Versatile Test Reactor Overview

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Argonne NATIONAL LABORATORY

INL Idaho National Laboratory

Los Alamos NATIONAL LABORATORY

OAK RIDGE National Laboratory

Mission Need

The *mission of the VTR program* is to provide leading edge capability for accelerated testing and qualification of advanced fuels and materials enabling the U.S. to regain and sustain technology leadership in the area of advanced reactor systems.

INDUSTRIAL INTEREST

- Fuels/Materials/Instrumentation &Sensors Testing
  - Sodium-cooled reactors
  - Lead/LBE-cooled reactors
  - Gas-cooled reactors
  - Molten salt reactors
- Accelerated testing for reactor materials

Domestic deployment for clean energy transition

Global market share

- Some concepts may be ready for a demonstration unit within 10 years
- VTR will help with continuous improvements in operations and economics beyond initial demonstration within 10 years
  - E.g. LWR technology evolution history (progress from 60 to 90% availability)

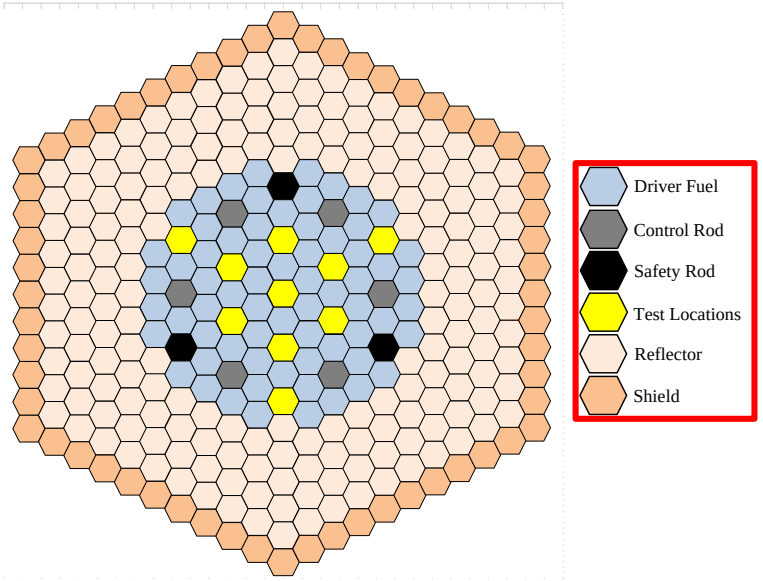
NATIONAL SECURITY/SCIENTIFIC INTERESTS

- State-of-the art knowledge of fast reactor technology
  - Global safety and security policies
  - Safeguards technologies
- Research on long-term fuel cycles
- Potential scientific research on
  - Fusion materials
  - Neutrino science/detector development

Science and technology leadership with strong influence on international standards and policies for the civilian use of nuclear energy and associated fuel cycles.

