Versatile Test Reactor

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Nuclear Energy Research Cooperation

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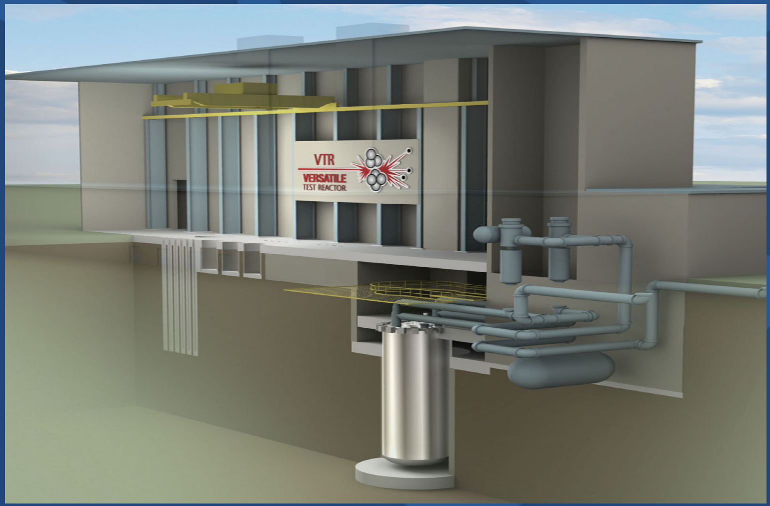


Note: Information regarding VTR site location is **preliminary**. The decision for site location is determined via DOE acquisition processes that have not yet been completed.

Argonne National Laboratory · Idaho National Laboratory · Los Alamos National Laboratory · Oak Ridge National Laboratory · Pacific Northwest National Laboratory · SRNL Savannah River National Laboratory

VERSATILE TEST REACTOR (VTR)

U.S. DOE PROJECT TO ESTABLISH A FAST SPECTRUM TESTING CAPABILITY

The DOE-NE (Office of Nuclear Energy) mission is to advance nuclear power to meet nation's energy, environmental, and national security needs.

Capability Gap

the US does not have the fast neutron spectrum testing capability to move forward in the development of next-generation nuclear reactors.

VTR to support the deployment of advanced reactor development and enable long term innovation

- Irradiation capabilities to support development of:
  - Advanced fuels and materials
  - Instrumentation & sensors
- Support development of advanced reactors:
  - Sodium-cooled reactors
  - Lead/LBE-cooled reactors
  - Gas-cooled reactors
  - Molten Salt reactors
- Continuous improvements in operations and economics beyond initial demonstration
- Support innovation for current reactor technologies

THE VTR PROJECT – DOE Process for Acquisition of Capital Assets

Critical Decisions (“CDs”)	CD-0 Approve Mission Need	CD-1 Approve Alternative Selection and Cost Range	CD-2 Approve Performance Baseline (PB)	CD-3 Approve Start of Construction	CD-4 Approve Start of Operations

