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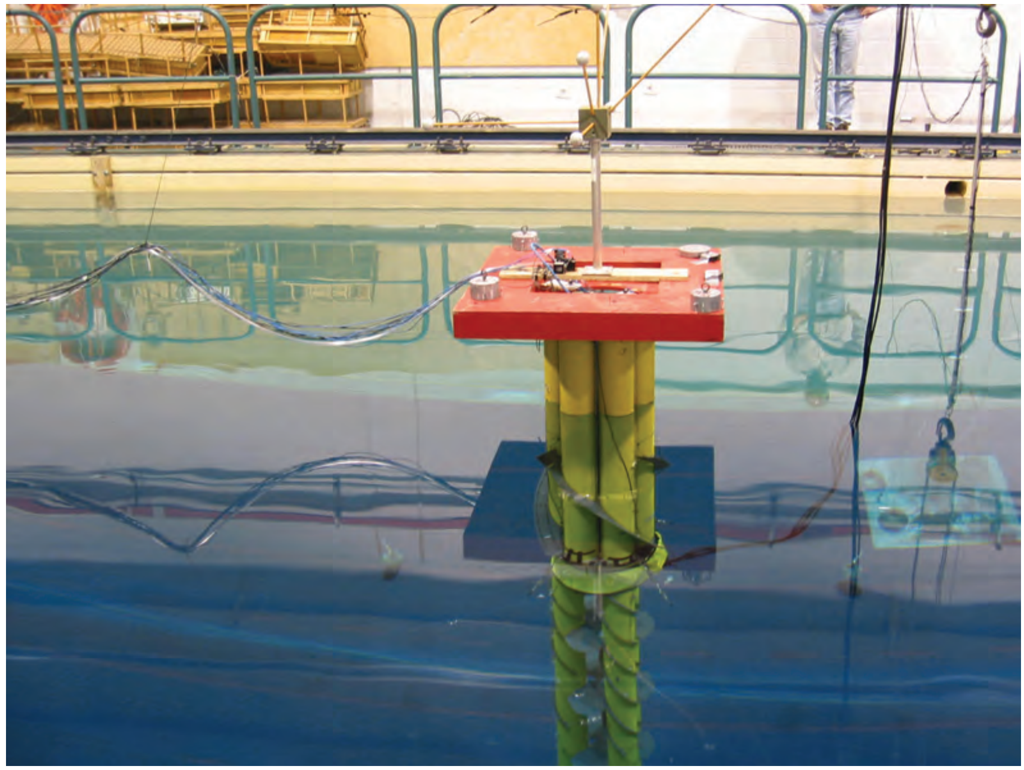
Deepwater Risers &

Hydrodynamic Performance Research

by Andrew Safer

Vortex-induced vibration (VIV) is a key issue for oil companies that are planning deepwater projects (water depth over 1,000 feet or 304 meters). VIV is the motion generated by the flow of water against the riser (the cylinder that connects the drilling or production platform to the subsea wellhead), producing vortices that are shed alternately from one side of the riser to the other. The longer the riser, the greater the VIV-induced loading, so VIV suppression devices are a critical component in deepwater riser design. As an eddy or vortex is shed from the cylinder, an area of low pressure is created pulling the cylinder to that side. Since the vortices are shed alternately from each side, this creates a cyclical loading on the cylinder ultimately leading to motion in the cross-flow direction. In order to minimize the concurrent shedding of vortices along the entire length of a cylinder, strakes are fitted to break up the vortices, thus significantly reducing the associated motion. (A strake is a spiraling strip engineered to break up uniform flow over cylinders such as on smokestacks (subject to wind loads)).

Oceanic Consulting Corporation of St. John's, NL, Canada, provides commercial research and development services to the marine industry, including conducting experiments on full-scale strakes and fairings (an auxiliary structure that serves to reduce drag) for oil majors and vendors to ensure they will provide the required VIV mitigation for specific offshore installations. Using a high-speed experimental rig designed and built in-house, Oceanic evaluates these devices in the 200-m wave/towing tank (12 m wide by 7 m deep) at the National Research Council's Institute for Ocean Technology (IOT-NRC) in St. John's. The maximum carriage speed is 10 meters per second. Between July 2010 and January, Oceanic completed a series of strake and fairing experiments for an oil and gas company. Over the past nine years, Oceanic has conducted numerous strake and fairing experiments for oil industry clients. Oceanic's recent research was among the world's first experiments involving two risers in tandem configuration using full-scale specimens, one upstream from the other.



