND PROCESS SPECIFICATION(S)

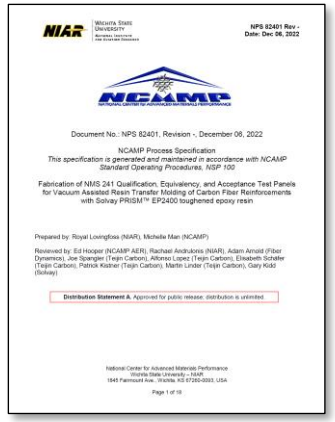
BASE FABRIC SPECIFICATION: DRY REINFORCEMENTS

BASE RESIN SPECIFICATION: RESIN



BASE LAMINATE SPECIFICATION: FINISHED LAMINATES

PROCESS SPECIFICATION: VARTM W/ PRISM™ EP2400 RESIN SYSTEM



TASK 5: MATERIAL QUALIFICATION

- **OVERVIEW OF APPROACH**
  - NOTE: Material shortages caused batches D,E to be added.

BATCH DEFINITION

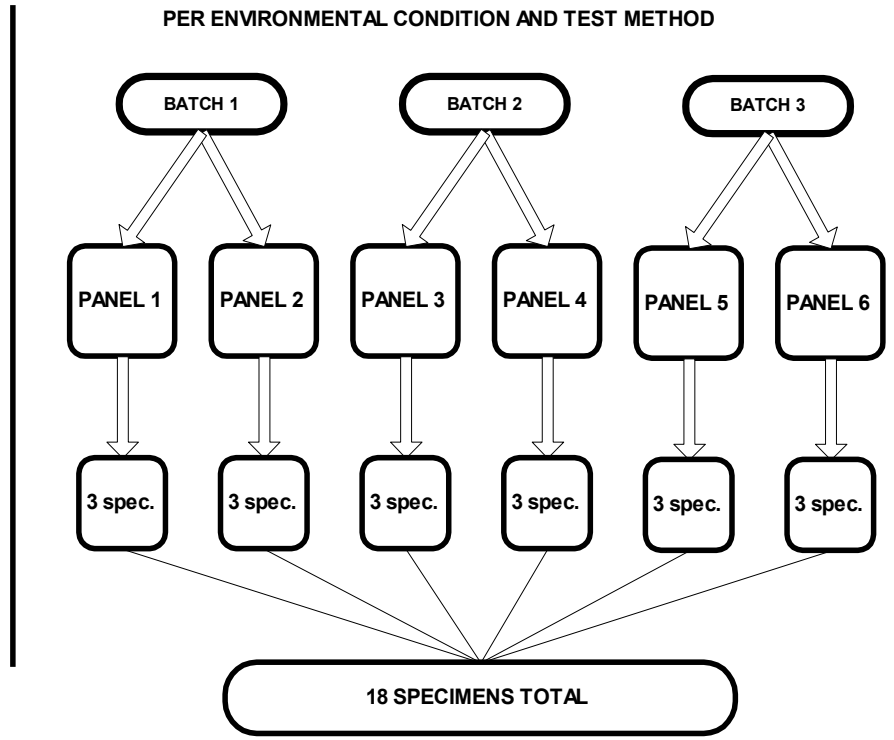
Laminate Test Batch	A	B	C	D	E
Dry Reinforcement	Material Lot 1	Material Lot 2	Material Lot 3	Material Lot 2	Material Lot 3
Resin Batch	1	2	3	1	1

MATERIAL INFORMATION: RESIN & REINFORCEMENTS

Resin Name	Description About the Resin	Spec #
Solvay PRISM™ EP2400 Resin System	One Part toughened resin developed for RTM, VARTM and CAPRI processing.	NMS 241R/1

Fiber Name of NCF	Description About the Reinforcement	Spec #
Teijin Tenax® -E Dry Reinforcement Woven Fabric (DRWF)	Fiber: IMS65 E23 24K Unidirectional Fiber; Weft weaving yarn: Combifusible bonding yarn, 200 dtex Product areal weight 196 gsm	NMS 241F/3
Teijin Tenax ® -E Dry Reinforcement Non-Crimp Fabric Biaxial (DRNF)	Fiber: IMS65 E23 24K Fiber; Stitching yarn:EP-1390 30 dtex; (tricot loop 3.6 mm) Product areal weight (without binder): 392 gsm, Total areal weight: 402 gsm Stitched fiber angles: 0°/90° and 90°/0°	NMS 241F/1
Teijin Tenax ® -E Dry Reinforcement Non-Crimp Fabric Bidiagonal (DRNF)	Fiber: IMS65 E23 24K Fiber; Stitching yarn:EP-1390 30 dtex; (tricot pillar loop 4.0 mm) Product areal weight (without binder): 392 gsm, Total areal weight: 402 gsm Stitched fiber angles: +45°/-45° and -45°/+45°	NMS 241F/2

SPECIMEN SELECTION METHODOLOGY



TASK 5: MATERIAL QUALIFICATION

TEST MATRIX: BIAXIAL DRNF LAMINA LEVEL TEST

Fiber Layup	Test direction	Test Type	Property	Number of Batches x Number of Panels x Number of Test Specimens				
				Test Temperature/Moisture Condition				
				CTA (4)	RTA	ETA	ETW 1	ETW2
$[0/90]_{4S}$	0°	ASTM D3039 Tension	Strength, Modulus, and Poisson's Ratio	3x2x3	3x2x3 (3)	3x2x3	3x2x3	
$[0/90]_{4S}$	0°	ASTM D6641 Compression	Strength and Modulus		3x2x3 (1)	3x2x3	3x2x3	1x2x3
$[0/90]_{4S}$	90°	ASTM D3039 Tension	Strength and Modulus	3x2x3	3x2x3 (3)	3x2x3	3x2x3	
$[0/90]_{4S}$	90°	ASTM D6641 Compression	Strength and Modulus		3x2x3 (1)	3x2x3	3x2x3	1x2x3
$[45/-45]_{3S}$ (rotated out of 0/90 and 90/0)	0°	ASTM D3518 In-Plane Shear (2)	Strength and Modulus	3x2x3	3x2x3 (3)	3x2x3	3x2x3	
$[0/90]_{8S}$	0°	ASTM D2344 Short Beam	Strength	3x2x3	3x2x3	3x2x3	3x2x3	1x2x3
$[0/90]_{4S}$	0°	ASTM D7264 Flex (5)	Strength and Modulus		3x2x3			

Note 1: Back-to-back strain gages were used on the first two specimens. If no buckling is observed, the remaining modulus specimens were strain gaged on one side of the specimens only.
Note 2: Gripped (tab) length was 1.5±0.5" on each end of the 10" long specimen. Once the samples reached the 5% strain level, the actuator/crosshead displacement rate was increased to four times the initial rate. Testing continued at the higher strain rate until ultimate failure was observed.
Note 3: At least two specimens were gaged to obtain full stress-strain curve to failure. An appropriate extensometer was used in place of the strain gage for the remaining specimens.
Note 4: Strain gage was used in lieu of extensometers (where applicable) to avoid slippage due to frost formation.
Note 5: Procedure A. Span of 16:1. Specimens were taken from 0° CLC panels.

TEST MATRIX: BIDIAGONAL DRNF LAMINA LEVEL TEST

Fiber Layup	Test direction	Test Type	Property	Number of Batches x Number of Panels x Number of Test Specimens				
				Test Temperature/Moisture Condition				
				CTA (4)	RTA	ETA	ETW1	ETW2
$[0/90]_{4S}$ (BD rotated by 45°)	0°	ASTM D3039 Tension	Strength, Modulus, and Poisson's Ratio	3x2x3	3x2x3 (3)	3x2x3	3x2x3	
$[0/90]_{4S}$ (BD rotated by 45°)	0°	ASTM D6641 Compression	Strength and Modulus		3x2x3 (1)	3x2x3	3x2x3	1x2x3
$[45/-45]_{3S}$	0°	ASTM D3518 In-Plane Shear (2)	Strength and Modulus	3x2x3	3x2x3 (3)	3x2x3	3x2x3	
$[0/90]_{8S}$ (BD rotated by 45°)	0°	ASTM D2344 Short Beam	Strength	3x2x3	3x2x3	3x2x3	3x2x3	1x2x3
$[0/90]_{4S}$ (BD rotated by 45°)	0°	ASTM D7264 Flex (5)	Strength and Modulus		3x2x3			

Note 1: Back-to-back strain gages were used on the first two specimens. If no buckling is observed, the remaining modulus specimens were strain gaged on one side of the specimens only.
Note 2: Gripped (tab) length was 1.5±0.5" on each end of the 10" long specimen. Once the samples reached the 5% strain level, the actuator/crosshead displacement rate was increased by four times the initial rate. Testing continued at the higher strain rate until ultimate failure was observed.
Note 3: At least two specimens were gaged to obtain full stress-strain curve to failure. An appropriate extensometer was used in place of the strain gage for the remaining specimens.
Note 4: Strain gage was used in lieu of extensometers (where applicable) to avoid slippage due to frost formation.
Note 5: Procedure A. Span of 16:1. Specimens were taken from 0° CLC panels.

