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CNGS Engineering Accelerates Offshore Oil Field Development Using Bentley's Structural Analysis and Design Software

Creates Innovative Steel-plated Jacket for Ice-resistant Offshore Platform

Project Summary

Organization:
CNGS Engineering

Solution:
Process Manufacturing

Location:
Caspian Sea, Russia

Project Objective:

- Design fixed offshore platform to resist damaging ice loads.
- Develop efficient piping and equipment layout for the platform's constrained space.
- Monitor topside installation and track order of platform assembly.

Products used:
Bentley AutoPIPE
Bentley Navigator
Bentley Raceway and Cable Management
MicroStation
PlantSpace Design Series
ProjectWise
promis•e
SACS
Structural Modeler

Fast Facts

- CNGS executed Lukoil's Filanovsky oil field development project on the northern shelf of the Caspian Sea.
- Bentley's 3D technology was used to design the offshore facilities, including the LSP-1 ice-resistant offshore platform.
- This project represents the company's first application of integrated analysis and design using Structural Modeler and SACS.

ROI

- Detailed 3D designs of each platform were completed in 40 days.

Inventive Design for EPIC Project

CNGS Engineering is part of the CNGS Group, an international group of companies providing world-class engineering and construction services for the oil and gas industry. Lukoil, an international oil and gas company that produces 2.2 percent of the world's crude oil, retained CNGS to execute the Filanovsky oil field development project on the northern shelf of the Caspian Sea, where crushing ice piles present significant risk to offshore platforms. CNGS used Bentley's 3D design products from basic design through detail design of the offshore facilities, including the innovative steel-plated jacket for their ice-resistant fixed offshore platforms.

North Caspian's Extreme Conditions

The Filanovsky oil field is estimated to have recoverable oil reserves of approximately 1,100 million barrels. (Russia's total oil reserves are estimated at a minimum of 60 billion barrels.) Staged development of this field involves deployment of offshore infrastructure facilities subject to the extreme conditions of the North Caspian Sea. In winter when the sea surface freezes, ice that is nearly a meter thick forms piles reaching up to 10 meters above sea level. In the spring, the ice breaks up into massive chunks that flow with the ocean currents. Under these conditions, the ice creates crushing loads that can damage or even destroy offshore drilling platforms.

Located at the shallow depth of seven meters, the Filanovsky oil field drilling zone could not be reached by drill ship. The first stage of the oil field development project was to design and construct seven ice-resistant platforms. The scope of work for CNGS included design of the largest drilling platforms, LSP-1 and LSP-2, as well as the central process platform (CPP). Fuel from LSP-1 and LSP-2 was transferred to the CPP, which incorporated a processing plant to prepare 1 million tons of oil and 1 billion cubic meters of gas for transportation to shore each year.

The 20,750 ton LSP-1 platform, which was equipped with a fixed drilling rig, towered more than 90 meters above sea level and had an overall area of 50-by-96 meters – comparable in size to a U.S. football field. Technical challenges on this project included providing for simultaneous drilling and production, product collection and treatment, fluid rate measuring, and oil and gas transportation to shore. Above all, the facilities had to operate year-round in the punishing conditions of the North Caspian Sea.

Bentley's Structural Modeler Aids Innovative Jacket Design

CNGS has executed a number of engineering, procurement, installation, and commissioning (EPIC) projects in the Caspian Sea using Bentley software products from basic design, to bid development and comment, through detail design. Bentley technology facilitates the project team designing platform structures with sufficient detail to reduce the risk of ice damage under the most severe conditions. Moreover, it enables CNGS to accomplish project objectives within the shortest possible time period.

Using Bentley software, CNGS designed all platform jacket structures to withstand ice flow conditions without risk of damage.

Using Bentley's 3D design software, CNGS developed a unique design concept for the ice-resistant jacket that incorporated support units to sustain the weight of the platform and prevent damaging ice loads. The jacket was comprised of steel plate structures designed using Structural Modeler. In addition to the complex steel structures,

"We divided the very complex structure of the jacket into sections, each of which is an assembly unit. This allowed us not only to carry out the design but also to monitor the installation progress and track the order of assembly. The steel structures that we designed using Structural Modeler are so complex that we simply would not be able to design them without using Bentley technology."

