Dual Gradient Drilling Technology At Work After Long Development Cycle

SEA CON Contributes Connectors, Cables to DGD Joint Industry Project

By Michael Mulcahy

SEA CON (El Cajon, California) began supporting proof-of-concept dual gradient drilling (DGD) projects well over a decade ago and has since collaborated with major oilfield contractors to supply more than 1,000 connectors and cable assemblies. It has also provided cable and connector logistical project management for the installation of a seagoing DGD system on the dynamically positioned deepwater drillship Pacific Santa Ana, currently operating in the Gulf of Mexico. The complexity of outfitting the entire system resulted in SEA CON’s participation in planning, system integration and commissioning support at a much higher level than is customary for a connector and cable system manufacturer.

The relatively long history of DGD technology development from concept to first production drilling system illustrates that sometimes technical feasibility alone is not enough to ensure commercial success until the marketplace accepts it, and that process can be accelerated only so much.

Background/History

In 1996, the Subsea MudLift Drilling Joint Industry Project (SMD-JIP) was formed to study the feasibility of an alternative deep-water drilling technology that came to be called dual gradient drilling. The technology’s success hinged on development of a mud lift pump sufficiently robust to move drilling mud containing considerable embedded solids of various sizes to the surface, without clogging intermediate drilling system components.

Chevron North America Exploration and Production Co. (Houston, Texas) encapsulated the operating principle and benefits of DGD by saying: “Unlike conventional deepwater drilling, which uses a single drilling fluid weight in the borehole, [DGD] employs two weights of drilling fluid—one above the seabed, the other below. This allows drillers to

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>Subsea MudLift Drilling (SMD) Joint Industry Project is formed, with participants including major oil and gas industry contractors. Purpose: to investigate feasibility of developing a mud lift pump (MLP) as the prime component of a Dual Gradient Drilling (DGD) system. SEA CON collaborates with MLP developer GE Oil and Gas (GEOG) by providing cables and connectors for the proof-of-concept phase.</td>
</tr>
<tr>
<td>2001</td>
<td>Semi-submersible rig Ocean New Era successfully drills a test well applying DGD technology in 910 ft. of water in the Gulf of Mexico.</td>
</tr>
<tr>
<td>2008</td>
<td>A 2-year Front End Engineering Design (FEED) program is initiated. SEA CON’s engineering and project management team works closely with GEOG to develop the range of connector and cable products needed to meet the highest level of reliability, with particular focus on American Petroleum Institute (API) compliance.</td>
</tr>
<tr>
<td>2010</td>
<td>Contract is signed with GEOG for first MaxLift Pump to be used in a DGD application. The full-scale technology development project would culminate in the first production DGD system.</td>
</tr>
<tr>
<td>May 2012</td>
<td>Newbuild drillship Pacific Santa Ana arrives in Gulf of Mexico to start its maiden drilling contract with Chevron.</td>
</tr>
<tr>
<td>February-May 2014</td>
<td>First field trials of the DGD technology onboard Pacific Santa Ana in the Gulf of Mexico.</td>
</tr>
</tbody>
</table>

DGD Timeline 1996-2014

Face view of SEA CON’s MSSK connector, which complies fully with API 16D design requirements.
project management, final assembly and testing services, ultimately delivering connectors and cables for the Pacific Santa Ana’s major DGD components, including (from deepest to shallowest): blowout preventer (BOP), seawater-powered MaxLift pump, solids processing unit (SPU) to feed the MaxLift pump drilling mud containing solids at the maximum pumpable size of 1.5-inch thickness, and subsea rotating device (SRD) to separate mud from riser fluid.

In total, SEA CON provided more than 360 cable assemblies, 720 bulkhead connector receptacles and multiple pressure-compensated distribution manifolds (totals including spares), most of which were purpose-developed to meet critical API guidelines.

Pacific Santa Ana is rated for 12,000 feet of water during normal drilling operations. It is equipped with a DGD riser, a mud lift pump handling system, six mud pumps (three for drilling fluid and three for seawater), extensive fluid management system enhancements, and more than 13 miles of DGD-related cables. The DGD system is rated for 10,000 feet.