Oceanic's Senior Consultant Paul Herrington notes that in recent years, "more and more installations have multiple risers coming up through the water column that are getting closer and closer together. They're trying to incorporate more production facilities in a smaller location." This requires mitigating the VIV generated by multiple risers. In the recent research campaign, Oceanic evaluated the performance of fairings and strakes on tandem-oriented cylinders at distances ranging from three-

Dan Walker, President, Oceanic

Paul Herrington, Senior Consultant, Oceanic

cylinder diameters to 20-cylinder diameters apart. To do this, they used a high-Reynolds-number experimental rig capable of evaluating up to 23"-diameter cylinders in both single and tandem configurations. ('Reynolds number' is a non-dimensional measurement that takes into account three key parameters such as diameter, velocity and viscosity of the water. Offshore installations typically involve flows at high Reynolds numbers.) Oceanic built the rig in 2002 to evaluate 12"-diameter cylinders for their first DeepStar project. DeepStar is a Houston-based joint industry project between oil companies, vendors, academics and research institutes whose focus is to develop deepwater technologies. While the rig was set up in the towing tank to conduct the recent experiments, Oceanic also investigated fairings for two other clients to reduce the set-up and take-down costs for each project.

Over the last five years, Herrington notes, Oceanic has seen a marked increase in research involving fairings because they reduce the drag more significantly than strakes. **"With some fairing designs, the size of the fairing can be doubled for the same drag of a similar size strake," he adds. "As a result, Oceanic has been able to investigate larger-diameter cylinders—up to 23 inches, compared to up to 18 inches with strakes."**

Owen Oakley, a research consultant with Chevron's Energy Technology Company in San Ramon, California, has been heavily involved with fluid dynamics research, particularly the physics and modeling of vortex-induced vibrations. He recalls Oceanic's early work for DeepStar: "They were the first to assemble a test rig where we could investigate cylinder vortex-induced vibrations in multi-degrees of freedom at full scale. We also looked at different cylinder roughnesses and the effect of ambient turbulence. It was quite revealing and set us on the path to a whole series of experiments." Oakley adds that most testing had been done in laboratories at small scales and industry needed to understand if the physics was similar at higher Reynolds numbers. "If you're going to try to dangle an array of risers in 10,000 feet of water and expect them to last 20 years, you can't afford to allow them to fatigue," he added. "We absolutely need to be able to predict what the currents and excitation are going to be, and ensure we can suppress vibrations adequately over the life of the structure. We have done extensive studies on how to reduce riser vibration with strakes and fairings, and how marine growth might reduce their effectiveness. We come to Oceanic to do these tests because they are equipped to run them at essentially full scale." Confirming Oakley's assessment, Herrington notes that since these offshore installations are such large capital programs which require assurances against VIV failures, Oceanic integrates with a variety of industry stakeholders such as oil companies, equipment suppliers, and multiple joint industry projects, including both DeepStar and the Norwegian Deepwater Programmes. Oceanic Consulting Corporation President Dan Walker started the company in 1993 to promote contract research using the test facilities at the Ocean Engineering Research Centre at Memorial University of Newfoundland, the Institute for Marine Dynamics' (now the National Research Council's Institute for Ocean Technology's) towing tank, ice tank and offshore engineering basin, and the flume tank and Centre for Marine Simulation at the Marine Institute, all located in St. John's. In 1996, Oceanic built their first experimental rig to test fairings that had been developed to reduce the drag on the cables of a seismic array. In 2003, they conducted a variety of experiments on what was to become the world's first cell spar facility in the Red Hawk field in the Gulf of Mexico. These included evaluating the VIV characteristics and resistance drag loads of the floating production facility, and the hydrodynamic loads on strakes. Most of Oceanic's full-scale VIV work has been completed for projects in the Gulf of Mexico where there are loop currents, and offshore Brazil, where there are deep surface currents.