Deep Water Platform Analysis
using the WaveBook

Petroleum Exploration

Application Note #59

Application Summary

Oil drilling rigs designed for deep-water installations differ considerably from those intended for terra firma sites. They come with a set of operational requirements that test the skills and ingenuity of the finest engineers and architects. Stabilizing rigs in angry seas involves designing structures and finding other means to withstand the forces of both wind and water currents during the worst of storms. Shell International Exploration and Production, based in Houston, Texas, was one of the first companies to recognize the critical need to simulate many of these parameters in a laboratory setting. They constructed and instrumented a one million-gallon wave tank to test models of new designs for these offshore structures. They simulate storm conditions from around the world and measure the motions and reactive forces of the test models.

Another tank, capable of speeds to 7 ft/s, tests the effects of current on various tubular components, pipe collisions, and impacts. These data help engineers design systems that mitigate hazardous effects. In addition, they field test the motion of anchor-handling vessels, and compare it to the motion of a package being lowering to the seafloor 6,000 feet below. The motion of the vessel is sometimes amplified in the support cable and tends to destabilize the package.

Possible Solution

Joe Haws, Senior Technical Associate at Shell E&P, purchased several well-known brands of data acquisition boards and software a few years ago to monitor and measure all the critical variables involved in the tests, including the speeds and forces in the tank. And although he and his colleagues still use some of the original equipment, much of it is not compatible with other instrumentation and software that could help Haws make more flexible use of his facility. For instance, the hardware cannot accommodate either customized or other widely used software packages, and the data acquisition speeds are too slow for some measurements.

IOtech's Solution

These hardware and software limitations encouraged Haws to evaluate other data acquisition systems, including those from IOtech, Inc. After completing his tests, he purchased some IOtech DaqBooks® and WaveBooks™ with WBK10™ expansion chassis. He also uses the DaqView™ and WaveView™ software that came with the hardware. In addition, Haws can now use his own software for analyzing the test data, something he was unable to do with the previous data acquisition system.

The two most common uses for the equipment are in the current tank facility that simulates the water flowing around ocean platforms. It is a loop of water, about 100 ft. long, 20 ft. deep, and 3.5 ft. wide, containing a large, hydraulic-powered propeller that drives the water around the tank. "We put models in a test section and measure various loads, accelerations, and tensions," says Haws. "We measure collisions between pipes using the WaveBook because the impacts generate relatively high-frequency signals."

Shell's test lab includes a water tank where pipe collisions simulate the motion of an oil rig's support structure under hydrodynamic conditions. IOtech DaqBooks and WaveBooks collect the high-frequency vibration signals generated so engineers can analyze improved structural designs.

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The pipes bang together under the force of the current and generate so-called vortex-induced vibrations. Haws and his colleagues have been researching this phenomenon for about 15 years, but until just recently, people outside his company claimed it didn't exist. At one time, the results of the tests were proprietary information, but now Shell E&P sells the data to other companies as well as partners with them on various projects.

The input to the data acquisition system comes from a variety of sensors, such as load cells, accelerometers, and strain gages. Quite often Haws instruments an aluminum rod placed in the center of the pipe that attaches to the sides with stand-offs. Strain gages are attached to the rod, accelerometers are fastened to the stand-offs, and bi-directional load cells are mounted to the top and bottom. Haws puts the pipe under tension and measures it with the load cells, then installs video cameras and paints stripes on the pipe to measure the motion.

"The speed of the WaveBook is a big help," claims Haws, "because the other equipment we had couldn't run fast enough. Even now we are pushing the WaveBooks and DaqBooks pretty hard to measure the collision impacts. With the number of channels we use, 40 channels at 10 kHz per channel, the acquisition rate is about 400 kHz or a little faster." The frequency content of the impact is around 1,000 Hz, and Haws usually tries to operate ten times faster than the measured variable.

Haws has enough expansion chassis for as many as 60 channels, but most of the time, 40 channels have been adequate. "When you start taking data with that many channels, that fast, you get buried alive in data real quick," says Haws. "Especially when we are doing multiple tests, like two or three hundred, we wind up with some monstrous files, and then of course, the video files are huge too, so we consume lots of real estate in data."

Conclusion

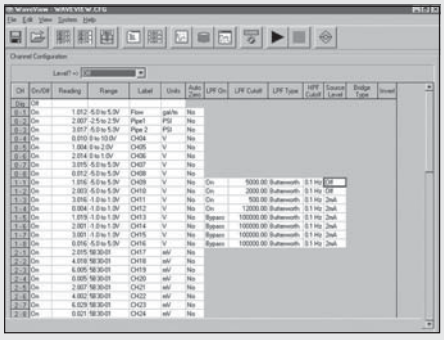
Data acquisition systems comprising IOtech WaveBook and DaqBook hardware and software monitor variables in a test facility housing a unique water tank. A large hydraulic motor-driven propeller forces a current of water through the tank to simulate the ocean currents surrounding oil-drilling rigs in stormy seas. The force, speed, and vibration data collected on models in the tank help engineers design strong and robust platforms to withstand the worst possible storms.

WaveBook Series

The WaveBook™ series of portable and desktop digitizers offer multi-channel waveform acquisition and analysis for portable or laboratory applications. All WaveBook models include 8 built-in channels expandable up to 72 channels of voltage, accelerometer, microphone, strain gage, thermocouple, position encoder, frequency, high voltage, and other signal types. For applications beyond 72 channels, up to four WaveBooks can be combined within one measurement system, for a total capacity of 288 channels. WaveBooks are available with either an Ethernet or parallel connection to a PC.

Features

- PC connection via Ethernet, parallel, PC-Card, or PCI card
- 1 µs/channel scanning of any combination of channels
- Expandable up to 288 high-speed channels
- SYNC connection allows multiple units to measure synchronously
- Add up to 224 lower-speed thermocouple channels
- DSP-based design provides real-time digital calibration on all channels
- Single and multichannel analog triggering with programmable level and slope
- Digital TTL-level and pattern triggering
- Pulse trigger and external clock
- Programmable pre- and post-trigger sampling rates
- Sixteen 1-MHz digital inputs
- Operable from AC line, a 10 to 30 VDC source, such as a car battery, or optional compact rechargeable battery module



Using WaveView software's spreadsheet-style interface, you can easily set up your application and begin taking data within minutes.

Included Software

- WaveView™ for *Out-of-the-Box*™ setup, acquisition, and real-time display:
  - Scope mode for real-time waveform display
  - Logger mode for continuous streaming to disk
- eZ-Analyst™ for real-time spectrum analysis
- Export data in third-party formats
- Includes drivers for Visual Basic®, Delphi™, C++ for Windows®; DASYLab®, and LabVIEW®
- ActiveX/COM development tools