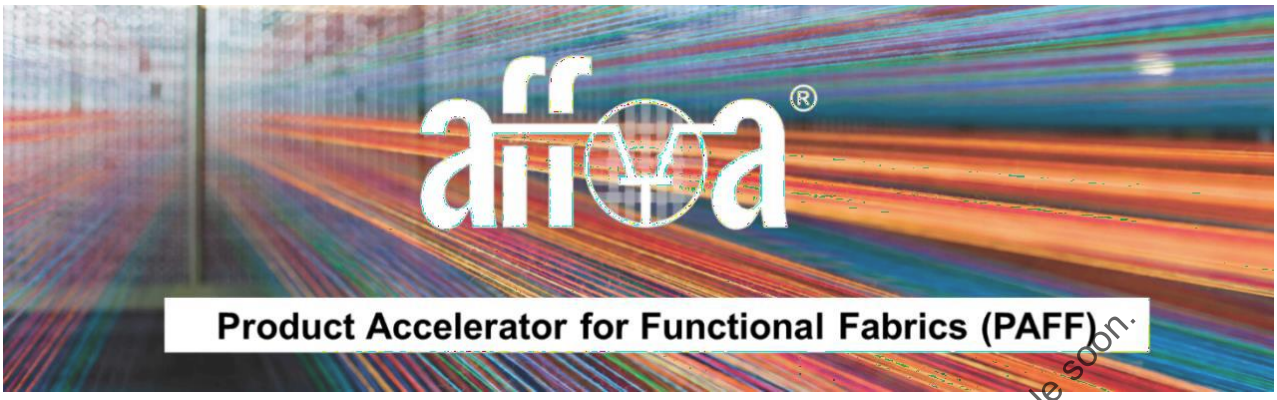

GUIDEBOOK

VERSION 1.0
Published on September 25th, 2023

This material is based on research sponsored by Air Force Research Laboratory under agreement number FA8650-20-2-5506, as conducted through the flexible hybrid electronics manufacturing innovation institute, NextFlex. The U.S. Government is authorized to reproduce and distribute reprints for Governmental purposes notwithstanding any copyright notation thereon.

The views and conclusions contained herein are those of the authors and should not be interpreted as necessarily representing the official policies or endorsements, either expressed or implied, of Air Force Research Laboratory or the U.S. Government.

TABLE OF CONTENTS

SECTION 1. Introduction and Background

1.1 AFFOA's Mission

In 2016 Advanced Functional Fabrics of America (AFFOA), an independent not-for-profit organization, was stood up as a DoD sponsored Manufacturing USA Institute with the mission to rekindle the domestic textiles industry by leading a nationwide enterprise for advanced fiber & fabric technology development and manufacturing, enabling revolutionary system capabilities for national security and commercial markets. To pursue this mission, AFFOA is addressing the spectrum of challenges associated with volume manufacturing of revolutionary fibers and textiles from design to end-product prototypes through various efforts, including the Product Accelerator for Functional Fabrics Program. The goal of these efforts is to accelerate the development and commercialization of products based on revolutionary fibers and fabrics.

Meeting AFFOA's mission starts with understanding the problem and developing key collaborations. AFFOA actively leverages capabilities within our Fabric Innovation Network of domestic academic institutions, startups, manufacturers and large industry partners in conjunction with our own agile capabilities for advanced fiber and fabric prototyping and process improvement to foster innovation and manufacturing maturation for defense and commercial products.

More information on AFFOA's mission, impact, and the Fabric Innovation Network can be found on our website at: www.affoa.org.

SECTION 2. Product Accelerator for Functional Fabrics Scope & Information

2.1 Product Accelerator for Functional Fabrics (PAFF) Scope

The PAFF program enables organizations to utilize AFFOA's capabilities and personnel to increase the speed to market of Advanced Functional Fabric (AFF) products for commercial and defense applications. AFFOA's intent is to use the PAFF to develop and foster collaborations in product and/or process development with our Fabric Innovation Network (FIN). This guidebook outlines the process to apply for the PAFF program. Consistent with the goal to improve the volume and timing of market introductions of AFF products, applicants to the PAFF program will be expected to explain their financial commitment to the project to ensure company success in commercialization is planned.

