UNIVERSITY OF TENNESSEE PERSPECTIVE on PUBLIC-PRIVATE CONSORTIUM FRAMEWORK (PPCF) to ADVANCE FUSION TECHNOLOGY

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The University of Tennessee (UT) has a strong nuclear engineering department, with seven faculty actively leading research projects funded by the Department of Energy Fusion Energy Sciences, has managed the Oak Ridge National Laboratory as a 50-50 partner with Battelle Energy Alliance since 2000, and has a 501(c)(3) organization, the UT Research Foundation (UTRF), which promotes entrepreneurial engagement and commercialization of UT intellectual property, has extensive experience with integrated multisector consortia development and contributes to state and regional economic development. As an example, UTRF is the lead organization of IACMI [1], the Composites Institute, which is a public-private non-profit consortium that was initially funded in 2015 with DOE funding and includes participation of multiple National Laboratory and University partners, five state Economic Development organizations and has numerous industry partners. IACMI, which grew out of the carbon-fiber manufacturing composite consortium represents a clear example of a successful PPCF that has now transitioned to 50% DOE and 50% DOD funding and has a large cadre of industrial partners.

Knoxville, East TN and the entire state of TN present a tremendous innovation ecosystem for the advancement of fusion materials and technology. The state of TN has invested $80M into creating the University of Tennessee – Oak Ridge Innovation Institute (UT-ORII) and in 2023 [2], TN Governor Bill Lee appointed a new TN Nuclear Energy Advisory Council [3] and charged its members with using their unique industry expertise to ensure that TN is a leader in the nuclear innovation economy. Further, the state of TN has also invested $60 million in a fund to support the recruitment of nuclear industries to the state and expand the nuclear workforce [3]. Recently, UT-ORII has has committed investments of $10 million in fusion material technologies [4].

Beyond IACMI, another possible model for consideration is the NSF regional innovation engine ecosystem program [5]. UTRF has just submitted a preliminary proposal to NSF for a nuclear power and nuclear medicine innovation engine, which is focused on a combination of use-inspired research, developing a trained workforce across all levels of post-secondary education, translation of innovation to practice and the development of both a supply chain and financing and capital to create a rapidly growing ecosystem. The experience gained in submitting the preliminary proposal has provided significant capability in engaging stakeholders and partners across TN associated with technical and community partners, state and local economic development entities, community and labor partners, National Laboratories, advanced industry and market accelerators. Such experience, and the program focused on public – private partnerships and rapid development of an innovation ecosystem from the NSF regional innovation engine expertise represents the regional ecosystem DOE Fusion Energy Sciences should, and must, engage in for the PPCF fusion and materials technology.

A further local growth opportunity is the recent UT-ORII investment in fusion material technologies [4], which represents an increase to the already strong UT Knoxville and Oak Ridge National Laboratory partnership. This partial convergent research initiative in fusion materials and technology provides an impetus for increased leadership in federal and privately funded fusion technology initiative(s), to serve as a technology incubator for an emerging East Tennessee fusion technology industry, and to train the required engineers and research scientists required to enable this growth. Our initiative contains 3 thrusts: Magnets, Materials and Modeling. The magnets thrust is focused on aspects that complement but do not compete with private industry. Thus we plan new researcher hires and expanded capability focused on evaluating and optimizing the integration of high temperature superconducting coils with the coil insulation and magnet structure, testing the uniformity and performance of these integrated magnet structures and their

joints, including the high priority partially insulated cables for ramped DC magnets, and the stability and degradation of these magnets under cryogenic temperature and high-energy particle irradiation. The coupling of the multiscale magnet modeling with the testing capabilities will provide for integrated design optimization of magnet structures, and ability to improve the quench protection protocols.

The materials thrust focuses on new researcher hires that strongly leverages unique, world-leading ORNL-UTK capabilities to design and then manufacture integrated structural component prototypes of PFC armor, structural and blanket structures at cm-scale, test (& model) their performance under extreme environments of high-heat flux, high-energy particle radiation stability at high temperatures (order 500-800°C) and hydrogen isotope permeation and retention. The combination of materials performance and degradation experiments and closely connected modeling provides an opportunity to accelerate the technological maturation through an iterative cycle of design, manufacturing and testing.

