America's Flexible Hybrid Electronics Manufacturing Institute

PROJECT CALL 9.0

GUIDEBOOK

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PROJECT CALL 9.0

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PREFACE

Project Call (PC) 9.0 is the ninth project call issued by NextFlex® (the "Institute"). Like the previous project calls, it is intended to advance the state of the art in manufacturing for hybrid electronics and to promote the strength, competitiveness, and interconnectedness of the U.S. manufacturing ecosystem for hybrid electronics. Each NextFlex project call has a unique character and implements changes relative to past project calls, and all proposers should carefully read all sections of this guidebook to understand changes in proposal development, required content, submission, evaluation, eligibility, and selection criteria. Important considerations for PC 9.0:

- Proposal process will be 1-stage (straight to full proposal) – there is no pre-proposal round
- Discussion with NextFlex during proposal development is strongly encouraged to ensure that proposals align to the goals of the topics
- Projects are expected to be technically focused and of modest duration (maximum duration from 12 to 18 months, by topic)
- Topic areas are broadly defined, allowing proposers to determine the specific subject of their proposal; proposals should explain the importance and relevance of the chosen subject
- Alignment of proposals to DoD Critical Technology Areas is strongly encouraged (for more information, see https://www.cto.mil/usdre-strat-vision-critical-tech-areas/)
- Projects that leverage prior NextFlex investments and that address technology transitions are encouraged.

SECTION 1. HYBRID ELECTRONICS DEFINITION

NextFlex uses a broad definition of hybrid electronics when advancing the ecosystem. The Institute definition includes electronics that incorporate additively manufactured circuitry, passive devices, and sensor systems that may be manufactured using additive methods (sometimes referred to as printed electronics) along with discrete components (e.g. bare or packaged ICs, passive devices, sensors, etc.). These devices take advantage of the power and miniaturization of semiconductors and the economies and unique capabilities of printed circuitry to form a new class of devices for the Internet of Things (IoT), medical, robotics, consumer, communication, and defense markets. Hybrid electronic devices may conform to any shape, and may also bend, twist, and stretch. While NextFlex has historically used the term "flexible," the Institute is broadly focused on hybrid electronics manufacturing methods, which includes rigid, flexible, stretchable, conformable, conformal (circuitry applied directly to a 3D surface without the need for a substrate or carrier, also called direct-deposited circuitry); mechanical flexibility is a possible attribute, though not a requirement for hybrid electronics and projects may or may not focus on devices that are mechanically flexible. Closely related hybrid electronics topics that employ these manufacturing approaches, such as additive semiconductor packaging and additive printed circuit fabrication, are in-scope.

In light of this, the Institute will focus its efforts on solutions that incorporate discrete components into flexible, stretchable, conformal, or rigid systems with a significant component of additive processing as part of the design and fabrication approach. Proposals and approaches that target pure "printed systems" or additive processing of organic transistors or other logic systems (metal oxide, carbon nanotubes) as their primary focus will most likely be considered at too low of a Technology Readiness Level (TRL) for Institute Project Calls at this time. Conversely, approaches that appear to be incremental advancements on currently mature manufacturing technologies will potentially be considered at too high a TRL/MRL (Manufacturing Readiness Level) to be considered for Institute funding (such as a traditional printed flexible circuit board approach utilizing solely etched copper for conductors, Commercial Off the Shelf (COTS) packaged die for the active components at the system level, and solder reflow assembly). More details on MRL and TRL can be found at http://www.nextflex.us/trl-cheat-sheet/ and http://www.dodmrl.com/.

SECTION 2. INTRODUCTION AND BACKGROUND

As a Manufacturing Innovation Institute that is part of Manufacturing USA, NextFlex is an industry-led, dynamic, collaboration-based Institute formed to facilitate technology innovation, transition, and commercialization, accelerate workforce development, and promote sustainable U.S. ecosystems for advanced manufacturing. One mechanism to enable technology adoption is to provide funding to proposal teams undertaking development projects that are critical to hybrid electronics manufacturing. In these cases, the Institute may provide funding for up to 50 percent of the development cost of the project through a structured selection process. Projects submitted to NextFlex for funding should consider the value to the Institute and the hybrid electronics industry as well as the future goals of advancing the hybrid electronics ecosystem within the U.S., and clearly articulate those aspects to the Institute in the proposal process. In addition, all projects should define a commercialization or technology transition plan that demonstrates industry pull for the proposed manufacturing technology development.

It is an underlying tenet of the Institute funding model that projects should benefit all members, not only those performing the work. Projects are typically proposed and executed as a collaboration between at least several member organizations (e.g. companies and/or universities). Each project team presents periodic updates and publishes technical reports for other NextFlex members to review.

Project Call 9.0 addresses prioritized technical gaps identified in the Hybrid Electronics Technology Roadmap developed by the NextFlex Technical Working Groups (TWGs) through partnership among industry, government, and university subject matter experts (SMEs). PC 9.0 emphasizes projects that address critical hybrid electronics manufacturing challenges, enabling the transition of hybrid electronics devices into applications that require superior performance, assured reliability, and improved environmental sustainability.

Projects are intended to be technically focused, of moderate size, and of duration consistent with recent past NextFlex Project Calls. Each topic aligns with the roadmap gaps from one or more TWG. Projects that aim to develop technology demonstrators should also address manufacturing challenges associated with applications and devices in those areas.

Through the first eight Project Calls, NextFlex has increasingly focused the process, building upon developments from preceding Project Calls. A summary of the technical focus of each previous NextFlex Project Calls is presented in Table 1.

Table 1: Summary of the technical focus of previous Project Calls.

Project Call	Technical Focus
PC 1.0	Human health monitoring and asset monitoring
PC 2.0	Equipment development for FHE-specific production tools, process development, and demonstrators
PC 3.0	Subsystem development and manufacturing process or capability gaps
PC 4.0	Areas lacking in MRL and demonstrators showing newly enabled applications
PC 5.0	Manufacturing gaps and growing DoD agency connections
PC 6.0	Broad topics addressing manufacturing and technology gaps from Technology Roadmap
PC 7.0	Prioritized manufacturing gaps and additive semiconductor packaging and PCBs

PC 8.0	Advanced packaging, reliability in harsh environments, and environmental sustainability

Project Call 9.0 continues the use of broadly defined topics to enable a diverse proposer base, with special emphasis on areas in which hybrid electronics can impact high priority U.S. manufacturing opportunities and areas of emerging importance within the hybrid electronics community. Proposals should build on and take advantage of developments from prior project calls, where appropriate, as well as the best available technology.

Projects are expected to address industry-driven problems, with proposed solutions and concepts to transition to the U.S. industrial manufacturing base. Within the broadly defined topics, proposers must identify the specific needs and opportunities as well as the impact that success will have on the U.S. hybrid electronics manufacturing ecosystem. PC 9.0 is anticipated to fund up to approximately $5.3M, potentially resulting in multiple awards in one or more topics. Including cost-share, the total project value is expected to exceed $11M based on recent historical projects. The number of awards per topic will be based on the quantity and quality of the submitted proposals, the funding requests of those proposals, and alignment with the overall roadmap and mission of the Institute.

Projects focused on developing or demonstrating manufacturing capabilities will focus on developing processes, critical components, foundational data, or software tools. Projects proposing to develop hybrid electronics demonstrators may produce fully functioning systems or focus on demonstrating hybrid electronics-based subsystems. In the latter case it is important that the proposal clearly describe criteria, metrics, and methods for how the demonstrator will be evaluated to show that the project advances the field. Projects that produce demonstrator devices will be required to produce a sufficient quantity of these demonstrators/prototypes to ensure that scalable manufacturing techniques are used in the production thereof. Efforts in all areas will be expected to generate data to be shared with the NextFlex member community.

In the interest of expanding the set of organizations leading Project Call projects, NextFlex has included an open topic for “new project leads” (defined as organizations that have not led a project in PC 5.0, PC 6.0, PC 7.0, PC 8.0, or an Open Project Call within the last four years). This topic allows submission of proposals that address any gap on the NextFlex Roadmaps or topics that are not currently captured by the Hybrid Electronics Roadmaps but have justification for inclusion in future roadmap updates to address an unmet need in the ecosystem. Proposers should pay special attention to proposal, teaming, and eligibility requirements and seek clarification from NextFlex if necessary. Proposers and teams that meet the eligibility requirement may submit proposals to the “new project leads” open topic even if the topic’s scope falls within that of other PC 9.0 topics. Differences in funding limits should be noted when deciding to which topic to submit a proposal.

Important considerations:

- NextFlex anticipates funding one or more project in each topic area; however, other outcomes are possible depending on the cost and quality of the projects proposed.
- Given the clear focus on projects that have a near-term commercial impact and transition potential, teams that are industry-led or have a strong industry partner as part of the commercialization plan will be favorably considered in the evaluation process.
- Proposals that fall within the topics area definitions that address DoD Critical Technology Areas will be viewed favorably.
- Prior to final granting of awards, recipients and their partners who are not already NextFlex members will be required to become members of the Institute and execute a development agreement.
- Should teams find that the topics listed herein are not of interest to their organizations, NextFlex always welcomes suggestions for future project call topics; recommendations should be brought to the attention of the NextFlex TWGs.

