

Entergy Nuclear

Simulates nuclear plant maintenance with DS PLM solutions and services





Entergy Nuclear Objectives

- Upgrade existing nuclear plants to double lifespan
- Reduce business risk and improve safety through superior planning
- Shorten maintenance outages to save \$1 million/day
- Transfer knowledge to a new generation of workers

ENTERGY NUCLEAR

Company Overview

Entergy is a U.S. energy provider with nearly 15,000 employees and 30,000 megawatts of generating capacity, serving 2.7 million customers in Arkansas, Louisiana, Mississippi and Texas and generating 2008 revenues of \$13 billion. Entergy has twice been named to the Forbes list of *America's Most Trustworthy Companies* for its corporate governance and accounting transparency.

Entergy Nuclear is a division of Entergy headquartered in Jackson, Mississippi. Entergy Nuclear and its nearly 6,000 employees manage the second-largest fleet of nuclear reactors in North America, with 11,022 megawatts of generating capacity – roughly equivalent to the peak power demand of New York City in 2003. It operates ten commercial nuclear power sites with a total of 12 reactors.

Business Challenges

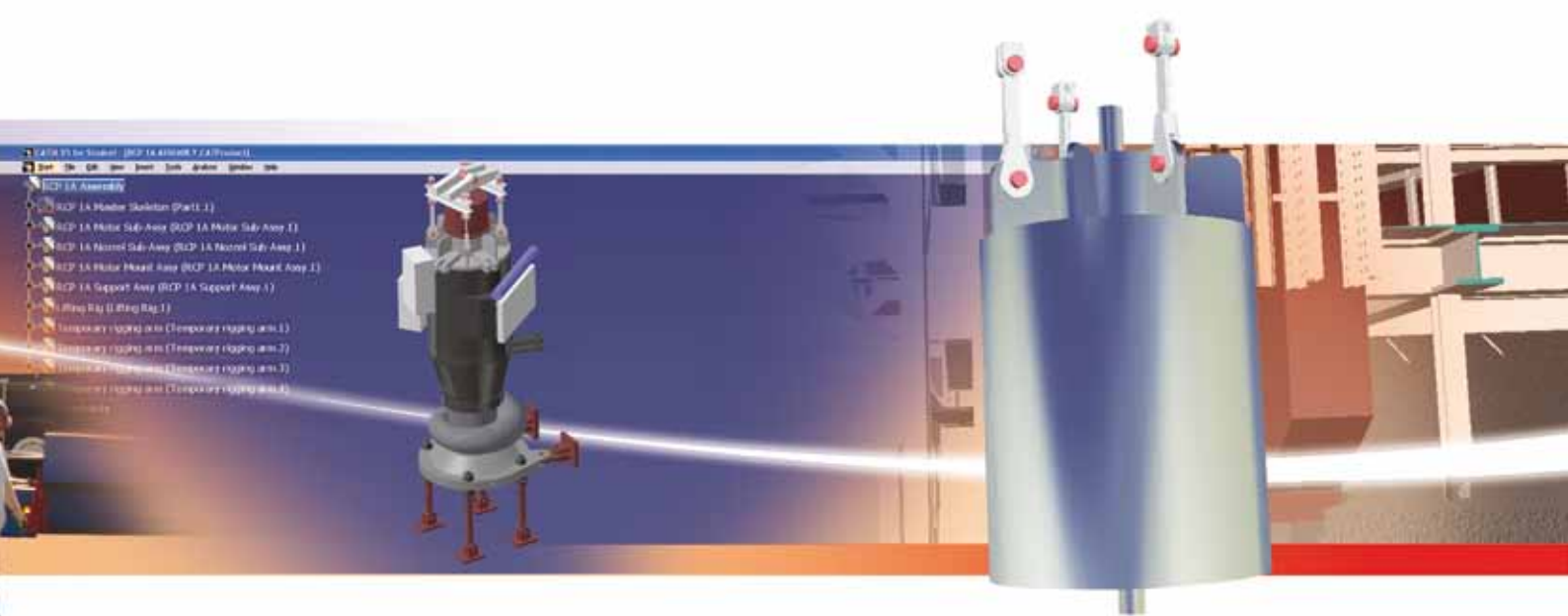
Most US nuclear power plants, originally licensed for 40 years, are having their licenses extended, bringing their permitted life to 60 years or more. Keeping the plants in top condition and updating key aspects of technology often requires complex and difficult one-of-a-kind maintenance operations. Many involve moving objects that weigh tons through spaces with clearances smaller than most mobile telephones.

