U.S. DEPARTMENT OF ENERGY | Office of NUCLEAR ENERGY

Clean. Reliable. Nuclear.

DOE Microreactor Program

Microreactor Program Overview and Needs

GAIN-EPRI-NEI Virtual Microreactor Workshop

August 18, 2020

Dr. Jess C. Gehin, INL

National Technical Director, Microreactor Program

Jess.Gehin@inl.gov

Workshop Purpose and Organization

Inform advanced nuclear technology developers and stakeholders of accomplishments and future plans as well as solicit feedback on microreactor developer needs

Day 1 (August 18) – Discuss Microreactor Program Activities, Accomplishments and future plans

Day 2 (August 19) – Stakeholder/end user presentations and topic discussions to inform program

Microreactor Program Leadership & Support

Tom Sowinski , Federal Manager (DOE)

Joss Cohn, National Technical Director (INL)

DV Rao (LANL), Technical Advisor

Brad Couch (INL), Program Controls

Helen Guymon (NL), Project Manager (INL)

Trenna Muckleroy (INL), Financial Controls

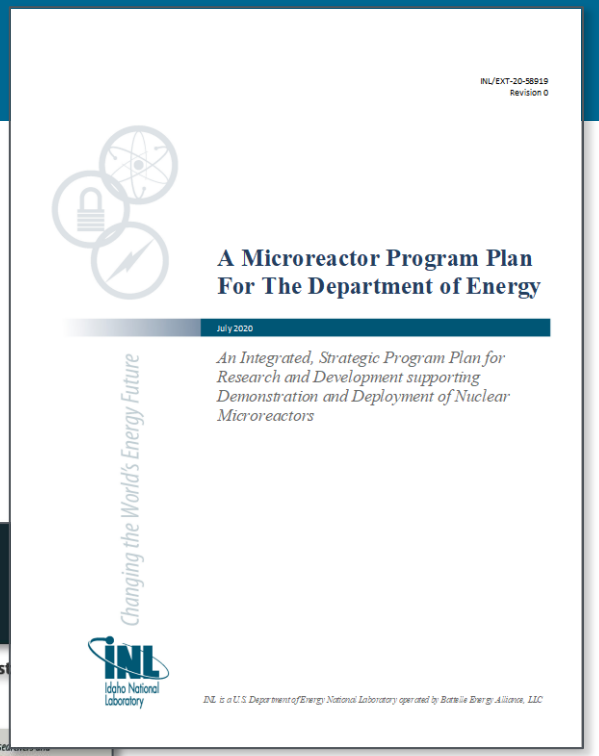
Scott Greenwood (ORNL)
Technical Area Lead for
System Integration &
Analysis

Holly Trellue (LANL)
Technical Area Lead
for Technology
Maturation

Piyush Sabharwall (INL)
Technical Area Lead for
Demonstration Support
Capabilities

Microreactor Program Resources

- Microreactor Program Website
  https://gain.inl.gov/SitePages/MicroreactorProgram.aspx
- Program Plan
- Fact Sheets
- Deliverable Reports



Developer Input from June 2019 GAIN Microreactor Workshop

Topic (not in priority order)	*Brief Summary of Activity*
1) High Assay Low-Enriched Uranium • *Need access to material* • *Deconversion to other than oxide*	• *MRP - Opportunity to developers to provide access to EBR-II recovered material (MRP)* • *NE-4 - Scope now considered in NE-4 HALEU activities*
2) Test Platforms • *Non-nuclear* • *Integrated heat transfer testing* • *Power conversion testing at full scale* • *Microgrid integration*	• *MRP - Developing non-nuclear testbed, and integrated heat transfer testing* • *MRP - Power conversion testing at full scale to be considered > FY20* • *MRP/IES – Microgrid integration to be considered in collaboration with IES*
3) Demonstration siting	• *MRP – Completed characterization of demonstration sites at INL, scope now within NRIC*
4) Addressing spent/used fuel and waste disposal • *Consider reuse of uranium*	• *MRP – Initial FY20 scope proposed on disposition of demonstration reactors, scope now within NRIC* • *NE-4 – R&D on uranium recovery*
5) Licensing • *Autonomous/remote operation* • *Transportation* • *Risk-informed licensing* • *US/Canada coordination on licensing* • *EPZ/Emergency planning* • *Physical Security*	• *MRP – Regulatory activity to research and input to NRC, NEI, and LMP-related activities.* • *Regulatory – Scope to be coordinated with ART regulatory activities including those listed here.*

Developer Input from June 2019 GAIN Microreactor Workshop

Topic (not in priority order)	*Brief Summary of Activity*
6) Access to computing capability and codes • High performance computer access • Fully coupled codes • V&V	• NSUF – HPC access to INL computers developers available upon request. See: http://inl.gov/ncrc • NEAMS – Development of microreactor M&S capabilities, MRP applying and providing feedback • MRP – Non-nuclear testbed and dedicated experiments to develop validation data.
7) Nuclear Data and Critical Experiments • High temperature moderators • Epithermal data • Beryllium • HALEU/TRISO • Composite shielding • Fission product yields/gamma production • Structural materials/DPA	• MRP– Critical experiment being planned for high-temperature moderator. Need to priorities other needs and align with appropriate program. • TCR – Thermal scattering data for YH moderator
8) Fuel and Structural Material Qualification • TRISO • Irradiation testing • Code cases • Graphite data (low DPA) • Be data at high temperature	• GCR – TRISO and Graphite programs • NSUF – Opportunities for developers to pursue materials irradiation • MRP/FR – Developing code cases for additional materials (G91 steel). • GCR – Graphite program • MRP – Seeking input on priority for high-temp Be Data