NextFlex Technology Hub and Pilot Line: NextFlex and its members have collaborated to create a shared hybrid electronics fabrication facility for prototyping and low volume manufacturing in a class 10,000 cleanroom, along with the design and process engineering to support it. This facility, the NextFlex "Technology Hub," includes both standard EMS and printing tools as well as hybrid electronics manufacturing tools developed through prior Project Calls. Capabilities are intended to provide a transition from development to production manufacturing for Institute members. The NextFlex Technology Hub is an ideal environment to integrate and collaborate across projects, thereby strengthening long-term capabilities for the hybrid electronics community. Proposal teams are encouraged, when possible, to:

1) Leverage the hybrid electronics manufacturing and testing capabilities in the NextFlex Technology Hub during the execution of the project, and
2) Demonstrate newly developed hybrid electronics manufacturing processes on the Technology Hub tools. This facility may also be appropriate for technology demonstrator projects.

To accomplish these, proposal teams may seek the involvement of NextFlex Technology Hub staff from engineering and fab groups in projects.

Proposal teams may receive more information about the Technology Hub and its capabilities through the website [*] and may initiate discussion about integrating its capabilities into proposals by contacting proposal@nextflex.us.

Manufacturing USA: All submitters, regardless of prior proposal experience, should take special note that the ways in which NextFlex and Manufacturing USA Institutes operate may be quite different than those to which proposers may be accustomed. NextFlex development projects should not be compared to SBIR, STTR, NIH, or other similar programs. The objective is not to develop a specific product nor to conduct basic scientific research, but rather to solve common gaps that many companies in the hybrid electronics manufacturing ecosystem are facing. Research institutions familiar with NIH or NSF funding should be aware that NextFlex projects are intended to be Advanced Technology Development and designed around time-bound and measurable deliverables with clear performance metrics. If these cannot be established at the outset of the project, the subject matter under consideration may be of too low an MRL and thus more suitable for submission to an agency focused on basic research. For those accustomed to government acquisitions, these programs are aimed at co-funded development; thus, a cost share element is required. Companies that typically focus on commercial customer activities should be aware that because these projects are not aimed at developing or delivering a specific product, the *approach taken* is as important as the promised outcomes, and the proposal evaluation criteria reflect this. Project funding will follow a cost reimbursable agreement. If the lead or any partners of the proposal team have audited indirect rates, please use those. Commercial rates or profit (fee) are not allowable for Project Call proposal submissions.

Project Scale and Duration: The federal funding available on a per project, per topic basis is indicated in each topic description section. These numbers were developed by the Technical Working Group process, based on anticipated scope and resources required to deliver the requested statement of work. The maximum duration of proposed projects ranges by topic from 12 to 18 months or less for PC 9.0 and the maximum for each topic is specified; aggressive timelines are encouraged.

NextFlex projects must meet a minimum MRL of 4 in the foundational work upon which projects are built. In consideration of this requirement, proposing teams must demonstrate that this criterion is met by providing sufficient evidence in the technical proposal (e.g. by providing published references, photos and data regarding physical demonstrators, etc.) or in an accompanying file submission (to be used for information that cannot be presented in the written proposal, e.g. video demonstration). Such accompanying submissions must not be used to exceed the proposal length limits. The option to provide physical samples to demonstrate MRL may be discussed during pre-submission consultation with NextFlex.

[*] https://www.nextflex.us/technology-hub/

Cross-Institute Collaboration and Leveraged Funding: As of 2024, 17 Manufacturing USA Institutes exist in various technology areas. Proposals that enable collaboration between Institute programs and have access to funding from more than one Institute should be identified by the proposers for the consideration of the reviewer base, as collaboration across technology fields with strong market demand is always encouraged. NextFlex also encourages proposals that bring in co-investment from other sources including other government agencies, commercial sponsors, state governments and where appropriate, other type of research entities. Projects with co-investment by DoD customers and those that complement other ongoing DoD sponsored projects are highly encouraged and such leverage should be described to the extent possible.

Leverage of Other Programs: As already noted, projects that address DoD Critical Technology Areas are strongly encouraged. Proposers that are currently working on programs funded by other sources that could be enhanced by additional scope funded through this project call may propose such activities. All requirements of this project call must still be met. Such leverage of other sources of funding sources will be viewed favorably, however it should be noted that other government funding cannot be counted as cost share and no cost share may be double-counted for separate projects.

SECTION 3. HYBRID ELECTRONICS ROADMAP – 2023 UPDATE

NextFlex and the field of hybrid electronics leverage a broad U.S. industrial base including the electronics industry and the high-performance printing industry, both well-established U.S. industrial and academic areas of strength. NextFlex members have developed a comprehensive roadmap by collaboration among industrial partners, academics, and government SMEs in a variety of fields. The roadmap topics include different facets of application-specific devices/components for technology demonstration as well as various aspects covering design, materials, process, equipment, and test development that would enable realizing advanced manufacturing capabilities to meet the overall vision of the Institute and the hybrid electronics ecosystem. The following areas are the focus of the Technical Working Groups that developed the roadmap:

- Manufacturing Thrust Area
  - Device Integration & Packaging
  - Materials
  - Modeling & Design
  - Printed Flexible Components & Microfluidics
  - Standards, Test & Reliability

- Technology Platform Demonstrators
  - Asset Monitoring Systems
  - Automotive
  - Flexible Power
  - Human Monitoring Systems
  - Integrated Array Antennas
  - Soft & Wearable Robotics

Successful proposals must align to the NextFlex Roadmaps, and all proposals should identify the Technical Working Group and roadmap elements to which they align. Access to the NextFlex Roadmaps is a benefit of NextFlex membership. Beginning in 2022, NextFlex has produced a public summary of the Hybrid Electronics Roadmap that is available to non-members and may be useful in formulating proposals. Non-member proposers are encouraged to consult with NextFlex as outlined later in this document or to partner with NextFlex members on proposals to ensure alignment.

Since technology transition and adoption through enabling manufacturing readiness is the primary mission of the Institute, only proposals in the TRL 4 to 7 and MRL 4 to 7 range will be considered for funding. Based on the gaps identified through the TWG roadmapping process, proposals in the following areas have been prioritized and will be considered for potential funding in PC 9.0.

SECTION 4. PROJECT CALL TOPICS

In PC 9.0, there are six Project Call topics, which aim to advance hybrid electronics technology and fill gaps identified by the TWGs in the Roadmaps. The outcomes of the projects that are selected are expected to have broad impact on both commercial and defense applications and to advance U.S. hybrid electronics manufacturing capability. All proposers are encouraged to build off developments from previous NextFlex project calls.

As the NextFlex community and hybrid electronics manufacturing matures, there are opportunities to combine NextFlex development investments with other government agencies or commercial interests. To that end, proposals that bring external DoD agency funding for technology solutions to specific DoD requirements or direct funding from a separate commercial business unit will be viewed favorably during evaluation. Additional DoD agency funding can be executed through the NextFlex cooperative agreement or a separate agreement or contract.

A natural evolution of the field of hybrid electronics is a shift to focus on reliability of hybrid electronic solutions and the importance of standards-based testing. All PC 9.0 proposals are encouraged to address these needs for reliability and standards within their project plans in a manner appropriate for the topic and specific proposal.

Table 2 presents a summary of Project Call 9.0 topics and the TWGs with which they align, either directly or indirectly.

Table 2: Project Call 9.0 topic summary

Topic #	Topic Description	Max Duration (months)	Max Funding *	Technical Working Group Alignment										
				Printed Components & Microfluidics	Materials	Device Integration & Packaging	Modeling & Design	Standard, Test & Reliability	Human Monitoring Systems	Asset Monitoring Systems	Integrated Array Antennas	Soft & Wearable Robotics	Flexible Power	Automotive
9.1	Manufacturing of High Resolution, Multilayer Electronic Packages and Devices	18	$ 500k	X	X	X		O	O	O	O			O
9.2	Thermal Management for Power Electronics	18	$ 500k	X	X	X	O	X			O		O	X
9.3	Reliable Hybrid Electronics for Extreme Conditions	18	$ 500k	X	X	X	O	X	X	X	X	X	O	X
9.4	Conformal & Structurally Integrated Hybrid Electronics	18	$ 500k	O	O	X	X	X			X	O		X
9.5	Additive Processes for Improved Environmental Sustainability of Electronics Manufacturing	18	$ 500k	X	X	O		X						
9.6	Open Topic for "New Project Leads"	12	$ 400k	X	X	X	X	X	X	X	X	X	X	X
				X	Direct TWG Alignment									
				O	Indirect TWG Alignment									

The objectives of these projects are to focus on developing and qualifying manufacturing processes, methods, or tools, or demonstrating hybrid electronic systems and subsystems identified as gaps via the roadmapping process and discussions with TWG leads, members, and government partners. The processes and the tools developed will have a considerable impact on the manufacture of cost-effective, reliable systems for a wide range of defense and commercial applications.

