Joint Use Modular Plant Program Research, Development & Deployment Activities

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Joint Use Modular Plant (JUMP) Program

The JUMP Program, based at INL and coordinated with the operating utility, UAMPS, and the plant vendor, NuScale, will:

- Provide a unique opportunity to conduct research within an operating commercial reactor environment
- Support demonstration of the use of nuclear energy beyond the electricity sector
- Provide abundant data for model verification and validation (V&V), design refinement
- Support development and demonstration of innovative nuclear technologies (fuels, materials, sensors, etc.)

Includes RD&D activities and commercial use within a single multi-module nuclear plant, wherein a specific module is allocated to RD&D

JUMP is a key aspect of the Carbon Free Power Project (CFPP)

- The first plant module would be designated for JUMP; anticipated operational date of 2027
Constraints on JUMP RD&D

• Consider potential impacts on regulatory processes
• Should not require significant modification of the nuclear island within the standard plant design
  – Most RD&D projects are likely to require license amendment
  – Potential licensing impacts will be identified and evaluated
  – Alteration of the secondary side systems may require addition of a transition heat exchanger to decouple the RD&D components from the NuScale Power Module secondary coolant system
• Module must be able to return to standard electricity production service at the end of the contractual agreement

Designed for up to 100% steam bypass

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Key Research Priority: Integrated Energy Systems

- Tighter coupling of nuclear plant output required to achieve highly efficient integrated energy systems
- JUMP provides opportunity to measure energy transport phenomena for non-steady-state process operations

Today
Electricity-only focus

Potential Future Energy System
Integrated grid system that leverages contributions from nuclear fission beyond electricity sector

- Advanced Reactors
- Small Modular Reactors
- Large Light Water Reactors
- New Chemical Processes
- Clean Water
- Hydrogen for Vehicles and Industry
- Industry
- Heat
Overview of the JUMP concept relative to the NuScale module in the UAMPS commercial facility
Integrated Energy System Concepts

JUMP provides a platform for demonstration of:

- Coordinated operation with nearby renewable installations
- Front-end control approaches, communications standards, control reliability
- Data collection and analytics to maintain process stability
- Thermal and electrical energy delivery system effectiveness
- Physical feedback in the system
- Multiple energy users/industrial applications:
  - Energy storage (electrical, thermal, chemical)
  - Industrial process pilot scale demonstration:
    - Hydrogen generation, desalination, carbon conversion, etc.
    - Verify process chemistry, operational stability
  - Grid emulation environment to replicate arbitrary grid conditions relative to integrated system operations, measure process response characteristics
- Demonstrate human factors aspects of integrated system operation
- Exercise new regulatory approaches

Example: Pre-conceptual integrated system design with thermal energy storage.
**Innovative Technologies and Approaches**

**Advanced Instrumentation and Model V&V**
- Test and demonstrate advanced instrumentation and sensor technologies in relevant reactor conditions
- Collect valuable data for system characterization, model development and V&V; reduce design conservatisms

**Fuels and Materials Testing, Characterization**
- Provide prototypic commercial operating conditions
- Characterize materials as a function of design, fabrication methods, operating parameters, load cases
- Test advanced fuels under various operational conditions; leverage module ability to accept full assemblies
- Provide data to support licensing

**Human Factors**
- Measure and evaluate human performance via a realistic operational environment
- Inform future control rooms and training simulator designs, increase reliability of safety critical systems, and increase operator awareness in unfamiliar operating environments

**Cybersecurity**
- Demonstrate operator situational awareness in cyber-attack scenarios
- Evaluate supply chain security

**Regulatory Research**
- Inform regulatory approach for fully digital instrumentation and control
- Exercise specialized licensing paths for non-traditional applications

Leveraging Relevant Facilities in the DOE Complex

- Systems Integration Laboratory
- Human Systems Simulation Laboratory
- Fuels and Materials Development and Testing
- High Temperature Test Laboratory (sensor development and testing)
Process to Determine JUMP Research Prioritization

- Collect RD&D proposals in multiple focused brainstorming sessions with DOE programmatic leads and RD&D thought leaders
- Screen concepts for preliminary licensing feasibility with subject matter experts and plant designers
- Review programmatic and other stakeholder interests
  - Gauge overall support within DOE research programs
  - Obtain vendor (NuScale) input on RD&D concept and high-level design
  - Establish preliminary prioritization
- Assess complementary RD&D activities that can be coupled or conducted in parallel
- Evaluate alternatives available to achieve the desired RD&D results
- Develop order-of-magnitude cost estimates for high-priority activities
- Review concepts with DOE and other stakeholders – select options to proceed to detailed design
Schedule and Task Summary

**Phase 1 (2018–2021): Planning**
- Develop detailed program plan, RD&D plan, schedule and budget, analysis of alternatives
- Establish contractual agreements
- Conduct preliminary JUMP RD&D hardware design activities
- Assess licensing impacts and development of inputs to licensing (engage NRC staff)

**Phase 2 (2021–2026): Precursor Activities, Hardware Installation & Pre-Op RD&D**
- Modeling, benchtop testing, and scaled non-nuclear demonstrations for the selected RD&D activities
- Final design of JUMP hardware, infrastructure
- NRC engagement; submit license amendments
- Procure and install JUMP-related hardware and infrastructure

**Phase 3 (2027–2037): Post-Op JUMP RD&D**
- Initial testing of hardware
- Execute JUMP RD&D plan
- Assess and plan for future use of JUMP
Memorandum of Understanding (signed December 2018)

• Parties:
  U.S. Department of Energy, Utah Associated Municipal Power Systems (UAMPS), Battelle Energy Alliance

• Scope:
  – Contemplate the licensing, construction, and operation of a first-of-a-kind SMR at INL
  – One module would be dedicated to research, development, and demonstration (RD&D) under the JUMP program
  – One module would be used for power production to support INL energy needs (via Power Purchase Agreement [PPA])
  – Includes collaboration during pre-construction, construction, and licensing periods

• JUMP Agreement Scope
  – UAMPS to work with the U.S. Nuclear Regulatory Commission (NRC) to develop a licensing approach to include RD&D activities
  – Anticipated 15-yr term w/potential for 15-yr renewal
Questions?

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