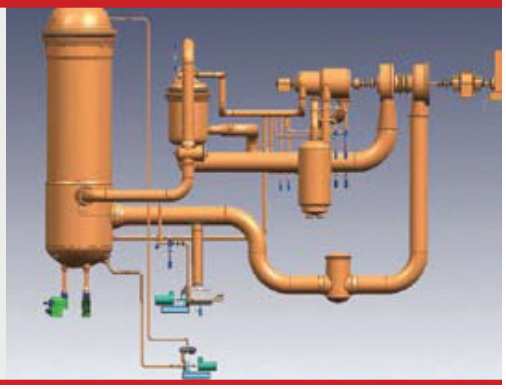
SOLUTION BRIEF

Reducing Building Costs and Improving Safety in Nuclear Power Plants

Meeting the economic challenge through systematic use of simulation



Nuclear Power Industry Challenges

Nuclear power as an energy source has clear advantages, most notably the clean production of electricity without the release of harmful gases into the atmosphere, as from the burning of fossil fuels. The nuclear power industry, however, still faces many challenges, including the relatively high cost of building nuclear power plants and the safe operation of those plants after highly publicized accidents in the industry. Nuclear power plants are designed for a 40 year life span, and must provide an acceptable return on investment for stakeholders as well as operate safely throughout their expected life. These factors, along with complex structural-mechanical systems and strict regulatory requirements, present unique design challenges to the industry.

In light of these challenges and the current downturn in economic conditions worldwide, the role of engineering simulation and virtual prototyping in the nuclear plant design process as a means to reduce cost and power plant completion time is especially important. By incorporating simulation into their design process, nuclear plant designers and equipment manufacturers can evaluate virtual "what if" scenarios to improve safety, compress project schedules, and reduce overall project costs.

Why Simulation Is Important in the Design of Nuclear Power Plants and Components

Engineers and designers in the nuclear power industry can use engineering simulation to understand the behavior of complex power plant systems and components prior to construction and manufacturing. This helps uncover potential problems before critical systems and components are built, while the cost of making design changes is still relatively low.

Simulation also enables nuclear power engineers and designers to perform virtual prototype testing of design concepts and investigate the performance of parts and components before physical prototypes are built and tested. This reduces the number of costly physical testing trials typically required for performance validation and nuclear certification.

Key Success Factors for Simulation

Nuclear power plants contain many complex systems which are challenging to analyze and design. These systems often interact with each other, and are subject to loading from multiple sources including pressure, heat, flow, and impact.

To accurately predict the performance of these systems engineers and designers need powerful simulation technology that incorporates complex physics with process automation and management of large amounts of data. This type of simulation technology offers a simulation environment in which nuclear plant engineers and designers can generate and interpret the information necessary to develop better designs in less time and reduced cost.

The key success factors required for engineering simulation in the nuclear power industry include:

1. Coupled simulations accounting for multiple engineering disciplines, such as thermal-structural coupling and fluidstructure interaction
2. Knowledge and best practice capture for consistent repeatability of simulation processes and results
3. Validation of simulations by correlation with physical test data
4. Management and traceability of simulation processes and data for regulatory compliance and reporting

Virtual testing and studies typical in the design of nuclear power plants:

- Structural analysis of nuclear core support structures and concrete containment structures
- Structural analysis of mechanical components and equipment such as pressure vessels, pumps, valves, piping systems and storage tanks
- Vibration analysis of equipment and components
- Thermal-structural analysis of reactor core and other thermal-mechanical systems
- Drop testing of nuclear waste disposal casks
- Impact analysis of critical systems from fragments due to accidental explosions
- Blast analysis of structural systems due to bomb blast
- Impact analysis of exterior structures due to acts of terrorism