Technology transition to the manufacturing base is a key objective for NextFlex programs, including transfer of process knowledge or developed processes. As such, having demonstrated participation and support from a manufacturing organization and / or government transition partner strengthens a proposal. For example, a process development proposal from an R&D organization may include an original equipment

manufacturer (OEM) or contract manufacturer as a team member, and a letter of support indicating that organization's interest in implementing the process. Similarly, a proposal that develops a capability of interest to a DoD stakeholders may include a letter describing the stakeholder's specific interests in the project. Although government partners cannot be funded team members on a project, they can participate in the performance of the project if separately funded. Transition partnerships may take many forms and the preceding examples of industry and DoD partnerships are meant for illustration only.

Any development of software tools should include licenses or provisions to allow NextFlex members and Institute personnel to access and use the tools for development purposes, and it is expected that third-party licensing needs or maintenance costs required to operate the tools will be considered by the proposal team and addressed as part of the proposal.

In the case of projects focused on process development, it is expected that those developments will be documented with enough detail that they are reliably replicable and that they may be included in manufacturing guidelines for relevant processes in the future. Processes or approaches developed under NextFlex Project Call funding must provide unencumbered use licenses for their implementation at the NextFlex Technology Hub to continue the advancement of the NextFlex ecosystem.

More specifically, these topics shall include, but are not limited to, the following deliverables:

1. Data (raw and processed) on materials, processes, performance, and reliability for sharing at quarterly reporting intervals following the acquisition of the data.
2. A flow chart of the process steps and design information (such as drawings, CAD files, etc.) for device fabrication or process repetition.
3. Relevant process information including:
    a. Resolution, thickness, and material properties (e.g., sheet resistance) that can be obtained with the developed recipe
    b. Tolerance and yield of components, along with a comparison to device manufacturing processes that are currently used in the industry
    c. Consistency of print quality (line edge roughness, loss or gain in dimension, uniformity in thickness and layer roughness) of the layer(s) in the device
    d. Consistency in device properties (resistance, capacitance, inductance, etc.) along with a comparison to similar devices that are commercially available
    e. Optimized print equipment parameters (print speed, ink volumes, ink viscosity, curing conditions, print environment, etc.)
    f. Mechanical constraints (e.g., tensile strength, bending) of the printed devices
4. Details of the method of test and measurement performed during development to establish TRL and MRL advancements.
5. Identification of the specific task and outcome that results in TRL and/or MRL advancements.
6. Cost model framework and associated assumptions for the proposed manufacturing technique.

Proposals that focus on the development of technology demonstrators should describe the relevance of the application in sufficient detail that reviewers who are subject matter experts in hybrid electronics and other application areas can assess and compare proposals that address varying application areas. Generally, technology demonstrator projects may address quite disparate applications within a particular topic area, and as such the business case and relevance of the application is a technical merit factor. Technology demonstrator proposals shall also describe specifically the technical need and commercial value of hybrid electronics to this application area within the proposal's innovative claims and commercial strategy sections.

The following section outlines the topic areas for PC 9.0. Each topic has a maximum funding and duration; proposals that seek lower levels of funding and shorter duration are welcome. Most of the topics are structured with a description that include all requirements, followed by lettered examples of proposal subject matter that would meet the topic area requirements and align to prioritized roadmap gaps. *These examples are not sub-topics into which proposals must fit*, and any proposal that meets the topic area requirements will be equally considered whether it addresses one of the examples or not. Moreover, a proposal may address only part of an example area and still be responsive to the Topic so long as it meets all requirements of the Topic.

Topic 9.1: Manufacturing of High Resolution, Multilayer Packages and Devices

$500,000 maximum Institute funds / Up to an 18-month duration

This topic seeks development and evaluation of manufacturing approaches for multilayer advanced packages and hybrid electronic devices that could transition to volume-manufacturing scale. Proposers are encouraged to produce enough test articles to estimate yield and include modeling and simulation of RF performance, if appropriate. Proposers must identify why the manufacturing approach is preferred over the state-of-the-art. Examples of possible approaches of interest include, but are not limited to:

a. High Resolution Direct Write Interconnects for Heterogenous Integration
Additive and hybrid electronic manufacturing processes have demonstrated potential advantages in advanced semiconductor packaging and heterogenous integration, especially in high density interconnects for integration of dies. This area seeks demonstration of high yield process flows that support IC / chiplet and package integration that require digital, power, and/or RF co-packaging. Manufacturing of multichip modules is also within scope. Requirements such as interconnect pitch and via diameters should be clearly defined by the proposer and driven by the proposed application(s). Demonstration and reliability testing of hermetic encapsulation of the package is also desired.

b. Additive Manufacturing of 3D Hybrid Electronic Devices
This area seeks demonstration of multifunctional prototype devices in a 3D printed geometric structure that require at least four conductive layers and more than 20 passive electronic components in a single printed structure. Demonstrated attachment of multiple 40+ pin electronic components with high yield is sought. Architectures should be optimized for product function and reliability. Innovative 3D design is required for a successful award. Devices should include a combination of a power source, on/off switch, LED indicators, sensor functionality, and wireless transmission. Capabilities and requirements must be clearly defined by proposers and must align with the proposed application use-case.

c. Higher Throughput Manufacturing Processes for Multilayer Hybrid Electronics
This area seeks evaluation of hybrid electronic manufacturing processes with higher throughput capabilities compared to standard sheet-to-sheet processing on discrete manufacturing and process tools. Manufacturing methods should include *in situ* processing (including printing and annealing / curing) capable of resolutions <30 µm with precision layer-to-layer registration capability (<10 µm) for high volume commercial manufacturing of components and devices. Automated high-speed assembly of bare and / or packaged dies and passive components is highly desired. Establishment of standard process parameters for printed resistors, capacitors, and inductors with a tolerance of <10% are of particular interest using a variety of industry standard hybrid electronics substrates and ink systems.

d. High Frequency RF / Millimeter Wave Devices
Hybrid electronics manufacturing approaches have become increasingly attractive for numerous RF and lower microwave bands for antennas and electronics. However, as applications demand higher millimeter wave bands (including V, W, or G-bands), circuits demand very high resolutions. (lines / spaces on the order of a few microns to 10s of microns with surface roughness on the order of 1 micron). This area seeks demonstration of high mm-wave RF modules with interconnects, passives, absorbers, and active mm-Wave MMIC chips integrated within a non-planar hybrid package. Printed multilayered PCB structures, mm-Wave antennas, and 3D RF interconnects should be integrated and demonstrated to show performance and reliability.

Topic 9.2: Thermal Management for Power Electronics

$500,000 maximum Institute funds / Up to an 18-month duration

Dissipation of heat from electronic packages and devices is an increasingly important challenge as performance advances and components are moved closer together, and even stacked in three-dimensions. This topic seeks evaluation of additive and hybrid electronics manufacturing approaches for thermal management in advanced semiconductor packaging and electronic components / devices. Active and passive cooling technologies are within scope, if they demonstrate a route to manufacturability and reliability. Thermal management performance should be fully characterized using test methods and standards consistent with those appropriate for the given application(s) described by the proposer. Multiphysics modeling and experimental validation of performance is desired, but should not be the focus of a proposed project. Topics of interest include, but are not limited to:

a. High-Power Modules with Additive Active Cooling Schemes
This area seeks demonstration of electronic modules with active fluidic cooling technologies for improved heat dissipation for improved performance and reliability. The design of the power module should include several layers and maintain the temperature of the die / component(s) below ~150°C during transient heat pulses and sustained high temperature operation. Manufacturing approaches for multilayer embedded active cooling channels for fully embedded components are of particular interest.

b. Hybrid Electronics with High Efficiency Passive Cooling Structures
This area seeks demonstration of additive manufacturing of passive cooling solutions electronic components and PCB products. This includes integrated heat pipes in multilayer structures. Printed complex 3D heat exchanger structures with optimized designs are also of interest. Proposers should align thermal management requirements and testing protocols based on the application(s) and justify why the additive approach is required or preferred over traditionally manufactured components.

c. Materials Solutions for Thermal Management
This area seeks demonstration of materials solutions for thermal management in advanced packaging and component assembly. Material classes of interest include substrates, thermal interface materials, dielectric underfills, and other thermally conductive dielectrics that improve the heat transfer away from heat producing dies, packaged IC, or other components. Characterization of the thermal transfer performance and resultant device reliability is required, and associated simulation and modeling is highly desired. Materials should be compatible with common additive and hybrid electronic process flow.

