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

Clean. Reliable. Nuclear.

Gateway for Accelerated Innovation in Nuclear (GAIN) and Small Modular Reactors in the United States

NEA 71st NDC Meeting, 10-11 July 2019

Bill McCaughey
Director, Advanced Fuels Technologies
U.S. Department of Energy

Agenda

- Gateway for Accelerated Innovation in Nuclear
  - Vision and Mission
  - What GAIN Does
  - Organization
  - GAIN Vouchers
  - 10-Year Look Ahead

- Small Modular Reactors
  - Licensing Technical Support Program (FY 2012-2017)
  - Research and Development Program (FY 2018 >)
  - Support to NuScale and Utah Associated Municipal Power Systems
  - Support to Tennessee Valley Authority Early Site Permit

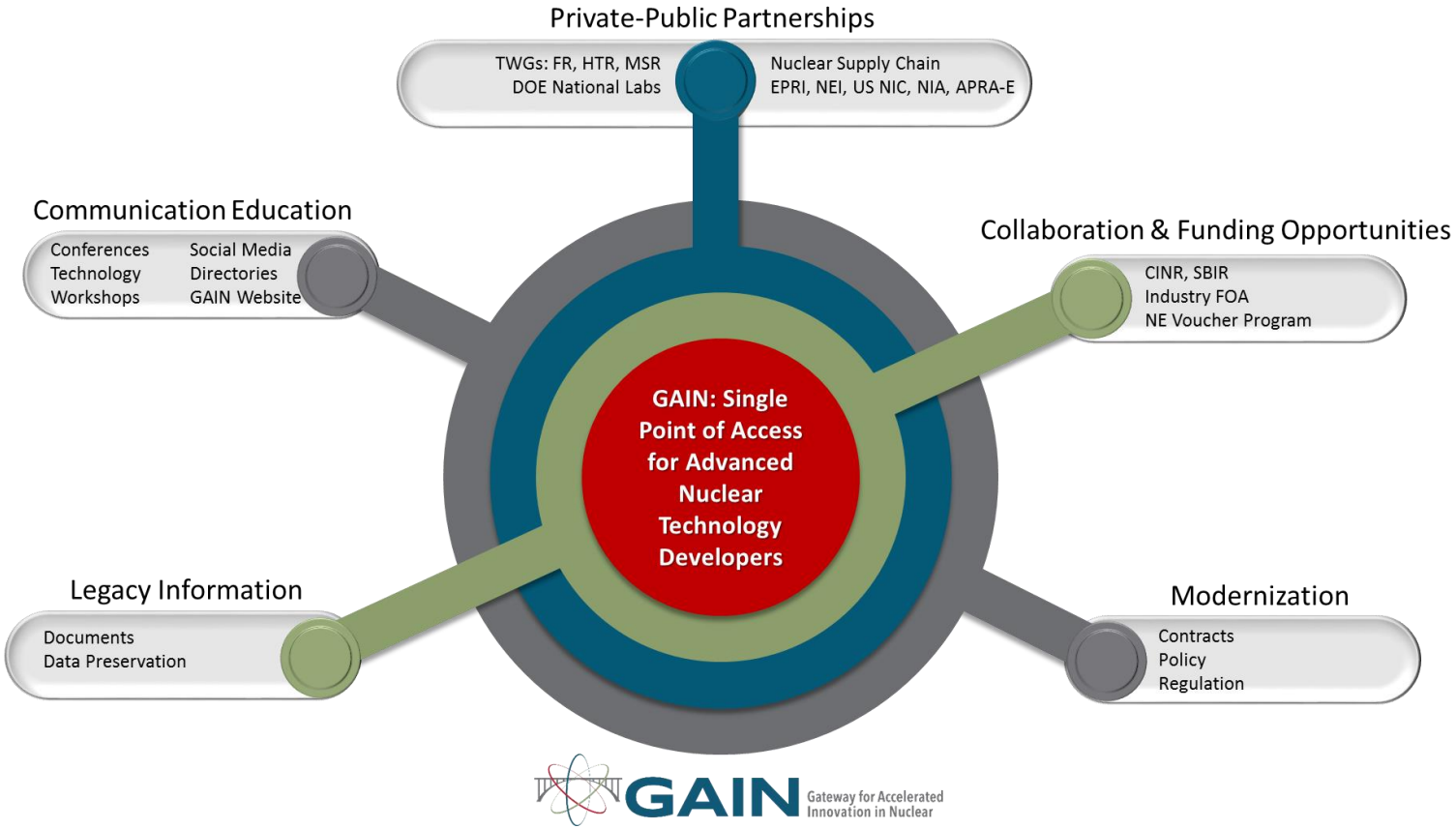
Vision and Mission

Vision (2030)

The U.S. nuclear industry is equipped to lead the world in development of innovative nuclear technologies to supply urgently needed abundant clean energy, both domestically and globally.

