

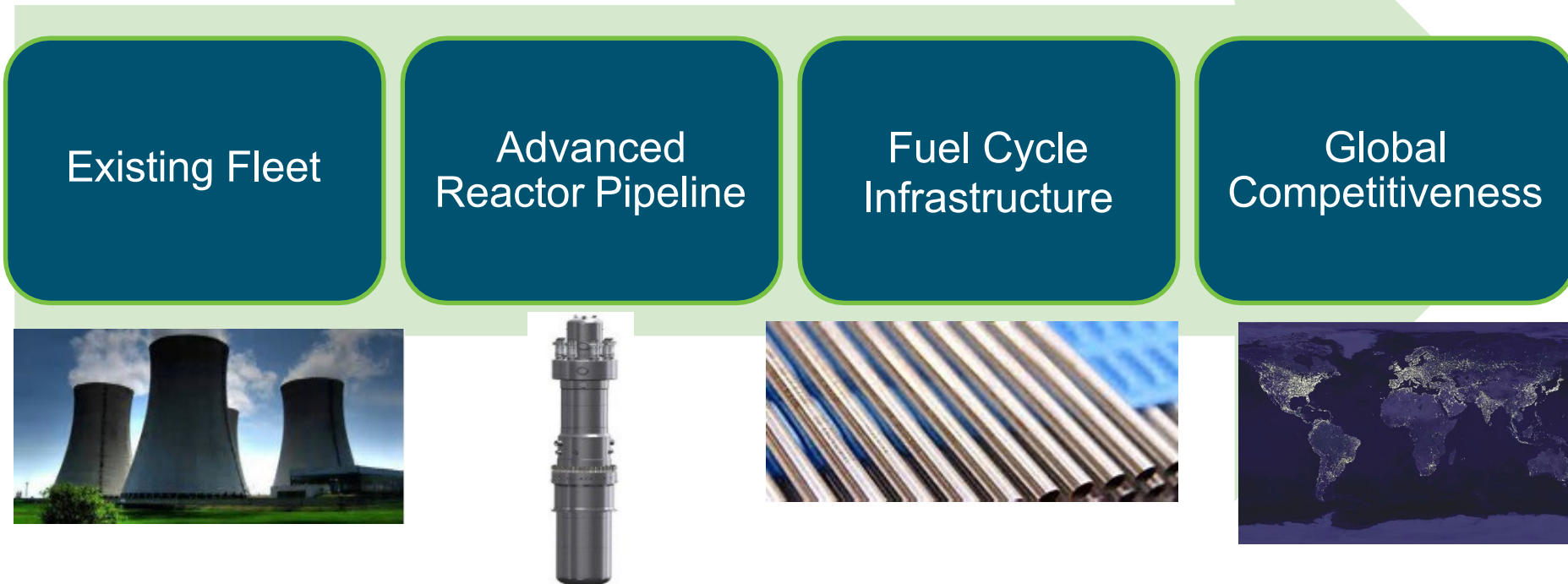
Advance Methods for Manufacture Program

Annual Review Technical Review
December 2-3, 2020

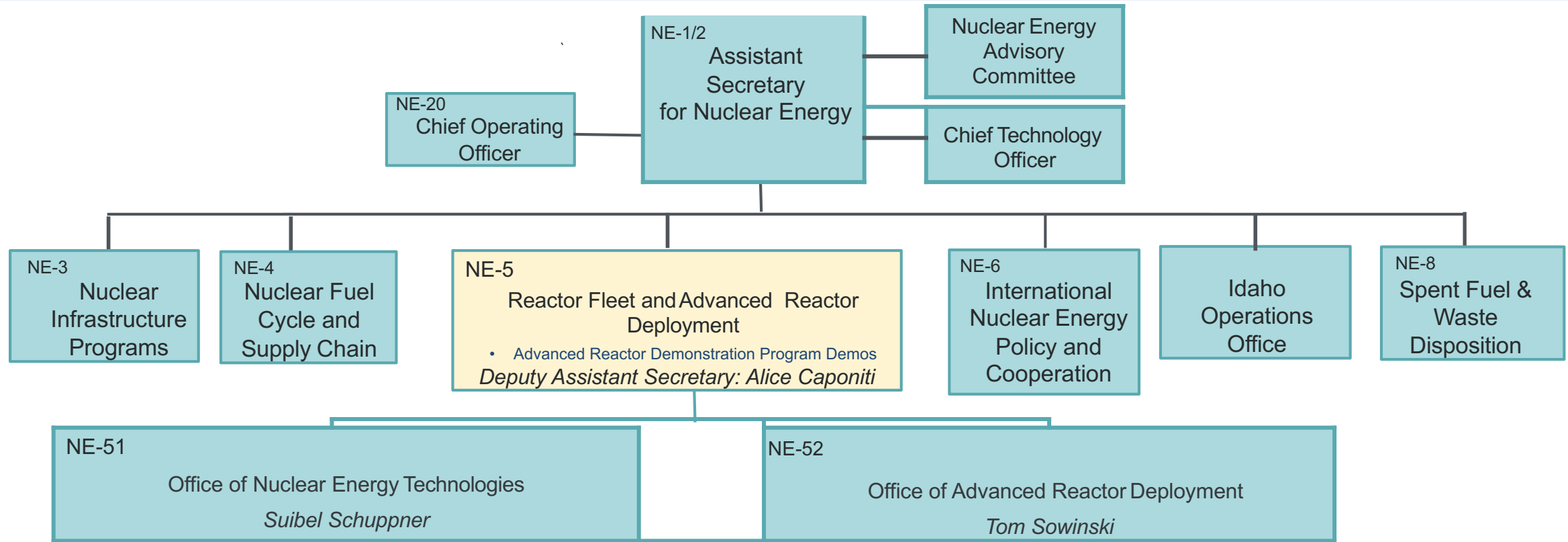
Dirk Cairns-Gallimore
DOE-NEET-AMM Federal Program Manager