Topic 9.3: Reliable Hybrid Electronics for Extreme Conditions

$500,000 maximum Institute funds / Up to an 18-month duration

Hybrid electronics have demonstrated high reliability and survivability in numerous applications and use-cases, including harsh environments. This topic seeks to further advance demonstration and evaluation of hybrid electronic interconnects and / or components into additional extreme environments and CONOPS not sufficiently explored. Extreme conditions of interest include, but are not limited to: high or low temperature and humidity, thermal shock, high vibrations, high G-force / shock, vacuum, ionizing radiation, high strain rate deformation, corrosive chemical exposure, and high particulate matter environments. Projects should include full reliability testing appropriate for the target use-case. Alignment to specific standards (i.e. MIL-STD-810G, or similar) is required. Examples of projects of interest include, but are not limited to:

a. Evaluation of Hybrid Electronics for Space Applications
Many programs in hybrid electronics have a need to function in space-like environments or were designed with the intention of being used in space. There is a need for additional testing data showing that these substrates can function in space or space-like environments. This topic seeks evaluation of hybrid electronics materials and components for associated space orbit requirements, including radiation requirements for low earth, medium earth, geosynchronous, and geostationary orbits. Common space-effects testing may include: functional and static thermal cycling, vacuum/depressurization testing, thermal vacuum testing, shock and vibration, radiation testing including proton, x-ray, heavy ion, and pulsed photon. Proposers shall identify hybrid electronics designs ready for space effects testing (targeting available existing designs rather than designing new systems), perform target testing, provide results and feedback for improvements to design including material suggestions.

b. Electronics for High Shock and Strain
Launchable systems must survive and perform under severe loading scenarios. A need exists to evaluate systems with integrated electronics and sensors that can perform reliability under impact, high shock, or rapid multi-axial deformation, in the case of flexible and stretchable systems, such as parachutes, inflatables, automotive safety belts, and similar systems. In many operational environments, such systems also undergo extreme environmental conditions, such as rapid changes in temperature, which can lead to additional materials challenges. This topic seeks to evaluate the performance and reliability of hybrid electronics for various sensing applications under such harsh conditions. Proposals that address the need for improved modeling data for conductive, dielectric, and / or hyperelastic materials under high shock / strain and material properties versus high strain are desired.

c. High Temperature Inks from Domestic Sources
Inks made of extreme high-temperature resistant metals (Au, Pt, Pd, and alloys) and printable dielectrics (ceramic precursors, etc.) are increasing important for defense applications. The lack of availability of these critical materials from domestic sources is an additional gap that hinders the development and maturation of printed technologies for key defense and aerospace applications, including hypersonics and space applications. This topic seeks evaluation and demonstration of the performance and reliability of high temperature conductive and dielectric ink formulations. Conductive metal alloy inks (Cu, Ni, Cr and rare earth additives) that can survive 1000˚C in oxygen rich environments, and provide significant cost benefit over noble metal inks are of particular interest. A study on the availability of these materials and the state of the domestic supply chain of the proposed material solution(s), including critical raw input materials, is of high interest but should not be the primary focus of this effort.

Topic 9.4: Conformal & Structurally Integrated Hybrid Electronics

$500,000 maximum Institute funds / Up to an 18-month duration

Transitioning from planar electronics to complex 3D conformal and structurally integrated electronics enables exciting new device architectures, however, considerable challenges remain throughout the ideation-to-manufacturing pipeline that must be addressed before these devices can be successfully manufactured at scale. This topic seeks solutions for common challenges / gaps associated with printing and assembly of additive electronics integrated onto and into complex 3D surfaces, including mechanical / electronic design, multilayer toolpath generation, high fidelity print and post processing, multiphysics validation and simulation, and reliability and performance testing. Examples of projects of interest include, but are not limited to:

a. Printed Module-to-Module Interconnections Wire Harness Replacement
As the number of electrical components in an aerospace, automotive, and space platforms continues to increase, so does the need to reliably connect them and reduce the considerable weight associated with traditional round-wire cable harnesses. Additive and hybrid electronic

manufacturing processes provide the potential to directly print interconnects onto or into complex 3D surfaces and structural elements of the platform body / chassis during manufacturing. Significant technical gaps remain to realize this approach. This area seeks development and evaluation of manufacturing techniques for complex interconnect printing on platform surfaces for module-to-module interconnection. Proposers should fully characterize the performance and reliability of the printed wire harness alternative against standards or specifications consistent with traditional wire harnesses, including in harsh environments appropriate for the given application. The SWaP-C benefits associated with printed harnesses should also be modeled. The proposed solution must focus on hybrid electronic processes and not traditional copper flex.

b. Improved Software Tools for Printing on Complex 3D Geometries
There exists growing demands to integrate conformal circuits and other types of metallized patterns into and onto doubly curved composite structures and surfaces. That is, to create what are essentially curved printed circuit boards. Existing CAD tools are not as well-suited for designing conformal circuit patterns. Current commercial software tools require a pattern to be first drawn on a flat plane, then wrapped or projected onto the curved surface. This leads to distortion and inaccuracies and inconsistencies in toolpath design and as-printed structures. This topic seeks development and demonstration of software tools to improve the process flow for designing conformal electronics on complex singly and doubly curved surfaces and depositing said pattern with high accuracy and precious. It is highly desired to also address process flow challenges associated with then performing modeling and simulation.

c. Printable Dielectric Materials for 3D RF Devices
Currently, there are very few high-quality dielectric materials for printing applications; most applications simply "make do" with materials that can be printed, but have not been specifically designed or optimized for print. This area seeks evaluation of materials that are printable and can be cured using a low temperature or light-based modalities and have low RF loss from 1-20 GHz and a dielectric constant close to 1. Proposers must demonstrate the capability to manufacture low loss materials suitable for advanced 3D electronics applications. High frequency (20-60 Ghz) range is also highly desired and should be a stretch goal of this effort. Materials should be able to be printed to a thickness of at least 10 microns with a minimum trace width of 20-50 microns. The ability to tune dielectric properties of the printed layer is also of interest.

Topic 9.5: Additive Processes for Improved Environmental Sustainability of Electronics Manufacturing

$500,000 maximum Institute funds / Up to an 18-month duration - Intend to fund 4 projects with dedicated DoD funding.

Additive manufacturing materials and process technologies have demonstrated improved environmental sustainability versus traditional electronics manufacturing by greatly reducing the materials waste and utilizing novel materials systems that reduce or eliminate harsh solvents and require reduced energy input to anneal / cure. Near-term opportunities exist to adopt additive processes into workflows for existing electronic products (including PCBs and PCBAs) to greatly reduce the number of processing steps, and therefore the time, materials, and energy input for manufacturing. This topic seeks to further address the environmental sustainability of hybrid electronics manufacturing and explore their adoption and potential impact.

Note: Proposals for Topic 9.5 may include optional tasks outside of the scope, funding, and period of performance of the core project proposal. The objective of the optional tasks is to further mature the technologies for transition and / or commercialization or support actual transition activities. Details of the proposed optional tasks should be included in Section 10 of the proposal submission, and is excluded from the proposal's page count limit; this optional task description must not exceed two pages. Additional information can be found in Section 5.4 of this document. The budget for optional tasks must not exceed $250,000 and will require additional cost-share of at least 1:1. Whether or not proposed, these optional tasks will not be evaluated by reviewers at this time and will not factor into selection of

projects. For any projects that are selected for award, these optional tasks will be evaluated for possible subsequent award during the project execution phase based on factors including but not limited to project performance, task objectives, anticipated impact, and availability of funds.

Areas of interest includes, but are not limited to:

a. Evaluation of Additive Processes for PCB Manufacturing
Adoption of additive manufacturing technologies into traditional PCB / PCBA manufacturing presents several opportunities for improved environmental sustainability, including reduced material use, reduced water use, reduced waste streams, and reduced energy consumption. Several challenges remain that are preventing adoption into process flow, including alignment, feature size, power handling, and validated harsh environment reliability. This area seeks evaluation and demonstration of additive tools and materials for manufacturing of PCBs (or PCB equivalents). Areas of particular interest include, but are not limited to:

i. Embedded Printed Passives (resistors, capacitors, and/or inductors)
ii. Printed Solder Masks and Conformal Coatings
iii. Additive Vias, Interconnects, and Component Attach

Proposers must show repeatability and reliability using testing protocols and standards used by traditional PCB manufacturers that are appropriate for the given application(s). Development of manufacturing design rules for yield, reliability, and performance is highly desired and should align closely with current standards used by contract manufacturers of PCBs, electrical components, and devices. Proposers should also demonstrate predictable component- and board-level performance after all post-processing treatments typically required for traditional PCB manufacturing.

b. Automated Rework and Repair of Electronics for Reduced E-Waste Generation
This area seeks solutions for semi or fully automated rework and repair of traditional electronic products (including components and PCBs) using additive approaches to improve manufacturing yield or extend the service lifetime of systems, therefore reducing the scrap rate and generation of e-waste. Proposers should identify requirements for the specific types of rework and / or repairs being addressed and demonstrate that the selection of materials and processes is suitable for the particular application. Factors such as ink availability, printing method, affordability, and environmental impact will be considered for effective repairs. Long-term reliability of reworked or repaired components will also be a primary measure of value when accessing the data, including validation of performance and reliability specifications using the original test standard. Evaluation of risks for failure and degradation of the printed traces when subjected to accelerated stress-testing is desired. Approaches utilizing *in situ* monitoring, closed loop control, and artificial intelligence / machine learning are desired, but not a requirement.

c. Environmentally Sustainable Electronics Encapsulants and Overmold Materials
Previous projects have explored alternative substrates and conductive inks formed from more environmentally sustainable materials, including biodegradable polymer substrates, paper-based substrates, and water-solvent inks. This topics seeks evaluation of dielectric encapsulant and overmold materials that can be used in hybrid electronic manufacturing and feature improved environmental sustainability.