Planners must have confidence the operations are feasible, safe and can be completed in brief maintenance shutdown periods. Traditional tools, including physical mockups, tabletop exercises and walkthroughs, are effective but expensive and cannot be stored or replicated for training or reuse. Each day added to an outage schedule by



“The use of DS PLM during the planning process reduces overall risk and improves scenario planning for any major project.”

John M. Mahoney, Innovation Leader,
Entergy Nuclear



unanticipated issues can add \$1 million to the bill, just for the cost of purchased replacement power.

Solution

Entergy Nuclear chose PLM (Plant Lifecycle Management) solutions from Dassault Systèmes (DS) for three projects at its Waterford 3 plant near New Orleans, Louisiana. Dassault Systèmes Industry Services (DSIS), the Professional Services arm of Dassault Systèmes, conducted virtual modeling and simulation for the projects, leveraging CATIA to create virtual models, DELMIA for virtual simulation, and DS-partner solution AREVA laser scanning to capture updates to the plant not reflected in the original plans.

The projects included: replacing a 9,700-horsepower reactor coolant pump (RCP) motor that weighs more than 57 tons; analyzing the potential impact of a fire on a fire-control panel in a key plant area; and replacing the in-core instrumentation (ICI) “thimbles” used to pass neutron detectors through the containment wall to monitor core processes.

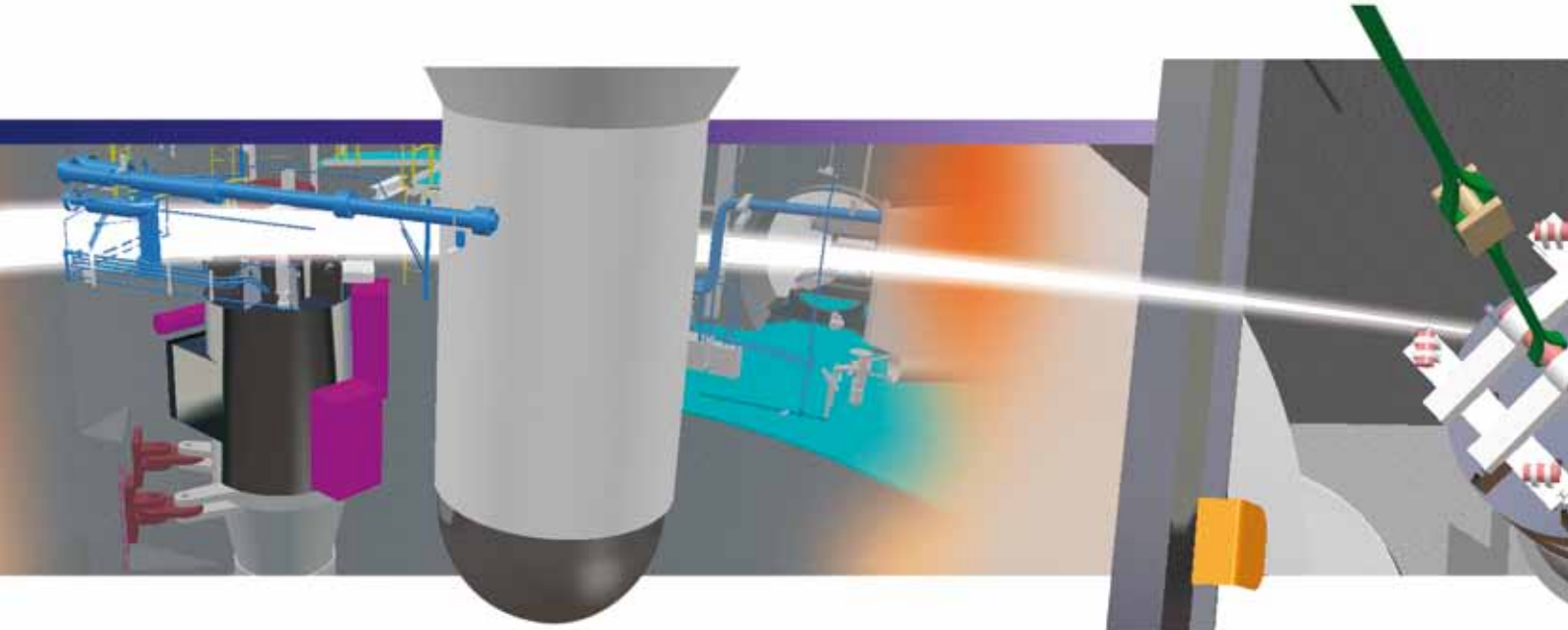
The projects were so successful that Waterford 3 is investing in its own licenses of CATIA and DELMIA software and training for a program to create future models and simulations in-house. Entergy Nuclear management also is considering ENOVIA for global collaborative lifecycle management for planning, construction and long-term maintenance of new nuclear power plants.