The Problem Being Solved. Commercialization of advanced functional fabric-based products requires companies to fill many roles and capabilities given the multidisciplinary nature of manufacturing processes embedded in these products. Specific equipment and specialized staff expertise may arise as a gap, where additional investment is either not possible, not yet justified or will simply not be available in time. This program is designed to help US companies close the gap(s) in their product and technology development. To improve the time to market for advanced functional fabric products, we intend to use the PAFF program to leverage AFFOA's established specialized capabilities to close critical capability gaps. The PAFF program is specifically targeting companies who have a product near commercialization or a process with a targeted improvement need that can be completed over a period of performance of up to 12 months.

The PAFF Solution. Since its establishment in 2016, AFFOA has fostered the development of a broad set of capabilities that leverage specialized equipment for prototype development and advanced functional fabric testing. AFFOA has also developed a team of experts ranging from textile designers and engineers to materials scientists and electrical system engineers. Collectively, the AFFOA team has gained extensive integration expertise that is critical to the ability to mature a broad range of textile-based products and processes for product commercialization. Further, AFFOA has assembled a patent aggregate of existing US university intellectual property that may be leveraged. Beyond prototype and process development, the team is also skilled at landscaping and translating across disciplines, with the ability to facilitate supply chain and partnership identification across the Fabric Innovation Network.

Product Accelerator for Functional Fabrics General Information

The PAFF program will support access to AFFOA's staff expertise and capabilities for your commercialization efforts, including:

- Textile and electronic product design
- Thermally drawn fiber*
- Textile yarn and fabric formation

- Electronics development
- Prototype manufacturing
- Component & product testing and failure analysis
- Process development engineering

A detailed description of AFFOA's technical capabilities, equipment and tools are provided in Appendix C. If equipment and tools needed for project execution are not included in Appendix C, then the proposer will need to work with AFFOA to identify available resources.

**No new development will be funded, capability is provided that has demonstrated manufacturing readiness level >4.*

SECTION 3. Proposal Submission Process

3.1 Product Accelerator for Functional Fabrics Process & Timeline

The Product Accelerator for Functional Fabrics (PAFF) will utilize a two-step proposal process. First, Proposers are expected to submit a pre-proposal. The AFFOA technical team will evaluate the pre-proposals. Down-selected finalists will be notified to submit a final proposal. At this stage, finalists will work with AFFOA's technical team members to better define AFFOA's Scope of Work and required internal resourcing. In addition, AFFOA will work with finalists on outlining the terms and conditions for the proposed effort.

Additional information on the processes for communication and evaluation can be found in Section 5. Final proposal submissions will undergo an evaluation by AFFOA following the rubric provided in Appendix B and successful proposers will be notified.

Please use the directions provided in Section 5 for contacting AFFOA with questions and to request a consultation. Feedback on proposals not selected for the PAFF program can be provided upon request.

Pre-proposals are due via email: proposals@affoa.org by 5:00 PM PST on November 8th, 2023.

Final proposals are due via email: proposals@affoa.org by 5:00 PM PST on December 12th, 2023.

The expected start date of the PAFF program effort will be January 15th, 2023 with a period of performance of up to 12 months.

Key stages and target dates are outlined in the table below	
9/25/23	PAFF announcement
10/12/23 at 2:00-3:00pm	PAFF announcement Webinar
10/16/23-11/3/23	Pre-Proposal Consultation Period
11/8/23	Pre-Proposal Deadline
11/21/23	Finalist Notification
11/27/23-12/8/23	Proposer Scope, Budget and T&Cs Consultations
12/12/23	Final Proposal Deadline
1/4/23	Notification of Awardees

3.2 Pre-Proposal and Final Proposal Format Guidelines

To maintain consistency through submission, review, and approval processes, please follow these guidelines:

Submission. Each Proposer shall submit a compiled document (PDF preferred) of their

proposal(s).

Figures, Graphs, Images, and Pictures. Figures and tables must be numbered and referenced in the text by that number. They should be of a size that is easily readable and may be in landscape orientation.

Font. Proposals are to be prepared with either Times New Roman or Arial font, 12-point in size and single-spaced. A 10-point font size of may be used in figures and tables.

Page Layout. The proposal document must be in portrait orientation except for larger figures, tables, graphs, images, and pictures in which a landscape orientation makes for improved legibility. Pages shall be single-spaced, 8.5 inches x 11 inches, with at least one-inch margins.

Page Limit. The main body is limited to 3 pages for the Pre-Proposal, not including the cover page, and 10 pages for the Final Proposal. Pages that exceed these guidelines may not be reviewed.