– Sergeii Prysiazhynyi, CAD Department Manager, CNGS Engineering LLC

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Structural Modeler was used to design structural members such as beams, braces, gaskets, plates, and beam transition pieces. The software allowed designers to take into account clearances for processes such as welding, and cutting and joining of beams.

CNGS also utilized PlantSpace Design Series, promis•e, and Bentley Raceway and Cable Management for pipelines, 3D elements, cable routing, and installation of cable trays. Three-dimensional modeling of the integrated design allowed the project team to determine the most efficient layout for piping and equipment, and to avoid interferences between the elements.

CNGS' scope of work included design of the largest ice-resistant drilling platforms – LSP-1 and LSP-2, and the ice-resistant Central Process Platform.

ProjectWise enabled team members located in three places: Simferopol and Sevastopol, Ukraine, and Moscow, Russia, to seamlessly work together on the project, as well as transfer data among contractors, subcontractors, manufacturing plants, construction site, and client. The ProjectWise engineering content management system allowed the entire project team to work and collaborate in a common information environment. This assured designers that data was current and version-controlled when working with a remote office or partner.

SACS Confirms Structural Strength

The topside steel structures and jacket structures required strength calculations, which Lukoil required to be performed in SCAD Office. In addition, CNGS cross-checked the strength calculations in Bentley's SACS, which is intended specifically for use in the design and analysis of offshore platforms.

SACS supports wave, wind, and earthquake dynamic response analysis; special high-end analysis for severe accidental loadings such as dynamic blast, ship impact, and structural collapse; and foundation design, as well as fatigue evaluations on jacket structures and topsides. SACS provided two-way integration with Bentley's structural modeling software, which enabled automated updates between 3D models. Similarly, Bentley AutoPIPE was used for strength analysis of the complex piping system designs.

Reducing Risks and Saving Costs

Using 3D technology, the project team was able to identify and eliminate mistakes, monitor corrections, and reduce the turnaround time for release of drawing revisions. Performing 3D model checks with Bentley Navigator aided in clash detection and elimination. CNGS was also able to use the 3D model to calculate material quantities and acquire design documentation including plant sections, views, and isometrics. With MicroStation's open application programming interface, CNGS also created custom software for acquiring design specifications, which saved considerable time.

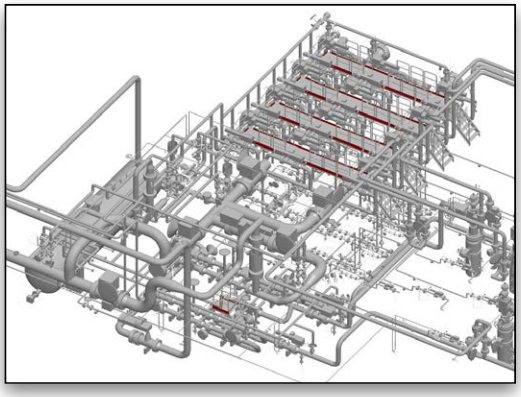
Design documents received from project partners in various formats were easily imported into Bentley software without loss of information. Bentley technology enabled CNGS to break the complex jacket structure into sections, each of which comprised an assembly unit. This allowed installation progress to be monitored, and the order of the assembly to be tracked. The 3D design facilitated construction planning and staging for LSP-1 and LSP-2, with MicroStation being used to simulate topside installation by float over.

Rapid Design Delivery

As both the topside and jacket steel structures for the platforms were so complex, CNGS would not have been able to design them without Bentley technology, according to CAD Department Manager Sergeii Prysiazhynyi. The software also accelerated the design process.

According to the project schedule, three months were planned to perform all work for each platform, starting from initial calculations and ending with drafts and specifications. All three ice resistant platforms were designed in only eight project months – one month faster. "We paid special attention to reflecting all elements because our 3D model was the source of delivering all project documentation," noted Prysiazhynyi. "It took 40 days to model an individual platform. So modeling all three platforms took 120 days out of 240 total project days, productively spending only 50 percent of the time. Such a quick turnaround was possible due to successful collaboration of design engineers."

In addition to accelerated design, the client, Lukoil, benefited from quality design documentation and visualizations. MicroStation's rendering engine produced visuals that gave deep insight into the design and constructability of the platform.



For strength analysis of complex pipe works, CNGS used AutoPIPE to provide integrated design of the platform piping.

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