One of the key efforts was to ensure system-wide commonality of cables, connectors and spares throughout the drill stack interconnects, not just in the MaxLift Pump portion but in the overall system as well. Because SEA CON was a strategic vendor for the MaxLift Pump, it was requested that SEA CON engineers work with their counterparts from the other project participants to order cables and connectors ensuring MaxLift Pump, SRD, and SPU interconnection and interoperability. It was essential to work with fellow suppliers to ensure system-wide connector compatibility, with components ordered by the most efficient and economical “just-in-time” process and staged before installation on the Pacific Santa Ana. SEA CON also provided deck cables and test boxes needed for on-site predeployment systems integration tests. SEA CON’s role as cable and connector logistics support vendor resulted in a high degree of reliability and assurance of component compatibility among connectors from various vendors that had to interoperate smoothly. SEA CON provided final connector checks and balances. Through its knowledge of the overall scope of the program, SEA CON could optimize among ordering, production, shipping and installation schedules, taking advantage of economies of scale and ensuring that spares were judiciously procured and staged.

**2008 Highlights**

In 2008, a two-year, front-end engineering design (FEED) program was initiated for DGD. Due to the complex requirements for this project, SEA CON reached across multiple divisions, collaborating to provide connector design, more closely match the pressures presented by nature and effectively eliminates water depth as a consideration in well design. DGD also allows drillers to more quickly detect and appropriately react to downhole pressure changes.”

In September 2001, the semisubmersible drill rig *Ocean New Era*, capable of drilling in 1,500-foot depths, drilled a successful DGD test well at 910 feet in the Gulf of Mexico, in the world’s first subsea field test of a full-scale DGD system.

Current Status

After installation in late 2013, the DGD system was “wet-deployed” aboard the Pacific Santa Ana in the Gulf of Mexico in February 2014, drilling exploratory holes and undergoing trials in preparation for full-production DGD. The tests are ongoing. Pacific Santa Ana is one of five purpose-designed, DGD-capable drillships owned by Pacific Drilling (Houston) that are either working today or under construc-
tion. The others are: *Pacific Khamsin*, *Pacific Sharav*, *Pacific Meltém* (under construction) and *Pacific Zonda* (under construction).

**Field Testimonials**

Having SEA CON support coordination and integration of cable and connector logistics, ordering and sparing helped keep successful system integration and interoperability as the overarching focuses of the DGD project, eliminating the potential for numerous problems.

SEA CON has received positive feedback for its DGD connector and cable assembly work in the *Pacific Santa Ana*’s commissioning deployment.

“The three deployments of 350-plus SEA CON connectors without any leak whatsoever is a very strong testament to both the quality of the connectors and to all of the offshore team who have delivered the installation quality needed to achieve that 100 percent performance level,” said Ken Smith, project manager for the Dual Gradient Drilling Project for Chevron North America Exploration and Production Co.

“SEA CON has provided us excellent service and support, ensuring the success of the PBOF [pressure-balanced, oil-filled] connectors since the beginning,” added Walter Cabucio, DGD consultant to the Chevron Dual Gradient Project Team.

**Outlook for the Future**

Several ultradeepwater DGD-capable drillships will be operating worldwide within less than two years. Industry estimates predict that DGD technology can save drillers $5 million or more per well drilled in deep (more than 4,000 feet) and ultradeep (more than 7,500 feet) waters. If these savings are realized, DGD technology, after nearly two decades of development and gradual industry buy-in, will have been well worth the collective effort.

©Copyright 2014 by Compass Publications Inc. Sea Technology (ISSN 0093-3651) is published monthly by Compass Publications Inc., 1600 Wilson Blvd., Suite 1010, Arlington, VA 22209; (703) 524-3136; oceanbiz@sea-technology.com. All rights reserved. Neither this publication nor any part of it may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior permission of Compass Publications Inc.