DEEP-WATER WELL DELIVERY AT ITS BEST

PARQUE DAS CONCHAS – BC-10

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SHELL BC-10: DEEP-WATER MOMENTUM AT ITS BEST

Watch video online
BC-10, also known as “Parque das Conchas”, offshore Brazil is one of Shell’s most challenging deep-water projects. Shell has a 50% interest in the project and is the operator, while Oil and Natural Gas Corporation has 27% and Qatar Petroleum International has 23%. It lies in around 1,780 metres of water in the Campos basin and develops the Ostra, Abalone, B-West, O-North, Massa and O-South fields.

The full field development comprises three phases. To ensure that the project could be viably developed, the wells had to be designed around a small number of drill centres in order to minimise costly sub-sea infrastructure.

The location of the fields 120 kilometres off the coast, the water depth of almost 2 kilometres and the scattered nature of the reservoirs posed daunting technical challenges.

BC-10 Phase 3 produced the biggest technical and non-technical challenges including:

- very thin and disconnected channel sand reservoirs;
- shales in the reservoir impacting sweep and ultimate recovery;
- limited seismic accuracy and geological markers;
- comparably small reserves; and
- increased technical challenges for the wells due to the reduced number of drill centres.
# JOURNEY MILESTONES

## PHASE 1
April 2008 – March 2010
- 10 development wells
- 2 appraisal wells
- 2 artificial lift manifolds

## PHASE 2
April 2012 – January 2014
- 11 development wells
- 2 appraisal wells
- 1 artificial lift manifold

## PHASE 3
January 2014 – August 2014
- 7 development wells
- 1 appraisal well
The start of any successful well campaign begins during the front-end design stages and follows Shell’s Global Well Delivery Process (GWDP).

The BC-10 team – from Front-End Engineering Design (FEED) team members in Houston to Operations personnel in Brazil – used this multi-disciplinary workflow to coordinate plans, collaboration and alignment in order to achieve outstanding well delivery performance for the benefit of the entire project.
JOURNEY MILESTONES

PHASE 1
April 2008 – March 2010

- Feasibility studies
- Hand-in-hand working across disciplines along the Global Well Delivery Process leveraging global deep-water expertise during design and execution
- Sub-sea blowout preventer (SBOP) on a 3rd generation moored rig, deploying Christmas trees and conductors from an anchor handling tug supply (AHTS) vessel

PHASE 2
April 2012 – January 2014

- Optimised standard well design – experimental move away from geometrical design trajectories for reservoir landing
- No suspension between lower completion and upper completion using fit-for-purpose suspension plug
- New team, new 6th generation dynamically positioned (DP) drillship

PHASE 3
January 2014 – August 2014

- Building on and leveraging the momentum and learnings of Phase 2
- Well design replication from Phase 2 while incorporating lessons learned and perfecting use of new technology, including full use of rotary steerable systems (RSS), logging while drilling (LWD), 3D mechanical earth models, and new wireline technologies for extended leak-off tests (XLOT)
- Strict management-of-change process
“Shell’s Well Delivery Process provided the robust framework for all involved and guided us to success. And success meant top-quartile performance in terms of well delivery time and cost to help the entire project be a commercial success, ensuring that everybody got home safely every day, and that our wells were safe during both construction and production.

The process operationalises the requirements for the project in a structured way, thereby allowing a competitive and integrated Well Delivery Plan to achieve the aligned and prioritised project objectives. For BC-10, keeping the well design geared for top-quartile performance while also meeting all process safety requirements was critical.”

DIOGENES ANGELIDIS
BC-10 Wells Project Manager Phases 2 & 3
Shell’s global deep-water organisation model allows global expertise in deep-water well delivery gained in numerous successful projects to be leveraged and applied as part of local projects to ensure safe and efficient delivery.