Page Numbering. Page numbers are requested starting with the cover page.

Summary Slide. For internal and external communication purposes, each Proposer is required to provide a single slide following the template provided on the PAFF program page found on AFFOA's website (www.affoa.org). This summary slide should not contain any proprietary information and be approved by your organization for future public release.

3.3 Pre-Proposal Content

The pre-proposal content guidelines are provided in this section. Please follow the instructions listed in Section 3.2 *Pre-Proposal and Final Proposal Format Guidelines* for formatting and other requirements. There is a 3-page limit for the proposal, excluding Cover Page and Summary Slide. Any text beyond the 3-page limit may not be reviewed during AFFOA's evaluation.

Pre-proposals should be *submitted via email: proposals@affoa.org* by 5:00 PM PST on November 8th, 2023.

The pre-proposal should include:

Frontmatter - Not included in the page count	
Page 1	Cover Page (see Appendix A)

Pre-Proposal Content – 3-Page Maximum; The cover page is excluded from page count.

~ 3 pages	Include the following items in the pre-proposal: Market analysis to demonstrate demand signal for product; Benchmark summary, including IP positioning of product or underlying technology and uniqueness of product; Product commercialization timeline; Current stage of product commercialization; Brief description of key challenges in product commercialization; Plan of use of AFFOA technical capabilities; Expected project outcome; financial commitment (see Section 4.4); Team member/company bios.

Summary Slide - Not included in the page count	
Page 5	Follow template provided on the PAFF program page found on AFFOA's website (www.affoa.org).

3.4 Final Proposal Content

The final proposal content guidelines are provided in this section. Please follow the instructions listed in *Pre-Proposal and Final Proposal Format Guidelines* (Section 3.2) (Section 3.2) for formatting and other requirements.

Proposals will be evaluated based on the rubric provided in Appendix B. It is imperative that proposals:

- Clearly identify the current capability and the quantitative target specifications that will determine the success of the project.
- Define commercialization milestones that are tangible, measurable, and demonstrable. The specifications of each milestone achievement should be clearly defined based on the goal of improving manufacturing and technology readiness. Examples of tangible milestones may include physical samples, written reports containing collected data, or live demonstrations of functionality.

Final proposals should be submitted via email: proposals@affoa.org by 5:00 PM PST on December 12th, 2023.

The final proposal should include:

Frontmatter - Not included in the page count	
Page 1	Cover Page (see Appendix A)
Page 2	Table of Contents
Page 3	Executive Summary: A succinct summary of no more than (1) page clearly articulating the problem being addressed, product/process concept(s), key challenges of product/process development, how use of AFFOA technical capabilities will accelerate commercialization, expected outcomes, and financial commitment (see Section 4.4).

(The page counts for each section are provided as a guide)

Final Proposal Content – 10 Page Maximum for Sections 1-4; Sections 5-6 are excluded from Page Count Suggested Length Section and Contents

1 page	1. Background: • Describe your organization's mission and commercialization motivation for applying to this program and the expected outcome(s) because of this program. Your approach to commercialization should include a market analysis.
1 page	2. Benchmarking: • Provide, in a table format, a comparison of the product to the current State-Of-The-Art. Summarize the innovation of your organization's product or process. • Clearly articulate how involvement in this program will establish key uniqueness or improvement in the product or process being supported.
~3 pages	3. Commercialization Strategy: • Detailed description of product/process capability today and effort made to date on commercialization. • List of key product specifications, including metrics/standards used for evaluation of the product or process. • List of developed intellectual property related to product and process, with a concise layman summary of the uniqueness of the intellectual property to your product or process. • Key challenges/technical gaps of product development. • Detailed development strategy for the product or use of process, including potential funding mechanisms that will be leveraged for additional advancement to commercialization. • Timeline of key milestones.
~2 pages	4. Work Plan*: • Detailed description of the use of AFFOA's technical capabilities outlining the impact on product or process development. The description should include details on the scale of effort needed, quantity of materials/prototypes developed, quantity of samples tested, and personnel time requirements, etc. • Related activity that will be led by your organization in support of the program efforts at AFFOA (including materials, effort, etc. & funding that is supporting your organization's effort toward commercialization (venture capital investment, government funding, company internal funds, etc.)). • Work plan timeline as defined by tasks and the corresponding deliverable(s). • Risk assessment analysis with risk mitigations. • List, within reason, potential areas of intellectual property development through this program, if anticipated. **This section should be drafted after consultation with AFFOA's technical team.*

