

Top to Bottom Current Profiling for the Offshore Environment

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Introduction

As the search for oil in the Gulf of Mexico has moved into deeper waters, the need for improved current monitoring has grown. The longer water columns associated with deep-water means that there are more variables to account for when planning an operation. Accurate information about the currents in the water column is necessary for carrying out those operations safely and cost-effectively.

The technical challenges of current monitoring have grown with the length of the water column. Traditionally, downward-looking Acoustic Doppler Current Profilers (ADCPs) have been used throughout the Gulf to provide detailed information about the undersea weather. But with increased operating depths now commonplace, a single downward-looking ADCP may not provide enough coverage. To solve this problem, RD Instruments engineered a variety of products that can be used individually, or in combination, to gather accurate, real-time data from throughout the water column. Most deep-water rigs operating in the Gulf, and throughout the world, now use RDI ADCPs for profiling currents.

Founded in 1982, RDI developed the first commercial ADCP products, which were immediately employed in offshore oil operations. RDI continues to innovate in the design, manufacture, supply, and support of state-of-the-art acoustic Doppler instrumentation. The company currently employs a multi-disciplinary crew of scientists, engineers, technicians, sales, and support personnel, and resides in a 30,000 square-foot ISO-9001: 2000 facility that includes state-of-the-art engineering, laboratory, manufacturing, and test areas.

Because drilling conditions vary, RDI's modular systems are designed for adaptation. At the surface, RDI's innovative Horizontal-ADCP (H-ADCP) measures near-surface currents that affect station keeping and surface-vessel navigation. The H-ADCP can also be configured to monitor wave activity around the platform. RDI's Ocean Observer extended-range 38 kHz ADCPs, and the Workhorse Long Ranger 75 kHz ADCPs, set the industry standards, providing accurate profiles to depths of 5000 feet. And for conditions where bottom currents must be monitored, RDI offers the upward-looking 75 kHz Long Ranger with acoustic telemetry for long-duration, unattended operation.

Surface Currents

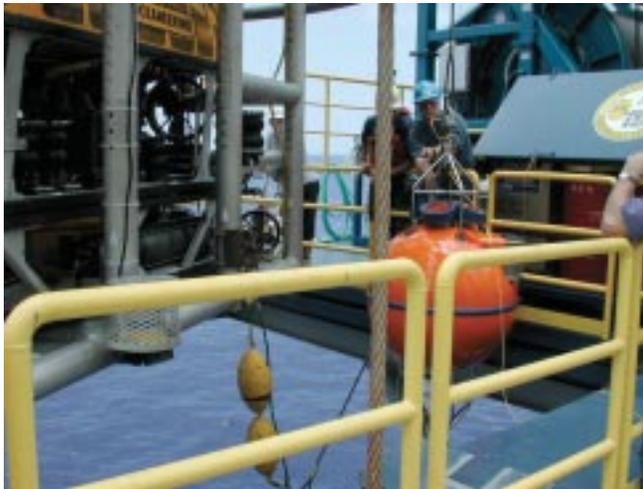
Ironically, the unique challenge of deep-water operation begins at the surface. Not only do surface currents affect logistical operations like loading and unloading, tender docking, and equipment recovery, but they can also cause excessive riser inclination during drilling operations. The unpredictable effects of the infamous Gulf of Mexico Loop Current, and its resulting eddies, make accurate near-surface current monitoring crucial for deep-water activities in the Gulf.

The commonly used downward-looking ADCP installation has operating characteristics that are not optimal for near-surface monitoring. Typically, for long-range operation, a low-frequency ADCP is chosen and configured with large depth-cell sizes. While this configuration provides current profiles of many thousands of feet, the measured area starts well below the near-surface currents acting on the platform. Even an upward-looking ADCP, mounted close to the surface, may not capture the top current layer directly impacting the rig, because of inherent limitations of the measuring-beam geometry.

Near the surface, the platform itself introduces changes in the current and wave fields, either due to the platform's size or through the use of thrusters for station-keeping. Measurements must be made beyond the rig's sphere of influence. Therefore, true near-surface measurements cannot be reliably accomplished by using any current meter that measures currents directly in the vicinity of the rig.

To meet the unique requirements of near-surface current profiling for offshore applications, RD Instruments created the Workhorse Horizontal-ADCP, a long-range system that can monitor the velocity of currents up to 700 feet away from the platform. Mounted at a depth of 20-50 feet, and oriented horizontally, the H-ADCP monitors current magnitude & direction at up to 128 individual points, forming a current profile extending away from the rig just below the surface.