Office of Nuclear Energy: Mission Pillars

- Advance nuclear power to meet the nation's energy, environmental, and national security needs.
- Resolve technical, cost, safety, security and regulatory issues through research, development and demonstration.



Office of Nuclear Energy



Enabling Technologies Team

- Advanced Sensors and Instrumentation (ASI)
- Advanced Methods for Manufacturing (AMM)
- Nuclear Energy Advanced Modeling and Simulation (NEAMS)
- Nuclear Science User Facilities (NSUF)
- Transformational Challenge Reactor (TCR)

University and Competitive Research Team

- Nuclear Energy University Program (NEUP)
- Integrated University Program (IUP)
- Research Reactor Infrastructure (RRI)
- Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR)
- Gateway for Accelerated Innovation in Nuclear (GAIN) Advanced Nuclear Industry Funding Opportunity (Industry FOA)
- Technology Commercialization Fund (TCF)

Reactor Optimization and Modernization Team

- Light Water Reactor Sustainability
- Advanced Small Modular Reactor R&D
- Integrated Energy Systems (IES)
- Nuclear Cyber Security (NCS)
- Advanced Reactors Safeguards (ARS)

Advanced Reactor Development Team

- Sodium-Cooled Fast Reactor
- Gas-Cooled High-Temperature Reactors
- Molten Salt Reactors
- Microreactors
- National Reactor Innovation Center (NRIC)
- Risk Reduction
- Advanced Reactor Regulatory Development

Office of Reactor Fleet and Advanced Reactor Deployment Mission (NE-5)

- **Vision** – Be a catalyst for the commercialization of NE-sponsored research, development and demonstration products
- **Mission** – Integrate NE’s research investments to achieve a productive and balanced portfolio of competitive and crosscutting research, development, and demonstration (RD&D) and research infrastructure to enable expansion of the U.S. commercial nuclear industry
- **Objectives**
 - Full and effective integration of NE RD&D planning, execution and oversight
 - Systematic management of NE investments in research capabilities
 - Alignment of NE’s RD&D programs with industry-identified technical and regulatory needs
 - Accelerate the introduction of innovative technologies into the marketplace through multiple mechanisms

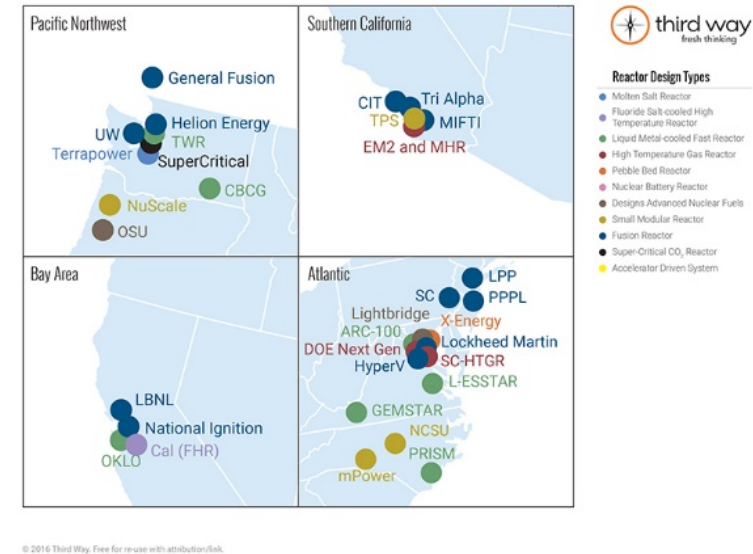
U.S. Advanced Reactor Landscape: Advanced Reactor Demonstration Program