~1 page	5. Manufacturing Impact: • How does your organization support domestic manufacturing? • How will this program affect your organization's domestic manufacturing goals? • How will IP in this program be made available to domestic manufacturers (through a contract manufacturing model, licensing, etc)?
As Needed; Excluded from Page Count	Appendix A.: Technical References (provided in IEEE format) Appendix B: Bio-sketches of key personnel from organization's executive team, business development team, and technical team that will be leading the engagement with AFFOA. Appendix C: Letter of Commitment • Statement acknowledging the proposal budget that will be provided by AFFOA. • Statement acknowledging that the source of PAFF program funding is from the US federal government and may not be used for future federal cost share. • Organization's financial commitment, including but not limited to: ○ Related activity that will be led by your organization in support of the program efforts by AFFOA (including materials, effort, etc. & identification of funding for this effort (venture capital investment, government funding, internal company funds (cost share), etc.)), ○ Potential for future collaboration efforts with AFFOA that may be sought through internal or external funding and/or future planned engagement with AFFOA towards product commercialization (on a fee-for-service basis), ○ Potential for licensing of AFFOA/member IP or the intention to partner in licensing or other equity-related relationships with AFFOA (particularly for start-up organizations), and/or ○ Support and commitment to AFFOA not-for-profit from revenue received through product commercialization, or commitment to share in licensing or product sales revenue of covered methods or products. • Letter should be on your organization's letterhead and signed by an organization representative. Appendix D: Letters of Support and Letters of Intent from key collaborators or stakeholders (such as state level or federal level program managers). Appendix E: Slide Summary using template provided on the PAFF program portal found on AFFOA's website (www.affoa.org).

SECTION 4. Administrative Topics

4.1 Confidential Information

AFFOA understands that it may be desirable to include information that is considered confidential and proprietary by the Proposers to convey the technical merits of the proposal fully and effectively. All submitted proposals will be distributed for the purpose of review to a select group of AFFOA staff member evaluators. AFFOA staff member evaluators are bound to customary confidentiality provisions under their employment agreements (no less than reasonable care standard). AFFOA reserves the right to engage other persons or entities as part of the proposal review & evaluation process (e.g., third-party SMEs), in which case AFFOA will require such evaluators to enter into a non-disclosure agreement with customary confidentiality provisions. AFFOA encourages Proposers to include publicly available information and content when available. Please be advised that the proposal submission requirement for the summary slide in the Pre-Proposal and Final Proposal submission guidelines (Section 3) will be made public and will not be held as confidential.

Any information that the Proposer deems "proprietary", should be clearly and conspicuously marked as such in the proposal and be limited to the minimum necessary to convey the highlights of the technical approach. Additionally, Proposers should refrain from including Export Controlled or trade secret information in their submissions. If a Proposer believes that the inclusion of Export Controlled, or trade secret information is required to fully respond to the technical topic or to fully convey the merits of their proposal, they should submit this as a request by question via the 'Questions and Consultation Requests' form on the Product Accelerator for Functional Fabrics Member Portal Opportunity Posting for members and Product Accelerator for Functional Fabrics section of AFFOA's website.

4.2 Intellectual Property

AFFOA recognizes that companies protect intellectual property ("IP") through various mechanisms, including patents, copyrights, and trade secrets. Proposers shall retain their rights to background IP; however, proposals are expected to address and detail each Proposer's (or joint Proposer's) willingness to share background IP or make background IP available to third parties upon reasonable business terms. Proposers should highlight any background IP that is not available for licensing or transferring to third parties upon reasonable business terms. Protection of background IP and know-how does not exclude a Proposer from participating in a project.

Foreground IP shall be retained by the Inventor; however, foreground IP shall be subject to the PAFF IP Terms and Conditions, which shall include government-purpose rights. When the assistance through the PAFF program supports a component product, AFFOA appreciates the willingness to make foreground IP (and background IP to the extent necessary) available to AFFOA's Membership either in the form of a license to practice or in product form, under commercially reasonable terms.

Joint Proposers are expected to agree on set forth joint background and foreground IP ownership terms between the partnering parties ahead of the final proposal submission.

The Product Accelerator for Functional Fabrics IP Terms and Conditions shall also specify that the Proposer agrees to: “Made in America” terms and conditions; and the Data Reporting requirements as outlined. AFFOA will initiate a discussion of these Terms and Conditions with Finalists as part of the Finalist Proposal Consultations as detailed in Section 5.

