Sandia National Laboratories

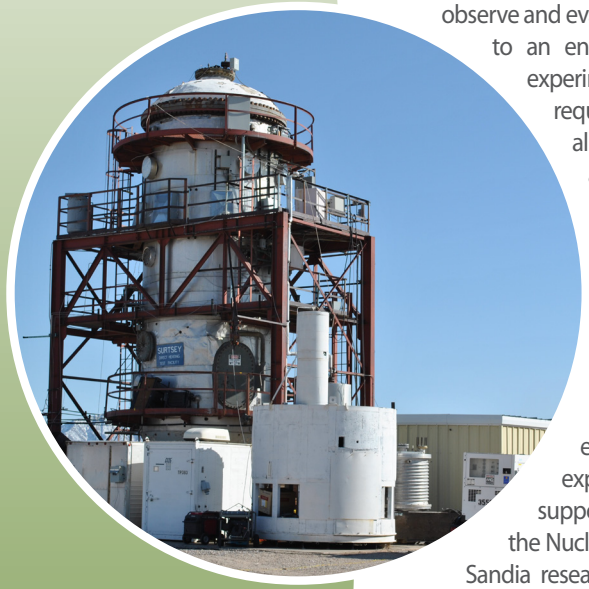
Energy, Climate & Infrastructure Security

Large-Scale Validation Experiments

Using science as a foundation, Sandia National Laboratories researchers conduct experiments to understand natural phenomenon and validate in-house models and codes.

Gathering Data for Validation

The nuclear energy industry and its regulators must have confidence that the technology used in all parts of the enterprise will perform accurately and reliably. Whether designing a new transportation package or certifying a nuclear reactor, performance is often tested through large-scale validation experiments. This allows researchers, designers, and regulators to observe and evaluate how a technology responds to an environment. The results of these experiments indicate whether regulatory requirements are satisfied and can also be used to benchmark further analysis.



Surtsey test facility

Sandia National Laboratories leverages nearly six decades of extensive testing experience with a wide variety of high profile testing facilities to serve as an institutional hub for the design, preparation, and execution of large-scale validation experiments. With a long history of support to regulatory agencies such as the Nuclear Regulatory Commission (NRC), Sandia researchers apply detailed knowledge of nuclear energy regulations and the regulatory environment to experiments, ensuring that experiments generate the best, most accurate data.

Performing Large-Scale Experiments in Nuclear Energy

Drawing on its legacy mission work in nuclear weapons testing, Sandia performs classified and unclassified experiments, and high consequence testing involving hazardous and radioactive material. As the only institution in the world to have performed a containment certification test using actual radioactive material, Sandia maintains strong leadership in this area.

Sandia researchers often perform validation experiments on complete assemblies or high fidelity models. Rather than using simplified models, these assemblies are generally full-scale or near-scale prototype units. By testing what will actually be in use, researchers gather accurate, increasingly realistic performance data. This allows them to determine how the technology's performance measures up to regulatory requirements. Through validation experiments, Sandia is able to test and certify package design, for example, for regulatory agencies.

TRUPACT drop test

Available Nowhere Else in the Country

Sandia performs a number of large-scale validation experiments that cannot be done anywhere else in the country. It is the only institution in the U.S. capable of testing air transportation packages. Using either the Rocket Sled Track to accelerate the package into a target or the Aerial Cable Site to pull it downwards to its impact target, air transportation package designs are tested and certified in extreme environments according to regulations and validation standards.

Full-scale fire tests of large packages are also performed at Sandia, but nowhere else in the U.S. These large-scale validation experiments leverage Sandia's extensive collection of high profile, large-scale fire testing facilities including the Laurance Canyon Burn Facility and the Thermal Test Complex. Using a variety of data acquisition tools including the in-house-developed Mobile Instrumentation

For more information please contact:

Douglas J. Ammerman, Ph.D.
E-mail: djammer@sandia.gov
Phone: (505) 845-8158
Website: ne.sandia.gov

U.S. DEPARTMENT OF ENERGY

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Data Acquisition System (MIDAS), researchers efficiently and effectively gather performance data needed to satisfy fire-based regulatory and validation requirements.

Customization Opportunities Based on Experiments

Depending on the needs of a specific experiment, Sandia customizes its facilities, adapting them to meet the unique needs of each situation. For example, Sandia maintains a large outdoor lake facility that was used for Liquefied Natural Gas (LNG) experiments. Researchers are able to adjust the pool's size, blocking off sections when needed, to accommodate the needs and parameters of individual tests. This customization helps researchers generate increasingly detailed, accurate performance data since the physical characteristics of the test environment closely resemble those of the actual environment of interest.

LNG experiment at Sandia's outdoor lake facility

Sandia also constructs custom facilities, when needed. In support of the NRC and Japan's Nuclear Power Engineering Corporation, Sandia's researchers custom-built a quarter-scale nuclear reactor designed to test the point at which overpressurization would result in structural failure.

Analyzing Validation Data

In general, data generated through large-scale validation experiments is analyzed to determine whether or not a technology meets requirements. Documenting and characterizing how the technology performs in a particular environment, the resulting analysis indicates what industry and regulatory agencies can expect if the situation were to occur when the technology was deployed. This data is particularly valuable when used to inform risk and safety assessments.

Additionally, data derived from large-scale validation experiments benchmarks modeling and simulation tools. Without physically executing the experiment, these tools generate performance data for technology subjected to a variety of environments and situational scenarios. However, since the experiments are simulated, benchmarks are necessary to permit high confidence in data generated from non-tested scenarios.

Large-Scale Validation Experiments in Action: Quarter-Scale Reactor Experiment

Sponsored by the NRC and Japan's Nuclear Power Engineering Corporation, the quarter-scale reactor experiment was performed to validate NRC computer codes used to predict pre-stressed concrete containment vessel (PCCV) pressure tolerances in severe accidents, and to demonstrate that existing reactors at power plants in Japan and the U.S. could perform safety functions reliably in an accident.

Over the course of three years, Sandia constructed a 70-foot tall, 35-foot diameter PCCV as a small replica of one operating at a nuclear power plant in Japan. During the experiment, the vessel was "tested to failure" as Sandia researchers pumped nitrogen gas and water into the concrete model, gradually increasing the pressure until the structure failed. It is the largest nuclear reactor containment vessel model ever tested to failure.

The PCCV model was built with nearly 1,500 sensors and fiber optic lines embedded into its materials enabling researchers to gather tens of thousands of lines of data about its performance before and during the test. Data from the test was used by an international team of experts to benchmark structural analysis codes and develop new state-of-the-art accident response models.

The largest nuclear reactor containment vessel model ever tested to failure

For more information please contact:

Douglas J. Ammerman, Ph.D.
E-mail: djammer@sandia.gov
Phone: (505) 845-8158
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