- **DOE Advanced Reactor Demonstration Program**
 - \$230 million initial year funding to establish a program to demonstrate multiple advanced reactor designs at various stages of technological maturity
 - Construction of **two demonstration reactors** within five to seven years
 - Terrapower, LLC – Sodium Reactor – Sodium-Cooled Fast Reactor
 - X-energy – High-temperature Gas Cooled Reactor
 - Additional risk reduction awards to be announced
- **Advantages**
 - Focus DOE and non-federal resources on the construction of real demonstration reactors and supporting activities for commercial use
 - Congress funded DOE to establish a program to demonstrate multiple advanced reactor designs
 - Technology agnostic – all advanced technologies are eligible, including LWR-based designs
 - Construct and demonstrate several advanced reactors with beneficial capabilities, such as:
 - Inherent safety features
 - Superior reliability
 - Lower waste yields
 - Proliferation resistance
 - Greater fuel utilization
 - Improved thermal efficiency
 - Ability to integrate electric & non-electric applications

Congressional support for Reactor Deployment

Companies and Research Institutions Developing Advanced Nuclear Technology Across the Country

Advanced Nuclear Industry: Next Generation - A Recent Survey by Third Way



Over 60 companies and research institutions are working on advanced nuclear projects for a wide array of capabilities to meet the energy needs of the future

- Significant levels of private sector investment

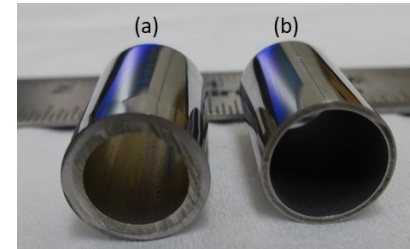
Advanced Methods for Manufacturing (AMM)

Vision

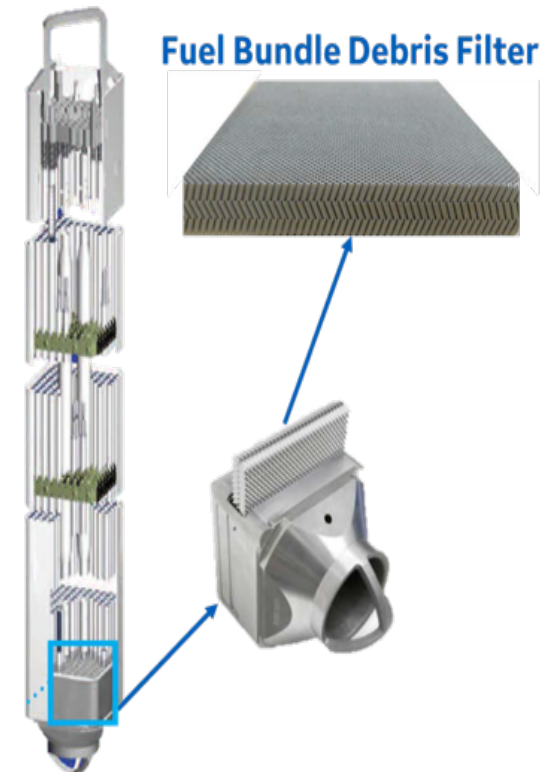
- To improve and demonstrate the methods by which nuclear equipment, components, and plants are manufactured, fabricated, and assembled by utilizing 'state of the art' methods

Goal

- To reduce cost and schedule for new nuclear plant construction
- To make fabrication of nuclear power plant (NPP) components faster, less expensive, and more reliable