TASK 5: MATERIAL QUALIFICATION

TEST MATRIX: BIAXIAL DRNF LAMINA LEVEL TEST

Fiber Layup	Test direction	Test Type	Property	Number of Batches x Number of Panels x Number of Test Specimens Test Temperature/Moisture Condition				
				CTA (4)	RTA	ETA	ETW 1	ETW2
$[0/90]_{4S}$	0°	ASTM D3039 Tension	Strength, Modulus, and Poisson's Ratio	3x2x3	3x2x3 (3)	3x2x3	3x2x3	
[0/		STM D6641 Compression	Strength and Modulus		3x2x3 (1)	3x2x3	3x2x3	1x2x3
$[0/90]_{4S}$	90°	ASTM D3039 Tension	Strength and Modulus	3x2x3	3x2x3 (3)	3x2x3	3x2x3	
$[0/90]_{4S}$	90°	ASTM D6641 Compression	Strength and Modulus		3x2x3 (1)	3x2x3	3x2x3	1x2x3
$[45/-45]_{3S}$ (rotated out of 0/90 and 90/0)	0°	ASTM D3518 In-Plane Shear (2)	Strength and Modulus	3x2x3	3x2x3			
$[0/90]_{8S}$	0°	ASTM D2344 Short Beam	Strength	3x2x3				1x2x3
$[0/90]_{4S}$	0°	ASTM D7264 Flex (5)	Strength and Modulus		3x2x3			

TRANSVERSE TESTING ON BIAXIAL

SINGLE BATCH FOR WET PROPERTIES @ 250F

Note 1: Back-to-back strain gages were used on the first two specimens. If no buckling is observed, the remaining modulus specimens were strain gaged on one side of the specimens only.
Note 2: Gripped (tab) length was 1.5±0.5" on each end of the 10" long specimen. Once the samples reached the 5% strain level, the actuator/crosshead displacement rate was increased to four times the initial rate. Testing continued at the higher strain rate until ultimate failure was observed.
Note 3: At least two specimens were gaged to obtain full stress-strain curve to failure. An appropriate extensometer was used in place of the strain gage for the remaining specimens.
Note 4: Strain gage was used in lieu of extensometers (where applicable) to avoid slippage due to frost formation.
Note 5: Procedure A. Span of 16:1. Specimens were taken from 0° CLC panels.

TEST MATRIX: BIDIAGONAL DRNF LAMINA LEVEL TEST

Fiber Layup	Test direction	Test Type	Property	Number of Batches x Number of Panels x Number of Test Specimens Test Temperature/Moisture Condition				
				CTA (4)	RTA	ETA	ETW1	ETW2
$[0/90]_{4S}$ (BD rotated by 45°)	0°	ASTM D3039 Tension	Strength, Modulus, and Poisson's Ratio	3x2x3	3x2x3 (3)	3x2x3	3x2x3	
$[0/90]_{4S}$ (BD rotated by 45°)	0°	ASTM D6641 Compression	Strength and Modulus		3x2x3 (1)	3x2x3	3x2x3	1x2x3
$[45/-45]_{3S}$	0°	ASTM D3518 In-Plane Shear (2)	Strength and Modulus	3x2x3	3x2x3 (3)	3x2x3	3x2x3	
$[0/90]_{8S}$ (BD rotated by 45°)	0°	ASTM D2344 Short Beam	Strength	3x2x3				1x2x3
$[0/90]_{4S}$ (BD rotated by 45°)	0°	ASTM D7264 Flex (5)	Strength and Modulus		3x2x3			

SINGLE BATCH FOR WET PROPERTIES @ 250F

Note 1: Back-to-back strain gages were used on the first two specimens. If no buckling is observed, the remaining modulus specimens were strain gaged on one side of the specimens only.
Note 2: Gripped (tab) length was 1.5±0.5" on each end of the 10" long specimen. Once the samples reached the 5% strain level, the actuator/crosshead displacement rate was increased by four times the initial rate. Testing continued at the higher strain rate until ultimate failure was observed.
Note 3: At least two specimens were gaged to obtain full stress-strain curve to failure. An appropriate extensometer was used in place of the strain gage for the remaining specimens.
Note 4: Strain gage was used in lieu of extensometers (where applicable) to avoid slippage due to frost formation.
Note 5: Procedure A. Span of 16:1. Specimens were taken from 0° CLC panels.

TASK 5: MATERIAL QUALIFICATION

TEST MATRIX: UNIDIRECTIONAL DRWF LAMINA LEVEL TEST

Fiber Layup	Test direction	Test Type	Property	Number of Batches x Number of Panels x Number of Test Specimens Test Temperature/Moisture Condition				
				CTA (4)	RTA	ETA	ETW1	ETW2
$[0/90]_{4S}$	0°	ASTM D3039 Tension	Strength, Modulus, and Poisson's Ratio	3x2x3	3x2x3 (3)	3x2x3	3x2x3	
$[0/90]_{4S}$	0°	ASTM D6641 Compression (6)	Strength and Modulus		3x2x3 (1)	3x2x3	3x2x3	1x2x3
$[0]_{8}$	0°	ASTM D3039 Tabbed Tension	Strength and Modulus	3x2x3	3x2x3 (3)	3x2x3	3x2x3	1x2x3
$[0]_{16}$	0°	ASTM D6641 Compression	Modulus		3x2x3 (1)	3x2x3	3x2x3	1x2x3
$[45/-45]_{3S}$	0°	ASTM D3518 In-Plane Shear (2)	Strength and Modulus	3x2x3	3x2x3	3x2x3	3x2x3	
[0]32	0°	ASTM D2344 Short Beam	Strength	3x2x3	3x2x3	3x2x3	3x2x3	1x2x3
$[0/90]_{4S}$	0°	ASTM D7264 Flex (5)	Strength and Modulus		3x2x3			

Note 1: Back-to-back strain gages were used on the first two specimens. If no buckling is observed, the remaining modulus specimens were strain gaged on one side of the specimens only.
Note 2: Gripped (tab) length was 1.5±0.5" on each end of the 10" long specimen. Once the samples reached the 5% strain level, the actuator/crosshead displacement rate can be increased by four times the initial rate. Testing continued at the higher strain rate until ultimate failure was observed.
Note 3: At least two specimens were gaged to obtain full stress-strain curve to failure. An appropriate extensometer was used in place of the strain gage for the remaining specimens.
Note 4: Strain gage was used in lieu of extensometers (where applicable) to avoid slippage due to frost formation.
Note 5: Procedure A. Span of 16:1. Specimens were taken from UNC0 panels
Note 6: Derived 0° lamina compressive strength ($F^{cu}_{0°plies}$) using the following:

$$F^{cu}_{0°plies} = F^{cu}_{0°/90°}\frac{E_1}{E_{0°/90°}}$$

TEST MATRIX: LAMINATE OVERVIEW

- **LAMINATE TESTING PROPERTIES**
  - Unnotched Tension
  - Unnotched Compression
  - Short Beam Shear
  - Open Hole Tension
  - Filled Hole Tension
  - Open Hole Compression
  - Filled Hole Compression
  - Single Shear Bearing
  - Interlaminar Tension
  - Compression After Impact
  - Fluid Screening:
    - Woven Fabric
    - Short Beam Shear
    - 13 fluids + controls
    - RT and ET testing

TASK 5: MATERIAL QUALIFICATION

TEST MATRIX: UNIDIRECTIONAL DRWF LAMINA LEVEL TEST

Fiber Layup	Test direction	Test Type	Property	Number of Batches x Number of Panels x Number of Test Specimens Test Temperature/Moisture Condition				
				CTA (4)	RTA	ETA	ETW1	ETW2
$[0/90]_{4S}$	0°	ASTM D3039 Tension	Strength, Modulus, and Poisson's Ratio	3x2x3	3x2x3 (3)	3x2x3	3x2x3	
[0/		TM D6641 Compression (6)	Strength and Modulus		3x2x3 (1)	3x2x3	3x2x3	1x2x3
$[0]_8$	0°	ASTM D3039 Tabbed Tension	Strength and Modulus	3x2x3	3x2x3 (3)	3x2x3	3x2x3	1x2x3
$[0]_{16}$	0°	ASTM D6641 Compression	Modulus		3x2x3 (1)	3x2x3	3x2x3	1x2x3
$[45/-45]_{3S}$	0°	ASTM D3518 In-Plane Shear (2)	Strength and Modulus	3x2x3	3x2x3	3x2x3	3x2x3	
[0]32	0°	ASTM D2344 Short Beam	Strength	3x2x3	3x2x3	3x2x3	3x2x3	1x2x3
$[0/90]_{4S}$	0°	ASTM D7264 Flex (5)	Strength and Modulus		3x2x3			

ADDED IN UNI PANEL STACKING SEQUENCES

Note 1: Back-to-back strain gages were used on the first two specimens. If no buckling is observed, the remaining modulus specimens were strain gaged on one side of the specimens only.
Note 2: Gripped (tab) length was 1.5±0.5" on each end of the 10" long specimen. Once the samples reached the 5% strain level, the actuator/crosshead displacement rate can be increased by four times the initial rate. Testing continued at the higher strain rate until ultimate failure was observed.
Note 3: At least two specimens were gaged to obtain full stress-strain curve to failure. An appropriate extensometer was used in place of the strain gage for the remaining specimens.
Note 4: Strain gage was used in lieu of extensometers (where applicable) to avoid slippage due to frost formation.
Note 5: Procedure A. Span of 16:1. Specimens were taken from UNC0 panels
Note 6: Derived 0° lamina compressive strength ($F^{cu}_{0°\,plies}$) using the following:

$$F^{cu}_{0°\,plies} = F^{cu}_{0°/90°}\frac{E_1}{E_{0°/90°}}$$

TEST MATRIX: LAMINATE OVERVIEW

- **LAMINATE TESTING PROPERTIES**
  - Unnotched Tension
  - Unnotched Compression
  - Short Beam Shear
  - Open Hole Tension
  - Filled Hole Tension
  - Open Hole Compression
  - Filled Hole Compression
  - Single Shear Bearing
  - Interlaminar Tension
  - Compression After Impact
  - Fluid Screening:
    - Woven Fabric
    - Short Beam Shear
    - 13 fluids + controls
    - RT and ET testing