Topic 9.6: Open Topic for "New Project Leads"

$400,000 maximum Institute funds / Up to a 12-month duration

Delivering the NextFlex mission requires participation from across the U.S. hybrid electronics ecosystem. The purpose of this topic is to encourage participation from organizations that have not led a NextFlex PC project in the recent past. Projects must align to the NextFlex Roadmaps and may address either manufacturing thrust or technology demonstrator topics. In the case of technology

demonstrator development, the project should, at least in part, address the challenge of manufacturing such a demonstrator.

For this open topic, proposals must clearly identify the technical working group(s) to which the project aligns, and the manufacturing capability gaps to be addressed.

Eligibility requirements: The lead proposer organization for this project must not have led a NextFlex project call project under either of the four most recent project calls (PC 5.0 – PC 8.0). As with all proposals, teaming is strongly encouraged; organizations that have led projects under PC 5.0 through PC 8.0 may be project partners, however at least 60% of the NextFlex funding for projects in this category must be allocated to organizations that meet the eligibility requirement (there is no restriction on allocation of cost share).

For clarity, organizations that have participated as partners/subcontractors on prior project calls do qualify as "new project leads" provided they have not led a PC 5.0 - PC 8.0 project.

SECTION 5. PROPOSAL SUBMISSION PROCESS

All proposers, including experienced NextFlex project teams, should pay attention to this section, as changes have been made to certain proposal elements and the evaluation process and structure over the last several project calls.

5.1 Project Call 9.0 Timeline

Project Call 9.0 will utilize a single step proposal process. Full proposals are to be submitted directly, rather than utilizing a two-step process with a pre-proposal / white paper stage to select and invite full proposals, as some previous NextFlex Project Calls did. For PC 9.0, these "Full Proposals" are simply referred to as "Proposals."

To ensure that proposal teams have an opportunity to receive feedback from NextFlex on their project concepts, teaming, roadmap and DoD priority alignment, and other relevant criteria, proposers are **strongly encouraged** to contact NextFlex to schedule a conference call with Institute representatives. These pre-submission consultation calls are a valuable opportunity for all proposers. For proposers that are new to a NextFlex Project Call, this step may be particularly helpful in understanding the nuances of proposals and reviews within the Institute framework. To schedule a pre-submission consultation, please contact proposal@nextflex.us.

Submitted proposals undergo a rigorous multi-tier evaluation as the selection process. Key steps and target dates are outlined in the table below.

Project Call Announcement and Posting	06/03/2024
Optional PC 9.0 Proposers Day Webinar	06/10/2024
Teaming Event	06/10/2024
First Date for Optional Pre-submission Consultation	06/14/2024
Proposal Online Cover Sheet Due	07/24/2024
Proposal Submission Deadline	**07/31/2024**
Approximate Technical Council Review	Mid-Sept
Approximate Governing Council Review	Late-Sept

5.2 Required Proposal Elements

A complete proposal shall consist of three separate files:

1. Technical Proposal – following the format and content guidelines below in Sections 5.3 and 5.4
2. Summary PowerPoint Slide – for review purposes, this is considered part of the Technical Proposal although it is submitted as a separate file. Additional information and template link are found in Section 5.3.
3. Budget Workbook (Cost Proposal) according to the NextFlex provided template, to be submitted in Microsoft Excel format. Additional information may be found in Section 5.5.

Proposals will be accepted online at https://nextflex.formstack.com/forms/pc9_proposal_submission until **5:00 PM PACIFIC TIME** on **July 31, 2024**.

5.3 Technical Proposal Format Guidelines

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

Submission. The proposer shall submit one (1) word-processed electronic copy of their proposal via online submission form at https://nextflex.formstack.com/forms/pc9_proposal_submission.

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. They must fit on an 8.5 by 11-inch paper size.

Font. Proposals are to be prepared with easy-to-read font (such as Times New Roman or Arial), 10-point minimum), single-spaced. Smaller font may be used in figures and tables but must be legible.

Page Layout. The proposal document must be in portrait orientation except for figures, tables, graphs, images, and pictures. Pages shall be single-spaced, 8.5 by 11 inches, with at least one-inch margins on all four sides of each page.

Page Limit. The main body is limited to 15 pages for the proposal. The page limit includes all required sections of the proposal except as indicated in Section 5.3. Pages that exceed these guidelines may not be reviewed.

Page Numbering. Number pages sequentially within each major section of the proposal (frontmatter, proposal content, appendices).

Summary PowerPoint Slide. Each team is required to provide a single PowerPoint slide for their proposal which outlines proposed budget, funding, duration, objective, and deliverables, to be used by the Technical Council while reviewing the projects for selection. Graphics or other relevant and impactful materials are often helpful in this regard. A template for this slide may be downloaded at: https://www.nextflex.us/project-call/project-call-9-0/. Proposals that are selected for funding will be required to provide a version of this slide for public release as part of the contracting process.

5.4 Technical Proposal Content Guidelines

The proposal table of contents and guidelines are provided in this section. Please follow instructions in Section 5.2 for format and other requirements. Use the standardized cover page format (Appendix A). The table of contents for the proposal is outlined below. If required, additional tables may be included, but may not be used to artificially exceed the proposal page length. Please ensure that all table or figure references include a clear numbering system and are cross-referenced in the proposal text. Please ensure that proposals clearly identify the current capability and the quantitative target specifications that will determine success of the project.

It is imperative that proposals define milestones that are tangible, measurable, and demonstrable. The specifications of each milestone achievement should be clearly defined as well as the starting state of the art for the same characteristics that the project is improving upon. Examples of tangible milestones may include physical samples, written reports containing collected data, or live demonstrations of functionality.

Please note that this is not a typical government grant or contract opportunity. NextFlex staff are available and encourage clarifying questions and will provide guidance during the process of the proposal preparation.

Content: The proposal shall comply with the following content and structure. Importantly, the budget sheets must be filled out completely and consistent with format provided.

Proposal Table of Contents

Frontmatter – Not Included in the Page Count	
Page I	Cover Page (see Appendix A)
Page II	Table of Contents
Page III-IV	Executive Summary: A succinct summary of **no more than two pages** clearly articulating the big picture problem being addressed, proposal objectives, relevance to hybrid electronics, approach to address all critical technical and non-technical aspects, expected outcome and overall cost/cost share information.

Pages 1-15: Proposal Content
There is a 15-page maximum for the proposal, excluding appendices and PowerPoint Slide Project Description; the page count in each section is for guidance. Total number of pages is more important than the page count in each section.

Proposal Content – 15-Page Maximum for Sections 1-7; Sections 8-9 are Excluded from Page Count	
Suggested Length	**Section and Contents**
~1.5 Pages	**1. Background and Need** 1.1. Identify the Hybrid Electronics Opportunity and Proposed Solution 1.2. Describe Background, Current State-Of-The-Art, and Alignment to NextFlex TWGs and DoD Critical Technology Areas* 1.3. Addressed Roadmap Gap (or manufacturing gap not previously identified) and Problem Definition
~4 Pages	**2. Technical Objectives, Scope, and Approach** 2.1. Technical Objectives 2.2. Technical Scope and Approach 2.3. Innovative Claims† 2.4. Performance and Reliability Metrics/Standards 2.5. Key Target Specifications

*The DoD has described technology focus areas critical for ensuring continued advantage over potential adversaries. If applicable, proposals should call out and clearly describe how the project aligns with one or more of these focus areas. (https://www.cto.mil/usdre-strat-vision-critical-tech-areas/)

† For demonstrators, clearly define the value to the ecosystem, long-felt need, and justification for why hybrid electronics technology is appropriate/advantageous.

