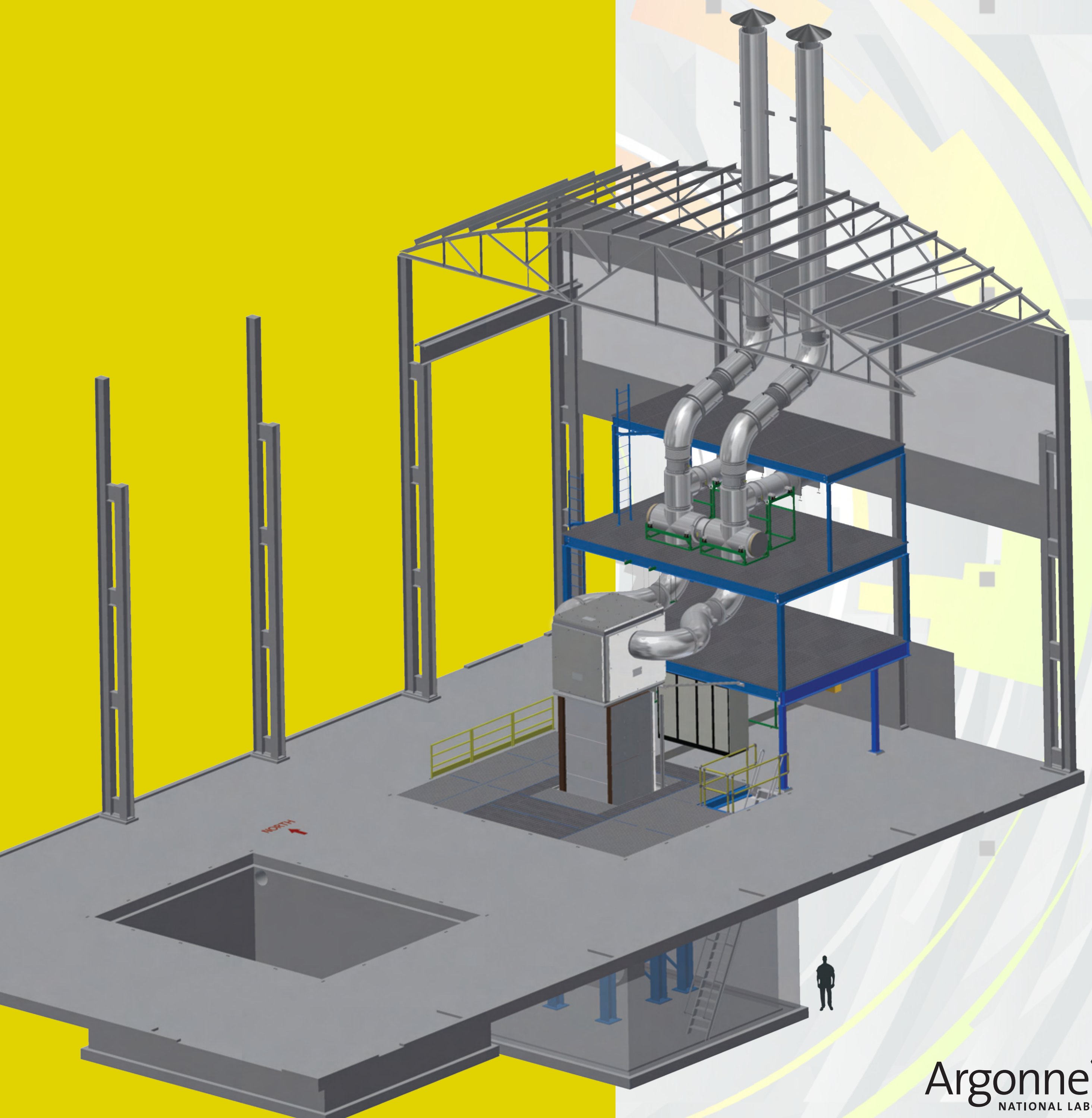
NSTF

Argonne National Laboratory's

Natural Convection Shutdown Heat Removal Test Facility



Argonne NATIONAL LABORATORY

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Natural Convection Shutdown Heat Removal Test Facility (NSTF) –

