Federal Aviation Administration

AVS Research, Engineering and Development

AVS RE&D Portfolio:

Advanced Materials/Structural Safety (A11C)

Research Plan: 2022- 2027

January 26, 2022

Part 1: BLI Definition and Scope

Program Area: Advanced Materials/Structural Safety (A11C)

FAA Domain: Aircraft Safety Assurance

BLI Scope: Advanced Materials/Structural Safety

The Advanced Materials and Structural Safety program conducts research to support FAA safety and regulatory activities in the technical areas of composites and other advanced materials and processes, and their impact on flight safety. The overall goal of this BLI is to support Development of Standardized Certification Protocols and Safe Manufacturing and Maintenance Practices for Advanced Materials and Structural Applications. This BLI must keep abreast with industry advances to support standards that ensure safe and efficient practices for the future.

The program focuses on potential issues with material and structural performance, manufacturing quality control and assurance, and operational support/maintenance needs. Research results are used by FAA personnel to develop policy, guidance, and training, drive industry group engagement, and inform COS evaluations. As materials and structures are a common technology across all product types and new applications (e.g., UAM), this BLI supports multiple FAA strategic focus areas, including continued passenger transport operations, certification for emerging aircraft, and standards for emerging materials. Knowledge can be transferred between different product types as appropriate within principles of the safety continuum.

Part 2: Service/Office Research Requirements and Research Gap Analysis

1.0 Operational Capability: *New Material and Process Characterization*		
Definition: Develop guidelines for characterizing new material forms and assessing manufacturing maturity		
Primary S/O: Cindy Ashforth, AIR-600 **Secondary S/O**: N/A		
S/O Priority: 4		
Outcome: Documented standards, protocols, and guidelines to characterize and control advanced materials in a way that produces consistently sound structure		
Research Gap Analysis		
Research Questions	**Contribution**	**Research Output**
1.1 What are minimum requirements to adequately control new advanced materials and processes and develop design allowables and strength values for a range of applications spanning from low to high criticality?	50%	Protocols and standards for developing material specifications, process specifications and material datasets as well as evaluation of analytical methods for the new advanced material and/or process.
1.2 What are the requirements to evaluate equivalence for changes to materials and processes relative to an existing database?	30%	Protocols and standards to assess changes to materials and processes.
1.3 What are the key process parameters (Kpp) and key characteristics (Kc)for new advanced materials and processes, and what is the effectiveness of manufacturing control and inspection methods including in-situ monitoring and NDI?	20%	Public guidelines on Kpp and Kc for the advanced material and process as well as best practices that evaluate effectiveness (or ineffectiveness) of selected manufacturing and quality assurance techniques.

2.0 Operational Capability: *Evaluate fatigue, damage tolerance, and other aging behaviors of advanced materials*
Definition: Evaluate long-term material and structural behavior and associated maintenance activities
Primary S/O: Cindy Ashforth, AIR-600 **Secondary S/O**: N/A
S/O Priority: 1
Outcome: Documented assessment of long-term behavior and management methods of advanced materials and structures, including aging effects, fatigue, and damage tolerance.

Research Gap Analysis

Research Questions	Contribution	Research Output
2.1 What are the aging mechanisms for the advanced material and process and can they be simulated during certification?	30%	Public documentation of the aging behavior and best practices for certification of the advanced material and process.
2.2 What is the fatigue and damage tolerance behavior of a composite structural detail that has service issues?	40%	Public documentation of the aging behavior and best practices for certification and maintenance of the structural detail.
2.3 What is the fatigue behavior of metallic AM materials?	30%	Document fatigue and age-related behavior of metallic additively manufactured materials and evaluate associated analytical tools.

3.0 Operational Capability: *Dynamic Behavior*

Definition: Evaluate and characterize dynamic behavior of advanced structures to drive new test and certification standards and guidelines

Primary S/O: Cindy Ashforth, AIR-600
Secondary S/O: AIR-626

S/O Priority: 3

Outcome: Successful implementation of composites into analytical certification methods for dynamic behavior.

Research Gap Analysis

Research Questions	Contribution	Research Output
3.1 Are analytical methods effective to model composite seat performance?	50%	Recommended guidelines for how to apply analytical modeling in lieu of dynamic testing per 2x.562 to bring parity to metallic seats.
3.2 Are analytical methods effective to model bird strike of composite structure?	40%	Best practices and FAA guidance and/or industry standards for dynamic modeling bird strike events.
3.3 What is the dynamic behavior of composites and other advanced materials/processes?	10%	Document dynamic behavior of emerging materials and processes, such as thermoplastics, discontinuous fiber composites, or additively manufactured materials and their application to new aerospace vehicles.

4.0 Operational Capability: *Characterize Structural Details*

Definition: Develop efficient methods for characterizing composite and additively manufactured structural details and elements to tie to best practice design and certification principles

Primary S/O: Cindy Ashforth, AIR-600
Secondary S/O: N/A

S/O Priority: 5

Outcome: Standardize test configurations and methods for common mid-level building block structural details and elements for both composite and additive parts

Research Gap Analysis

Research Questions	Contribution	Research Output
4.1 How can we standardize methods for characterizing/testing mid-level composite building block structural configurations with geometric design complexity beyond standard material coupons?	40%	Identify common composite mid-level building block *(i.e., feature-based)* configurations (details and elements), and then develop standardized test methods that can generate data for adequately assessing structural behavior
4.2 How can we standardize methods for characterizing/testing mid-level additive manufacturing building block structural configurations with geometric design complexity found in printed features?	40%	Identify common mid-level building block *(i.e., feature-based)* configurations of additive manufacturing (AM) details and then develop standardized test methods for those design details to generate data that is useful for adequately assessing full-scale structural behavior.
4.3 Are there any non-structural behaviors of advanced materials and processes that require unique evaluation methods?	20%	Evaluate flammability and lightning characteristics of advanced materials, to ensure existing standards are adequate and appropriate, or to support development of new standards if required.

