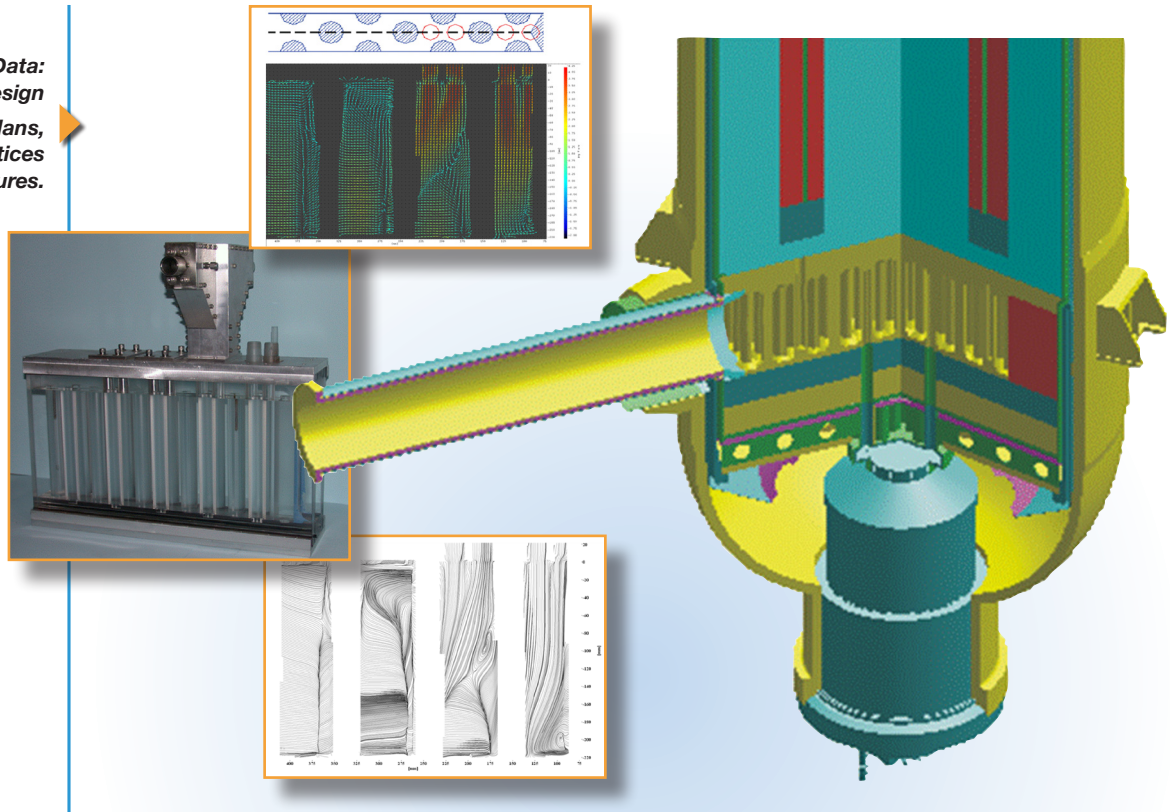
Validation Data: Experiment Design

Scaling studies, test plans, feasibility studies, practices and procedures.



Design Methods and Validation

Next Generation Nuclear Plant

The Very High Temperature Reactor (VHTR) Technology Development Office Program is working to develop high temperature gas-cooled reactor (HTGR) technology that will meet the commercial needs of a wide range of industrial end users. Idaho National Laboratory (INL) manages the research and development of NGNP for the Department of Energy.

The NGNP Design Methods and Validation Program conducts experiments to validate the analysis tools used to design and license the NGNP. Most of these tools are already available and consist of a mixture of commercial software and software written by the national laboratories. Where existing tools are deemed inadequate for simulating HTGR behavior, new methods and codes will be developed.

Design and licensing of the NGNP will require multiple and varied analyses and computational methods. Gas-cooled thermal reactors, built and operated in the U.S. and elsewhere, are characterized by sustained operations at conditions that provide or have substantial design and safety margins. The margins were designed to be large because the legacy analysis tools were not capable of calculating important local limiting parameters with sufficient accuracy and certainty to reduce the safety margins.