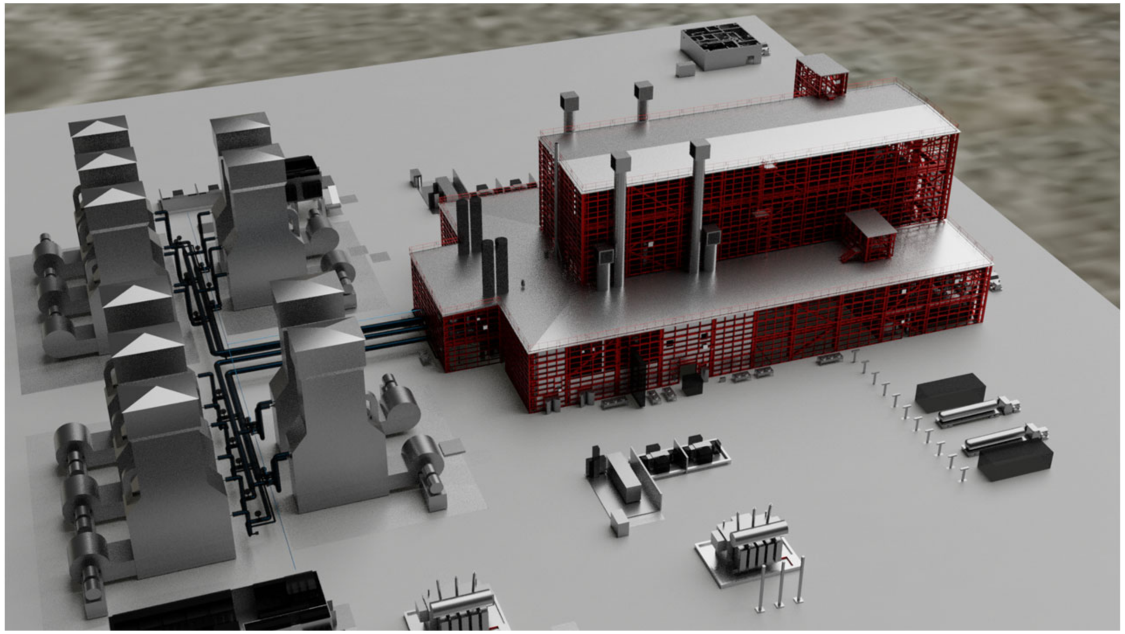
	Critical Decision Schedule	Approved at CD-0	Actual*/ Projected**
CD-0	Approve Mission Need	Feb 22, 2019	Feb 22, 2019*
CD-1	Approve Alternative Selection and Cost Range	1st Qtr FY 2021	September 11, 2020*
CD-2/3	Approve Performance Baseline / Approve Start of Construction	FY 2022	2nd Qtr FY 2023**
CD-4	Approve Start of Operations or Project Completion	FY 2026 – FY 2030	4th Qtr FY 2026**

CD-0 approved by Deputy Secretary Brouillette February 22, 2019.