Because it profiles away from the rig, the Horizontal ADCP gives measurements of the current outside of the rig's sphere of influence, resulting in data that is more representative of actual current conditions. The Horizontal ADCP can also be configured



RD Instruments Long Ranger ADCP being deployed from an oil rig to collect deep water current profiling data

to measure the directional and height spectra of the wave field. This information contributes greatly to the safe operation of surface vessels near the platform. Data collected by the H-ADCP also contributes to future rig design.

Mid-Column Currents

The oil, of course, isn't near the surface; it's at the bottom. In-between is a column of water whose currents can wreak havoc on a drilling operation. Whereas the near-surface currents can tend to push a drilling rig off station, the mid-column currents can tend to deform the riser itself. This is no real surprise; with risers sometimes being only 12 inches in diameter, yet thousands of feet long, high currents within the upper 1500 feet of the ocean can easily stress risers, similar to the wind stress on a tall building. Loop Current eddies have exhibited sustained current velocities of several knots, to depths of over 1000 feet. Understanding the drag-induced stress is critical to design, and important in everyday operations. The expense of lost operation time, or a damaged riser, is so great that it pays to know how much "wind" is blowing down there.

That's where RDI's extended range systems come into play. The Ocean Observer 38kHz ADCP is the premier extended-range ADCP, profiling currents up to 5000 feet down. For platforms operating in shallower depths, the Workhorse Long Ranger 75kHz system profiles downward to depths of 2000 feet.

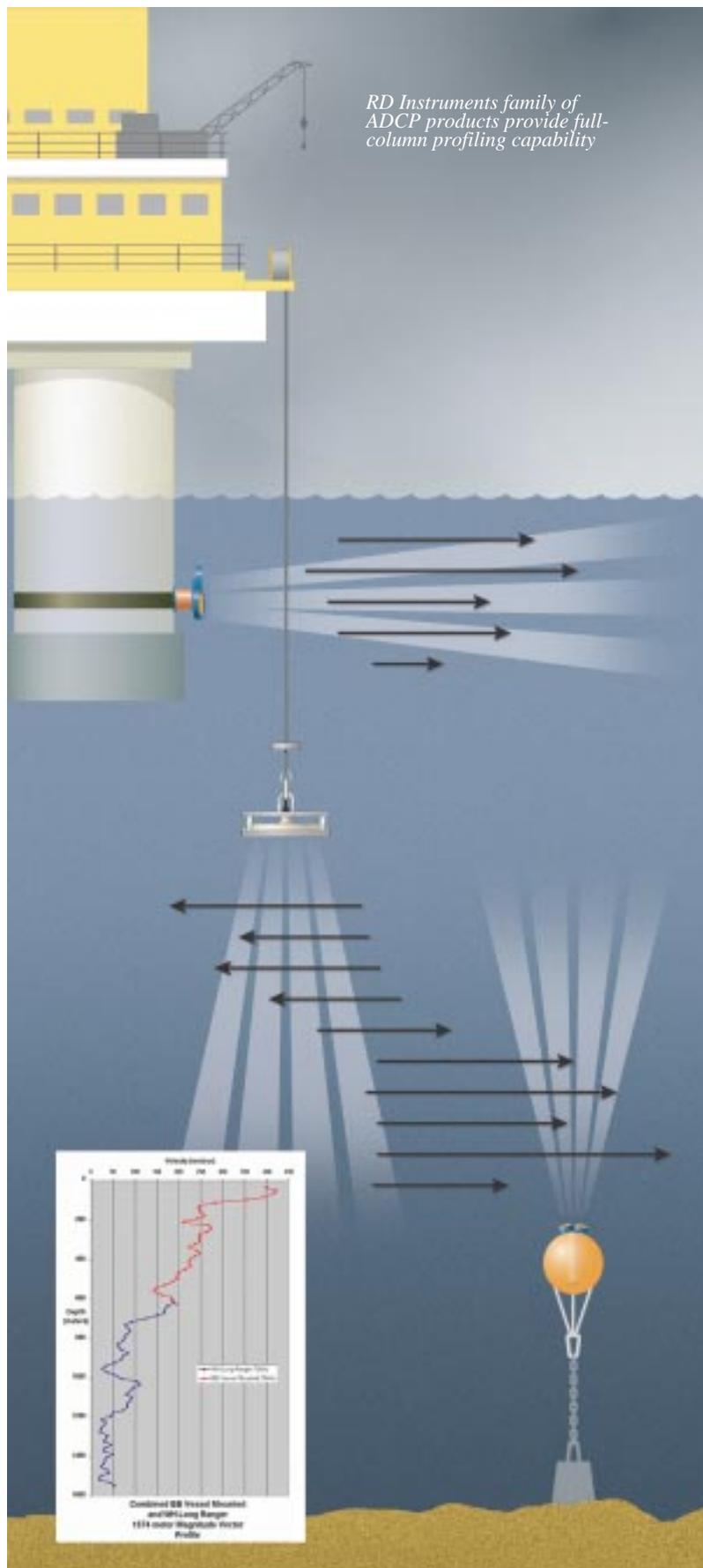
The unparalleled range of the Ocean Observer and Workhorse Long Ranger ADCPs means that nothing must be deployed deep within the water column, where it could interfere with operations. Either system can be mounted on the rig or near the surface. It is common to mount these downward-looking systems onto the same fixture used for the Horizontal ADCP. This reduces installation costs and makes routine maintenance more efficient.