TASK 5: MATERIAL QUALIFICATION

BIAXIAL DRNF: QUALIFICATION TESTING

Reinforcement : Tenax™ E Reinforcement Fabrics - DRNF IM BA
Material Specification: NMS 241/1, NMS 241F/1 and NMS 241R/1
Process Specification: NPS 82401
Matrix: PRISM™ EP2400

Syensqo PRISM™ EP2400 with Tenax™ DRNF - Biaxial Lamina Properties Summary

Tg(dry): 314°F **Tg(wet):** 275°F **Tg METHOD:** ASTM D7028

Date of fiber manufacture Apr-Oct 2021
Date of resin manufacture 2022 and 2023
Date of composite manufacture Mar to Dec 2023
Date of testing July 2023 to July 2024

LAMINA MECHANICAL PROPERTY SUMMARY
Data reported as: Normalized & Measured
(Normalized by CPT=0.014 inch)

DRAFT

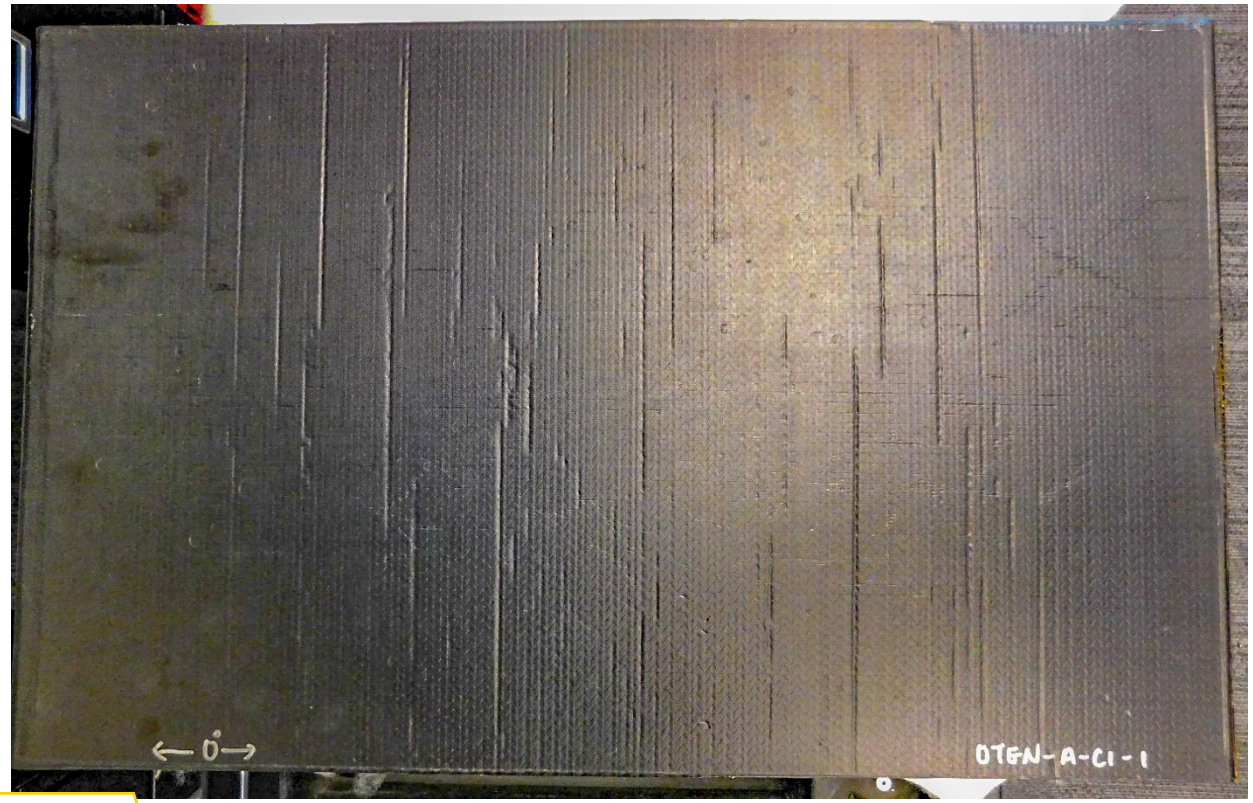
Properties	CTA (-65°F) Mean		RTA (70°F) Mean		ETA (180°F) Mean		ETW1 (180°F) Mean		ETW2 (250°F) Mean	
	Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured
F_1^{tu} [ksi]	196.2	180.1	207.3	190.7	211.5	193.9	206.9	190.3		
E_1^t [Msi]	12.49	11.47	12.49	11.50	12.17	11.16	12.22	11.24		
ν_{12}^{τ}		0.0400		0.0399		0.0280		0.0315		
F_2^{tu} [ksi]	214.1	198.8	223.8	208.6	228.4	211.3	222.9	208.4		
E_2^t [Msi]	12.74	11.84	12.74	11.85	12.50	11.56	12.52	11.67		
F_1^{cu} [ksi]			99.99	90.30	74.82	68.09	70.81	64.32	47.68	42.76
E_1^c [Msi]			11.20	10.12	11.08	10.07	11.35	10.32	11.20	10.04
F_2^{cu} [ksi]			106.5	96.44	82.81	73.86	80.83	72.78	56.81	50.66
E_2^c [Msi]			11.36	10.30	11.98	10.71	11.71	10.55	11.07	9.901
SBS [ksi]		9.876		10.01		7.313		6.317		3.622
$F_{12}^{s0.2\%}$ [ksi]		8.139		5.762		4.079		3.669		
$F_{12}^{s5\%strain}$ [ksi]		13.92		10.21		7.156		6.056		
G_{12}^s [Msi]		0.7199		0.5770		0.4282		0.3935		
Flex [ksi]			152.5	136.3						

BIAXIAL DRNF: PRE-QUALIFICATION TESTING

- **0-TENSION**
  - STRENGTH: 190.7 vs 191.7 (-0.52%)
  - MODULUS: 11.50 vs 10.67 (+8.80%)
- **0-COMPRESSION**
  - STRENGTH: 90.30 vs 89.67 (+0.70%)
  - MODULUS: 10.12 vs 9.900 (+0.29%)
- **IN-PLANE SHEAR**
  - 0.2% STRENGTH: 5.762 vs 5.150 (+11.88%)
  - 5.0% STRENGTH: 10.21 vs 10.18 (+0.29%)
  - MODULUS: 0.577 vs 0.590 (-2.25%)
- **FLEXURAL**
  - STRENGTH: 136.3 vs 154.36 (-13.25%)

- **KEY OBSERVATIONS DURING PANEL FABRICATION**
  - DESCRIPTION: Creasing in NMS 241/1 (0/90) Non-Crimp Fabric Layups.

REPRESENTATIVE ARTIFACTS: BIAXIAL 0-TEN PANEL



- **ARTIFACT PRESENCE**
  - These creases became noticeable during stacking of multi-ply laminates laid up in a (0/90)X orientation, with no ply rotation.
- **NMS 241/1 (BIAXIAL) FABRIC CONSTRUCTION**
  - The 90° tows in this fabric are stabilized by stitching, which introduces tension and produces small inconsistent gaps between adjacent tows in the 90° direction.
  - When multiple (0/90) plies are stacked without rotation, random ply alignment can cause creases to stack on top of each other from layer to layer.
  - This random stacking can result in random creases, causing localized increase in thickness and visual surface creasing in the dry preform.
  - These features are distributed randomly, with varying lengths and frequency of occurrence along the 90° fiber direction.

TASK 5: MATERIAL QUALIFICATION

BIAXIAL TEST RESULTS: 0-DEG PROPERTIES

Material: Syensqo PRISM™ EP2400 with Tenax™ DRNF - Biaxial
Resin content: 35.34 %wt **Comp. density:** 1.525 g/cc
Fiber volume: 55.42 %vol
Ply count: 8
Test method: ASTM D3039-17 **Modulus calculation:** 1000-3000 microstrain
Normalized by: 0.0140 in. CPT

Tension, 1-axis
Syensqo PRISM™ EP2400 with Tenax™ DRNF - Biaxial [0/90]4S

		CTA		RTA		ETA		ETW1	
Test Temperature [°F]		-65		70		180		180	
Moisture Conditioning		Ambient		Ambient		Ambient		Equilibrium	
Equilibrium at T, RH								160F, 85%	
Source code		BA-0TEN-X-X-X-XB		BA-0TEN-X-X-X-XA		BA-0TEN-X-X-X-XC		BA-0TEN-X-X-X-XD	
		Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured
F_1^{tu} [ksi]	Mean	196.2	180.1	207.3	190.7	211.5	193.9	206.9	190.3
	Minimum	184.2	170.2	183.5	169.4	191.3	179.7	190.2	177.0
	Maximum	207.0	192.1	219.4	205.5	223.6	204.3	218.3	202.8
	C.V.(%)	3.368	3.681	4.055	4.183	3.629	3.443	3.418	3.509
	No. Specimens	18		18		21		18	
	No. FD Batches	3		3		3		3	
E_1^t [Msi]	Mean	12.49	11.47	12.49	11.50	12.17	11.16	12.22	11.24
	Minimum	11.74	10.68	11.63	10.72	12.05	10.65	12.08	10.97
	Maximum	13.32	12.30	12.99	12.26	12.45	11.44	12.52	11.82
	C.V.(%)	3.972	4.763	3.144	4.132	0.7590	1.659	0.8655	1.971
	No. Specimens	18		18		21		18	
	No. FD Batches	3		3		3		3	