“Harvesting the use of 3D PLM and laser scanning technology is as transformational to the engineering and project management disciplines as moving from the slide rule to calculators was in the late 1960s,” says John M. Mahoney, corporate innovation leader for Entergy Nuclear. “We are using

“Dimensional clearances for the RCP motor replacement project are as tight as two inches (about 5 centimeters). Simulation gives our workers an intelligent model with an immense return on investment.”

John M. Mahoney, Innovation Leader,
Entergy Nuclear





“3D modeling and simulation with DS PLM was that extra check to gain the comfort level we had to have, and it discovered an interference that would have added 1-2 days to the outage.”

Don Marpe, Project Manager,
Early-Stage DS PLM Projects

digital simulation for large projects where risk is high because of potential impacts on operations or electricity production, and wherever radiation exposure can be reduced.”

Results

CATIA accurately models complex facilities

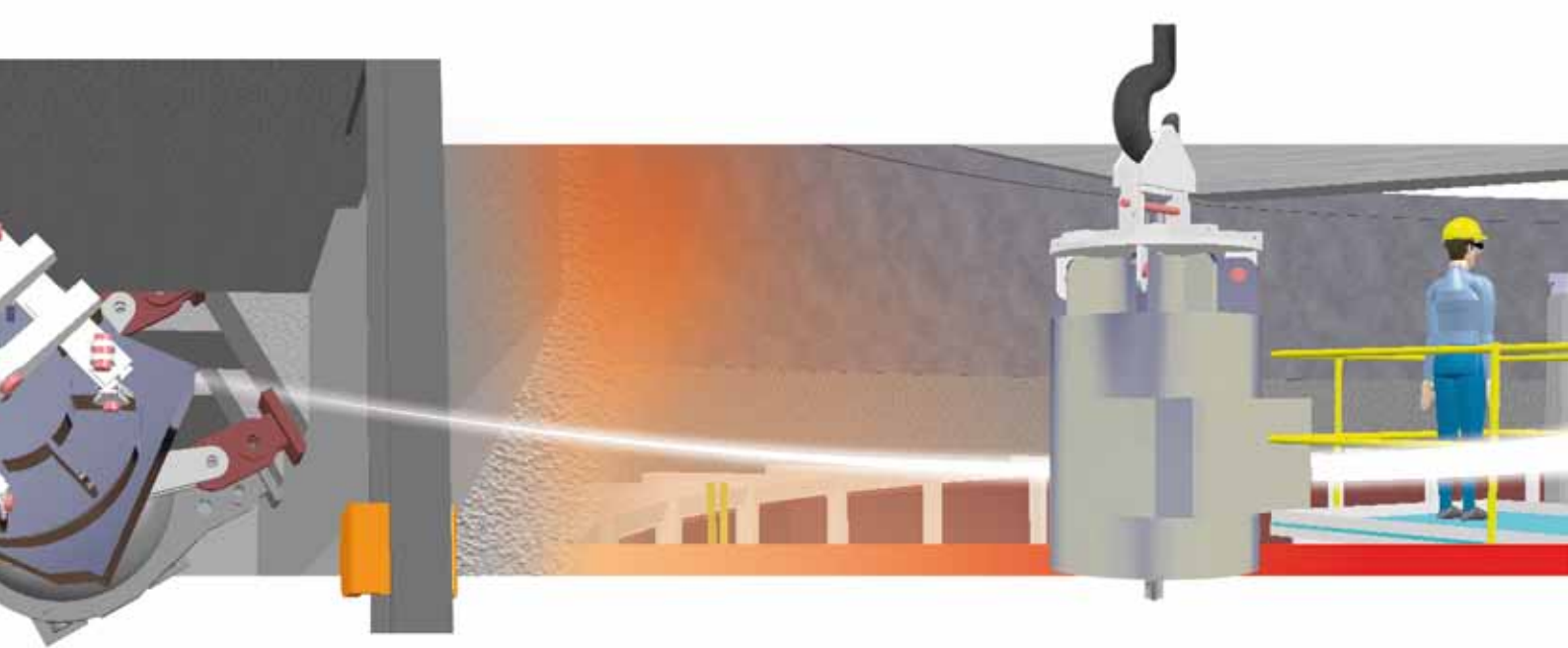
Waterford 3 began operating in 1984, long before 3D modeling technology was available to the nuclear industry. To create accurate models as the basis for simulating removal of the RCP motor, DSIS used CATIA to create detailed, accurate 3D models of the environment the RCP motor would move through, as well as the equipment and processes employed in the operation. Models were built from the original plans for the facility and updated with AREVA laser scanning data, used to capture recent changes and structural elements. Mahoney notes that the models “provided project planners, workers and engineers with a true representation of plant areas that cannot normally be accessed during power operations.”

DELMIA simulations improve planners’ “comfort level”

Once the 3D models were built, all the underlying engineering processes for the RCP motor removal process were simulated in the DELMIA DPM Assembly package, based on a schedule consisting of detailed removal procedures developed by Entergy Nuclear and its contractors. The simulation identified two previously unrecognized obstructions. Entergy Nuclear officials estimate that if the obstructions had not been identified and planned for in advance, dealing with them could have added one to two days to the planned outage, driving up costs by at least \$1 million-\$2 million.

DSIS delivers on-demand solution

To validate the effectiveness of DS PLM in simulating complex maintenance projects, Waterford 3 turned to the modeling and simulation experts at Dassault Systèmes Industry Services (DSIS). DSIS quickly and effectively created the necessary



CATIA models and DELMIA simulations on an outsourced basis, allowing Waterford 3 to simulate its processes in a manner consistent with real-life working conditions. Working from engineering drawings, photographs and AREVA laser scans, DSIS modeled the complete environment in CATIA. It then simulated the removal processes developed by Waterford 3 in DELMIA to test for any unanticipated issues. The two identified issues were eliminated with small but critical alterations to Waterford 3's planned removal process. The work, including data collection, modeling, and a complete simulation video, was completed in about six weeks.