For proposals of equal merit in all other evaluation criteria, support will be provided to Proposers most favorably willing to share information in support of the domestic manufacturing mission.

4.3 Membership Requirements

Non-AFFOA members may submit proposals in response to the Product Accelerator for Functional Fabrics. However, to qualify for project support, the Proposer and any partners that are selected to move forwards must be a member in good standing or become members of the FIN prior to project inception. Project Leads/Primes are responsible for communicating this requirement to their respective partners and coordinating membership onboarding with AFFOA. Potential members are encouraged to visit www.affoa.org and/or reach out to info@affoa.org to learn more about AFFOA’s membership benefits and how to join.

4.4 Financial Commitment

The Product Accelerator for Functional Fabrics is a partnership with industry members, start-ups, and established manufacturers to work toward market readiness for an advanced functional fabric-based product. This program is designed to bring needed expertise to fill gaps in existing development teams. AFFOA realizes that financial needs may extend beyond the funding available as part of this program and seeks to build long-term relationships with member companies. For this reason, an evaluation factor in the PAFF selection process will be the financial commitment of the Proposer to the product commercialization and to its commitment toward a long-term relationship with AFFOA and other FIN members. This can be outlined in the Pre-Proposal (See Section 3.3) and then more formally detailed in the Letter of Commitment of the Final Proposal (See Section 3.4). Within the Letter of Commitment, the proposer should include:

- Related activity that will be led by your organization in support of the program efforts by AFFOA (including materials, effort, etc. & identification of funding for this effort (venture capital investment, government funding, company internal funds (cost share), etc.)),
- Potential for future collaboration efforts with AFFOA that may be sought through internal or external funding and/or future planned engagement with AFFOA towards product commercialization (on a fee-for-service basis),
- Potential for licensing of AFFOA/member IP or the intention to partner in licensing or other equity-related relationships with AFFOA (particularly for start-up organizations), and/or
- Support and commitment to AFFOA not-for-profit from revenue received through product commercialization, or commitment to share in licensing or product sales revenue of covered methods or products

SECTION 5. Proposal Communication and Evaluation

5.1 General Overview and Guidelines

AFFOA's Product Accelerator for Functional Fabrics is a two-stage proposal process aimed at providing evaluation at the Pre-Proposal and Final Proposal stages. AFFOA will evaluate, down-select, and engage Proposers after the Pre-Proposal. Feedback on the Pre-Proposal and Final Proposal will be available upon request. Based on the number of Pre-Proposal submissions, it may not be possible to provide pointed feedback to all Proposers.

Of those down-selected to submit a Final Proposal, AFFOA will evaluate all proposals and provide feedback. AFFOA may make recommendations for proposal modifications to some Proposers as appropriate to best leverage the capabilities provided by AFFOA.

5.2 Pre-Proposal Consultation with AFFOA

The purpose of discussing your proposal(s) with AFFOA prior to the official submission of the Pre-Proposal is to receive *general* feedback on the proposed scope of effort and clarification on AFFOA's capability offerings. This consultation is meant to strengthen the competitiveness of the proposal. It is the responsibility of each Proposer to decide how to incorporate or not incorporate the feedback. This consultation does not factor into the proposal evaluation. The consultation period can be found in Section 3.

AFFOA respectfully requests that a list of questions and no more than a 1-page summary of the project is provided prior to arranging the Pre-Proposal consultation. All communication documentation sent in the summary should be labeled as 'non-confidential'. *Please use the form on the* Product Accelerator for Functional Fabrics Member Portal Opportunity Posting for members and Product Accelerator for Functional Fabrics section of AFFOA's website (www.affoa.org) for *questions and consultation requests.*

5.3 Final Proposal Consultation with AFFOA

Once selected as a finalist, Proposers are required to meet with AFFOA's technical team to review the scope of the proposed effort and ensure that it is within the budget of the program. Proposers will also receive feedback on all aspects of the proposal, including technical approach, partnering, connection to previous AFFOA projects, etc. Note that a cost proposal is not required to be included in the Final Proposal since the budget is entirely within AFFOA HQ. Initial discussions may also be had at this stage regarding the terms and conditions and intellectual property assignments. *Finalists who submit a proposal without having these discussions will not be evaluated or accepted.* Proposals will be evaluated based on the criteria outlined in the table provided in Appendix B. The consultation period can be found in Section 3.