Fuel tubes produced by cold spray



GEH BWR fuel bundle w/debris filter insert

Connections of AMM program to other R&D programs, NRC, Industry

NEAMS

ART

ASI

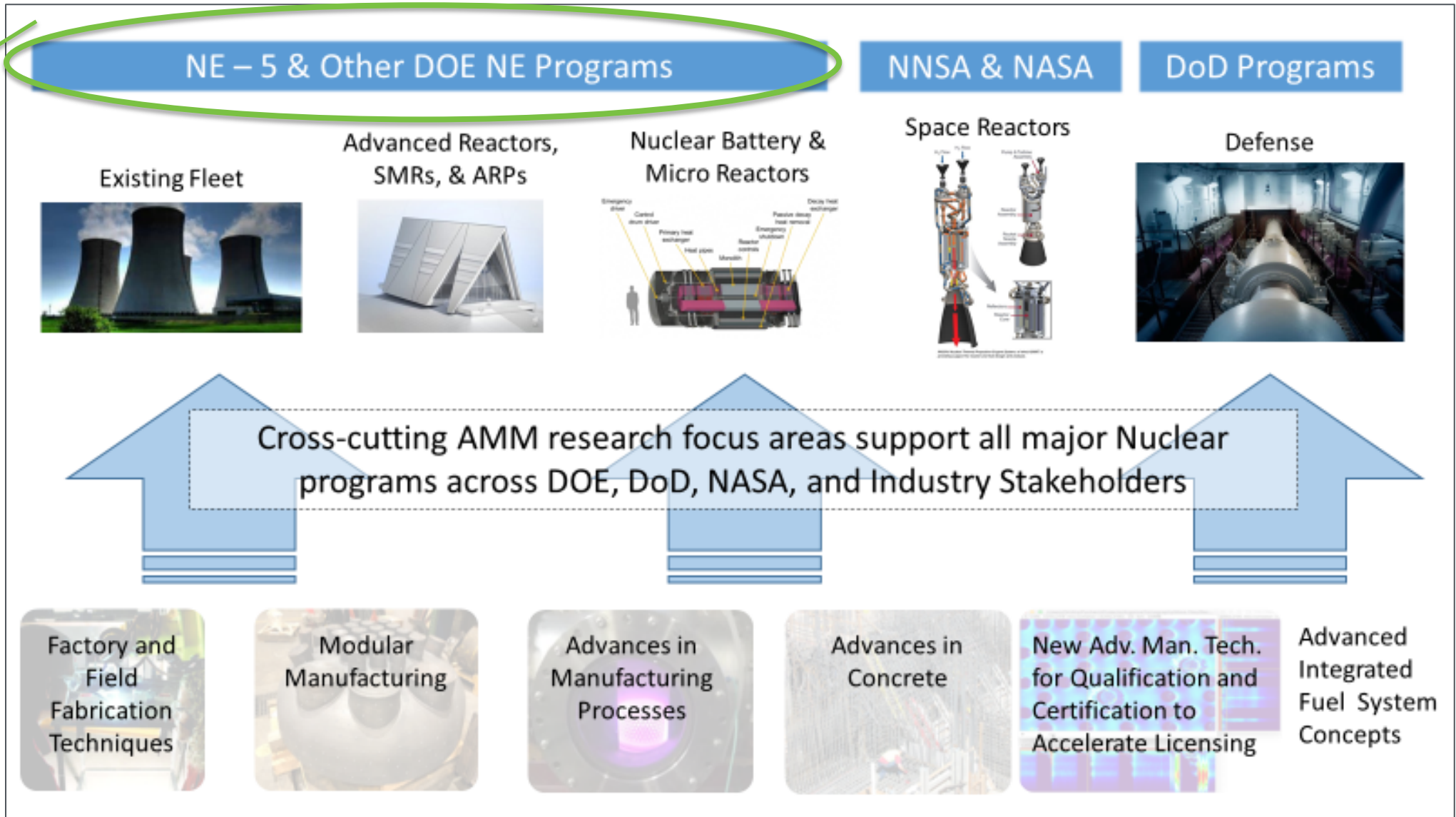
GAIN

NSUF & NMDQi

TCR

IES

NE-4
- VTR
- TREAT

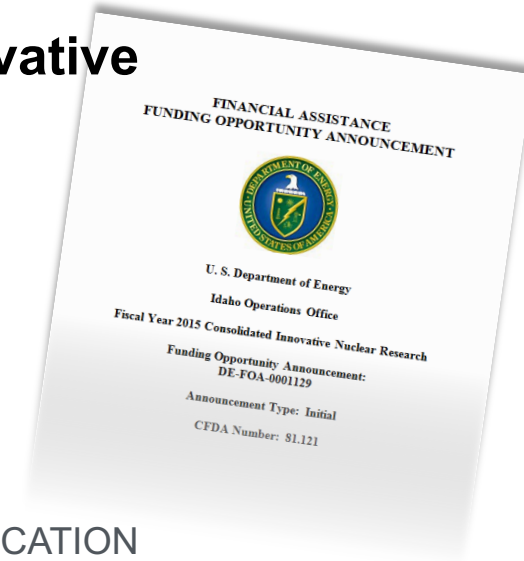


High Impact Materials & Manufacturing Technology Challenges

- Design approaches for manufacturing
 - More qualified materials are needed by reactor developers to allow for design flexibility and to meet performance targets.
 - Optimized process modeling and AI
 - Interface design
 - Residual stresses relationships to design features
 - Topology optimization
- Develop and qualify high strength, corrosion and radiation resistant materials for molten salt reactors
- Accelerate qualification (new paradigm?)
 - Verification of quality & validation of modeling tools: specific manufacturing process modeling
 - “New” material discovery (or is it adoption of lessons learned from other disciplines)
 - High-throughput testing and characterization
 - Verification of quality & validation of modeling tools: specific manufacturing process modeling
 - Acceptance protocols for high temperature reactor components fabricated by advanced manufacturing methods
 - Integrated shared databases
- Compact Heat Exchangers