Preliminary requirements/assumptions for VTR

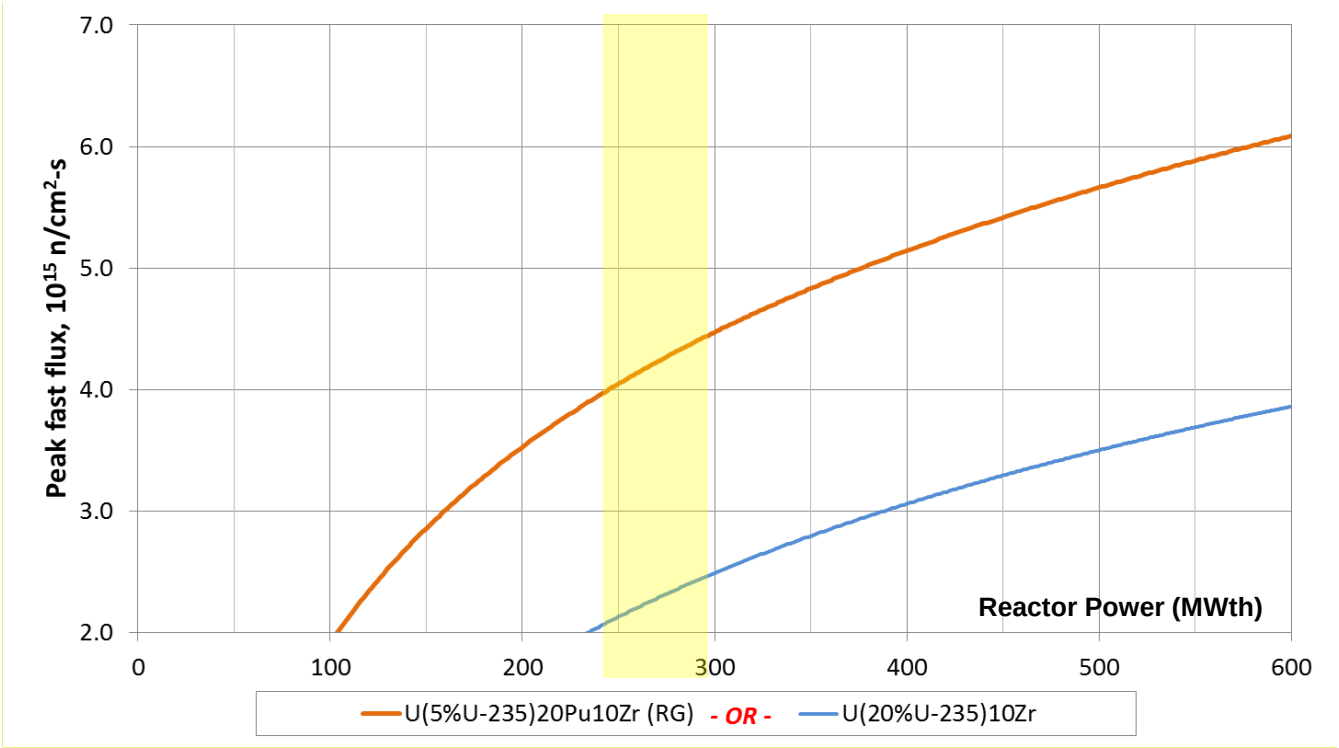
Parameter	Target
High neutron flux	≥ 4 x 10^{15} n/cm^2-s
High fluence	≥ 30 dpa/yr
High test volume in the core	≥ 7 L (multiple locations)
Representative testing height	0.6 ≤ L ≤ 1 m
Flexible test environment	Rabbit & Loops (Na, Pb, LBE, He, Salt)
Advance instrumentation & sensors	In-situ, real time data
Experiment life cycle	Proximity to other infrastructure
Driver fuel life cycle management	Existing facilities as much as possible



ASSUMPTIONS:

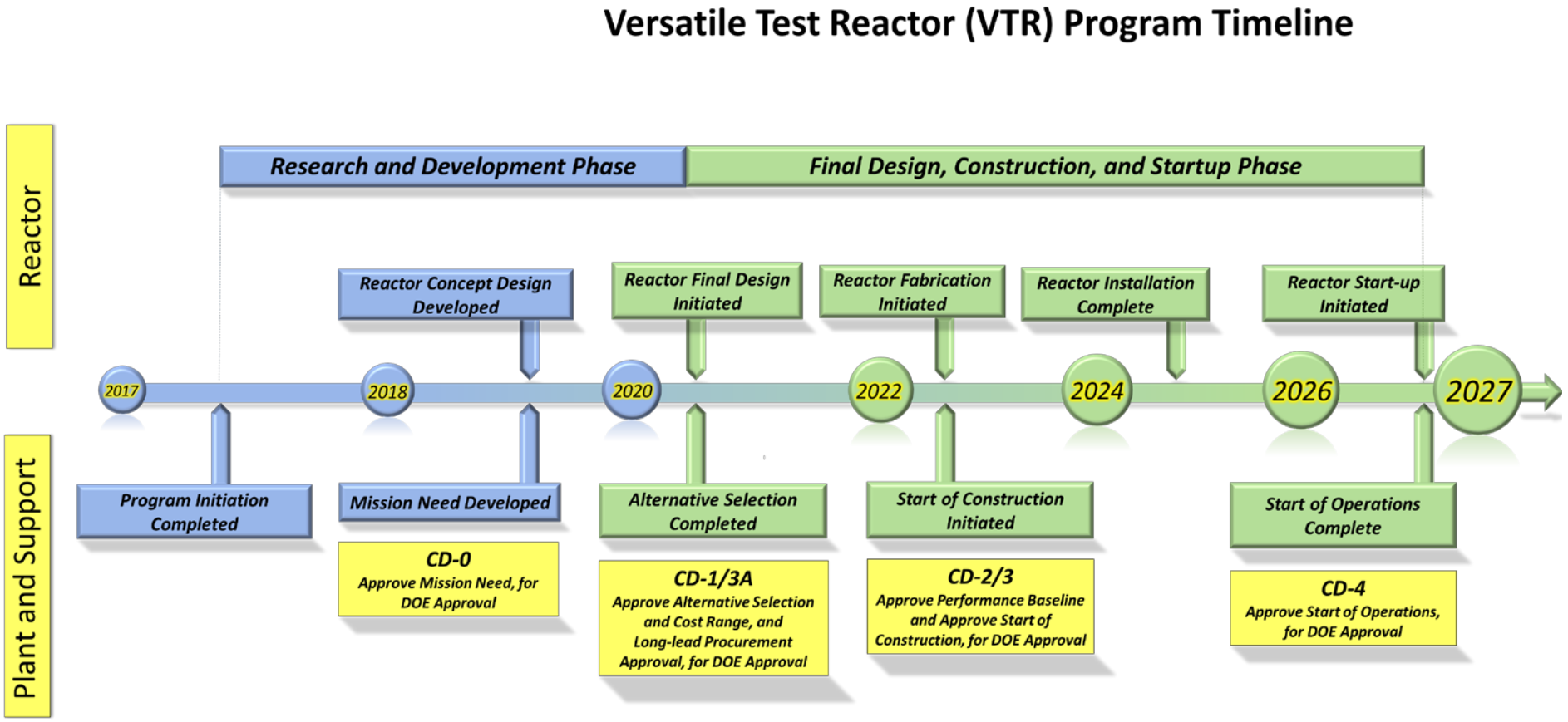
- Mature Technology: Sodium-cooled pool type reactor
- Metallic alloy fuel (HALEU, LEU+Pu, DU-Pu)
- Novel testing capabilities
- Start date: 2026

Preliminary VTR sizing studies



Fuel Composition	Peak Fast Neutron Flux n/cm^2-s 300 MW VTR*	Fuel Current TRL	Annual HM Requirement
U-20Pu-10Zr with 5% ^{235}U (BASELINE)	~ 4.5×10^{15}	High	330 kg/y Pu and 1170 kg/y U with 5% ^{235}U
U-27Pu-10Zr with depleted or natural U	~ 5.0×10^{15}	Low	450 kg/y Pu and 1050 kg/y U
U-10Zr with ~20% ^{235}U	~ 2.5×10^{15}	High	1500 kg/yr of U with ~20% ^{235}U

VTR program timeline



Reactor design support contract

To achieve the lowest risk acquisition, the following principles guide the acquisition:

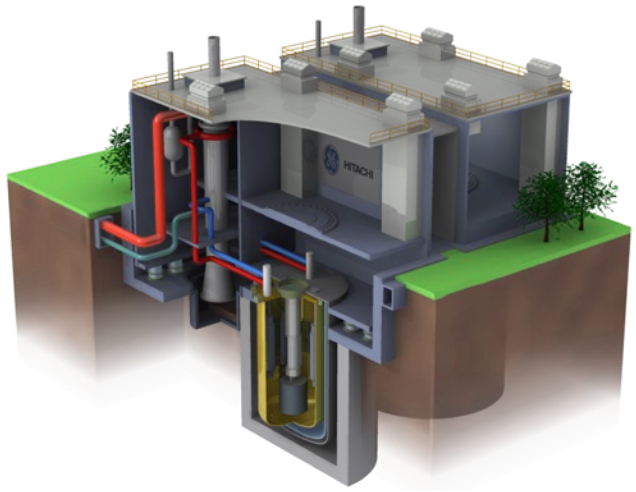
- Use proven technology and materials with modern design and construction tools
- Reduce scope to the absolute minimum, utilizing or modifying existing facilities
- Streamline acquisition processes to achieve the least overall risk.
- Use the best resources,.
- Understand and mitigate the nuclear design/construction risks.

