



Project Summary

Organization:
L&T-Sargent & Lundy Limited

Solution:
Power Generation

Location:
Nagpur, Maharashtra, India

Project Objective:

- Deliver detailed engineering design for the boiler, turbine and generator (BTG) island configuration within 24 months
- Optimize the plant's use of space within the constraints of an irregularly shaped site
- Meet environmental and corporate social responsibility requirements for a high-efficiency, low-emissions supercritical power plant

Products used:
MicroStation
Bentley Navigator
STAAD.Pro
Structural Modeler

Fast Facts

- The 3x660 MW plant is twice the size of any plant previously designed by L&T-S&L
- The project called for collaboration among six disciplines as well as coordination with vendors, OEMs, the client, and the owner's engineer
- L&T-S&L implemented PLADES (Plant Design Software), a custom system developed by S&L and built on the Bentley platform
- MicroStation VBA was used to develop organization- and project-specific tools

ROI

- The customized 3D environment helped reduce plant space by nearly 10 percent
- Faster design cycles and approval processes reduced engineering time by approximately 10 percent
- The bulk of the engineering was completed within 20 months – four months less than projected

L&T-Sargent & Lundy Uses MicroStation for 3D Design of Supercritical Power Plant in India

Bentley Software Optimizes Design Cycle Reducing Engineering Time by 10% for Faster Project Completion

Overcame Site Constraints and Environmental Requirements

In support of sustainable economic growth and the associated spike in power demand, India is phasing out old, inefficient power stations in favor of more advanced, environmentally friendly plants. The US \$1.5 billion supercritical thermal power plant under construction in Nagpur, Maharashtra, will replace existing facilities with a high-efficiency, low-emission 3x660 megawatt (MW) coal-fired plant. Working extensively on a 3D platform built on Bentley products, L&T-Sargent & Lundy Limited (L&T-S&L) overcame the challenge of site constraints and meeting environment requirements while delivering an error-free design on budget and within the twenty-month project time frame for bulk engineering.



Architectural view of the service building generated using Bentley software.

L&T-S&L was established in 1995 and is now a premier engineering and consultancy firm in the power sector, born out of the shared vision of two renowned organizations – Larsen & Toubro Limited (L&T), India's largest engineering and construction company, and Sargent & Lundy LLC – USA (S&L), a global consulting firm in the power industry since 1891. Besides having considerable expertise in gas and subcritical coal power projects, L&T-S&L is pioneering engineering for supercritical coal-based projects and forms the engineering base for L&T's thrust into turnkey supercritical technology.

The expansion project in Nagpur is the first supercritical facility for Maharashtra State Power Generation Co. Ltd. (MAHAGENCO). The net capacity addition is 1,560 MW, replacing the existing 4x105 MW de-rated units. MAHAGENCO awarded the contract for the main plant to L&T, which subcontracted L&T-S&L to complete engineering services for the boiler, turbine, generator (BTG) island, along with related auxiliaries and the extended balance of plant (BOP) configuration.

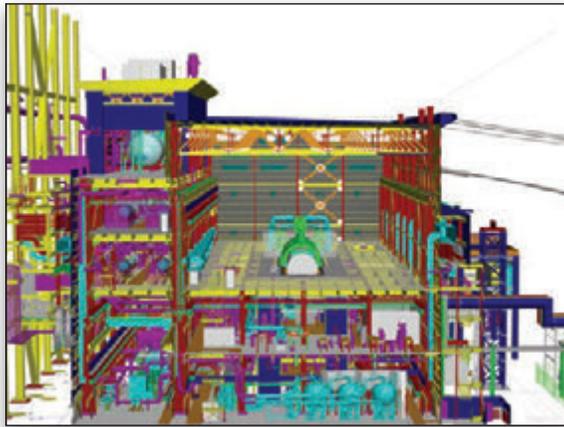
Primary Goal was Space Optimization

The 660 MW units called for over-sized facilities to be squeezed into an area constrained by the existing plant and adjacent agricultural land. In India, land is a scarce commodity, and converting agricultural land to non-agricultural use was not an option. As a result, the primary goal was to optimize the use of space by creating a compact plant layout within the irregularly shaped site.

The design was further complicated by strict environmental standards and corporate social responsibility requirements. Objectives included minimizing the plant's water consumption, solid waste generation, air pollutant emissions, and carbon footprint.

“Using MicroStation for 3D modeling enabled our client to clearly see how we could reduce plant layout by 10 percent while ensuring proper access for operations and maintenance, as well as ease of constructability. Visualization also allowed for faster client approvals, helping reduce the engineering cycle time.”

— Jignesh Chokshi, deputy general manager-civil, structural, and architectural
L&T-Sargent & Lundy Limited



Cross sectional views aid in both construction planning and operational training.

Engineering Technology Unified Global Team

The project called for collaboration among six disciplines: piping, electrical, special engineering services, civil/structural/architectural, instrumentation and control, and mechanical. Supported by vendors and OEMs, and with oversight by the client (L&T) and the owner, L&T-S&L also had to engage with numerous stakeholders and agencies. Communicating with and integrating input from multiple parties while keeping the project on track posed a significant challenge.

L&T-S&L looked to advanced engineering technology to overcome these challenges. "Great performance can be achieved through state-of-the-art tools and technology," noted Jignesh Chokshi, L&T-S&L's deputy general manager-civil, structural, and architectural.