Material: Syensqo PRISM™ EP2400 with Tenax™ DRNF - Biaxial
Resin content: 36.63 %wt **Comp. density:** 1.517 g/cc
Fiber volume: 54.04 %vol
Ply count: 8
Test method: ASTM D6641-16ε1 **Modulus calculation:** 1000-3000 microstrain
Normalized by: 0.0140 in. CPT

Compression, 1-axis
Syensqo PRISM™ EP2400 with Tenax™ DRNF - Biaxial [0/90]4S

		RTA		ETA		ETW1		ETW2	
Test Temperature [°F]		70		180		180		250	
Moisture Conditioning		Ambient		Ambient		Equilibrium		Equilibrium	
Equilibrium at T, RH						160F, 85%		160F, 85%	
Source code		BA-0CLC-X-X-X-XA		BA-0CLC-X-X-X-XC		BA-0CLC-X-X-X-XD		BA-0CLC-X-X-X-XF	
		Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured
F_1^{cu} [ksi]	Mean	99.99	90.30	74.82	68.09	70.81	64.32	47.68	42.76
	Minimum	89.63	79.15	60.37	55.93	62.66	57.79	42.29	37.54
	Maximum	114.8	103.3	87.89	80.31	77.76	70.93	54.92	49.34
	C.V.(%)	8.603	8.745	10.02	9.457	5.783	5.635	8.996	9.728
	No. Specimens	17		20		18		6	
	No. FD Batches	3		3		3		1	
E_1^c [Msi]	Mean	11.20	10.12	11.08	10.07	11.35	10.32	11.20	10.04
	Minimum	10.65	9.715	10.42	9.561	10.38	9.369	10.78	9.500
	Maximum	11.92	10.46	11.54	10.63	12.95	11.96	11.62	10.56
	C.V.(%)	2.576	2.599	3.034	2.729	6.192	6.711	2.990	3.916
	No. Specimens	18		18		18		6	
	No. FD Batches	3		3		3		1	

TENSILE STRENGTH [ksi]: F1 vs F2

CTA: 180.1 vs 198.8 (-10.4%)
RTA: 190.7 vs 208.6 (-9.4%)

ETA: 193.9 vs 211.3 (-8.97%)
ETW1: 190.3 vs 208.4 (-9.51%)

TENSILE MODULUS [Msi]: E1 vs E2

CTA: 11.47 vs 11.84 (-3.23%)
RTA: 11.50 vs 11.85 (-3.04%)

ETA: 11.16 vs 11.56 (-3.58%)
ETW1: 11.34 vs 11.67 (-2.91%)

COMPRESSIVE STRENGTH [ksi]: F1 vs F2

CTA: 90.3 vs 96.44 (-6.8%)
RTA: 68.09 vs 73.86 (-8.47%)

ETA: 64.32 vs 72.78 (-13.15%)
ETW1: 42.75 vs 50.65 (-18.48%)

COMPRESSIVE MODULUS [Msi]: E1 vs E2

CTA: 10.12 vs 10.30 (-1.78%)
RTA: 10.07 vs 10.71 (-5.98%)

ETA: 11.35 vs 10.55 (7.05%)
ETW1: 11.20 vs 9.901 (11.60%)

BIAXIAL TEST RESULTS: 90-DEG PROPERTIES

Material: Syensqo PRISM™ EP2400 with Tenax™ DRNF - Biaxial
Resin content: 35.08 %wt **Comp. density:** 1.527 g/cc
Fiber volume: 55.69 %vol
Ply count: 8
Test method: ASTM D3039-17 **Modulus calculation:** 1000-3000 microstrain
Normalized by: 0.0140 in. CPT

Tension, 2-axis
Syensqo PRISM™ EP2400 with Tenax™ DRNF - Biaxial [0/90]4s

		CTA		RTA		ETA		ETW1	
Test Temperature [°F]		-65		70		180		180	
Moisture Conditioning		Ambient		Ambient		Dry		Equilibrium	
Equilibrium at T, RH								160F, 85%	
Source code		BA-90TEN-X-X-X-XB		BA-90TEN-X-X-X-XA		BA-90TEN-X-X-X-XC		BA-90TEN-X-X-X-XD	
		Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured
F_2^{tu} [ksi]	Mean	214.1	198.8	223.8	208.6	228.4	211.3	222.9	208.4
	Minimum	193.9	183.2	200.7	193.8	211.7	191.3	209.7	193.8
	Maximum	222.7	210.1	244.3	228.7	257.8	237.5	234.3	218.2
	C.V.(%)	3.431	4.455	5.477	4.934	5.611	5.638	3.016	3.269
	No. Specimens	18		21		19		17	
	No. FD Batches	3		3		3		3	
E_2^t [Msi]	Mean	12.74	11.84	12.74	11.85	12.50	11.56	12.52	11.67
	Minimum	11.88	10.93	11.93	10.84	11.84	10.62	12.03	11.05
	Maximum	14.07	13.36	14.06	13.59	13.65	12.57	13.56	12.20
	C.V.(%)	4.942	6.165	5.175	5.728	3.868	4.376	2.974	2.637
	No. Specimens	18		19		19		18	
	No. FD Batches	3		3		3		3	

Material: Syensqo PRISM™ EP2400 with Tenax™ DRNF - Biaxial
Resin content: 36.88 %wt **Comp. density:** 1.513 g/cc
Fiber volume: 53.69 %vol
Ply count: 8
Test method: ASTM D6641-16ε1 **Modulus calculation:** 1000-3000 microstrain
Normalized by: 0.0140 in. CPT

Compression, 2-axis
Syensqo PRISM™ EP2400 with Tenax™ DRNF - Biaxial [0/90]4s

		RTA		ETA		ETW1		ETW2	
Test Temperature [°F]		70		180		180		250	
Moisture Conditioning		Ambient		Ambient		Equilibrium		Equilibrium	
Equilibrium at T, RH						160F, 85%		160F, 85%	
Source code		BA-90CLC-X-X-X-XA		BA-90CLC-X-X-X-XC		BA-90CLC-X-X-X-XD		BA-90CLC-X-X-X-XF	
		Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured
F_2^{cu} [ksi]	Mean	106.5	96.44	82.81	73.86	80.83	72.78	56.81	50.66
	Minimum	84.80	76.87	73.43	64.97	68.48	61.06	52.31	46.24
	Maximum	123.4	112.2	96.13	84.50	89.05	81.65	60.00	53.59
	C.V.(%)	9.253	9.152	8.983	8.814	8.195	8.195	5.384	5.541
	No. Specimens	20		20		19		7	
	No. FD Batches	3		3		3		1	
E_2^c [Msi]	Mean	11.36	10.30	11.98	10.71	11.71	10.55	11.07	9.901
	Minimum	10.72	9.707	10.99	9.587	11.22	10.01	10.32	9.333
	Maximum	12.73	11.19	14.33	12.82	12.74	11.66	12.04	10.69
	C.V.(%)	4.053	4.092	7.702	7.397	3.645	4.708	6.617	5.012
	No. Specimens	18		19		18		6	
	No. FD Batches	3		3		3		1	

TASK 5: MATERIAL QUALIFICATION

BIAXIAL TEST RESULTS: 0-DEG PROPERTIES

Material:	Syensqo PRISM™ EP2400 with Tenax™ DRNF - Biaxial
Resin content:	35.34 %wt
Comp. density:	1.525 g/cc
Fiber volume:	55.42 %vol
Ply count:	8
Test method:	ASTM D3039-17
Modulus calculation:	1000-3000 microstrain
Normalized by:	0.0140 in. CPT

Tension, 1-axis
Syensqo PRISM™ EP2400 with Tenax™ DRNF - Biaxial [0/90]4S

		CTA		RTA		ETA		ETW1	
Test Temperature [°F]		-65		70		180		180	
Moisture Conditioning		Ambient		Ambient		Ambient		Equilibrium 160F, 85%	
Equilibrium at T, RH									
Source code		BA-0TEN-X-X-X-XB		BA-0TEN-X-X-X-XA		BA-0TEN-X-X-X-XC		BA-0TEN-X-X-X-XD	
		Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured
F_1^{tu} [ksi]	Mean	196.2	180.1	207.3	190.7	211.5	193.9	206.9	190.3
	Minimum	184.2	170.2	183.5	169.4	191.3	179.7	190.2	177.0
	Maximum	207.0	192.1	219.4	205.5	223.6	204.3	218.3	202.8
	C.V.(%)	3.368	3.681	4.055	4.183	3.629	3.443	3.418	3.509
	No. Specimens	18		18		21		18	

TENSILE STRENGTH [ksi]: F1 vs F2

CTA: 180.1 vs 198.8 (-10.4%)
RTA: 190.7 vs 208.6 (-9.4%)
ETA: 193.9 vs 211.3 (-8.97%)
ETW1: 190.3 vs 208.4 (-9.51%)

BIAXIAL TEST RESULTS: 90-DEG PROPERTIES

Material:	Syensqo PRISM™ EP2400 with Tenax™ DRNF - Biaxial
Resin content:	35.08 %wt
Comp. density:	1.527 g/cc
Fiber volume:	55.69 %vol
Ply count:	8
Test method:	ASTM D3039-17
Modulus calculation:	1000-3000 microstrain
Normalized by:	0.0140 in. CPT

Tension, 2-axis
Syensqo PRISM™ EP2400 with Tenax™ DRNF - Biaxial [0/90]4s

		CTA		RTA		ETA		ETW1	
Test Temperature [°F]		-65		70		180		180	
Moisture Conditioning		Ambient		Ambient		Dry		Equilibrium 160F, 85%	
Equilibrium at T, RH									
Source code		BA-90TEN-X-X-X-XB		BA-90TEN-X-X-X-XA		BA-90TEN-X-X-X-XC		BA-90TEN-X-X-X-XD	
		Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured
F_2^{tu} [ksi]	Mean	214.1	198.8	223.8	208.6	228.4	211.3	222.9	208.4
	Minimum	193.9	183.2	200.7	193.8	211.7	191.3	209.7	193.8
	Maximum	222.7	210.1	244.3	228.7	257.8	237.5	234.3	218.2
	C.V.(%)	3.431	4.455	5.477	4.934	5.611	5.638	3.016	3.269
	No. Specimens	18		21		19		17	

- The mechanical impact of these stacking-induced defects is measurable. Tensile and compressive test data for the NMS 241/1 (0/90) lamina showed notable variability, particularly in the 90° direction. This suggests that the random ridge formations influence fiber straightness and resin distribution, leading to inconsistencies in mechanical response and higher variation from the mean.
- However, this creasing issue is not expected to be prevalent in typical part construction. In real-world applications, the NMS 241 /1 (0/90) fabric is rarely used alone in a pure repeating layup. Instead, it is often combined with other reinforcement styles such as NMS 241/2 bidiagonal (±45) NCF or NMS 241/3 UD woven 0° fabric, or laid with ply rotation to create a more uniform laminate behavior.