one of the world's largest facilities for ex-vessel passive decay heat removal testing—confirms the performance of reactor cavity cooling systems (RCCS) and similar passive confinement or containment decay heat removal systems in modern Small Modular Reactors. Originally built to aid in the development of General Electric's Power Reactor Innovative Small Module (PRISM) Reactor Vessel Auxiliary Cooling System (RVACS), the NSTF has a long history of providing confirmatory data for the airside of the RVACS.

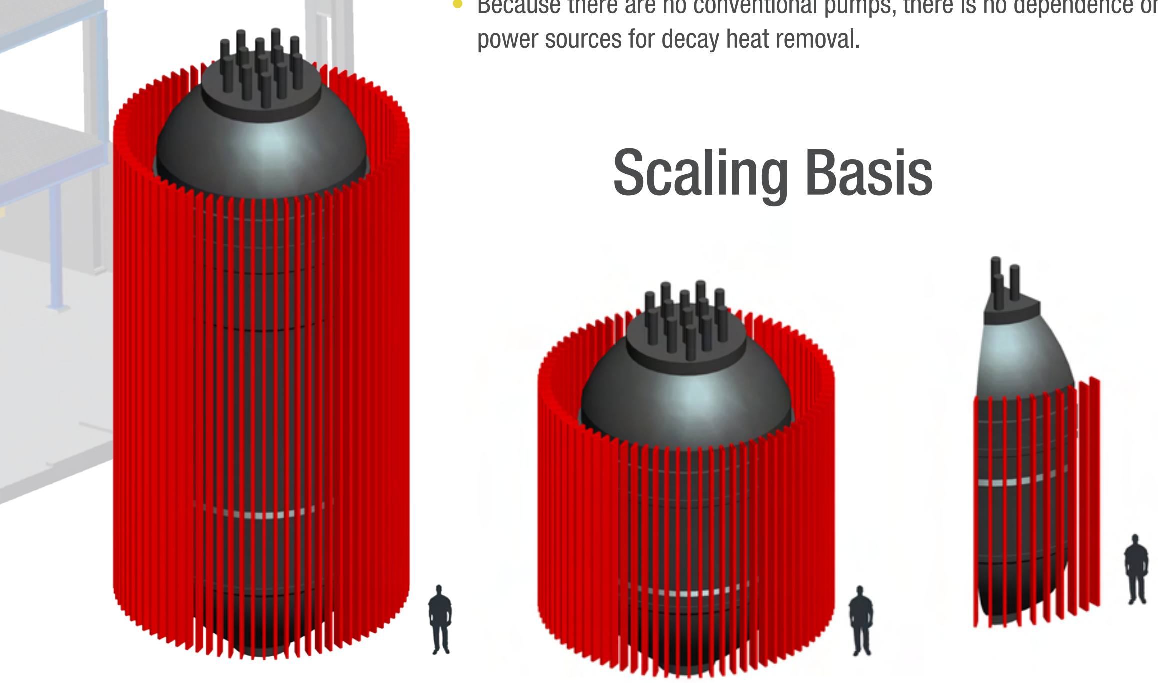
Argonne National Laboratory's NSTF is a state-of-the-art, large-scale facility for evaluating performance capabilities of containment cooling systems, providing reactor designers with data to validate computer simulations. Many of these simulations employ advanced computational tools running on supercomputers at Argonne's Leadership Computing Facility, home to a world-class computing capability dedicated to breakthrough science and engineering.