Custom Software Integrated Plant Models

Since its inception, L&T-S&L had been using Bentley products in conjunction with PLADES (Plant Design Software), a custom system developed by S&L. In addition to supporting 3D design, the environment facilitated communications through virtual visualization. Bentley products included MicroStation, Bentley Navigator, STAAD.Pro, and Structural Modeler. The Bentley platform ensured consistent design and execution among the 250 engineering, procurement, and construction staff.

Using MicroStation Visual Basic for Applications (VBA), L&T-S&L customized the platform to develop organization- and project-specific tools. Custom modules included physical design, model review, drawings and reports, bill of materials, project status, and system engineering. Parametric tools simplified the creation of complex models, allowing parameters to be changed quickly. With just a few clicks, revised models were easily generated for facilities, and equipment layouts. This helped to optimize layouts while maintaining constructability. "The customized tools helped manage rework effectively and accurately, while also maintaining the team's enthusiasm. This helped build a 'culture of innovation' for continuously improving the usage of the 3D environment," explained Chokshi.

Visualization Aided Project Communication, Faster Approvals

Using the integrated 3D model, L&T-S&L was able to use MicroStation's Luxology rendering engine to create high-quality images and animations of the plant design. These visualizations, along with 3D PDFs, helped L&T-S&L obtain faster approvals from

their client. "At first our client was hesitant about some aspects of the optimized design. But after we showed them 3D renderings from MicroStation of the plant design, they were very happy and approvals went much faster," said Chokshi.

Integrated Model Helped Eliminate Errors

With all disciplines working on a single platform, engineering information and deliverables were accurate and complete. Having access to the latest plant design data also facilitated materials management. Current, consistent data resided in one central location, from which all bills of quantities were extracted.

Material quantities were substantial. The plant expansion comprised 25,000 metric tons of steel, 180,000 cubic meters of concrete, 6,200 metric tons of power cycle piping, and 8,500 metric tons of large diameter piping. Bentley products provided a solution for modeling and analyzing the complex systems and optimizing quantities. For example, STAAD.Pro was used to model the 16,000-metric-ton turbine building.

Model Reviews Ensured Constructability

Inter-discipline model reviews eliminated interferences and the mismatching of physical drawings that cause construction errors and delays. Reviewing models with the construction team during the design phase not only confirmed constructability but also identified potential problems before they became issues on site. Drawings extracted from the approved models ensured design integrity.

Visualizations using Bentley Navigator also helped the team plan the sequence of construction. The entire plant was built first in the virtual environment, where the services and interfaces were integrated and checked for interferences. Rework was managed effectively within this controlled environment using the customized tools, eliminating costly errors, onsite modifications, and delays. L&T-S&L also chose to install Bentley Navigator at the construction site, to aid in the construction and commissioning of the plant. "Our construction personnel now use Bentley Navigator on-site to help ensure the construction process continues to run smoothly," explained Chokshi.

Real-time Modeling Optimized Size and Layout

L&T-S&L's unified platform provided consistency from conceptualization through detailed design. The customized 3D environment fostered a culture of innovation and collaboration among the geographically separated teams. Rather than the conventional approach of drawing production, followed by model production then clash checking, the engineers modeled first, then extracted the drawings. Accurate, effective, and user-friendly tools minimized risks and encouraged continuous improvement.



Pump house rendered in 3D.

"We used a coordinated and controlled 3D environment based on Bentley products for plant model integration. This intelligent plant system provided better interface management and smarter graphics to enable effective communication through virtual visualization."

—Jignesh Chokshi, deputy general manager-civil, structural, and architectural
L&T-Sargent & Lundy Limited

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Control building with view of supporting structures.

Real-time modeling helped to optimize plant size. For example, a planned 36-meter-wide building was reduced in size by nearly 10 percent, resulting in significant time and cost savings. The client was skeptical about the feasibility given the difficulty of operations in that building. Visualization of the facility demonstrated how problems could be addressed, and the client agreed to the tighter layout.

The 3D environment also transformed project deliverables, with 3D model PDFs embedded in 2D drawings. The models denoted dimensions, elevations, tags, notations, reference points, and more, to facilitate understanding, planning, and execution of the designs. The 3D PDFs helped construction teams to visualize complex machine foundations, piping systems, and equipment before construction. This resulted in a drastic drop in site clarifications, which in turn accelerated construction progress.

3D Deliverables Added Value for Owner

Information developed by various disciplines was integrated for handover to the owner. This included intelligent piping and instrumentation diagrams; piping stress analysis; models for piping, equipment, civil, structural, architectural, and electrical raceways; master schematics; and cable routing interference checks. To ensure the operation and maintenance requirements were met, L&T-S&L also modeled equipment maintenance space, personnel movement aisle spaces, crane operation clearances, and staircase approaches during the detailed engineering design stage.

Bentley Navigator aided the commissioning team in visualizing the plant from an operation and maintenance point of view. High-definition animations produced using 3D models were incorporated in the O&M planning and organizational knowledge base for later use as part of training programs. These deliverables added value for the owner.

Engineering Time Reduced by 10 Percent

Built upon the Bentley platform, the customized 3D environment helped L&T-S&L to reduce the area required by the plant expansion by nearly 10 percent, both by reducing the size of facilities and by reducing the distance between units. The unified environment also reduced engineering time by approximately 10 percent, in part due to reduced engineering cycle times and faster approval processes.

As a result, L&T-S&L met an aggressive engineering design schedule, delivering the first unit within 51 months of the Letter of Intent, and the third unit 12 months later. The bulk of the engineering was completed within 20 months, which was four months less than projected. Initiated in September 2009, the project is scheduled to undergo the first trial run in December 2013.