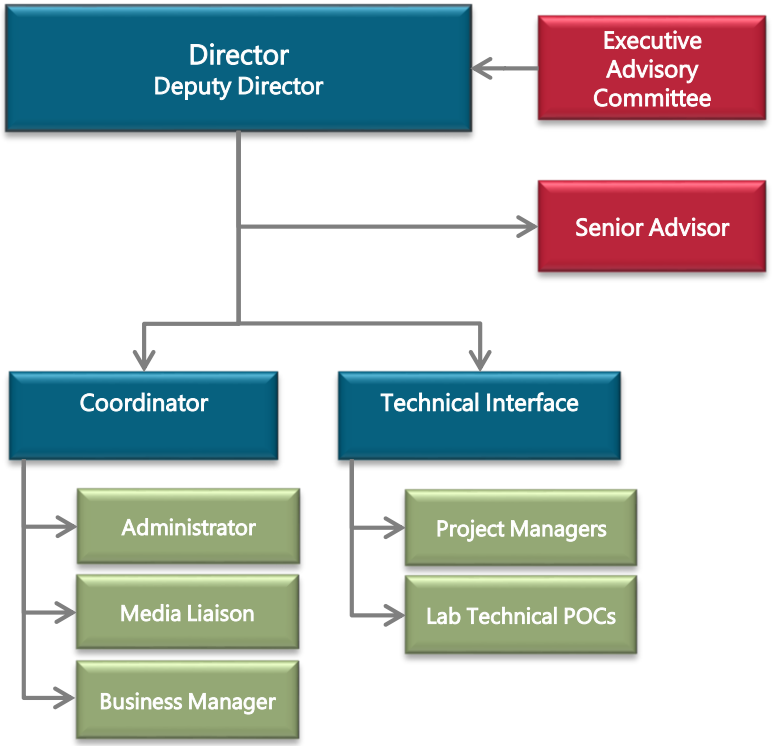
Mission
Provide the nuclear energy industry with access to the technical, regulatory, and financial support necessary to move innovative nuclear energy technologies toward *commercialization* in an accelerated and cost-effective fashion.

New accident tolerant fuel (ATF) U_3Si_2 fuel: Fabricated at INL (Fall 2018) and delivered to Westinghouse's Columbia Fuel Fab Facility for loading into Encore™ Lead Test Assembly (LTA). Shipped to Exelon's Byron Generating Station and installed in Unit 2 (April 2019).



Acronyms
TWG – technology working groups
CINR – Consolidated Innovative Nuclear Research
SBIR – Small Business Innovation Research
FOA – Funding Opportunity Announcement

GAIN Organization



What are GAIN NE Vouchers?

- Competitively awarded access to facilities and staff in the DOE national laboratory complex – **not a financial award**. Funds go directly to lab to perform work.
  - Access to capability that isn't available in the private sector
  - Awardee directs work through interaction with lab staff
- Opportunity for industry to work with the laboratories and establish relationships
- Tangible advancement of innovative technologies toward market readiness
- Available to businesses that are majority (51% or greater) U.S. owned and established in the U.S.
  - No size restriction on companies – small businesses receive extra consideration
  - Foreign affiliation will involve extra review

GAIN Impact (10-Year Look Ahead)

- DOE national laboratories are standing on their own, supporting GAIN philosophy
- At least one advanced reactor concept is demonstrated at a DOE national laboratory
- DOE complex-wide, collaborative, contracting mechanism is being used by national labs and advanced nuclear technology industry to tailor flexible CRADA intellectual property terms to meet industry needs to accelerate commercialization
- Industry has easy access to a full complement of nuclear R&D legacy documents to support technology development and licensing activities
- Advanced nuclear technology development supply chain is engaged and supporting commercialization requirements
- GAIN NE Voucher funding cap has been doubled, to support maturing advanced nuclear technology scope that has expanded in magnitude
- GAIN website is a fully functioning portal, providing industry one place to locate funding assistance, legacy information, supporting activities, and information on DOE national laboratory capabilities.