Unsurpassed Assessment Tools Support Modern Reactor Design

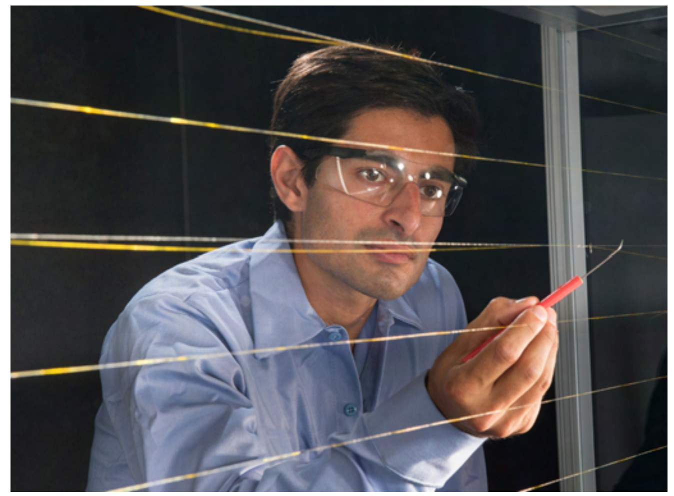
The next generation of nuclear reactors will incorporate passive safety systems, many in the form of natural circulation loops, to ensure safe and long-term operation. Omitting the need for fans, pumps or human intervention, these systems rely instead on natural forces to provide safe and dependable cooling during an emergency. The NSTF's design addresses many of the safety-related concerns set forth by the technological goals of future nuclear reactors, including:

- For critical applications, where truly passive and inherently safe means of heat removal are required, natural circulation systems provide a high level of performance with relative simplicity.
- Because there are no conventional pumps, there is no dependence on off-site AC power or on-site DC power sources for decay heat removal.

Scaling Basis



The diagram to the left shows the scaling basis for the NSTF. First, a full-scale nuclear plant design was reduced by half lengthwise, then a 20° sector slice was selected to create the dimensions and size of the NSTF facility.



Distributed Fiber Optic Sensing for High-Resolution Temperature Mapping

An innovative fiber optic temperature measurement system augments the NSTF's conventional instrumentation, supporting:

- High-resolution temperature measurement along nearly 100 meters (m) of combined cable length; the test system currently contains twelve fiber optic cables, some positioned within the gas space and others touching the duct walls.
- Multiplexing of dozens of sensors to generate measurements at thousands of locations—never before possible in large-scale thermal hydraulics facilities. This helps validate advanced simulation tools such as those being developed at Argonne under the U.S. Department of Energy's nuclear engineering advanced modeling and simulation (NEAMS) program.

Testing the fiber optic distributed temperature sensing system. The instrument uses standard telecom fibers and exploits scattering losses due to Rayleigh scattering; this 40-m-long sensor generates temperature measurements every 10 millimeters for a total of 4000 measurement points.

Sophisticated Data Acquisition and Control Tools Ensure Accuracy and Safety

The NSTF's LabVIEW-based data acquisition and power controller communications software and control system can measure and display a wide range of parameters, such as

- Local gas and structure temperatures,
- Bulk air flow rate,
- Radiative and convective components of heat flux to cooling ducts, and
- Heater power.

Installing the framework of the NSTF's heated cavity, where over 200 radiant heaters supply a heat flux that can mimic the walls of a nuclear reactor.

NSTF at a Glance

Purpose	• Examine passive safety for future nuclear reactors • User facility to examine alternative design concepts • Benchmark for computer code verification & validation
Operating principle	Natural circulation cooling with air
Facility height	26 m overall
Cooling channels	Twelve rectangular steel ducts, each 5 × 25 cm
Chimney design	Two 60-cm-diameter circular ducts, 18 m elevation
Heater power	220 kW maximum, 6.7 m height
Control modes	• Constant heat flux (max. 23 kW/m^2) • Constant temperature (max. 677°C) • 40 zones for cosine or azimuthal shaping

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http://www.ne.anl.gov/capabilities/rsta/nstf/

A World Leader in Nuclear Science and Technology

Argonne National Laboratory imagines, develops and integrates new nuclear technologies and demonstrates them in tangible ways by applying its unrivaled talent and global experience. The laboratory develops future experts and drives collaborative problem-solving among academia, industry, government and international partners to ensure the sustained availability and security of nuclear energy.

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