Minimizing radiation exposure through simulation

DELMIA provides for simulation of potential radiation exposure, a critical element of work that occurs in the radiation containment area, such as the ICI thimble replacement planning scenario. Like all reactor operators, Entergy Nuclear constantly monitors exposure levels of all employees and contractor craftspeople. Radiation simulation will allow Entergy Nuclear to accurately predict radiation exposures and test different scenarios and placements of workers to identify and develop procedures with the lowest total exposure. "Industrial safety and radiological safety are enhanced by using 3D PLM and laser scanning for predetermination of hazards in workspaces," Mahoney says.

Cutting costs by eliminating physical simulations

3D models, 4D visualization of the project and schedule, and simulations with DS PLM allow Entergy Nuclear to generate new engineering ideas and explore alternative solutions faster and at far less cost than traditional trial-and-error discovery projects or pilots with full-size, custom-built mockups. DS PLM also helps outage planners coordinate all tasks, test and change sequences, and boost contractors' productivity. "Even though a sheet metal mockup of the motor was made and that mockup moved in and out of containment, the necessary comfort level of really being able to move the motor was not reached" until digital simulations were performed, says Gerald Butts, Entergy Nuclear's original RCP project manager for Waterford 3.

DS PLM Key Benefits

\$1 million to \$2 million saved
Discovering unrecognized obstructions cut 1-2 days from RCP motor replacement outage at cost of \$1 million/day

Safer maintenance operations
Digital simulations facilitate improved worker training and help minimize radiation exposure

Lower-risk operations
By helping to ensure that every possibility has been anticipated, DS PLM helps reduce the risk of unanticipated delays

Lowered investment in physical mockups
As the industry's positive experience with virtual simulations expands, physical mockups can be phased out