COMPRESSIVE MODULUS [Msi]: E1 vs E2

TASK 5: MATERIAL QUALIFICATION

BIDIAGONAL DRNF: QUALIFICATION TESTING

Reinforcement : Tenax™ E Reinforcement Fabrics - DRNF IM BD
Material Specificatio NMS 241/2, NMS 241F/2 and NMS 241R/1
Process Specificatio NPS 82401
Matrix: PRISM™ EP2400

Syensqo PRISM™ EP2400 with Tenax™ DRNF - Bidiagonal Lamina Properties Summary

Tg(dry): 314°F **Tg(wet):** 274°F **Tg METHOD:** ASTM D7028

Date of fiber manufacture Apr-Oct 2021
Date of resin manufacture 2022 and 2023
Date of composite manufacture Mar to Dec 2023
Date of testing July 2023 to July 2024

LAMINA MECHANICAL PROPERTY SUMMARY
Data reported as: Normalized & Measured
(Normalized by CPT=0.014 inch)

DRAFT

Properties	CTA (-65°F) Mean		RTA (70°F) Mean		ETA (180°F) Mean		ETW1 (180°F) Mean		ETW2 (250°F) Mean	
	Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured
F_1^{tu} [ksi]	210.4	207.8	213.1	210.1	210.7	207.7	202.4	199.6		
E_1^t [Msi]	12.37	12.22	12.20	12.03	12.22	12.05	12.33	12.17		
ν_{12}^{τ}		0.0454		0.0345		0.0244		0.0292		
F_1^{cu} [ksi]			104.8	100.2	78.70	75.56	75.45	72.29	54.36	52.67
E_1^c [Msi]			11.43	10.93	11.56	11.11	11.88	11.38	11.44	11.08
SBS [ksi]		10.85		10.72		7.478		6.368		3.776
$F_{12}^{s0.2\%}$ [ksi]		8.658		6.101		4.341		3.946		
$F_{12}^{s5\%strain}$ [ksi]		15.49		10.78		7.590		6.477		
G_{12}^s [Msi]		0.7740		0.6197		0.4582		0.4262		
Flex [ksi]			161.4	154.2						

BIDIAGONAL DRNF: PRE-QUALIFICATION TESTING

- **0-TENSION**
  - STRENGTH: 210.1 vs 192.23 (+8.50%)
  - MODULUS: 12.03 vs 10.92 (+9.23%)
- **0-COMPRESSION***
  - STRENGTH: 100.2 vs 27.39 (+72.7%)
  - MODULUS: 10.93 vs 2.23 (+79.6%)
- **INTERLAMINER SHEAR***
  - STRENGTH: 10.72 vs 7.23 (+32.6%)
- **IN-PLANE SHEAR**
  - 0.2% STRENGTH: 6.101 vs 5.37 (+11.98%)
  - 5.0% STRENGTH: 10.78 vs 10.67 (+1.02%)
  - MODULUS: 0.620 vs 0.63 (-1.59%)
- **FLEXURAL***
  - STRENGTH: 154.2 vs 66.42 (+56.93%)

- **LIMITATIONS TO COMPARISONS***
  - PRE-QUAL extractions at 45-deg
  - Showing for sake of completeness

TASK 5: MATERIAL QUALIFICATION

UNIDIRECTIONAL DRNF: QUALIFICATION TESTING

Reinforcement : Tenax™ E Reinforcement Fabrics - DRWF IM UD
Material Specification: NMS 241/3, NMS 241F/3 and NMS 241R/1
Process Specification: NPS 82401
Matrix: PRISM™ EP2400

Syensqo PRISM™ EP2400 with Tenax™ DRWF - IM UD
Lamina Properties Summary

Tg(dry): 328°F **Tg(wet):** 288°F **Tg METHOD:** ASTM D7028

Date of fiber manufacture	Apr-Oct 2021	**Date of testing**	July 2023 to July 2024
Date of resin manufacture	2022 and 2023		
Date of composite manufacture	Mar to Dec 2023		

LAMINA MECHANICAL PROPERTY SUMMARY
Data reported as: Normalized & Measured
(Normalized by CPT=0.007 inch)

DRAFT

Properties	CTA (-65°F) Mean		RTA (70°F) Mean		ETA (180°F) Mean		ETW1 (180°F) Mean		ETW2 (250°F) Mean	
	Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured
F_1^{tu} [ksi]	417.8	415.6	427.0	421.9	412.1	409.8	391.6	390.4	350.8	348.9
E_1^{t} [Msi]	23.39	23.26	23.08	22.80	23.19	23.06	23.80	23.73	23.34	23.22
F_1^{cu} [ksi][1] from UNC0			189.2	186.1	133.0	131.8	118.4	117.0	59.02	59.55
E_1^{c} [Msi]			20.91	20.55	20.99	20.79	21.35	21.10	20.96	21.16
SBS [ksi]		16.23		11.69		6.974		5.736		3.419
UNT0 Strength [ksi]	209.3	210.5	210.8	212.3	205.8	207.2	201.2	202.5		
UNT0 Modulus [Msi]	12.15	12.23	12.06	12.14	11.95	12.01	11.98	12.06		
UNC0 Strength [ksi]			99.96	101.5	71.21	72.38	60.44	61.36	29.12	29.72
UNC0 Modulus [Msi]			11.05	11.21	11.24	11.42	10.89	11.06	10.34	10.56
$F_{12}^{s0.2\%}$ [ksi]		8.551		6.023		4.024		3.659		
$F_{12}^{s5\%strain}$ [ksi]		14.45		10.51		6.927		5.896		
G_{12}^{s} [Msi]		0.7621		0.6100		0.4282		0.3980		
Flex [ksi]			161.3	162.9						

1 Derived from cross-ply using backout factor. See Note 6 of Table 1-3 for equation used.

UNIDIRECTIONAL DRNF: PRE-QUALIFICATION TESTING

- **0-TENSION***
  - STRENGTH: 212.3 vs 164.13 (+.%)
  - MODULUS: 12.14 vs 9.79 (+.%)
- **0-COMPRESSION***
  - STRENGTH: 101.5 vs 81.95 (+.%)
  - MODULUS: 11.21 vs 8.92 (+.%)

* Specimens… → Not Direct Comparison

- **LIMITATIONS TO COMPARISONS***
  - PRE-QUAL panels $[0/90]_{3S}$ vs $[0/90]_{4S}$
  - Showing for sake of completeness

BIAXIAL DRNF: NCAMP RECOMMENDED B-BASIS STRENGTH VALUES

NCAMP Recommended B-Basis Values for
Syensqo PRISM™ EP2400 toughened epoxy resin
All B-Basis values in this table meet the standards for publication in CMH-17-1H Handbook
Values are for normalized data unless noted

Biaxial Lamina Strength Tests DRAFT

Environment	Statistic	0CLC	0TEN	90CLC	90TEN	IPS*		FLEX	SBS*
						0.2% Offset Strength	Strength at 5% Strain		
CTA (-65°F)	B-basis		174.6		199.6	7.187	12.10		8.738
	Mean		196.2		214.1	8.139	13.73		9.876
	CV		6.000		3.431	6.000	6.000		6.565
RTA (70°F)	B-basis	NA	185.8	87.48	NA: A	5.216	9.244	127.3	8.868
	Mean	99.99	207.3	106.5	223.8	5.762	10.21	152.5	10.01
	CV	8.603	6.028	9.253	6.739	6.000	6.000	8.354	6.000
ETA (180°F)	B-basis	60.37	190.3	67.20	198.1	3.534	6.193		6.458
	Mean	74.82	211.5	82.81	228.4	4.079	7.156		7.313
	CV	10.02	6.000	8.983	6.805	6.000	6.000		6.000
ETW1 (180°F)	B-basis	61.18	185.4	NA: A	NA	3.235	5.339		5.569
	Mean	70.81	206.9	80.83	222.9	3.669	6.056		6.317
	CV	6.891	6.000	8.195	6.000	6.000	6.000		6.000

Notes: The modified CV B-basis value is recommended when available.
The CV provided corresponds with the B-basis value given.
NA implies that tests were run but data did not meet NCAMP's recommended requirements.
NA: A implies ANOVA with three batches.
ETW2 not included as there were no recommended B-Basis values.
* Data is as measured rather than normalized