Tools developed for the original high temperature reactor programs have not been developed and modernized as were their light water reactor counterparts. Conversely, light water reactor analysis tools do not capture the unique physics and

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NGNP Next Generation Nuclear Plant

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coolant flow regimes of graphite-moderated, TRISO-fueled reactor systems.

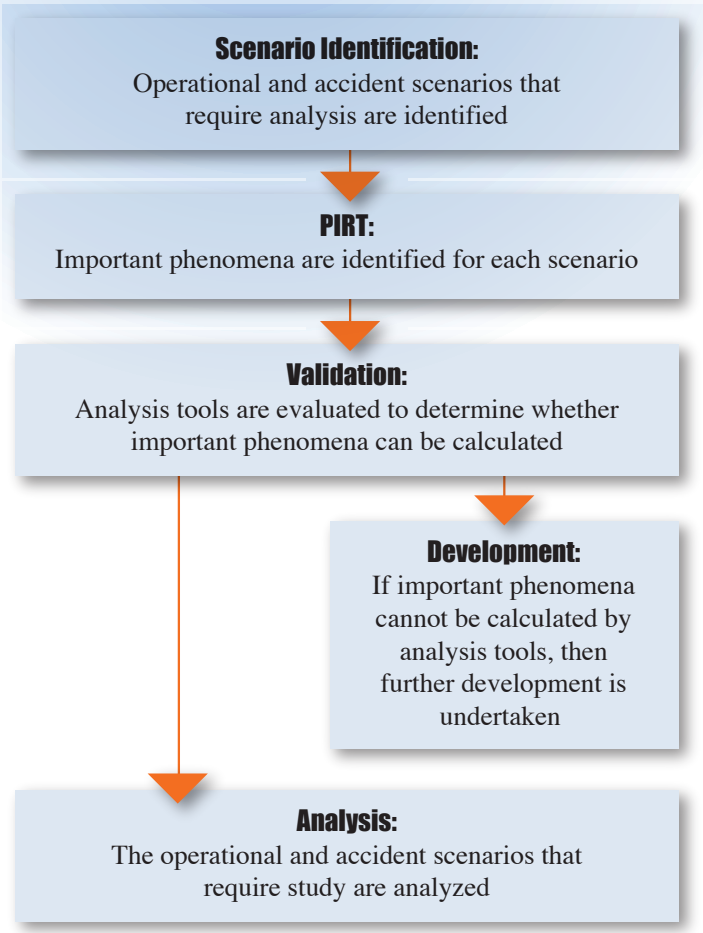
Activities focus on developing and benchmarking state-of-the-art analysis tools that will enable vendors, the Nuclear Regulatory Commission (NRC), and DOE analysts to accurately calculate the behaviors of a HTGR. These tools will be used to analyze normal, off-normal, and accident conditions. The advanced analysis tools offer the following advantages over older legacy analysis tools:

- Reduced design uncertainty and risk — the localized conditions can be calculated with less uncertainty
- Reduced design iterations and costs — the plant designers can more rapidly converge on their desired design configuration with less uncertainty
- An accelerated licensing process — the process of prescribing arbitrary safety factors — is transformed to a process of using known quantities with quantified uncertainties
- The capability of quantifying the safety and operational margins with less uncertainty, thereby allowing safe operation at higher performance levels

Much of the Design Methods and Validation Program is focused on software verification and validation (V&V). Once V&V of the software is completed, the new tools can be used with confidence to characterize plant behavior and to confirm NRC or vendor analyses. The validation data can also be used by stakeholders to validate their own tools.

Although detailed plant designs do not yet exist, the process of developing tools and methods for HTGR analysis is independent of most design features. This process, based upon NUREG 1.203, is under way and consists of the following five steps.

1. Identify scenarios of importance
2. Identify key phenomena for the scenarios Phenomena Identification and Ranking Tables (PIRT)
3. Determine whether the tools used to analyze the scenario progressions are adequate (validation)
4. Correct or complete existing software and carry out any software development that may be needed to ensure analysis tools are adequate
5. Perform required analyses.



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