CD-1 approved by Deputy Secretary Menezes September 11, 2020.

VTR: KEY PERFORMANCE PARAMETERS

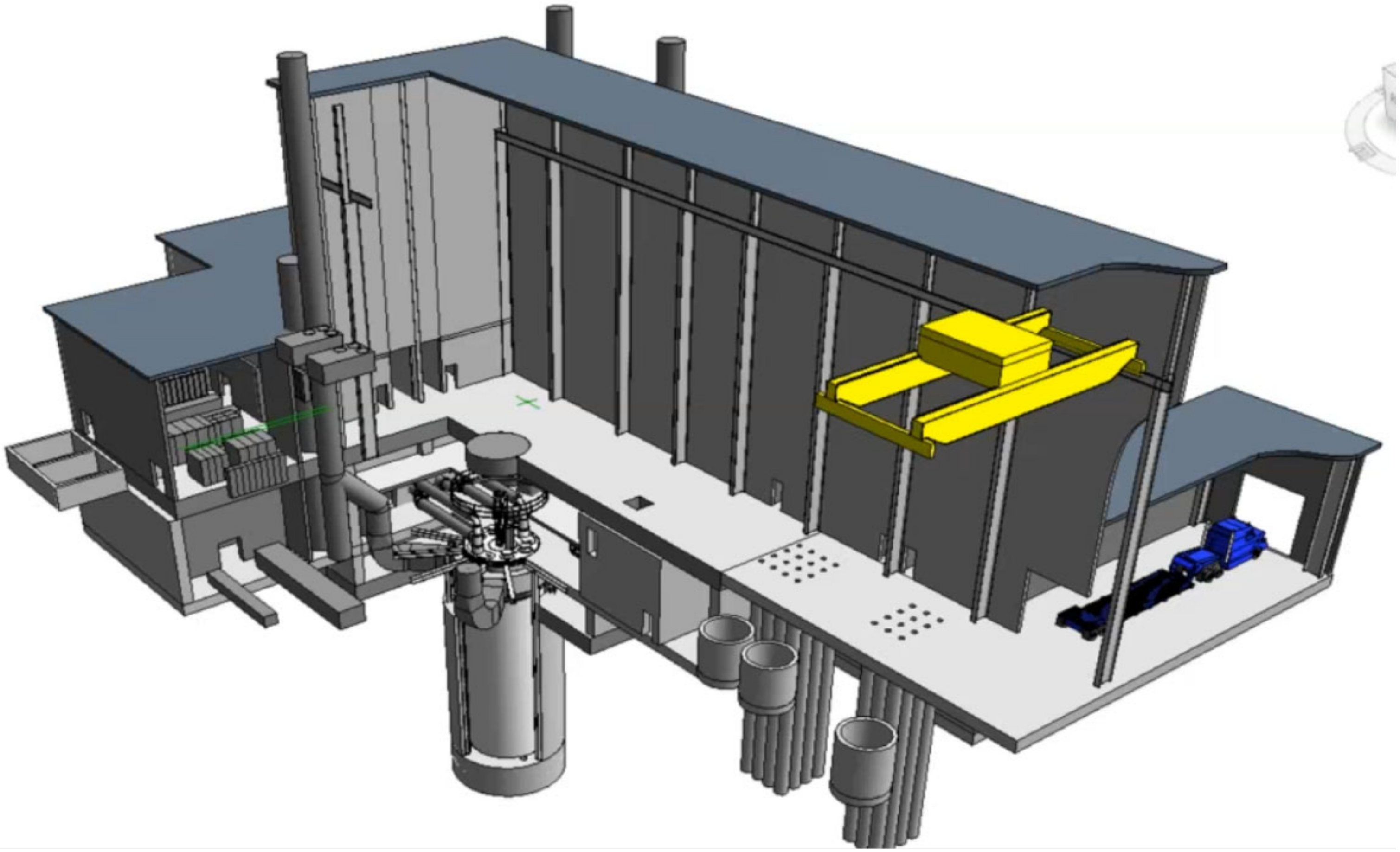
Parameter	Target
High neutron flux	$\geq 4 \times 10^{15}$ n/cm^2-s
High fluence	≥ 30 dpa/yr
High test volume in the core	≥ 7 L (multiple locations)
Representative testing height	0.6 ≤ L ≤ 1 m
Flexible test environment	Rabbit & Loops (Na, Pb, LBE, He, Salt)
Advance instrumentation and sensors	In-situ,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