Consultations will be scheduled by AFFOA personnel with each finalist. While not necessary, it may be beneficial for the consultation to occur at AFFOA HQ (Cambridge, MA) to facilitate a better understanding of AFFOA's capability offerings.

5.4 Selection Process

Upon notification of selection for the PAFF program, Proposers and AFFOA will finalize the schedule, budget, intellectual property, and/or other relevant factors contained in the proposal in advance of effort to be performed by AFFOA. Upon approval by AFFOA, the effort will be executed through an agreement between the parties. In the case that the Proposer is not already a member of AFFOA or is not a member in good standing, the Proposer must officially become an AFFOA member or renew membership prior to the PAFF effort starting.

Note that the number of proposals selected in response to this PAFF program is contingent upon the current and continued availability of US government funding.

SECTION 6. Reference Document Kits

All the following reference documents are in the Product Accelerator for Functional Fabrics Reference Documents section of the Product Accelerator for Functional Fabrics Member Portal Opportunity Posting for members and Product Accelerator for Functional Fabrics section of AFFOA's website.

1. Product Accelerator for Functional Fabrics Guidebook
2. AFFOA Technical Expertise and Capability Booklet
3. Webinar Slide Decks and Video Recordings
4. Coversheet, PPT Slide Submission, and Final Proposal Budget Templates
5. Online Form for Questions and Consultation Requests
6. Common Q&A Document (updated as necessary)

For additional information on membership please visit go.affoa.org and/or contact info@affoa.org.

APPENDICES

Appendix A. Cover Sheet Template

Project Title:
Date of Submission: <XX/YY/2023>

Project Leader

Name and Title	
Organization	
Address	
Phone Number	
Email Address	

Lead Organization DUNS Number:
Lead Organization AFFOA Member status:

External Collaborators <copy and paste for each lead collaborator>

Name and Title	
Organization	
Email Address	
AFFOA Member Status of Organization	

Use of AFFOA Capability Summary

Check the box of AFFOA capabilities needed

☐	Textile and electronic product design
☐	Thermally drawn fiber
☐	Textile yarn and fabric formation
☐	Electronics development
☐	Prototype manufacturing
☐	Component & product testing
☐	Process engineering

Appendix B. Proposal Evaluation Criteria

Scoring (5 points is the highest score; 1 point is the lowest score)	
Criteria	
Background & Benchmarking	
There is a clear commercial motivation provided in the proposal with a clear differentiation of the product vs. the current market options. The resulting product or process provide advantage to both the commercial and military markets.	5 pts: Strongly Agree 4 pts: Agree 3 pts: Neither Agree nor Disagree 2 pts: Disagree 1 pts: Strongly Disagree
Current Product/Process Status	
The current product or process maturity is near commercialization. There is a high impact that the use of AFFOA's capabilities on the achievement of commercialization.	5 pts: Strongly Agree 4 pts: Agree 3 pts: Neither Agree nor Disagree 2 pts: Disagree 1 pts: Strongly Disagree
Plan of Work	
The technical scope of the proposed work matches the capabilities of AFFOA's staff and available equipment. The proposed work is feasible within the period of performance provided. The risk level of successful use of AFFOA's capabilities is low.	5 pts: Very Likely 4 pts: Likely 3 pts: Neutral 2 pts: Unlikely 1 pts: Very Unlikely
Manufacturing Impact	
The organization demonstrates a clear motivation to support domestic manufacturing. The strategy to enable domestic manufacturing leveraging this program (including related intellectual property) is strongly stated.	5 pts: Strongly Agree 4 pts: Agree 3 pts: Neither Agree nor Disagree 2 pts: Disagree 1 pts: Strongly Disagree
Pathway to Commercialization	
The proposer's commercialization strategy activity beyond this effort has a high likelihood of success within 2 yrs. The PAFF program provides a meaningful step along that commercialization pathway.	5 pts: Very Likely 4 pts: Likely 3 pts: Neutral 2 pts: Unlikely 1 pts: Very Unlikely
PAFF Program Financial Commitment	
The proposer has provided a satisfactory financial commitment to AFFOA to support future PAFF program efforts, assuming successful commercialization.	5 pts: Strongly Agree 4 pts: Agree 3 pts: Neither Agree nor Disagree 2 pts: Disagree 1 pts: Strongly Disagree
Total Score: (Maximum Score of 30)	
Comments:	