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Eight Years of Direct Support for U.S. Small Modular Reactor Technologies

- The U.S. Department of Energy recognizes the potential benefits of advanced SMR technologies:
  - **Safety, Cost, Siting Flexibility, Resilience, and Economic and Job Growth**
- Retiring fossil plants spurred interest in SMRs in the early 2010s
- **FY2012 – FY2017** – SMR Licensing Technical Support Program focused on earlier stage design development, certification, and licensing
- Two SMR funding opportunities focused on:
  - Ability to certify, license, and deploy an SMR in the early to mid-2020s
  - Innovations in safety and operations
- Program successfully met the goal of assuring that the most viable US SMR designs established a licensing pathway

Multiple Awards to Support the Continued Development of SMRs

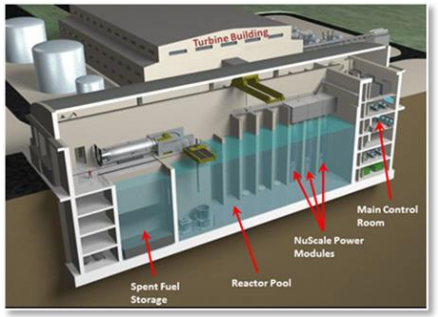
- **NuScale Power** - NuScale Small Modular Reactor First-Of-A-Kind Nuclear Demonstration Readiness Project (Phase 1 and 2)
- **BWXT** - Establishment of an integrated advanced manufacturing and data science driven paradigm for advanced reactor systems
- **Columbia Basin Consulting Group, LLC** - Conceptual Engineering for a Small Modular Reactor (SMR) power plant based on Lead-Bismuth Fast Reactor (LBFR) Technology
- **EPRI** - Experimental Verification of Post-Accident Integrated Pressurized Water Reactor (iPWR) Aerosol Behavior, Phase 3
- **Holtec International** - Advancing and Commercializing Hybrid Laser Arc Welding (HLAW) for Nuclear Vessel Fabrication, Including Small Modular Reactors
- **Pittsburgh Technical, LLC** - Regulatory Support for Advanced Light Water Reactor Deployment: Advanced Boiling Water Reactor Source Term Reduction
- **SMR, LLC** - Integral and Separate Effects Test Program for the Investigation and Validation of Passive Safety System Performance of SMRs
- **EPRI** - Establishing Modular In-Chamber Electron Beam Welding
- **PSE&G, Rolls-Royce NA, INL** - Integrated Risk-Informed Condition Based Maintenance Capability and Automated Platform

DOE Continues Support of NuScale SMR Design

- NuScale submitted the first SMR Design Certification Application (DCA) to the U.S. Nuclear Regulatory Commission in January 2017

- DCA Review on schedule, projected January 2021 completion (potential to accelerate to September 2020)

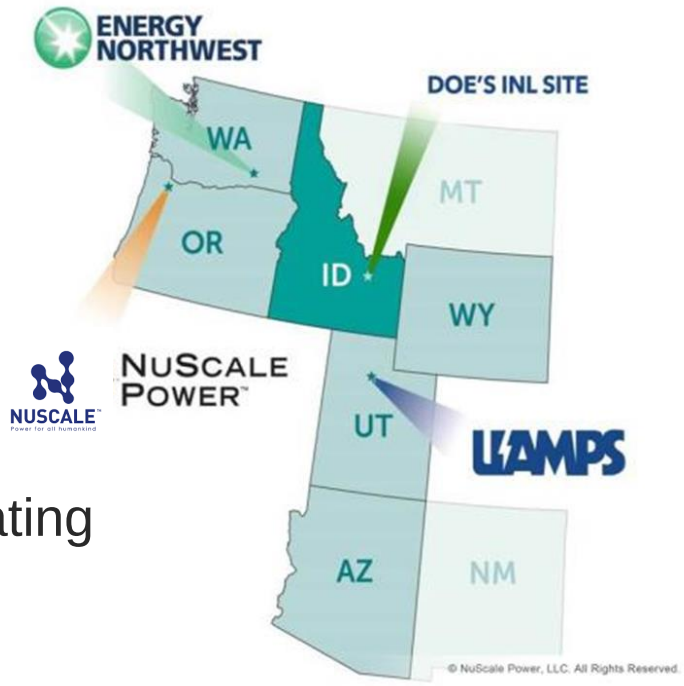
- Recent successes include:
  - Addressing significant licensing issues, (e.g., no need for off-site power and reduced control room staffing requirements)
  - Key component prototyping underway (e.g., ECCS valves)
  - Selected BWX Technologies, Inc. to support major systems manufacturing of the Nuclear Power Module