DOE

BEA

GEH

Bechtel



Courtesy of GE-HITACHI

GE-HITACHI & BECHTEL DELIVERABLES

- ✓ Adapt PRISM concept for VTR mission… delete/add/modify SSCs
- ✓ Advance conceptual/preliminary design
- ✓ High confidence cost assessment
- ✓ High confidence schedule assessment

Experiment development approach – University & Industry Collaborations

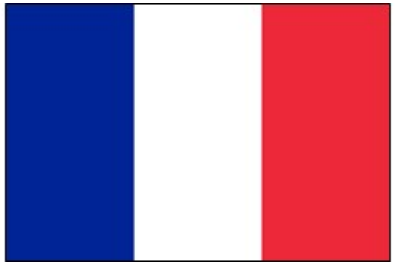
- Subcontracts are in place with 12 Universities (13 Awards) under 9 collaboration areas.
- An additional call will go out in January, expecting ~5-7 additional subcontracts.
- Industry stakeholders will be engaged to participate in the development of experimental vehicles for sodium, lead, gas fast reactor, and molten salt reactor fuels.
- First year goal for industry partners is to concepts for test vehicles required to inform core design.

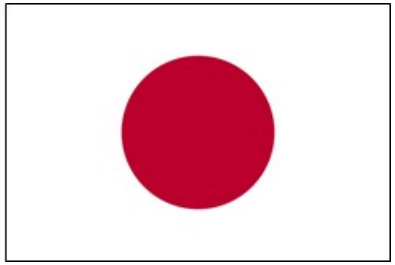
Key University and Industry Experiment Development Collaborations			
Collaboration Area	Lead Lab	University Collaborator	Industry Collaborator
Sodium Cooled Fast Reactor	ANL	University of Wisconsin Madison	Framatome
Lead/Lead LBE-cooled Fast Reactor	LANL	University of New Mexico	Westinghouse
Molten Salt Reactors	ORNL	University of Utah, University of Idaho	TerraPower
Gas Cooled Fast Reactor	INL	Texas A&M University	General Atomics
Virtual Design & Construction	INL	North Carolina State University	General Electric - Hitachi
Structural Materials Testing	LANL	Oregon State University	EPRI
Data Analytics Combined with M&S	INL	Abilene Christian University, Colorado School of Mines, Georgia Tech, Massachusetts Institute of Technology	Hierarchical Data Format (HDF) Group
Rabbit Systems	PNNL	Texas A&M University	
Strategic Initiatives	INL	University of Pittsburgh	

International Collaborations

- South Korea
  - MOU in final review
- France
  - IA under discussion
- Japan
  - MOU under discussion

- DESIGN & SAFETY ANALYSES BENCHMARKS
- FUELS AND MATERIALS DATA
- EQUIPMENT/COMPONENT TESTING
- EXPERIMENTS DESIGN
- INSTRUMENTATION & CONTROL SYSTEMS
  - Data Analytics
- MODELING & SIMULATION TOOLS
- SUPPLY CHAIN





Conclusion

- DOE-NE is investing in the R&D infrastructures to assure a sustainable advanced reactor industry in the long-run.
  - Multiple facilities and upgrades for PIE, ATR Upgrades, TREAT already restarted
  - Versatile Test Reactor (VTR) targeted for availability within by 2026.
- VTR will be operated under the DOE authority but we will work closely and engage with the NRC.
  - An engagement framework (MOU) is being developed.
- Strong stake-holder engagement throughout the project
  - **VTR Task Force under NEI Advanced Reactor Working Group is established.**
- DOE capital acquisition processes (413.3B) will be tailored and used to minimize acquisition risk.
- Strong reliance on modern digital engineering platform
- Strong bi-partisan congressional support
  - The FY 2018 authorization of $35M and FY 2019 of $65M
  - NEICA, S. 97