Appendix C. AFFOA HQ Technical Capabilities

AFFOA headquarters Fabric Discovery Center, located in Cambridge, MA, includes end-to-end advanced fiber and fabric prototyping and testing capabilities. AFFOA's HQ FDC has 12,000 sq ft of state-of-the-art research & manufacturing equipment serving industry and government agencies. Technical teams led by experienced engineering leaders are capable of:

1) Textile and electronic product design
2) Thermally drawn fiber development & Low-Rate Initial Production manufacturing
3) Textile yarn and fabric formation
4) Electronics development
5) Prototype manufacturing
6) Component & product testing and failure analysis
7) Process engineering

Textile and Electronic Product Design

Custom garment, electronic, and hardware design and modeling through a range of computer aided design tools.

- Custom pattern development for e-textile integration
- 3D garment modeling and simulation
- Custom PCB and enclosure design
- E-textile system architecture design for rapid prototyping
- Technical data package development

Software list:

- CLO 3D
  - 3D garment simulation and fabric digitalization
  - 2D and 3D patterning making
- Altium
  - PCB board design and layout
  - Generate manufacturing documentation and BOMs
- Fusion 360
  - 3D modeling
  - PCB enclosure design
- Adobe Suite
  - Technical garment flat development
  - System architecture layout and renderings
- Product Lifecycle Management system
  - Material database development
  - Technical data package development

Thermally Drawn Fiber

AFFOA has matured unique thermal preform to fiber draw process used to manufacture advanced fibers that can sense the environment, communicate information, and respond to stimuli. AFFOA has optimized the process of combining disparate materials including conductors, insulators, and semiconductors into composite monofilament fibers that behave as devices. This includes the introduction of conductors of various compositions, strengthening members, and optical fibers. These materials can be brought together in a single process step, while simultaneously engineering specific material properties at various levels and thickness/. *Through this program, the thermally drawn fiber capability is provided only for this technology that has been qualified at Manufacturing Readiness Level 7 or higher.*

Equipment list:

- 25mm and 50mm diameter furnaces
- Broad, polymer relevant temperature ranges
- In-line diameter measurement
- Fiber diameters from 200um to 2mm
- Fully equipped machine shop for preform manufacturing

Textile Yarn and Fabric Formation

Yarn Preparation

AFFOA owns an R&D scale yarn plying and core-wrapping machine capable of manufacturing custom yarns and fibers. It also owns an R&D scale package to package yarn sizing machine that can help in the preparation of yarns for weaving, knitting, or embroidery. AFFOA's custom in-line coating machine enables the coating of advanced yarns and fibers at R&D scales and speed and can be used in line with AFFOA draw towers.

Equipment list:

- Agteks DirectTwist B6 "D6"
- CCi SS600 Single-End Sizing Machine
- AFFOA custom In-line coating machine

Embroidery

The ZSK JGVA is an R&D scale version of an industrial digital embroidery machine. This machine represents the state-of-the-art for technical embroidery capabilities, with new attachments and functions being added every year. The basic capabilities for e-textiles on the ZSK JGVA can be achieved using the machine's three stitching heads.

Equipment list:

- ZSK JGVA industrial digital embroidery machine with F, K, and W heads

Knitting

The Stoll ADF and Shima Seiki mini are two state-of-the-art Industrial weft knitting machines that have seamless technology and knit-to-shape output. Both machines are used to trial new materials and advanced structures. On-demand output provides low

levels of MOQ prototyping with minimum material use, Advanced machine technology and accessories are developed with robotics for e-textile knit integration. The Santoni is an industrial circular knitting machine with the capability to produce fine gauge fabric with jacquard structures to be used for cut and sew assembly.

Equipment list:

- Stoll ADF, weft knit wide double bed, 14gg
    - Seamless Knit & Wear®
    - M1PLUS, CREATE PLUS proprietary software
- Shima Seiki, weft knit mini double bed, 10gg
    - Seamless WHOLEGARMENT®
    - Apex proprietary software
- Santoni, circular knit single bed, 24gg

Weaving

AFFOA has a dedicated weaving studio designed to facilitate the development of advanced woven structures for integration into small-scale product prototyping and production efforts. Capabilities and offerings include integration of e-textile components, novel material sampling to de-risk low TRL/MRL level yarns and fibers, development of e-textile circuits via Jacquard capability.