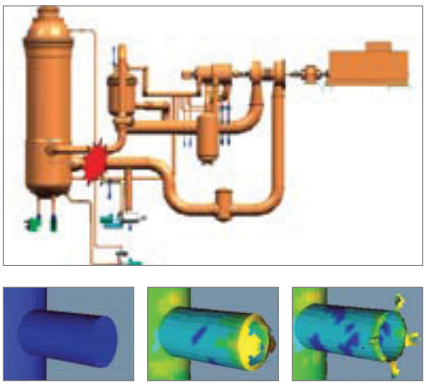
Fuel Cask Platform Drop Test Simulation

MSC Software

MSC Software Adds Value to Nuclear Power Technology Design

MSC Software offers a comprehensive simulation and process/data management solution suite that enables companies in the nuclear power industry to achieve the key success factors for engineering simulation. MSC Software's solutions enable virtual design iterations and "what if" studies for complex nuclear plant systems and components requiring multidisciplinary engineering simulation, best practice knowledge capture and reuse across your engineering organization, and engineering process and data management for facilitating regulatory documentation and reporting requirements. The MSC solution suite for applications in the nuclear power industry consists of:

- Multidisciplinary Engineering Simulation
- Best Practice Capture & Reuse
- Simulation Process & Data Management



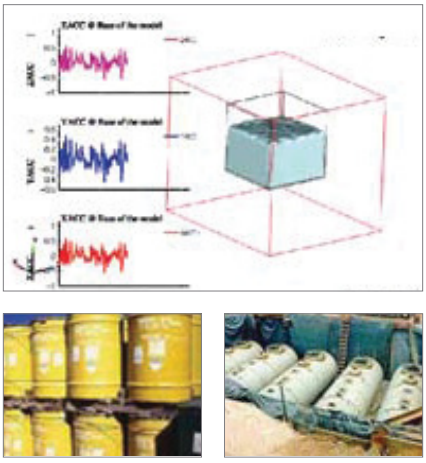
Reactor Pressure Vessel Outlet Pipe Burst Simulation

Multidiscipline Engineering to Simulate Complex Interactions

Simulating Real World Problems

Nuclear power plants inherently include many complex systems, parts, and components which must meet both performance and safety design requirements. Systems and components in power plants are commonly subject to thermal-structural and fluid-structure interaction, and impact loading due to burst of pressurized pipes. In addition, power plant buildings are subject to acts of terrorism, requiring special design considerations for impact and blast.

With MSC Software, engineers can simulate the real-world engineering problems encountered in nuclear power plant design and analysis. Multidisciplinary simulation takes into account the simultaneous interaction of multiple engineering disciplines, such as coupled thermal-structural analysis and fluid-structure interaction, resulting in more efficient and accurate solutions for loading due to heat, pressure, and fluid flow. Multidiscipline simulation also enables impact and blast simulation for loading from accidental explosions or deliberate acts of terrorism.



Simulation of Sloshing in Underground Nuclear Waste Tanks Under Seismic Loading

Best Practices for Simulation

Knowledge Capture and Process Automation

The nuclear industry has strict requirements for repeatability of simulations. Designers must demonstrate that their simulation models are robust, and produce consistently repeatable and predictable results.

With MSC Software, engineers and designers can capture their organization's proprietary knowledge and best practices. This enables simulation process automation incorporating the accumulated knowledge, experience, and expertise of engineering teams across multiple disciplines. MSC's technology enables robustness and repeatability of simulation results to comply with nuclear industry requirements, and also empowers non-experts in the organization to perform complex simulations with predictable reliability.

Auditable Simulation Processes

Simulation Process and Data Documentation

Process and data documentation is required for regulatory compliance in the nuclear power industry. The management, traceability, and reporting of simulation processes and data is therefore a key challenge for companies designing power plants or suppliers providing parts and components. SimManager provides a convenient infrastructure for managing simulation processes and data, with an audit trail so that data and results can be traced back to any point in a simulation process. Nuclear plant designers can benefit from tracking changes to simulation models and data and immediately knowing what effects those changes had on their design, and by creating automated, customizable reports to comply with regulatory reporting requirements. SimManager can also manage other simulation content such as correlation with physical test results and software version tracking for software tools used to perform the simulation.

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