~5 Pages	**3. Work Plan** 3.1. Project Schedule 3.2. Detailed Description of Milestones, Tasks, and Deliverables 3.3. Project Risk Assessment and Mitigation Plan 3.4. Project Management Approach, Roles, and Relationship of Key Personnel
~2 Pages	**4. Commercialization Strategy** 4.1. TRL/MRL Assessment (current state of the technology, expected level to be achieved, and explanation of how the proposed work will advance the TRL/MRL) 4.2. Market Analysis and Business Case for Proposed Technology (including relevance to the hybrid electronics ecosystem)* 4.3. Manufacturing Partners and Approach 4.4. Technology Transition / Commercialization Plan 4.5. Tool Accessibility to NextFlex Members and Broader Ecosystem (this section is required only for proposals that are developing equipment/tools for manufacturing or test and software such as design or modeling tools) 4.6. IP: Existing Portfolio and Future Strategy (related to the proposal topic)
~1 Page	**5. Budget Justification and Cost Share** 5.1. Summary breakdown of costs (labor, materials, travel, etc.) by project team member. Sources of funding including NextFlex funds, participant cost share, 3rd party cost share, and any other sources. This section provides budgetary information for the technical reviewers. Do not include any proprietary rate information in this section; appendix includes detailed costing. 5.2. Value and Quality of Cost Share
~1.5 Pages	**6. Capability to Meet Technical and Business Goals** 6.1. Key Personnel Experience and Qualifications 6.2. Prior Work Toward This Specific Effort 6.3. Relevant Facilities and Equipment Infrastructure (pertinent to the proposal)
Brief Statement	**7. Education & Workforce Development** 7.1. Education and Training Component of the Proposal. Proposals that include substantial education or workforce development activities (e.g. beyond inclusion of graduate or undergraduate student researchers/developers to carry out technical tasks) should expand this section.
As Needed; Excluded from Page Count	**8. Appendix** 8.1. Bio-sketches 8.2. Facilities and Infrastructure Detail Relevant to the Proposal 8.3. Technical References and List of Patents 8.4. Letters of Support
Excluded from Page Count	**9. Single Page PPT Slide Project Description (format provided)†**
Excluded from Page Count Limit 2 pages	**10. <u>FOR TOPIC 9.5 ONLY</u>: Optional Task(s) Description** 10.1. Objective of Optional Task(s) Focused on Technology Transitions 10.2. Detailed Description of Milestones, Tasks, and Deliverables 10.3. Impact to Technology Transitions / Commercialization

<u>For Topic 9.5 Proposals Only:</u> the content describing the optional task(s) in Section 10 of the above table is excluded from the page count limit; *<u>this optional task description must not exceed two pages</u>*. Whether or not proposed, these optional tasks will not be evaluated by reviewers at this time and will not factor into

* For demonstrators, describe the commercial need / value of the hybrid electronics solution for this application.

selection of projects. For any projects that are selected for award, these optional tasks will be evaluated for possible subsequent award during the project execution phase based on factors including but not limited to project performance, task objectives, anticipated impact, and availability of funds. An abbreviated proposal may be requested for selection of this optional task; timing is anticipated to be Spring 2025.

5.4 Cost Proposal Guidelines

Proposal cost calculations shall be in the Excel format provided; the spreadsheet should be submitted as a separate file with the submission, not included in the Technical Proposal. For clarity, the technical proposal Section 5.1 includes a high-level budget summary that technical reviewers will use to evaluate the proposal; the cost proposal is used for detailed evaluation by NextFlex staff and government advisors. Cost proposals are not shared with the Technical Reviewers.

The cost proposal spreadsheet may be downloaded at https://www.nextflex.us/project-call/project-call-9-0/
Additional worksheets should be added to the Workbook for additional partner organizations.
Cost proposals must include labor (by staff position / role, not by individual name), materials, travel, and all other direct expenses, and overhead, including overhead rates, each divided by source of funds. Questions about cost proposals including submission of rate information should be addressed to NextFlex at proposal@nextflex.us.

SECTION 6. ADMINISTRATIVE TOPICS

6.1 Confidential Information

It is recognized that it may be desirable to include information that is considered confidential and proprietary by the submitter to fully and effectively convey the technical merits of the proposal. All submitted proposals are distributed for the purpose of review to a slate of reviewers. Besides NextFlex staff, the majority of NextFlex's proposal reviewers are NextFlex members, and as such, they are bound to customary confidentiality provisions (no less than reasonable care standard, marking requirement or written confirmation for oral disclosure, standard exclusions such as for publicly available information) via NextFlex's IP Policy to maintain the confidentiality within the NextFlex membership (relevant IP Policy sections will be made available upon request). Representatives of the U.S. Government also serve as proposal reviewers. NextFlex reserves the right to engage other persons or entities as part of the proposal review process (e.g., third-party SMEs), in which case NextFlex will require such reviewer to enter into a special purpose non-disclosure agreement. Please keep the foregoing in mind when determining the information to provide in your proposal. It is recommended that the included confidential or proprietary information be clearly marked and be limited to the minimum necessary to convey the highlights of the technical approach.

Additionally, proposers must refrain from including Export Controlled information in their submissions. If a proposer believes that inclusion of Export Controlled information is required to fully respond to the technical topic or to fully convey the merits of their proposal, they should contact NextFlex by email to proposal@nextflex.us to discuss this fact no later than the online cover sheet submission deadline; alternative submission and review procedures may be required.

6.2 Financial and Cost Share Requirements

Development agreements will be awarded as cost reimbursement, not-to-exceed contracts, with periodic payments to be made linked to achievement of milestones as presented in the proposal. If the proposer's organization has a US government-approved rate structure, please use it. The methods used to value "cost sharing" must be the same as those used to value the full project costs. All developers are expected to have a government approved or industry standard accounting system by which actual project costs are tracked and reported. This is an absolute requirement to be sure that cost share obligations are met. Overall guidance on the working principles and requirements of cost-share (in-kind cost share, and cash and cash equivalent cost share), including various regulations governing federally funded programs are given in a

separate document, “Cost Share Definitions and Guidance,” available at https://www.nextflex.us/project-call/project-call-9-0/.

6.3 Work Requirements

To submit a response to PC 9.0 and to subsequently be considered for an award, the following requirements must be met:

- Proposal teams should include at least one corporate/industrial organization and are encouraged to be industrially led when appropriate.
- The company or composite team of companies/government labs/academics must have a significant presence in the US in the form of R&D activities and/or manufacturing. One hundred percent of the work activity (funds) must be spent within the United States operations.
- The company or companies must be committed to making available the developed products and providing to NextFlex and its Members on a right-of-first acceptance basis. Applied research conducted by universities will be considered and does not need to meet this requirement. However, in the latter case, a pathway to commercialization must be envisioned and described.
- Process development projects should include sufficient documentation that the method is replicable at the NextFlex Technology Hub in San Jose, CA, or member companies’ facilities or both as appropriate.
- Test methods, materials data, or design tools should be foundational and available for incorporation into tools for the advancement of hybrid electronics manufacturing and not limit collaboration.
- The total project funds must be matched at a minimum of 1:1. Teams may determine how to divide that requirement among their members. The cost share is defined in the Participation Agreement to include matching share of the development cost in cash and in-kind contributions, e.g., labor and materials, of at least 50 percent.

6.4 Membership Requirement

To qualify for funding awards, lead organizations on projects that are selected for an award, as well as the other performers on their project team, who are not already members of the Institute, must join NextFlex at the appropriate membership Tier (not Observer Level or Associate Member) before a development agreement can be finalized with the project lead. Suppliers from whom standard parts, components, or materials are acquired, such as those with a catalog part number or industry standard supply chain (e.g., build-to-print part) are exempted from this requirement; this exemption may include experimental grades of materials, components, or parts that are provided at competitive fair market price for the purchased units, not paying for the full development cost of that experimental item. It is the responsibility of the project lead(s) to communicate this requirement to their respective partners and coordinate their membership process with NextFlex. Potential members can find out more at: https://www.nextflex.us/membership-inquiry-form/.

SECTION 7. PROPOSAL EVALUATION CRITERIA

All proposals are evaluated using a three-step process.

1. Review by Subject Matter Experts
2. Selection Recommendations from the NextFlex Technical Council
3. Selection by the NextFlex Governing Council

Details of these steps are found below.

Proposals are assigned to slates of technical reviewers comprising subject matter experts (SMEs) from among NextFlex industry, government, and academic institution members. In rare cases, NextFlex may engage 3rd party SMEs who are not NextFlex members as part of the review process.

Reviewers independently review the technical proposals and provide feedback to NextFlex according to proposal evaluation criteria described below. Based on the quantitative and descriptive feedback from the

reviewers, NextFlex formulates a set of recommendations that are considered by the NextFlex Technical Council, which through voting creates a set of recommendations for selection that is sent to the NextFlex Governing Council. Infrequently, the Technical Council may recommend certain proposals subject to modifications. The NextFlex Governing Council, comprising representatives of certain NextFlex industry, academic, and government member organizations, has final selection authority and considers the recommendations from the Technical Council in voting its recommendations.