Bottom Currents

The benefits of near-surface and mid-column current monitoring are obvious and nearly universal. But when operating in depths beyond the reach of a downward-looking ADCP, operations like surveying and ROV deployment require knowledge of the near-bottom "boundary-layer" current velocities. A recent Minerals Management Service survey, conducted near the Sigsbee Escarpment in the Gulf of Mexico, reported periodic bottom current velocities of roughly two knots, with a period of 8-12 days. Bottom-current data can also be important in areas where the sea floor has steep topography.

RDI's solution is an upward-looking Workhorse Long Ranger 75 kHz ADCP moored to the sea floor, or attached to a bottom structure. This arrangement not only provides accurate profiles of the bottom current, but can be situated so that its beams overlap with those of the downward-looking ADCP above, providing mid-column current measurements as well. For applications requiring high-resolution profiling of bottom currents, an RDI Workhorse Sentinel 300 kHz ADCP could be used in addition to the Long Ranger.

In a recent deployment, RDI and Shell International EP placed an RDI Workhorse Long Ranger 75kHz ADCP in 5,164 feet of water in the Gulf of Mexico. The Long Ranger ADCP and a Linkquest acoustic modem were mounted in a one-meter sphere and moored to the sea floor with a 615-pound anchor weight. The Workhorse Long Ranger was chosen because it has the longest profiling range of any self-con-



RDI Instruments family of ADCP products provide full-column profiling capability

tained ADCP. This configuration allows for completely self-contained, unattended operation for up to three months, with data being transferred to the surface in real time. Maintenance of this system can be conducted during scheduled ROV inspection operations, thus limiting extraneous costs.

This deployment verified the feasibility of an upward-looking configuration for bottom-current measurement using acoustic telemetry to transfer data to the surface in real time. Data from the upward and downward-looking ADCPs in the region of overlap (about 164 feet) were consistent, showing strong agreement between the two instruments. This system, constructed entirely from off-the-shelf components, was so successful that Shell International EP ordered a complete system rated for operation at depths up to 10,000 feet.

Deployment of the Long Ranger can be accomplished either with a short mooring, as used in the Shell project, or by hard mounting on an available structure. If the BOP can provide a mounting location, with power and communication capability, the ADCP can be deployed for an extended period.

Conclusion

Reduction of operational risk, in terms of both safety and expense, requires a clear picture of the currents in the water column. RDI provides this picture by offering a modular solution comprised of off-the-shelf ADCPs that can measure currents from the top of the column to the bottom, and everywhere in-between.



RD Instruments H-ADCP collects both current measurements and wave data in the horizontal plane

The innovative Workhorse 300 kHz H-ADCP provides near-surface current measurements to support station keeping and surface-vessel navigation, while providing a resource of data that is invaluable for future rig design. When equipped with RDIs WAVES capability, the H-ADCP can measure wave height and direction, making surface operations even safer.

The Ocean Observer extended-range 38 kHz ADC can measure current profiles to depths of 5000 feet and the Workhorse Long Ranger 75 kHz ADCP provides a long-range, self-contained monitoring solution in both downward-looking and upward-looking configurations for full water-column coverage. Deep-water operations in the Gulf demand knowledge of the currents; RD Instruments provides it. ■