Developer Input from June 2019 GAIN Microreactor Workshop

Topic (not in priority order)	*Brief Summary of Activity*
9) Advanced manufacturing including additive manufacturing • Code qualification approach • What can and you cannot/do with AM?	• TCR– Code cases for additively manufacturing for materials being considered • AMM – Opportunities for broader range of advanced manufacturing approaches • MRP – Limited work on AM approaches for key microreactor structures
10) Instrumentation, sensors, controls • Autonomous operations (semi, full) • Sensors	• MRP – Instrumentation to support microreactor operations using sensors developed by ASI/in-pile program. Testing instrumentation/sensors in non-nuclear testbed • NEED ASI – sensor development • TCR – Related work being performed to support TCR operation and AM embedding of sensors
11) Independent Verification of Designs	• GAIN – Available upon request, suitable for GAIN vouchers
12) Fast-flux/high DPA irradiation capability	• Near term ATR/HFIR, longer-term VTR
13) Market/Economic Assessments	• MRP – Assessment of federal and non-federal markets, Studies lead by UW, UAA, NAP, Southern

Developer Input from June 2019 GAIN Microreactor Workshop

Topic (not in priority order)	*Brief Summary of Activity*
14) Advanced heat exchangers	• MRP – Scope related to heat transfer/coupling with heat exchangers/ability to test in non-nuclear testbed • Other programs (e.g. ARPA-E) targeting advanced heat exchangers
15) Security • Physical security • Cyber security • Physical protection	• Other programs focus on these areas. MRP will coordinate effort.
16) Access to legacy data and programmatic research products • New production reactor • Microreactor program	• MRP/FR – Metallic fuel data (U-Zr) • GAIN – Coordinating/supporting broad range of legacy data access
17) Community/user stakeholder engagement	• MRP, GAIN – Holding developer workshops, participation in meetings, conferences, etc.

University Participants – Nuclear Energy University Program Projects

FY19 Awarded Projects	*PI*
Determining the Effects of Neutron Irradiation on the Structural Integrity of Additively Manufactured Heat Exchangers for Very Small Modular Reactor Applications	Dr. Barton Prorok, Auburn University
Demonstrating Reactor Autonomous Control Framework using Graphite Exponential Pile	Dr. Kaichao Sun, MIT
Evaluation of Semi-Autonomous Passive Control Systems for HTGR Type Special Purpose Reactors	Dr. Brendan Kochunas, Univ. of Michigan
Experiments and computations to address the safety case of heat pipe failures in Special Purpose Reactors	Dr. Victor Petrov, Univ. of Michigan

FY20 Awarded Projects	*PI*
Flexible Siting Criteria and Staff Minimization for Micro-Reactors	Dr. Jacopo Buongiorno, MIT
Experiments for Modeling and Validation of Liquid-Metal Heat Pipe Simulation Tools for Micro-Reactor	Dr. Saya Lee, Texas A&M University
Evaluation of micro-reactor requirements and performance in an existing well-characterized micro-grid	Dr. Caleb Brooks, Univ. of Illinois

FY21 Draft Scope Released
Topics on technologies to reduce microreactor costs and microreactor applications

Preliminary FY21 Program and Priorities

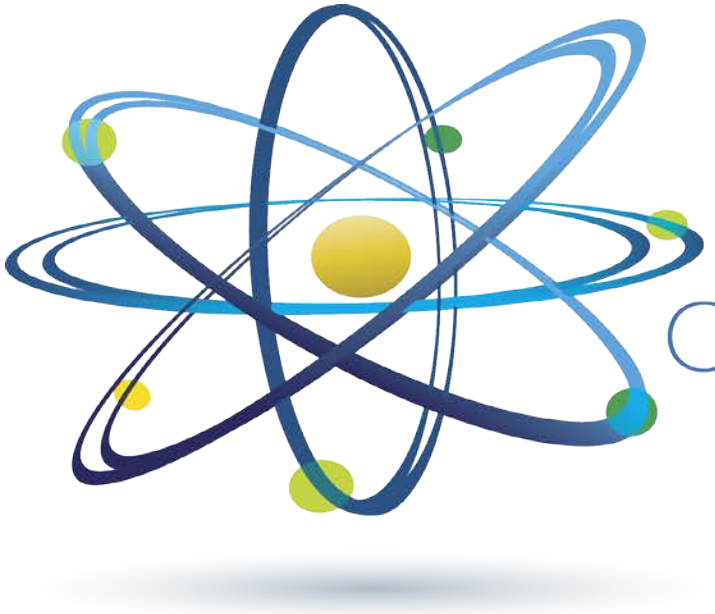
1) Establish a microreactor nuclear applications integration and testing platform to support applications testing to meet the requests and needs of potential end-users
2) Complete irradiation of an advanced moderator (yttrium hydride) and develop a handbook of material properties for industry use
3) Complete electrically heated testing of a microreactor core in MAGNET to obtain data on heat transfer to provide data for modeling and simulation code development (37 heat pipe test)
4) Develop additional heat transfer test articles to provide data for code validation
5) Completing on-going work including: market studies

Your Input Needed to Inform Program Activities & Priorities

- Specific input on topics of interest to developers and end users, for example:
  - Materials & material qualifications
  - Data and research for licensing and regulation
  - Power conversion systems and integration
  - Application integration testing
- Input on future means for engagement. Is there interested in:
  - Webinars on specific topics?
  - One-on-one meetings?
  - Mailing list with periodic email updates?
  - Additional items on website?

Goal is to generate an updated table of items to inform the program planning

Questions



Clean. **Reliable. Nuclear.**