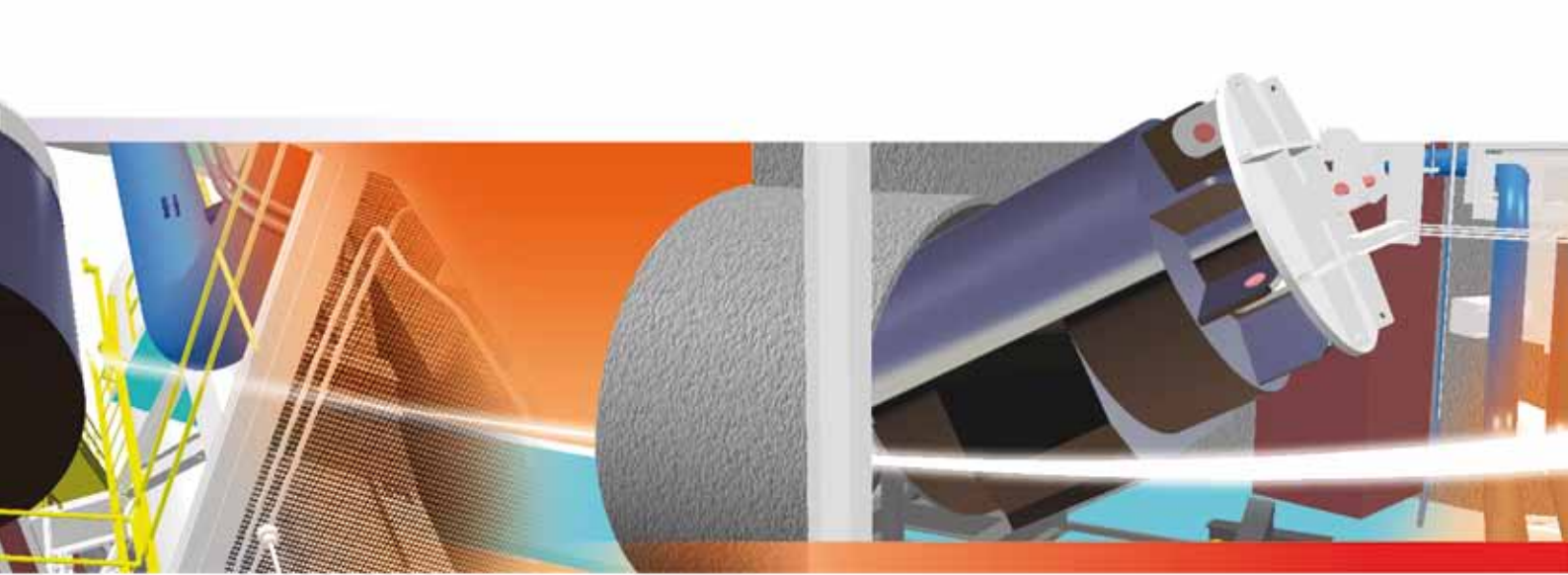


“Embracing DS PLM simulation and virtualization technologies, as Waterford 3 has, is the beginning of a new era for engineering and project planners in nuclear power. This will transform the way we work.”

John M. Mahoney, Innovation Leader,
Entergy Nuclear

Improving training and capturing institutional knowledge

Detailed simulations provide training for plant employees and craftspeople and familiarize everyone with the task at hand. For example, nuclear plant refueling, which occurs only once every 18-24 months, involves about 2,000 discrete tasks, half a dozen contractor companies and dozens of skilled craftspeople – few of who have ever been inside the plant’s containment building. 3D video simulations improve workers’ familiarity with their surroundings, reduce the risk of human error, and allow institutional knowledge to be passed to the next generation. “With these new capabilities to transfer plant knowledge to a new generation of workers quickly and comprehensively, intelligent systems will be created and retained in databases,” Mahoney says.



Future

“The transformation we are making with DS PLM is almost mandated to address the industry’s high rate of retirements,” Mahoney observes. “The significantly higher cost of physical mockups will be another factor driving the use of 3D virtualization. Not many innovative technologies come along these days that will change the way engineering is done, the way work plans are developed, and where training can be provided prior to doing work – all at once. Waterford 3 has determined that tying their long-range asset replacement planning process to 3D simulations is an ingenious way to be more efficient and cost-effective in their detailed engineering and project planning efforts associated with plant lifecycle management.”

DS PLM for the Energy Industry