We envision the modeling thrust providing the 'glue' and cohesiveness between the Magnets and Materials thrust activities, and will focus on new researcher hires that can extend our high-fidelity modeling capabilities from 10 cm into the plasma (the so-called pedestal and scrape off layer) to 10+ cm into the structure, encompassing plasma material interactions, high heat flux materials response, 14 MeV neutron degradation and tritium isotope retention and permeation, in addition to hiring new researchers to initiate a fundamental multiscale materials modeling activity for integrated magnet structures that will simultaneously attack the problem from the bottom-up and top-down. These two modeling activities will provide high fidelity models, complemented by the experimental results, to inform a Machine Learning-Artificial Intelligence capability to produce predictive, reduced order models appropriate for fusion pilot plant design and optimization.

The grand challenges within fusion technology, which have been identified in recent reports from the National Academies of Science, Engineering and Medicine [6,7] and the DOE Fusion Energy Sciences Advisory Committee [8], involve closing numerous engineering and technical gaps that are at low technological readiness levels. Further, the scale of funding required to deploy new technologies in nuclear energy is large, but to investors—including federal and state agencies as well as venture capital firms—the value proposition is equally large. For example, venture funding in nuclear fusion totaled $2.1 billion in 2021, and recently exceeded $7 billion [9], to support the ongoing translational development of transformative new technologies. Capitalizing on an investment from the TN Nuclear Energy Fund, ENRIcH stakeholder Type One Energy closed an $82.4 million seed funding process in July 2024 to construct a fusion reactor in eastern TN [10]. This recent UT-ORII investment of state of TN funds (~$10M) for fusion materials incorporates 3 thrusts (materials, magnets and modeling) and provides the seed foundation towards that a DOE FES PPCF program in fusion materials & technology. The remainder of this document discusses potential teaming opportunities through UTRF to bring multiple University, state and local economic development, workforce development, National Laboratory, and industry partners together, both from a funding and intellectual property (IP) management perspective.

UTRF has significant experience building effective innovation ecosystems grounded in research and discovery, executing the practical matters—the governing agreements, structures, and processes—that underpin their operations, and promoting shared intellectual property commercialization to enable the seamless transition of innovations to market. Under a wholly owned subsidiary, Collaborative Composites Solutions Corporation, UTRF leads and manages IACMI [1], a $200M+ DOE Manufacturing USA Institute established in 2015. In 2023, IACMI was the first Manufacturing USA Institute to be renewed, in recognition of its success creating academic and industry partnerships that accelerated innovations in advanced composite design and manufacturing. UTRF has played a major role in creating regional support for entrepreneurs and small businesses, including managing a $5 million pre-seed venture fund, developing a nationwide network of investors to provide follow-on investments, and nurturing the entrepreneurial spirit through programs like UTRF's New Venture and Entrepreneurial Fellows

program 11] and SPARK Accelerator [12], and ORNL's Innovation Crossroads [13]. UTRF is committed to working with stakeholders to support and nurture a fusion innovation ecosystem with the industries and workforce to support it.

IP Management

A Fusion PPCF IP process aims to ease and accelerate the timeline for transitioning technologies from lab to market). Key barriers to be addressed include IP ownership, use and control issues between research collaborators, and protracted contract negotiations with collaborators and industry partners that intend to develop technologies into products.