REFERENCE TECHNOLOGY

- Mature Technology: Sodium-cooled pool type reactor, inherent and passive safety
- Metallic alloy fuel
- 300 MW; no electricity production

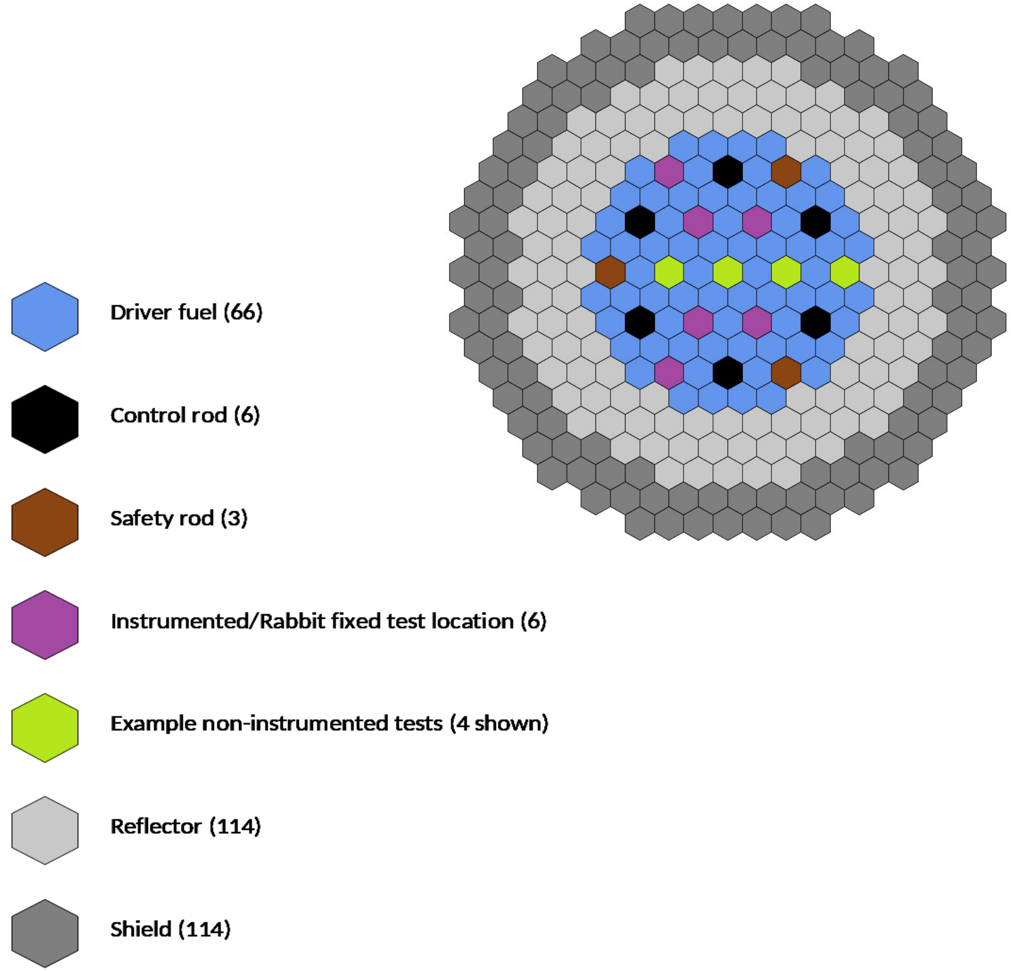
REACTOR BUILDING VIEW



VTR: TESTING CAPABILITIES

Irradiation tests are planned for the VTR using multiple methods of inserting test materials and or/sensors into the core.

1. **Normal test assembly**: A test assembly containing fuel or other materials is substituted for a normal driver fuel assembly.
2. **Extended length test assembly**: Extend through the reactor head and have instrumentation to record the relevant physical conditions of the test article. These test assemblies may be cartridge loops that use a self-contained coolant separate from the VTR primary sodium.
3. **Rabbit test assembly**: To insert and remove a specimen-carrying capsule into the reactor core via a predetermined position for short-term irradiation during reactor operation.
4. **Dismountable Test Assembly:** Same size and shape as a fueled core assembly but contains a removable test insert. It can be handled by the same equipment that handles other core assemblies.



THE VTR TEAM

Universities (includes co-PIs)