Dassault Systèmes provides comprehensive PLM solutions to allow owner operators, engineering procurement and construction companies and equipment suppliers in the energy industry to plan and execute end-to-end lifecycle management and maintenance of their assets. DS PLM solutions cover the design, construction, maintenance and monitoring requirements of sectors including oil and gas, chemicals, utilities and power, metals, and mining.

The DS PLM portfolio of CATIA, DELMIA, ENOVIA, SIMULIA, and 3DVIA enable energy companies to design facilities, simulate complex construction and renovation scenarios, validate schedules and budgets and check the feasibility of proposals submitted by outside contractors. From laying out piping to creating functional definitions of activities and assets, DS PLM is a powerful new tool in the energy arsenal.

For information about DS PLM solutions for the energy industry, visit www.3ds.com

For information about Energy, visit www.energy-nuclear.com

The Dassault Systèmes home page can be found at www.3ds.com

Dassault Systèmes
10, rue Marcel Dassault
78140 Vélizy-Villacoublay, France
Tel: +33 (0) 1 61 62 61 62

As a world leader in 3D and Product Lifecycle Management (PLM) solutions, the Dassault Systèmes group brings value to more than 100,000 customers in 80 countries. A pioneer in the 3D software market since 1981, Dassault Systèmes develops and markets PLM application software and services that support industrial processes and provide a 3D vision of the entire lifecycle of products from conception to maintenance.

The Dassault Systèmes V5 PLM offering consists of CATIA V5 for designing the virtual product, DELMIA for virtual production, ENOVIA for global collaborative lifecycle management (including ENOVIA VPLM, ENOVIA SmarTeam, and ENOVIA MatrixOne), and SIMULIA for virtual testing.

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