Operating Principles under consideration:

- Participants in a fusion PPCF will be required to accept standardized IP terms and conditions as a condition for receiving funds;
- Participants will control prosecution of their IP rights but will report such activities to the PPCF;
- The Entity will coordinate and assist with licensing/commercialization activities;
- Each partner receiving R&D funds shall have one representative on an IP Council responsible for providing ongoing feedback regarding IP and out-licensing activities (it will not have the responsibility to consult on individual licensing transactions);
- Out-licensing will occur in compliance with Bayh-Dole regulations, including a preference for small business under 37 CFR 401.7, preference for US industry under 37 CFR 401.14(i), and compliance with utilization reporting obligations under 37 CFR 401.14(h), and all other reporting obligations as mandated by the sponsors; and
- The Entity will make reasonable efforts to seek licensee(s) for the commercial development of Engine IP.

Starting point terms under consideration:

- A time-limited (6 months) option for an exclusive or non-exclusive, all fields or field of use, fully sublicensable, commercial license for PPCF-supported IP will be granted to the Industry partners ("Option") following disclosure to the inventor's TTO ("Originating Member") (subject to the reservation of rights described below). This timing permits universities to comply with Bayh-Dole obligations without incurring costs associated with evaluation/valuation.
- Background IP will remain unaffected, and universities may decide at the university's sole discretion to convey some rights in the BIP to the Industry partners.
- Should the Industry partners elect NOT to pursue commercialization or decline to fund further patenting activity for a given IP under Option, then the Option to that IP will expire. If the industry partner fails to enter into a bona fide license agreement to commercialize the IP within 6 months of the Option period for the IP, then the Option shall expire, and the industry members shall not have any commercialization rights to that IP.
- The aforementioned exclusive license to the industry members shall be subject to a reservation of rights to the Originating Member for teaching, research, education, public service, and other research-related purposes and to publish, as well as the rights obligated to the federal government.

Additional considerations:

- The Industry member will provide the Originating Member with all copies of agreements, amendments, reports, sublicense agreements, and other material documents received from licensees. It will provide for Originating Member indemnification from, and audit

rights of, licensees and sublicensees (and shall include all provisions customary in a University license.

- Payments must be made to the Originating Member within 90 days of each calendar year and accompanied by a report identifying:
    - the total gross third-party licensing consideration received,
    - the date received,
    - itemized deductions (if any),
    - the calculation of the Originating Member's share,
    - For any license involving intellectual property solely developed by the Originating Member and intellectual property developed jointly or exclusively with other parties, including other Members, Accordingly, the report must include details of the allocation between technologies or licenses (if any) and any other information not identified above;
- Originating Member: an annual report to the Entity setting forth the status of all commercial development and licensing activity relating to subject inventions of the Originating Member for the preceding year.
- IP management: The Originating Member will have the responsibility and authority to take all reasonable actions necessary and appropriate to seek patent protection for patent rights covering subject inventions using counsel of its choosing. The Originating Member will use reasonable efforts to keep the Entity reasonably informed as to all material patent prosecution actions and decisions, and the Originating Member will give due consideration to any recommendations made by the Entity concerning the patent prosecution. Originating Member will provide or direct outside patent counsel to provide Entity with all serial numbers and filing dates, together with copies of all applications in the patent rights, including copies of all office actions, responses, and all other communications from the U.S. Patent and Trademark Office and the patent offices in any other jurisdictions.

Tech Transfer

Engaging stakeholders at an early stage of development is critical for understanding the types of innovations that make sustainable impacts on society. To that end, we will closely partner with the various technology transfer offices to streamline the process of commercializing innovations developed by a Fusion PPCF. We will leverage the best practices on IP policy developed for the DOE's Manufacturing institute IACMI [1] led by UTRF to ensure the timely protection of innovations and licensing of those innovations to the industry.

UTRF is well positioned to work with the Technology Transfer offices to execute an IP management plan that will catalyze startup creation through business-friendly licensing terms for IP resulting from this funding. Start-ups, small or large businesses that wish to license Team TN IP to develop such innovation into products and services, will be expected to demonstrate commercialization plans, and related contracts shall include diligence milestones to ensure continued development towards a commercialized product for the public good.

Additionally, we will meet with stakeholders at various conferences and engage them from the beginning. This networking effort will lead to building an entrepreneurial and commercial component that will support the continuous growth of the innovation pipeline.

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