BIDIAGONAL DRNF: NCAMP RECOMMENDED B-BASIS STRENGTH VALUES

NCAMP Recommended B-Basis Values for
Syensqo PRISM™ EP2400 toughened epoxy resin
All B-Basis values in this table meet the standards for publication in CMH-17-1H Handbook
Values are for normalized data unless noted

Bidiagonal Lamina Strength Tests DRAFT

Environment	Statistic	0CLC	0TEN	IPS*		FLEX	SBS*
				0.2% Offset Strength	Strength at 5% Strain		
CTA (-65°F)	B-basis		188.2	7.618	13.37		9.900
	Mean		210.4	8.658	15.16		10.85
	CV		6.113	6.087	6.000		6.000
RTA (70°F)	B-basis	94.60	190.8	5.354	9.873	142.3	9.769
	Mean	104.8	213.1	6.101	10.78	161.4	10.72
	CV	6.569	6.157	6.281	6.059	6.000	6.000
ETA (180°F)	B-basis	68.53	188.3	3.827	6.680		6.527
	Mean	78.70	210.7	4.341	7.590		7.478
	CV	6.978	6.000	6.000	6.000		6.000
ETW1 (180°F)	B-basis	65.34	180.1	3.479	5.567		5.416
	Mean	75.45	202.4	3.946	6.477		6.368
	CV	6.255	6.213	6.000	6.000		6.000

Notes: The modified CV B-basis value is recommended when available.
The CV provided corresponds with the B-basis value given.
NA implies that tests were run but data did not meet NCAMP's recommended requirements.
ETW2 not included as there were no recommended B-Basis values.
* Data is as measured rather than normalized

UNIDIRECTIONAL DRNF: NCAMP RECOMMENDED B-BASIS STRENGTH VALUES

NCAMP Recommended B-Basis Values for
Syensqo PRISM™ EP2400 toughened epoxy resin
All B-Basis values in this table meet the standards for publication in CMH-17-1H Handbook
Values are for normalized data unless noted

Unidirectional Lamina Strength Tests

DRAFT

Environment	Statistic	0CLC	0TEN	UNC0	UNT0	IPS* 0.2% Offset Strength	IPS* Strength at 5% Strain	FLEX	SBS*
CTA (-65°F)	B-basis		361.1		186.9	7.538	12.74		14.27
	Mean		417.8		209.3	8.551	14.45		16.23
	CV		6.866		6.000	6.000	6.000		6.102
RTA (70°F)	B-basis	130.1	NA: A	89.94	188.5	NA	9.649	139.3	10.30
	Mean	144.7	427.0	99.96	210.8	6.023	10.51	161.3	11.69
	CV	6.599	6.892	6.599	6.747	6.000	6.000	6.896	6.000
ETA (180°F)	B-basis	NA: A	359.5	NA: A	183.5	3.548	6.065		6.148
	Mean	102.3	412.1	72.21	205.8	4.024	6.927		6.974
	CV	5.552	6.462	6.776	6.000	6.000	6.000		6.000
ETW1 (180°F)	B-basis	74.46	NA: A	50.42	178.8	3.231	5.029		5.016
	Mean	89.05	391.6	60.44	201.2	3.659	5.896		5.736
	CV	6.841	7.856	6.841	6.000	6.000	6.000		6.353

Notes: The modified CV B-basis value is recommended when available.
The CV provided corresponds with the B-basis value given.
NA implies that tests were run but data did not meet NCAMP's recommended requirements.
NA: A implies ANOVA with three batches.
ETW2 not included as there were no recommended B-Basis values.
* Data is as measured rather than normalized

LAMINATE: NCAMP RECOMMENDED B-BASIS STRENGTH VALUES

NCAMP Recommended B-Basis Values for
Syensqo PRISM™ EP2400 toughened epoxy resin
All B-Basis values in this table meet the standards for publication in CMH-17-1H Handbook
Values are for normalized data unless noted

Laminate Strength Tests

DRAFT

Layup	Environment	Statistic	UNT	UNC	SBS*	OHT	FHT	OHC	FHC	SSB 2% Offset Strength	SSB Ultimate Strength
25/50/25 (Quasi)	CTA (-65°F)	B-basis	117.1			77.86	76.98				
		Mean	131.6			87.33	86.04				
		CV	6.287			6.000	6.000				
	RTA (70°F)	B-basis	123.1	78.11	8.442	82.25	76.62	43.49	NA	101.8	121.1
		Mean	137.6	87.41	9.259	97.71	85.68	48.04	69.11	113.1	134.0
		CV	6.000	7.303	6.000	6.000	6.000	6.212	6.129	6.000	6.000
	ETA (180°F)	B-basis	124.9	53.26	5.872	81.11	77.53	33.42	47.83	85.76	102.2
		Mean	139.3	62.46	6.688	90.57	86.59	37.97	54.43	97.11	115.1
		CV	6.000	8.385	6.431	6.000	6.000	6.491	6.142	6.508	6.000
	ETW1 (180°F)	B-basis	122.3	46.26	5.188	82.63	78.71	30.75	43.12	88.50	101.4
		Mean	136.7	55.56	6.004	92.05	87.77	35.30	48.96	99.85	114.3
		CV	6.000	6.959	6.321	6.000	6.000	6.218	6.042	6.118	6.000
12.5/75/12.5 (Soft)	CTA (-65°F)	B-basis	82.68			52.80	62.12				
		Mean	91.74			59.01	68.77				
		CV	6.000			6.000	6.000				
	RTA (70°F)	B-basis	79.42	55.11		52.04	55.06	34.66	51.20	99.47	123.7
		Mean	88.47	60.65		58.25	61.70	38.48	56.38	112.4	137.5
		CV	6.000	6.000		6.000	6.000	6.000	6.061	6.000	6.000
	ETW1 (180°F)	B-basis	65.33	30.59		51.82	49.95	25.68	33.56	83.29	99.34
		Mean	74.38	36.13		58.03	56.60	29.49	38.74	96.20	113.1
		CV	6.000	6.339		6.000	6.000	6.302	6.000	7.709	6.041
50/40/10 (Hard)	CTA (-65°F)	B-basis	206.8			NA	114.6				
		Mean	232.6			146.7	128.6				
		CV	6.189			8.510	6.075				
	RTA (70°F)	B-basis	213.0	NA		136.4	115.0	55.99	73.34	92.61	117.1
		Mean	238.8	109.6		154.9	129.0	61.95	85.16	104.5	130.0
		CV	6.296	11.55		4.470	6.000	6.000	7.031	6.614	6.000
	ETW1 (180°F)	B-basis	192.9	54.70		161.8	122.7	35.66	NA	76.13	92.32
		Mean	218.7	65.88		179.9	136.7	41.63	56.71	88.02	105.2
		CV	6.542	8.599		1.956	6.000	6.631	6.000	6.946	6.000

Notes: The modified CV B-basis value is recommended when available.
The CV provided corresponds with the B-basis value given.
NA implies that tests were run but data did not meet NCAMP's recommended requirements.
ETW2 not included as there were no recommended B-Basis values.
* Data is as measured rather than normalized

BIAXIAL DRNF: NCAMP RECOMMENDED B-BASIS STRENGTH VALUES

Reinforcement :	Tenax™ E Reinforcement Fabrics - DRNF IM BA
Material Specification:	NMS 241/1, NMS 241F/1 and NMS 241R/1
Process Specification:	NPS 82401
Matrix:	PRISM™ EP2400

Syensqo PRISM™ EP2400 with Tenax™ DRNF - Biaxial Lamina Properties Summary

Tg(dry): 314°F **Tg(wet):** 275°F **Tg METHOD:** ASTM D7028

Date of fiber manufacture	Apr-Oct 2021
Date of resin manufacture	2022 and 2023
Date of composite manufacture	Mar to Dec 2023
Date of testing	July 2023 to July 2024
Date of analysis	August 2024

BIAXIAL LAMINA MECHANICAL PROPERTY B-BASIS SUMMARY
Data reported: As measured followed by normalized values in parentheses, normalizing CPT: 0.014 in
Values shown in shaded boxes do not meet CMH-17H requirements and are estimates only
These values may not be used for certification unless specifically allowed by the certifying agency

Test Condition	CTA		RTA		ETA		ETW1		ETW2	
Property	B-Basis	Modified CV B-Basis	B-Basis	Modified CV B-Basis	B-Basis	Modified CV B-Basis	B-Basis	Modified CV B-Basis	B-Basis	Modified CV B-Basis
F_1^{tu} [ksi]	167.9 (183.1)	160.3 (174.6)	178.5 (190.2)	170.9 (185.8)	181.9 (196.9)	174.4 (190.3)	178.1 (192.9)	170.5 (185.4)		
F_2^{tu} [ksi]	149.7 (199.6)	NA	150.8 (156.1)	NA	188.1 (203.4)	183.2 (198.1)	177.4 (209.5)	183.3 (196.2)		
F_1^{cu} [ksi]			51.00 (82.76)	NA	55.68 (60.37)		57.17 (49.35)	55.67 (61.18)	30.16 (34.69)	30.23 (34.76)
F_2^{cu} [ksi]			83.84 (90.85)	(87.48)	61.26 (67.20)	NA	60.11 (49.87)	NA	42.87 (48.32)	39.41 (44.19)
$F_{12}^{s0.2\%}$ [ksi]	7.095	7.187	5.472	5.216	3.790	3.534	3.306	3.235		
$F_{12}^{s5\%strain}$ [ksi]	11.64	12.10	8.814	9.244	6.803	6.193	5.109	5.339		
FLEX			114.3 (99.66)	(127.3)						
SBS	7.827	8.738	9.508	8.868	7.039	6.458	6.142	5.569	3.483	2.744