 - Develop scientific understanding of processing-properties relation for enhanced diffusion bond properties
- Large component fabrication and welding, Size limitations (Scalability – size, volume)
- Sensors:
 - Radiation tolerant sensors
 - Miniaturization of sensors
 - Integrated manufacturing processes
- Thermal barrier coatings: Interface designs to prevent scaling, functional materials, isolation

Addressing Challenges

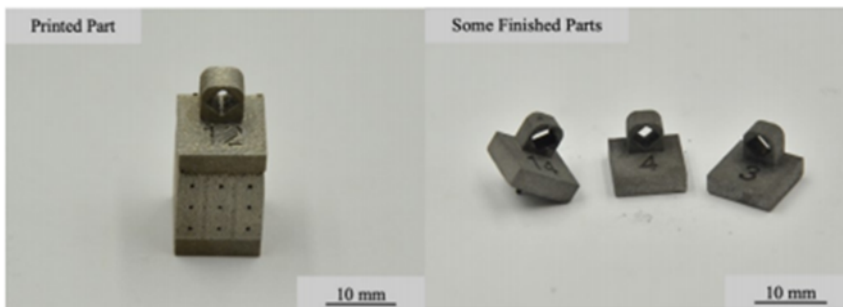
- **Competitively selected projects via Consolidated Innovative Nuclear Research (CINR) & Industry FOA**
 - Open to universities, national laboratories and Industry
 - R&D and irradiation/PIE projects funded
 - FY 21 workscopes
 - MODULAR ADVANCED MANUFACTURING APPROACHES
 - NEW ADVANCED MANUFACTURING TECHNOLOGIES FOR QUALIFICATION AND CERTIFICATION TO ACCELERATE LICENSING
 - IRRADIATION TESTING OF MATERIALS PRODUCED BY INNOVATIVE MANUFACTURING TECHNIQUES
 - AMM Qualification Workshop
 - GAIN-EPRI-NEI
 - Develop an integrated approach to the AMM qualification process for materials and components



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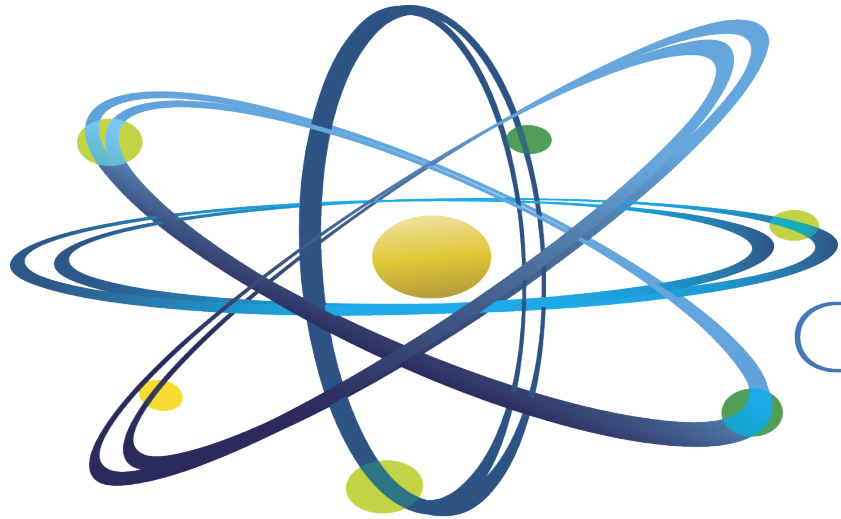


Dissolvable support structures (University of Pittsburg)



SMR Reactor Pressure Vessel (EPRI)
One-half lower head: Forge and electron beam weld

Questions?



Clean. **Reliable. Nuclear.**