In soliciting proposals, NextFlex plans to provide and administer funding that must be matched (1:1 minimum) with funds in the form of cash and in-kind contributions provided by the recipients to cover the total project cost. It is not a requirement that each team member demonstrates a cost share at a minimum of 1:1. However, the entire project must be cost-shared at least 1:1, and ratios greater than 1:1 are highly encouraged.

In responding to this solicitation, partnering among industrial companies or industrial company/R&D organization/university/government teams is very strongly encouraged. Individual company responses may be appropriate where company size, breadth, and expertise are sufficient to effectively cover all areas (e.g., technical resources, financial stability, and market presence) critical to the successful delivery of the demonstrator, prototypes, processes, or material proposed. Engagement with industry partner(s) will strengthen the value of the submission.

Pre-submission Consultation with NextFlex: All proposers are strongly encouraged to schedule a pre-submission consultation with NextFlex while developing their proposal. The purpose of discussing proposals with NextFlex prior to official submission is to receive feedback on all aspects of the proposal, including technical approach, partnering, connection to previous NextFlex projects, etc. This consultation is meant to strengthen the competitiveness of the proposal. It is the responsibility of each proposing team to decide how to incorporate or not incorporate the feedback. This consultation does not factor into the proposal evaluation.

Proposal Evaluation: Reviewers evaluate proposals against a set of criteria identified in the table below, as well as providing an overall assessment of worthiness of funding and pros and cons. The 14 criteria are divided into Technical Merit & Transition Potential (Technical, criteria 1 – 8) and Non-Technical Factors (criteria 9 – 14) categories; the criteria scores within each category are averaged to produce a Technical Score and a Non-Technical Score. The combined scores from all reviewers produce both average scores and a Technical Ranking. Project selection relies heavily on the Technical Score and Ranking; Non-Technical Score and reviewer feedback are particularly useful to distinguish proposals that are rated closely to each other, as well as to identify potential outliers (high or low). Ultimate selection relies on the numerical scoring, descriptive reviewer feedback, and the balance of project portfolio.

During the final selection process, communication between the proposers and NextFlex may be initiated over the terms, conditions, specifications, deliverables, schedule, or other relevant factors contained in the proposal in advance of awarding of a contract. (Granting of awards to proposals submitted in response to this Project Call is contingent upon the continued availability of US government funding and subject to mutually agreeable terms and conditions.)

The scores and comments from different reviewers on all proposals will be compiled, ranked, and prioritized; and they will be considered in voting by the Technical Council. The Technical Council may seek additional modifications before making recommendations to the NextFlex Governing Council. Upon approval by the Governing Council, the proposal shall advance to executing Development Agreements prior to awarding any funds and, if the lead developer or its partners are not already a member of NextFlex, also execute a Participation Agreement.

Proposal evaluation criteria are outlined in the table below. The lists of criteria are aligned with sections in the proposal Table of Contents. The explanations for the criteria in Appendix D provide guidelines to the submitters as well as the reviewers regarding relevant information and supporting details to be included in submitted proposals.

Section	Section Title	Criteria
1.0	Background and Need	(1) Problem statement, innovative solution, and potential impact on technical gap and/or DoD priorities
2.0	Technical Objectives	(2) Technical scope and approach
		(3) Logical technical plan; key deliverables and specifications
3.0	Work Plan	(4) Project organization
		(5) Probability of success
4.0	Commercialization Strategy	(6) Business case, value proposition
		(7) Manufacturing approach
		(8) Technology transition potential
	Manufacturing Readiness and Accessibility	(9) MRL/TRL assessment
		(10) Tool accessibility (for proposals developing tool hardware and software proposals only)
5.0	Budget Justification and Cost Share	(11) Cost and cost realism
		(12) Value and quality of cost share
6.0	Capability to Meet Technical and Business Goals	(13) Experience of personnel and quality of relevant facilities
7.0	Education & Workforce Development	(14) Quality of EWD section

Proposals that include use of the NextFlex Technology Hub should articulate the value proposition of this partnership to the project. Utilizing the Technology Hub is not an evaluation criterion. Technology Hub utilization in a proposal may be included in context with technical strategy leveraging state-of-the-art hybrid electronics capabilities, commercialization strategy, industry-relevant transition of manufacturing processes, and demonstrating manufacturing gaps. Any proposal team intending to utilize the Technology Hub in their project should engage NextFlex about this well ahead of proposal submission (as they would any other partner). Proposers needing introductions to the appropriate Technology Hub staff can request introduction by email to proposal@nextflex.us. All projects are encouraged to leverage the NextFlex technical staff expertise.

In support of NextFlex's dual mission to (1) promote development and U.S. manufacturing of hybrid electronics and (2) support DoD technology transitions, alignment of projects to DoD Critical Technology Areas will be considered (as described above) in the evaluation of proposals. This alignment may be a factor in the consideration of proposals by the Technical Council and Governing Council. Partnering with DoD labs or other DoD components is allowed and encouraged, however NextFlex funds cannot be paid to DoD.

Education & Workforce Development: Establishing a domestic manufacturing ecosystem in hybrid electronics will require not only the development of new manufacturing processes, but also training a workforce to design and manufacture hybrid electronic products. To that end, proposals that include a Education & Workforce Development (EWD) component that is well-integrated into the technical work and geared toward training tomorrow's workforce, retraining today's workforce, and/or K-12 STEM outreach activities are favorably considered. EWD may include, but is not limited to, undergraduate and graduate student contributions to projects, internships, microelectronics course development at community colleges or universities, short course development, the development of STEM programs, etc.

SECTION 8. CONTACT INFORMATION

Communication and questions during the proposal period and submission of proposals should be directed by email to proposal@nextflex.us.

SECTION 9. REFERENCE DOCUMENT KITS

All the following seven (7) reference documents are in the Project Call Reference Documents section of the PC 9.0 webpage (https://www.nextflex.us/project-call/project-call-9-0/):

a. Project Call 9.0 Guidebook
b. Project Call 9.0 FAQ
c. Hybrid Electronics Technology Roadmap Summaries
d. MRL/TRL Definitions
e. Cost Calculations Template
f. Cost Share Definitions and Guidance
g. Summary PPT Submission Template

Additional membership and submission information is available at the following locations:

h. Membership (https://www.nextflex.us/membership-inquiry-form/)
i. Online Cover Sheet (https://nextflex.formstack.com/forms/pc9_cover_sheet) – Proposal Cover Sheet must be submitted by **JULY 24, 2024.**
j. Online Submission Form (https://nextflex.formstack.com/forms/pc9_proposal_submission) – Proposal must be submitted by **JULY 31, 2024**.

SECTION 10. GLOSSARY OF TERMS

Abbreviation	Term
3D	Three-Dimensional
Au	Gold
CAD	Computer-Aided Design
CONOPS	Concept of Operations
COTS	Commercial Off-the-Shelf
Cr	Chromium
Cu	Copper
DoD	Department of Defense
EMI	Electromagnetic Interference
EMS	Electronics Manufacturing Services
EWD	Education & Workforce Development
FHE	Flexible Hybrid Electronics
GHz	Gigahertz
GC	Governing Council
ICs	Integrated Circuits
I/O	Input / Output
IoT	Internet of Things
LED	Light Emitting Diode
MRL	Manufacturing Readiness Level
MTA	Manufacturing Thrust Area
MHz	Megahertz
MMIC	Monolithic Microwave Integrated Circuit

Ni	Nickel
Pd	Palladium
Pt	Platinum
µm	Micron
mm	Millimeter
mmWave	Millimeter wave (30 GHz – 300 GHz)
OEM	Original Equipment Manufacturer
PC	Project Call
PI	Principal Investigator (i.e., leader for a project)
PCB	Printed Circuit Board
PCBA	Printed Circuit Board Assembly
R&D	Research and Development
RF	Radio Frequency
R2R	Roll-to-Roll
ROM	Rough Order of Magnitude
SWaP-C	Size, Weight, Power, and Cost
SME	Subject Matter Expert
SMA	SubMiniature version A
STEM	Science, Technology, Engineering, and Mathematics
TC	Technical Council (comprised of SMEs and voting Tier 1 and Tier 2 members from industry and academia)
TPD	Technology Platform Demonstrator
TRL	Technology Readiness Level
TWG	Technical Working Group
TPU	Thermoplastic Polyurethane

SECTION 11. APPENDICES

Appendix A: Cover Sheet Template

The chart below is to help you anticipate what information will be requested for your online cover sheet submission. Submission of cover sheets is required by the specified date to allow NextFlex to anticipate proposals that will be received and pre-align reviewers to facilitate timely proposal review. Estimated (ROM) project costs are required with the online cover sheet; it is expected that proposal teams may still be finalizing proposals and budgets at the time of the online cover sheet submission. Updated and final costs must be provided with the proposal submission.