Notes: NA means basis values were not computed for that combination of property/condition
Basis values are not computed for Interlaminar Tension properties
Shaded empty boxes mean that data was not available for that combination of property/condition

Table 3-5: Summary of B-Basis Values and Estimates for Biaxial Lamina Strength Tests

BIDIAGONAL DRNF: NCAMP RECOMMENDED B-BASIS STRENGTH VALUES

Reinforcement :	Tenax™ E Reinforcement Fabrics - DRNF IM BD
Material Specification:	NMS 241/2, NMS 241F/2 and NMS 241R/1
Process Specification:	NPS 82401
Matrix:	PRISM™ EP2400

Syensqo PRISM™ EP2400 with Tenax™ DRNF - Bidiagonal Lamina Properties Summary

Tg(dry): 314°F **Tg(wet):** 274°F **Tg METHOD:** ASTM D7028

Date of fiber manufacture	Apr-Oct 2021
Date of resin manufacture	2022 and 2023
Date of composite manufacture	Mar to Dec 2023
Date of testing	July 2023 to July 2024
Date of analysis	August 2024

BIDIAGONAL LAMINA MECHANICAL PROPERTY B-BASIS SUMMARY
Data reported: As measured followed by normalized values in parentheses, normalizing CPT: 0.014 in
Values shown in shaded boxes do not meet CMH-17H requirements and are estimates only
These values may not be used for certification unless specifically allowed by the certifying agency

Test Condition	CTA		RTA		ETA		ETW1		ETW2	
Property	B-Basis	Modified CV B-Basis	B-Basis	Modified CV B-Basis	B-Basis	Modified CV B-Basis	B-Basis	Modified CV B-Basis	B-Basis	Modified CV B-Basis
F_1^{tu} [ksi]	195.7 (193.1)	186.1 (188.2)	197.9 (162.8)	188.4 (190.8)	195.5 (170.4)	185.9 (188.3)	187.4 (148.2)	177.8 (180.1)		
F_1^{cu} [ksi]			92.71 (96.72)	90.54 (94.60)	68.11 (70.66)	65.94 (68.53)	64.88 (67.46)	62.72 (65.34)	47.52 (48.32)	39.98 (41.26)
$F_{12}^{s0.2\%}$ [ksi]	8.075	7.618	5.520	5.354	4.074	3.827	3.352	3.479		
$F_{12}^{s5\%strain}$ [ksi]	11.63	13.37	9.914	9.873	7.209	6.680	5.282	5.567		
FLEX			143.0 (149.3)	135.9 (142.3)						
SBS	10.12	9.900	10.01	9.769	7.041	6.527	6.218	5.416	3.536	2.866

Notes: Shaded empty boxes mean that data was not available for that combination of property/condition
Basis values are not computed for Interlaminar Tension properties

Table 3-6: Summary of B-Basis Values and Estimates for Bidiagonal Lamina Strength Tests

UNIDIRECTIONAL DRNF: NCAMP RECOMMENDED B-BASIS STRENGTH VALUES

Reinforcement :	Tenax™ E Reinforcement Fabrics - DRWF IM UD	Syensqo PRISM™ EP2400 with Tenax™ DRWF - IM UD Lamina Properties Summary
Material Specification:	NMS 241/2, NMS 241F/2 and NMS 241R/1	
Process Specification:	NPS 82401	
Matrix:	PRISM™ EP2400	

Tg(dry): 328°F Tg(wet): 288°F Tg METHOD: ASTM D7028

Date of fiber manufacture	Apr-Oct 2021
Date of resin manufacture	2022 and 2023
Date of composite manufacture	Mar to Dec 2023
Date of testing	July 2023 to July 2024
Date of analysis	August 2024

UNIDIRECTIONAL LAMINA MECHANICAL PROPERTY B-BASIS SUMMARY
Data reported: As measured followed by normalized values in parentheses, normalizing CPT: 0.007 in
Values shown in shaded boxes do not meet CMH-17H requirements and are estimates only
These values may not be used for certification unless specifically allowed by the certifying agency

Test Condition	CTA		RTA		ETA		ETW1		ETW2	
Property	B-Basis	Modified CV B-Basis	B-Basis	Modified CV B-Basis	B-Basis	Modified CV B-Basis	B-Basis	Modified CV B-Basis	B-Basis	Modified CV B-Basis
F_1^{tu} [ksi]	276.3 (370.5)	NA (361.1)	267.6 (290.6)	NA	290.6 (372.0)	NA (359.5)	223.7 (236.3)	NA	320.3 (309.6)	264.3 (265.8)
F_1^{cu} [ksi]			172.6 (140.1)	168.0 (170.0)	79.90 (92.66)	NA	103.6 (105.2)	99.01 (99.28)	36.62 (34.67)	
UNT0 Strength [ksi]	197.4 (179.0)	188.3 (186.9)	170.4 (162.5)	190.1 (188.5)	195.3 (187.4)	185.1 (183.5)	178.7 (173.6)	180.3 (178.8)		
UNC0 Strength [ksi]			94.29 (74.02)	91.80 (89.94)	43.89 (49.63)	NA	54.14 (53.66)	51.65 (50.42)	18.28 17.11	
$^{2\%}$ [ksi]	7.792	7.538	5.848	5.319	3.590	3.548	3.301	3.231		
^{strain} [ksi]	12.45	12.74	9.134	9.536	6.125	5.951	5.624	5.187		
FLEX			141.4 (142.8)	139.3 (139.3)						
SBS	14.88	14.27	10.25	10.30	5.261	6.148	4.022	5.016	2.858	2.591

Notes: NA means basis values were not computed for that combination of property/condition
Shaded empty boxes mean that data was not available for that combination of property/condition

Table 3-7: Summary of B-Basis Values and Estimates for Unidirectional Lamina Strength Tests

LAMINATE: NCAMP RECOMMENDED B-BASIS STRENGTH VALUES

Reinforcement :	Tenax™ E Reinforcement Fabrics	Syensqo PRISM™ EP2400 with Tenax™ DRNF & DRWF Laminate Properties Summary
Material Specification:	NMS 241 series	
Process Specification:	NPS 82401	
Matrix:	PRISM™ EP2400	

Tg(dry): 319°F Tg(wet): 281°F Tg METHOD: ASTM D7028

Date of fiber manufacture	Apr-Oct 2021
Date of resin manufacture	2022 and 2023
Date of composite manufacture	Mar to Dec 2023
Date of testing	July 2023 to July 2024
Date of analysis	August 2024

LAMINATE MECHANICAL PROPERTY B-BASIS SUMMARY
Data reported: As measured followed by normalized values in parentheses, normalizing CPT: 0.007 in
Values shown in shaded boxes do not meet CMH-17H requirements and are estimates only
These values may not be used for certification unless specifically allowed by the certifying agency

	Layup	25/50/25 (Quasi)		12.5/75/12.5 (Soft)		50/40/10 (Hard)		37.5/25/37.5	
Property	Test Condition	B-Basis	Modified CV B-Basis	B-Basis	Modified CV B-Basis	B-Basis	Modified CV B-Basis	B-Basis	Modified CV B-Basis
UNC Strength	RTA	71.71 (78.75)	71.52 (78.11)	44.85 (57.03)	50.70 (55.11)	81.48 (84.26)	82.41		
	ETA	48.95 (53.90)	48.75 (53.26)						
	ETW1	42.90 (46.91)	42.71 (46.26)	31.03 (32.52)	30.01 (30.59)	53.86 (54.70)			
	ETW2	21.75 (23.18)	20.99 (22.65)						
UNT Strength	CTA	97.22 (103.5)	110.1 (117.1)	62.66 (73.74)	78.80 (82.68)	214.6 (185.8)	203.6 (206.8)		
	RTA	122.0 (129.7)	115.8 (123.1)	71.30 (84.60)	75.75 (79.42)	219.2 (190.5)	208.7 (213.0)		
	ETA	123.7 (131.5)	117.5 (124.9)	66.76 (70.79)	62.24 (65.33)	199.5 (165.3)	190.6 (192.9)		
	ETW1	121.2 (128.8)	114.9 (122.3)						
FHT Strength	CTA	71.00 (82.79)	72.38 (76.98)	63.70 (58.85)	59.18 (62.12)	118.0 (120.4)	113.8 (114.6)		
	RTA	76.46 (82.43)	71.97 (76.62)	57.26 (55.80)	52.74 (55.06)	106.9 (120.8)	113.8 (115.0)		
	ETA	60.65 (68.81)	73.04 (77.53)	52.29 (53.69)	47.78 49.95)	127.6 (128.6)	121.9 (122.7)		
	ETW1	78.89 (84.52)	74.41 (78.71)						
OHT Strength	CTA	77.88 (82.64)	72.71 (77.86)	50.73 (57.54)	50.45 (52.80)	78.40 (90.76)	NA		
	RTA	82.25 (87.02)	NA (82.25)	45.51 (52.27)	49.98 (52.04)	104.5 (121.2)	132.9 (136.4)	82.61 (92.22)	70.25 (76.46)
	ETA	80.59 (85.88)	75.44 (81.11)						
	ETW1	82.42 (87.38)	77.16 (82.63)	52.58 (55.83)	49.66 (51.82)	148.8 (163.3)	158.9 (161.8)	89.13 (101.1)	87.03 (93.87)

UNIDIRECTIONAL DRNF: NCAMP RECOMMENDED B-BASIS STRENGTH VALUES

Reinforcement :	Tenax™ E Reinforcement Fabrics - DRWF IM UD
Material Specification:	NMS 241/2, NMS 241F/2 and NMS 241R/1
Process Specification:	NPS 82401
Matrix:	PRISM™ EP2400