Equipment list:

- CCi Studio Dobby Power Loom
    - Fully automated
    - 22 harnesses + auto leno selvedge
    - 19” weaving width
- TC2 Jacquard
    - Hand loom
    - Jacquard capable
    - 20” weaving width
- AVL CompuDobby
    - Hand loom
    - 24 harnesses
    - 20” weaving width

Electronics development

AFFOA’s Electrical and Systems Engineering (EASE) team has expertise in electrical and systems design for wearables, textiles, and soft goods applications. From requirements definition and system analysis to architecture and design, EASE can provide advanced embedded and analog hardware design services.

Service list:

- Architecture definition of systems
- Detailed design and schematics (Altium)

- Custom printed circuit board (PCB) design and layout
- Design validation and reference designs
- Sensor and actuators
- Compact and efficient designs
- Low power system design and Bluetooth
- Experience with RF, high speed, high power, low-level analog, digital, microprocessor designs.
- Component selection, BOM cost, size, and battery life.

Prototype manufacturing
AFFOA's textile engineering team has expertise in cut & sew integration of electrics for concealment and ruggedization, rapid prototyping using 3D print printing, laser cutting and ultrasonic welding to design and iterate on e-textile garments and soft goods, co-located with electrical engineers.

Equipment list:
- Industrial sewing equipment: Juki lockstitch, Pegasus 5 thread overlock, Pegasus 4 thread overlock, Bernina L890, Bernina B790+
    - Range of lockstitch, stretch overlock, flatlock, and chain stitch classes can be fabricated
    - Compatible with woven, knit and nonwoven fabrics.
- 3D printing: Stereolithography (SLA) vat polymerization printer, Fused deposition modeling (FDM) extrusion printer
- Universal laser system laser cutter (18 x 24 in bed)
    - Can cut plastics, metals, wood, fabric with high precision
- Chase FS-90 ultra sonic welder
    - Can weld synthetic materials for waterproof seams

Component & Product Testing
Fiber Characterization
AFFOA has developed a range of techniques and capabilities to characterize and test fibers based on the intended end-use applications.

Equipment list:
- Digital Microscopy (Keyence VHX-7000)
- Scanning Electron Microscopy (JEOL JSM-IT200 InTouchScope)
- Cross-sectioning grinder/polisher (Allied Tech Multiprep)
- FT-IR Spectroscopy (Bruker)
- Tensile testing (Instron 5900 series, with various grips)
- Bend fatigue testing (custom)

Fabric Testing
AFFOA has the capability to perform standardized test methods (ASTM, ISO, AATCC) or develop custom SOPs to capture key performance metrics, including tensile strength,

elongation, stiffness, and friction.

Equipment list:

- Mark-10 Model F105 test frame
- Instron 5967 tensile tester
- Schap uniaxial bend stiffness tester
- JA King SASD-672 circular bend stiffness tester
- SDS Atlas Vortex M6 washing machine
- Gelbo flex tester
- Memmert HPP 110 and HPP 260 climate chambers

Electrical Testing

AFFOA's Electrical and Systems Engineering (EASE) team has expertise in electrical and systems design for textile and soft goods applications. EASE can provide a complete test solution ranging from individual component tests individual to a complete system analysis.

Services

- Characterization of
  - Power electronics and energy consumption
  - Amplifier performance
  - Instrumentation and sensors
  - Batteries
- Embedded systems functionality troubleshooting and testing
- Thermal testing

Equipment list:

- DDM Novastar Reflow Oven
- 6.5 digits Keysight precision multimeter
- Programmable 0.1mA to 30A electrical load
- Rhode&Shwartz LCR Meter
- CSZ MCB-1.2 Environmental chamber
- Keysight MXR104A 1GHz Oscilloscope,
- Current probes, active differential probes
- 8 Channel, 12-bit DAQ system
- Qoitech Battery Analyzer
- 9 GHz Field Fox Spectrum and Vector Network Analyzer
- FOTRIC 348A-L44-L7 thermal camera

Process Engineering

AFFOA has expertise in extrusion, melt spinning, fiber drawing, winding, and characterization. Our experience ranges from the lab scale, g/min to industrial M/lbs/yr and various control schemes to ensure quality. We also have experience in roll-to-roll processing and coating/lamination in an industrial setting.

Equipment list:

- Single end fiber coating and encapsulation
- Keyence optical microscopy and imaging
- SEM and imaging
- Instron fiber physical testing
- Differential scanning calorimetry, DSC
- Parallel plate rheology