- Recent public announcement of several potential international customers, including Canada, Jordan, and Romania

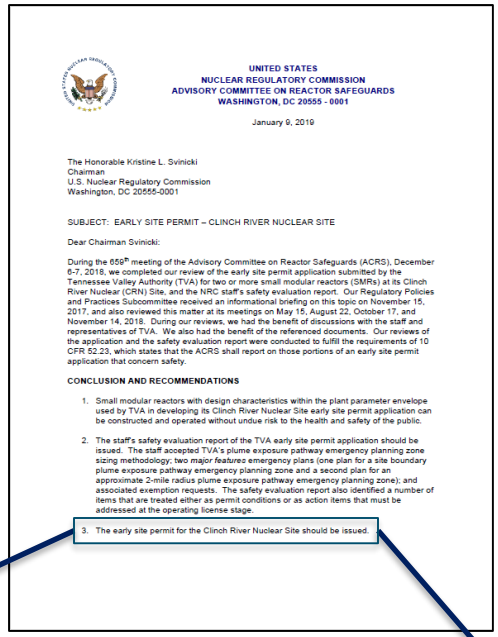
Memorandum of Understanding with Utah Associated Municipal Power Systems

- Utah Associated Municipal Power Systems (UAMPS) Carbon Free Power Project (CFPP) is aligned to have first SMR deployment (12-module plant)
- Preferred location within the INL site
- DOE awarded a cost-shared cooperative agreement to perform site selection, secure site and water, and prepare combined operating license application (COLA) to NRC
- Goal for commercial operation is 2026
- DOE pursuing Power Purchase Agreement for INL's electricity needs
- DOE researching potential implementation of a Joint Use Modular Plant (JUMP) for Research and Development activities



Tennessee Valley Authority
Early Site Permit for Clinch River Site

- Submitted Early Site Permit (ESP) Application to NRC in May 2016 for Clinch River Site near Oak Ridge, TN
- NRC review progressing ahead of schedule:
  - Advisory Committee on Reactor Safeguards (ACRS) issued letter to Commission recommending ESP issuance.
  - Final Environmental Impact Statement issued on April 3, 2019
  - Final Safety Evaluation Report issued on June 14, 2019
  - NRC Mandatory Hearing anticipated mid-August 2019
  - Issuance of ESP in 1st or 2nd quarter FY2020, contingent on commission approval



UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

January 9, 2019

The Honorable Kristine L. Svinicki
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: EARLY SITE PERMIT – CLINCH RIVER NUCLEAR SITE

Dear Chairman Svinicki:

During the 659th meeting of the Advisory Committee on Reactor Safeguards (ACRS), December 6-7, 2018, we completed our review of the early site permit application submitted by the Tennessee Valley Authority (TVA) for two or more small modular reactors (SMRs) at its Clinch River Nuclear (CRN) Site, and the NRC staff's safety evaluation report. Our Regulatory Policies and Practices Subcommittee received an informational briefing on this topic on November 15, 2017, and also reviewed this matter at its meetings on May 15, August 22, October 17, and November 14, 2018. During our reviews, we had the benefit of discussions with the staff and representatives of TVA. We also had the benefit of the referenced documents. Our reviews of the application and the safety evaluation report were conducted to fulfill the requirements of 10 CFR 52.23, which states that the ACRS shall report on those portions of an early site permit application that concern safety.

CONCLUSION AND RECOMMENDATIONS

1. Small modular reactors with design characteristics within the plant parameter envelope used by TVA in developing its Clinch River Nuclear Site early site permit application can be constructed and operated without undue risk to the health and safety of the public.
2. The staff's safety evaluation report of the TVA early site permit application should be issued. The staff accepted TVA's plume exposure pathway emergency planning zone sizing methodology; two *major features* emergency plans (one plan for a site boundary plume exposure pathway emergency planning zone and a second plan for an approximate 2-mile radius plume exposure pathway emergency planning zone); and associated exemption requests. The safety evaluation report also identified a number of items that are treated either as permit conditions or as action items that must be addressed at the operating license stage.
3. The early site permit for the Clinch River Nuclear Site should be issued.

"The early site permit for the Clinch River Nuclear Site should be issued."

In late 2018, TVA issued an Integrated Resource Plan that opens door for boosting resiliency through SMRs

Questions?

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