Syensqo PRISM™ EP2400 with Tenax™ DRWF - IM UD
Lamina Properties Summary

Tg(dry): 328°F Tg(wet): 288°F Tg METHOD: ASTM D7028

Date of fiber manufacture	Apr-Oct 2021
Date of resin manufacture	2022 and 2023
Date of composite manufacture	Mar to Dec 2023
Date of testing	July 2023 to July 2024
Date of analysis	August 2024

UNIDIRECTIONAL LAMINA MECHANICAL PROPERTY B-BASIS SUMMARY
Data reported: As measured followed by normalized values in parentheses, normalizing CPT: 0.007 in
Values shown in shaded boxes do not meet CMH-17H requirements and are estimates only
These values may not be used for certification unless specifically allowed by the certifying agency

Test Condition	CTA		RTA		ETA		ETW1		ETW2	
Property	B-Basis	Modified CV B-Basis	B-Basis	Modified CV B-Basis	B-Basis	Modified CV B-Basis	B-Basis	Modified CV B-Basis	B-Basis	Modified CV B-Basis
F_1^{tu} [ksi]	276.3 (370.5)	NA (361.1)	267.6 (290.6)	NA	290.6 (372.0)	NA (359.5)	223.7 (236.3)	NA	320.3 (309.6)	264.3 (265.8)
F_1^{cu} [ksi]			172.6 (140.1)	168.0 (170.0)	79.90 (92.66)	NA	103.6 (105.2)	99.01 (99.28)	36.62 (34.67)	
UNT0 Strength [ksi]	197.4 (179.0)	188.3 (186.9)	170.4 (162.5)	190.1 (188.5)	195.3 (187.4)	185.1 (183.5)	178.7 (173.6)	180.3 (178.8)		
UNC0 Strength [ksi]			94.29 (74.02)	91.80 (89.94)	43.89 (49.63)	NA	54.14 (53.66)	51.65 (50.42)	18.28 17.11	
$^{2\%}$ [ksi]	7.792	7.538	5.848	5.319	3.590	3.548	3.301	3.231		
^{strain} [ksi]	12.45	12.74	9.134	9.536	6.125	5.951	5.624	5.187		
FLEX			141.4 (142.8)	139.3 (139.3)						
SBS	14.88	14.27	10.25	10.30	5.261	6.148	4.022	5.016	2.858	2.591

Notes: NA means basis values were not computed for that combination of property/condition
Shaded empty boxes mean that data was not available for that combination of property/condition

Table 3-7: Summary of B-Basis Values and Estimates for Unidirectional Lamina Strength Tests

LAMINATE: NCAMP RECOMMENDED B-BASIS STRENGTH VALUES

	Layup	25/50/25 (Quasi)		12.5/75/12.5 (Soft)		50/40/10 (Hard)		37.5/25/37.5	
Property	Test Condition	B-Basis	Modified CV B-Basis	B-Basis	Modified CV B-Basis	B-Basis	Modified CV B-Basis	B-Basis	Modified CV B-Basis
FHC Strength	RTA	59.08 (63.22)	56.95 (60.63)	49.03 (52.93)	47.27 (51.20)	73.95 (74.97)	72.41 (73.34)		
	ETA	47.19 (49.83)	45.17 (47.83)						
	ETW1	42.43 (45.02)	40.53 (43.12)	34.39 (35.29)	32.71 (33.56)	53.18 (53.41)	NA		
OHC Strength	RTA	41.43 (44.37)	40.55 (43.49)	33.98 (35.96)	33.15 (34.66)	47.84 (57.89)	54.81 (55.99)	35.36 (37.83)	33.12 (36.25)
	ETA	31.99 (34.30)	31.11 (33.42)						
	ETW1	26.36 (26.50)	28.74 (30.75)	23.71 (22.00)	24.39 (25.68)	36.93 (37.56)	34.96 (35.66)	31.28 (32.27)	26.47 (28.85)
	ETW2	20.99 (23.40)	17.26 (18.64)						
SBS1 Strength [ksi]	RTA	8.529	8.442						
	ETA	4.918	5.872						
	ETW1	5.490	5.188						
SSB 2% Offset Strength	RTA	100.1 (105.1)	96.98 (101.8)	101.2 (105.4)	96.03 (99.47)	92.64 (94.79)	90.49 (92.61)		
	ETA	85.25 (89.08)	82.11 (85.76)						
	ETW1	86.64 (91.82)	83.50 (88.50)	60.12 (63.70)	79.98 (83.29)	76.47 (78.31)	74.31 (76.13)		
SSB Ultimate Strength [ksi]	RTA	122.2 (128.3)	115.4 (121.1)	126.2 (130.1)	119.2 (123.7)	120.9 (123.9)	114.4 (117.1)		
	ETA	104.7 (109.4)	97.81 (102.2)						
	ETW1	102.5 (108.7)	95.70 (101.4)	102.1 (105.8)	95.16 (99.34)	96.55 (99.14)	90.05 (92.32)		

Notes: NA means basis values were not computed for that combination of property/condition
Basis values are not computed for Compression After Impact properties
Shaded empty boxes mean that data was not available for that combination of property/condition

Table 3-8: Summary of B-Basis Values and Estimates for Laminate Strength Tests

WRAP-UP

REPORTING

- MAY 2025 DRAFT REVISION:

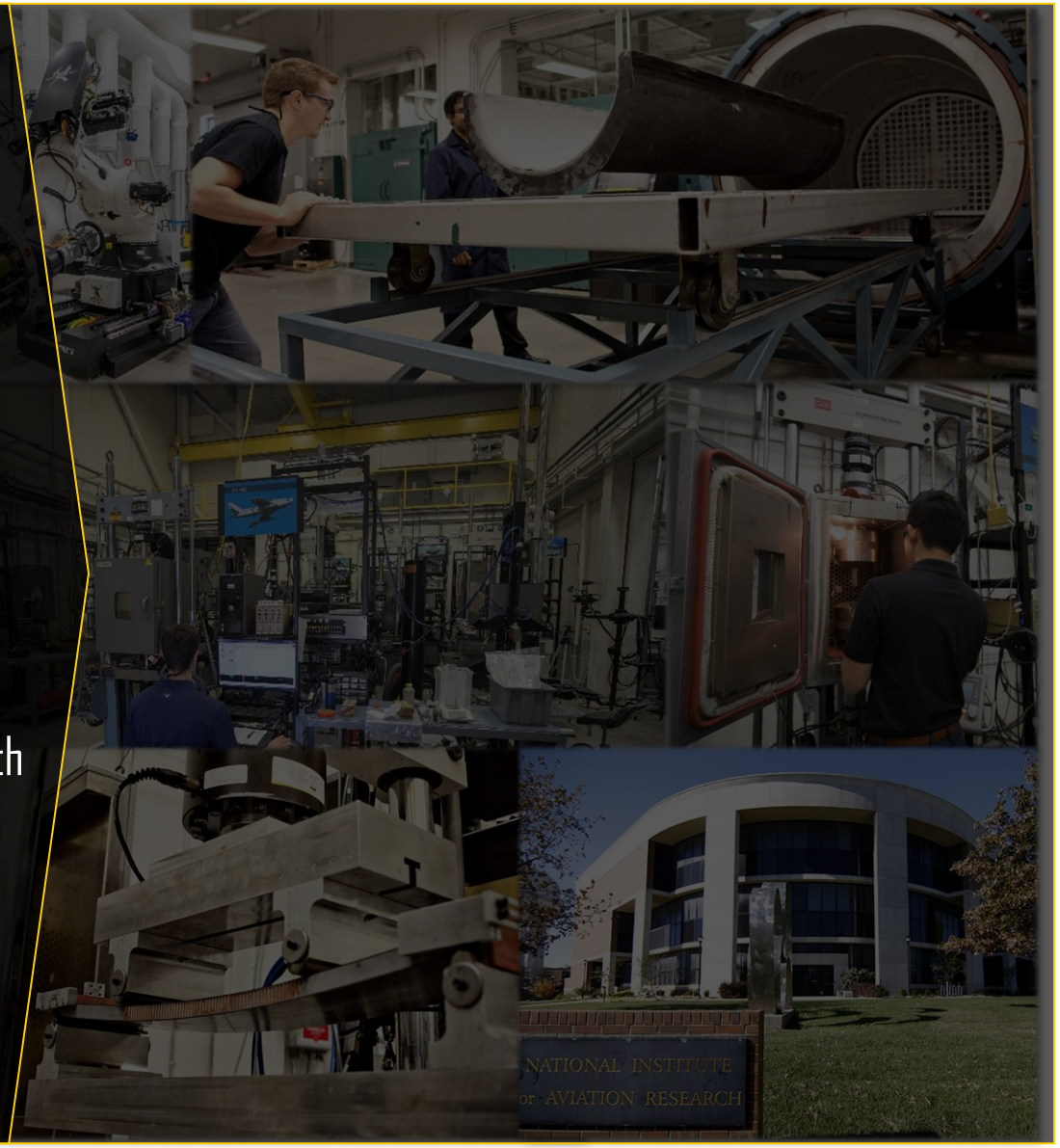
Resin Infused Fiber Reinforced Materials Guidelines for Aircraft Design and Certification: Volume 1 – Qualification Framework Development

- SEPTEMBER 2025 DRAFT:

Resin Infused Fiber Reinforced Materials Guidelines for Aircraft Design and Certification: Volume 2 – Validation of Qualification Framework and Statistical Guidelines.

BENEFIT TO AVIATION

- Publicly available resin infused fiber reinforced materials data along with framework for qualification.
- Guidelines generated in this program will be transitioned into shared databases, such as CMH-17



QUESTIONS?

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