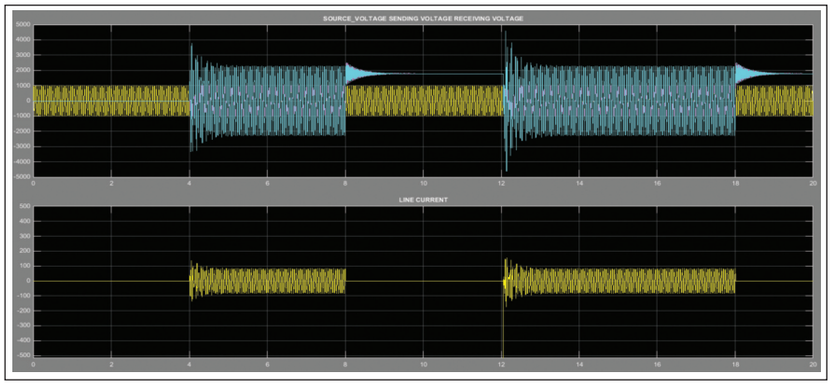
Model-based Design Approach Facilitates Decision-making

■ Simulations are helping engineers identify potential problems and gain valuable insight into equipment and system operation.



Voltage and current profile along a step-out are shown. (Image courtesy of ABS)

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Moving from concept to reality is a universal engineering challenge. One of the ways to simplify the transition from engineering design to construction is model-based design, an approach that allows engineers to explore a variety of alternatives and options for equipment and systems before making a capital commitment.

Several years ago, ABS embarked on the development of simulation capabilities as part of its technology development program. The resulting modeling and simulation proficiencies provide insight into equipment/system design and operation, including subsea power systems.

Research efforts to date have yielded models of step-outs coupled with tiebacks as well as models of offshore and marine power systems operating in a variety of advanced configurations such as closed ring and with connected energy storage.

Subsea power systems

Pumping stations and compression stations are located along the length of a tieback to achieve the desired flow for piping system capabilities. Linear step-outs supplied from shore are tapped into the tieback at multiple points along its length to deliver electrical energy for the pumping and compression stations at the required rate and with the appropriate quality.

Subsea modeling gives engineers a way to evaluate the interaction of the electrical power systems with the tieback and the pumping/compression stations. This approach allows them to study power quality phenomena during normal operation scenarios such as startup, acceleration, production and shutdown as well as during transient events.

In normal operation, the voltage at each tap point is dependent on the total system load as well as the loading of individual pumping stations, which can be modulated to meet operational requirements. The transfer of pumping/compression load from one station to another not only can impact the total system load but also can result in the potential excursion of power quality outside of acceptable values. The effects of these excursions can be mitigated using equipment capable of operating in a more diverse power quality environment or by using line compensation equipment to actively stabilize power quality.

When there is a fault in a pump/compressor station, a "trip" or reduction in capacity can occur. The effects of trips can propagate in both directions along the tieback and step-out, introducing potentially severe shock waves in the tieback and power quality excursions in the step-out.

Simulation and model-based design allow designers and engineers to design out faults identified prior to construction.

Advanced power systems

Offshore power system requirements are challenging the functional limits of traditional equipment and systems. The need to reduce emissions and improve operational efficiency is pushing the industry toward power systems that operate in closed bus and/or closed ring configurations. This, in turn, is opening the door for reintroducing direct current power distribution systems and developing energy storage systems.

The velocity and magnitude of change to equipment and systems as well as empirical experience have raised concerns about the reliability of power systems that incorporate these new technologies and the adequacy of the analysis techniques used to predict equipment and system performance.

In the dynamic-positioning space, for example, there is great interest in a technique known as live short circuit testing to validate predictive analysis of equipment and system performance.

ABS models are being developed to study equipment and system performance under a variety of normal and fault operating conditions. These same models also will allow engineers to study the optimal coupling point of energy storage systems. Optimizing the coupling point of energy storage systems offers the opportunity to reduce capex by providing the potential to justify reduction in the size and number of onboard generators. Opex and emissions can be reduced using this approach because it provides the opportunity to run the minimal set generators at their lowest cost and lowest emissions point.

In addition to allowing optimization of the coupling point, models help engineers understand the interaction of the various energy sources facilitating stable power system operation and power quality.

Simplifying the move from concept to reality

The ABS Simulation Project, which incorporates model-based design, is part of ongoing multiyear research targeting subsea power systems, power systems associated with dynamic-positioning vessels and other innovative technologies that are rapidly being rationalized and introduced into the offshore sector. ABS hopes to further these efforts through the formation of a joint industry project that will focus on practical marine and offshore applications of simulation technology.

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