To generate and submit an online cover sheet, please fill out the form:

https://nextflex.formstack.com/forms/pc9_cover_sheet

NextFlex PC 9.0 Cover Sheet Template	
Project Title	
Date of Submission	
Project Leader	
Organization, Department, and Address	
UEI Number	
Project Leader's Phone Number	
Project Leader's Email Address	
Industry Partner / Subcontractor Organization(s)*	Provide full name, location, and other details
Non-Industry Partner / Subcontractor Organization(s)†	Provide full name, location, and other details
Supplier Organization(s)‡	Provide full name, location, and other details
Project Topic Category	
MRL Level – Start	
MRL Level – Finish	
TRL Level – Start	
TRL Level – Finish	
NextFlex Membership Status and Level	
Estimated Total Project Cost:	$
Estimated Cost Share (in-kind, labor, material, etc.)	$
Estimated Cost Request from NextFlex	$
Project Duration (Months)	

* Industry Partner / Subcontractor Organizations are companies with whom the lead proposer organization is collaborating on the development work. This does not include suppliers of COTS components.
† Non-Industry Partner / Subcontractor Organizations are organizations (e.g. Universities) that are not for-profit companies.
‡ Supplier Organizations are other organizations that will *meaningfully contribute* to the project but that will not carry out funded development work. This may include, for example, key suppliers of COTS parts or services.

Appendix B: Instructions for Filling Out Proposal Cost Calculations Excel Workbook

There are specific requirements for planning and tracking proposal and project spending when receiving federal funding for Institute projects. To support those requirements, please lay out the project financials in the provided format. While budget details will be entered into the Excel tables provided, the following should serve to clarify what needs to be documented and how:

Overall the following areas are important for the Institute to understand:

- Total project cost
- Total cost share, including percent and amount of funding requested from NextFlex
- Type of costs
- In-kind contributions and types thereof
- Hours and rates for labor
- Any equipment purchases planned
- Materials purchases
- Travel expenses

In addition to detail on the above, you must provide spending by calendar year for which the project operates and a breakdown by lead and partners.

Therefore, the following explanation may be helpful.

The spreadsheet includes columns for six budget quarters. Most PC 9.0 topics are limited to shorter durations; do not plan a budget longer than the allowed maximum duration for the topic proposed.

Add additional “Project Detail” and “Cost Detail” tabs for each partner on the project, and please make sure to maintain one “Project Detail Total” and “Cost Detail Total” tab which summarizes the partner breakdown.

The primary objective of this supporting workbook for the project proposal is to ensure that the review process can adequately identify all details of the proposal. Proposals that advance to funded projects will be subject to further documentation and record retention requirements which will be provided in detail to the project lead at that point in time.

If the lead or any partners of the proposal team have audited indirect rates for labor, please use those.

If there are any additional questions on how to prepare the cost calculations workbook, proposers may contact proposal@nextflex.us for further clarification.

Appendix C: Questions for Pre-Submission Consultation with NextFlex

This list of questions has been developed to help proposal teams prepare for their proposal consulation calls with NextFlex. These questions are intended to help make the calls as productive and helpful as possible toward the goal of strengthening proposal competitiveness. The questions take cues from DARPA's Heilmeier Catechism (https://www.darpa.mil/work-with-us/heilmeier-catechism) with additions and modifications relevant to NextFlex project types.

Proposal teams are recommended to answer these questions in writing and provide to NextFlex well ahead of the scheduled call. Written responses must be concise – 2 pages maximum with 10 point font; figures may be included in this page count. During the call, teams will be able to ask questions on these topics or others specific to their proposal concepts.

Proposers should email proposal@nextflex.us to arrange a consultation.

1. Provide a synopsis of the proposed project (short paragraph). What PC 9.0 topic area are you addressing?
2. What is the proposed work attempting to accomplish or do? Avoid jargon.
3. How is it done today / what is the current state of the art, who does it, and what are the limitations?
4. Describe the team composition and team member roles. Why is this the right team to solve the problem? What capability gaps does your team have an what additional capabilities do you need to add (if any)?
5. What is innovative in your approach in the context of existing capabilities? Why do you think you can be successful?
6. What are the key technical challenges in your approach and how do you plan to overcome these? What is your biggest technical risk?
7. Who or what will be affected and what will be the impact if you are successful? Please be as quantitative as possible?
8. What is your proposed budget and duration?
9. What is the pathway to manufacturing or how will this work improve hybrid electronics manufacturing? What additional work will be required after this project is completed to deliver impact on industry, how much will it cost, and how long will it take?
10. What is the one main benefit that your project will deliver to the NextFlex Community and microelectronic ecosystem? How will the Hybrid Electronics Ecosystem and the NextFlex community benefit from the project?
11. What are the key non-technical challenges to your project and the barriers to adoption of the proposed approach?
12. Are you requesting support from NextFlex during the execution of your project (material, fab access, engineering services, etc.)?

Appendix D: Proposal Evaluation Criteria

	PC9.0 Full Proposal Project Review Criteria / Score Card			
	Criteria for all Project Call topics			**Score Guide: Low=1, High=5; refer to scoring rubric worksheet**
	Reviewer Name:	ADD YOUR NAME HERE		
	Reviewer Organization:	ADD YOUR ORGANIZATION HERE		
	Proposal Section	**Proposal Section**	**Criteria**	**Explanation of Criteria**
Technical Merit & Transition Potential	1.0	Background and Need	(1) Problem statement, innovative solution, and potential impact on technical gap and/or DoD priorities	Evaluate the problem definition in line with the background information and the gap analysis provided. Is the proposal aligned with TWG roadmaps and/or DoD Critical Technology Areas?
Technical Merit & Transition Potential	2.0	Technical Objectives	(2) Technical scope and approach	Is the objective, scope and approach aligned with the problem definition? Are performance and reliability metrics and standards appropriately addressed? For demonstrator projects, what are the value to the ecosystem and the advantage of an FHE solution for this problem?
Technical Merit & Transition Potential	2.0	Technical Objectives	(3) Logical technical plan; key deliverables and specifications	Do the specifications and deliverables meet the proposed objectives and final deliverables? What are the key tangible deliverables & how do we assess success?
Technical Merit & Transition Potential	3.0	Work Plan	(4) Project organization	Is the project organized well with milestones and tasks; Are the task descriptions clearly articulated: Is the schedule aligned well with critical interdependencies identified?
Technical Merit & Transition Potential	3.0	Work Plan	(5) Probability of success	Based on all of the above, including the cost and the team capability, assess the feasibility to achieve the stated goals within the planned timeline.
Technical Merit & Transition Potential	4.0	Commercialization Strategy	(6) Business case/value proposition	What is the targeted application or market? How is the technology/product a differentiator or a game changer? Is the appropriateness of a hybrid electronics solution explained?
Technical Merit & Transition Potential	4.0	Commercialization Strategy	(7) Manufacturing approach	Is the technology/approach matured and ready for manufacturing? Is it the right approach? Does it help advance the MRL/TRL goals? Does the team have the right partners? Are they US-based? How mature is the process and/or manufacturing infrastructure? How does it impact US manufacturing?
Technical Merit & Transition Potential	4.0	Commercialization Strategy	(8) Technology transition potential	Is there a clear path for technology transition / commercialization? Does it address a significant need? Are the appropriate stakeholders engaged? Is there a plan to demonstrate that the technology will be sufficiently derisked?
Non-Technical Factors	4.0	Commercialization Strategy	(9) MRL/TRL assessment	Are the starting MRL/TRL accurate? Are the end MRL/TRL assessed correctly, and is it realistic considering the overall quality of the project and maturity of technology and approach?
Non-Technical Factors	4.0	Commercialization Strategy	(10) Tool accessibility **(for proposals developing tool hardware and software proposals only)**	Will the equipment/tool/software developed as part of the proposal be available to the ecosystem, and where they will be located?
Non-Technical Factors	5.0	Budget Justification and Cost Share	(11) Cost and cost realism	Evaluate if the cost assessment is pragmatic based on the overall assessment of the project relative to its objective, team, advancement, timeline etc.
Non-Technical Factors	5.0	Budget Justification and Cost Share	(12) Value and quality of cost share	Assess based on the cost share value, cost share source and the purpose of the cost share.
Non-Technical Factors	6.0	Capability to Meet Technical and Business Goals	(13) Experience of personnel, quality of relevant facilities, and building supply chains	Assess the strength of the PI team as well as the partner/subcontract organizations to achieve the proposal's goals. Does this project build or strengthen organizational relationships / supply chains?
Non-Technical Factors	7.0	Education & Workforce Development	(14) Quality of EWD section	What aspects of EWD are proposed? Is intern, graduate / undergraduate student, incumbent worker training, etc. included? Are courses developed and / or implemented? Are there industry and / or student outreach opportunities?
				Technical Score
				Technical Ranking
				Non-Technical Score

In addition to numerical scoring, reviewers are asked to respond to the following questions:

- General Comments (Please provide succinct overall comments, especially regarding any particular section under the average score)
- Strengths (Please list the key strengths of the proposal)
- Weaknesses (Please list the key weaknesses of the proposal)
- Does this proposal meet your standard to be fundable?