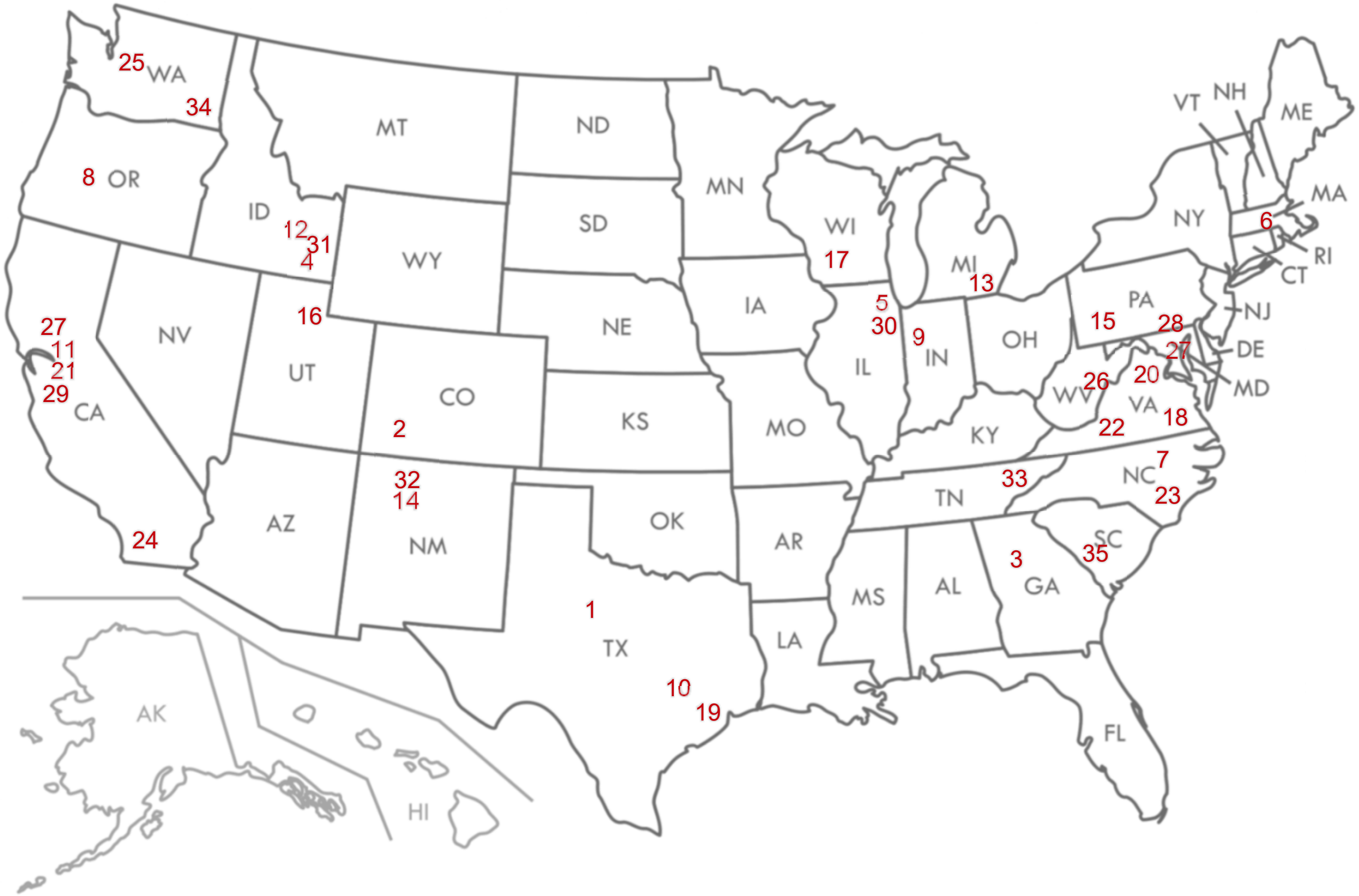
1 Abilene Christian University
2 Fort Lewis College
3 Georgia Institute Of Technology
4 Idaho State University
5 Illinois Institute Of Technology
6 Massachusetts Institute Of Technology
7 North Carolina State University
8 Oregon State University
9 Purdue University
10 Texas A&M University
11 University of California, Berkeley
12 University of Idaho, Idaho Falls
13 University of Michigan
14 University of New Mexico
15 University of Pittsburgh
16 University of Utah
17 University of Wisconsin - Madison
18 Virginia Commonwealth University
19 University of Houston

Industry

20 Bechtel Corporation
21 EPRI Electric Power Research Institute
22 framatome
23 General Electric
24 General Atomics
25 TerraPower
26 Westinghouse
27 The Cameron Group, Inc.
28 orano
29 Cosylab

Laboratories

30 Argonne National Laboratory
31 Idaho National Laboratory
32 Los Alamos National Laboratory
33 Oak Ridge National Laboratory
34 Pacific Northwest National Laboratory
35 Savannah River National Laboratory



VTR TEAM ROLES

- **Management, Integration, Core, Fuel, Safety Analysis, Safety Basis, Probabilistic Risk Assessment (PRA), Support Facilities:**
  - DOE Laboratories. INL Lead Laboratory
- **Design and Construction**
  - **Conceptual design, cost estimate**
  - **Engineering design, procurement, construction**
  - Industry
- **Experiment Capability Development:**
  - DOE Laboratories
  - Industry
  - Universities

JAPAN – US COLLABORATION ON VTR

The objective of this Memorandum of Cooperation (MOC) is to establish a framework for the Participants to collaborate on DOE's R&D and potential deployment of a versatile test reactor (VTR) to be used for testing of advanced technologies needed to support future deployment of advanced fast reactors.

- JAPAN METI/MEXT and US DOE - MEMORANDUM OF COOPERATION (MOC)
  - Signed in June 2019
  - Executive Committee formed
  - Project Arrangement (PA) between JAEA and DOE is under development. Identifies collaboration in following areas:
    1. Reactor Design and Safety Analysis (includes component design, sodium fire mitigation, and PRA)
    2. Fuel, cladding and materials
    3. Modeling and simulation
    4. Test Vehicles
    5. Instrumentation and controls for reactor and experiments
  - PA is under review by METI and MEXT

Thank you!