5.0 Operational Capability: *Knowledge Sharing*

Definition: Fund Joint Advanced Materials and Structures (JAMS) Center of Excellence (COE), industry handbooks, and educational initiatives.

Primary S/O: Cindy Ashforth, AIR-600
Secondary S/O: N/A

S/O Priority: 2

Outcome: Maintain research center of excellence, support industry handbooks and other standardization activities, and promote knowledge sharing

Research Gap Analysis

Research Questions	Contribution	Research Output
5.1 How can we support the congressionally mandated JAMS COE?	50%	Continued COE operation and administration.
5.2. How can we support industry organizations?	20%	Continuously updated industry publications that can be accepted by the FAA for means of compliance.
5.3 How can we promote knowledge sharing of key lessons for advanced materials and processes?	30%	Develop educational and training materials for FAA and industry personnel based on advances made through other research objectives.

Part 3: RE&D Management Team Programming

BLI Planning 3 Year Funding Profile (FY22-24) as of 01/28/2022

YEAR	Appropriation or Formulation Contract Funding ($)	INITIAL BLI TEAM PLANNING CONTRACT FUNDING – AFN BLI Target minus the Hold Back ($)	AVS-1 APPROVED CONTRACT FUNDING ($)
FY22 formulation or appropriation (if known)	**$557,027**		
FY23 formulation	**$1,654,926**		
FY24 AFN funding allocation target		**$1,134,146**	**$1,280,000**

BLI Plan 5 Year Outlook (FY22-27)

Complete (C)	In Progress (IP)	Programmed (P)	Need (N)

Research Activities	FY22	FY23	FY24	FY25	FY26	FY27
Operational Capability 1.0: *New Material and Process Characterization*						
1.1 What are minimum requirements to adequately control new advanced materials and processes and develop design allowables and strength values for a range of applications spanning from low to high criticality?		*P*	*P*	*N*	*N*	*N*
1.2 What are the requirements to evaluate equivalence for changes to materials and processes relative to an existing database?				*N*	*N*	*N*
1.3 What are the key process parameters (Kpp) and key characteristics (Kc)for new advanced materials and processes, and what is the effectiveness of manufacturing control and inspection methods including in-situ monitoring and NDI?		*P*	*N*	*N*	*N*	*C*
Research Activities	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**
Operational Capability 2.0: *Evaluate fatigue, damage tolerance, and other aging behaviors of advanced materials*						
2.1 What are the aging mechanisms for the advanced material and process and can they be simulated during certification?	*IP*	*P*	*P*	*N*	*N*	*C*
2.2 What is the fatigue and damage tolerance behavior of a composite structural detail that has service issues?	*P*	*P*	*P*	*N*	*C*	*C*
2.3 What is the fatigue behavior of metallic AM materials?		*P*	*P*	*N*	*N*	*C*
Research Activities	*P*	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**
Operational Capability 3.0: *Dynamic Behavior*						
3.1 Are analytical methods effective to model composite seat performance?		*P*	*P*	*N*	*N*	*C*

3.2 Are analytical methods effective to model bird strike of composite structure?				*N*	*N*	*N*
3.3 What is the dynamic behavior of composites and other advanced materials/processes?				*N*	*N*	*N*
Research Activities	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**
Operational Capability 4.0: *Characterize Structural Details*						
4.1 How can we standardize methods for characterizing/testing mid-level composite building block structural configurations with geometric design complexity beyond standard material coupons?		*P*	*P*	*N*	*N*	*C*
4.2 How can we standardize methods for characterizing/testing mid-level additive manufacturing building block structural configurations with geometric design complexity found in printed features?				*N*	*N*	*N*
4.3 Are there any non-structural behaviors of advanced materials and processes that require unique evaluation methods?				*N*	*N*	*N*
Research Activities	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**
Operational Capability 5.0: *Knowledge Sharing*						
5.1 How can we support the congressionally mandated JAMS COE?		*P*	*P*	*N*	*N*	*N*
5.2. How can we support industry organizations?				*N*	*N*	*N*
5.3 How can we promote knowledge sharing of key lessons for advanced materials and processes?		*P*	*N*	*N*	*N*	*N*

Part 4: BLI Team Members

Participants Name	Role	Routing Symbol
Jorge Fernandez	BLI Chair	AIR - 670
Cindy Ashforth	STS for composites / BLI Lead	AIR - 600
Larry Ilcewicz	CSTA for composites	AIR - 600
Joseph Pellettiere	CSTA for crash dynamics	AIR - 600
Michael Gorelik	CSTA for fatigue and damage tolerance	AIR - 600
Ahmet Oztekin	Performer SME	ANG - E281
Kevin Stonaker	Performer SME	ANG - E281