The project and risk management for the well campaigns in BC-10 in Phase 1 focused on optimising the individual drilling campaign components to mark a solid start. During the subsequent phases it evolved as part of constant communication between the different disciplines towards a holistic approach in which all aspects interplayed in a meticulously planned and concerted effort to optimise the overall project value for the joint venture.
PHASE 1
April 2008 – March 2010

- Semi-batch approach: drilling the first two sections of the wells in sequence and then following up with the last section per well
- Detailed risk assessment and mitigation
- Focus on equipment cost

PHASE 2
April 2012 – January 2014

- Move to “assembly line” approach based on detailed planning: full-batch drilling with a standardised well design – “easy first – hard last”
- Active project schedule management, incrementally increasing the moves of the sub-sea blowout preventer from well to well and the use of the Multi-Purpose Tower on Noble Bully II
- Shift in focus to total cost of ownership

PHASE 3
January 2014 – August 2014

- Perfection and fine-tuning of interplay of people, procedures and equipment
- Optimisation of the order of batch sequences
- Ambitious and stretched schedule to ensure viability of the project in challenging economic environment, aligned with key project interfaces
“Building on experience from other projects we applied a very structured approach to concert the effort and coordinate all the different bits and pieces that make deep-water drilling campaigns of this size normally fairly complex beasts. We put reasonable effort into the planning stage and dissected the drilling campaigns into their smallest process steps and tools to identify optimisation and standardisation potential and brought it all together. The outcome was a well-oiled machine delivering deep-water wells like a factory: repetitive and fine-tuned at a tremendous pace.”

ROBIN HARTMANN
BC-10 Wells Project Manager Phases 1 & 2

“Collaboration and integration of all the disciplines and functions are key to the success of the full project investment. The delivery of wells intersects with sub-surface, sub-sea, logistics, importation, operations, and many other areas. The project team continuously communicated the status of the many parallel work scopes and jointly developed risk mitigation plans when necessary. We worked as one team with the same goals.”

JEANNE MARIE LEBLANC
Project Manager BC-10 Phase 3

“We had agreed budget and schedule commitment, the team was required to focus its project management on the tightrope. It was critical to understand the campaign’s weaknesses and minimise their impact. For Phases 2 and 3, a key control measure was the judicious assessment and selection of enabling technology to mitigate the four key risks of major sub-sea equipment failure, wellbore stability, reservoir landing, and geosteering, and a failure to replicate successful practices and build on earlier learnings.”

DIOGENES ANGELIDIS
BC-10 Wells Project Manager Phases 2 & 3
Safety is Shell’s top priority. As with all projects, we apply lessons learned from our decades of experience in order to operate safely and responsibly in BC-10.

The drilling campaigns off the coast of Brazil are a good example of how we continually develop our people, procedures and equipment further in order to maintain high standards of asset integrity, process safety and personal safety at all times.

Particular key characteristics in the BC-10 drilling campaigns were the teamwork and continuity of staff which nurtured a mature HSSE culture in which people made an extra effort to prevent and solve issues in a timely fashion. That culture, coupled with the appropriate procedures and technologies, meant that more and more days without recordable incidents could be added to the Goal Zero journey throughout the three project phases.
JOURNEY MILESTONES

PHASE 1
April 2008 – March 2010

- 169 Goal Zero days recorded
- Detailed risk analysis and mitigation through appropriate well design, and compliance with procedures and safety rules
- Judicious selection of enabling technology

PHASE 2
April 2012 – January 2014

- 187 Goal Zero days recorded
- HSSE efforts and familiarisation of key staff on new rig started well before rig arrival in Brazil
- Assembly line campaign approach allowing staff to focus on safety aspects of their tasks
- Additional time and effort to prepare the blowout preventer (BOP) to keep it submerged to prevent major sub-sea hardware failure and challenges associated with tripping

PHASE 3
January 2014 – August 2014

- All wells (20,000 metres) drilled with ZERO recordable incidents - all 190 campaign days at Goal Zero
- Implementation of recognition schemes to support safety efforts
- Special merit in Shell’s 2014 Chief Executive Officer’s HSSE & SP Awards
“Continuity of team members and contractors - some of whom were part of the project since Phase 1 - has helped build the foundations of a safety culture. This was hallmarked by exceptional teamwork where people were encouraged to do the right thing at the right time, first time.

Achieving Goal Zero in an extremely challenging environment is a fantastic effort from all rig crew members and a testimonial of a felt and visible leadership. The Noble Bully II crew chose improving safety as a key habit and gave us an excellent example on how to do the right thing.”

VINICIUS RODRIGUEZ
BC-10 HSSE Manager

“The attention to detail in the planning and the high degree of standardisation allowing tasks to become repetitive not only helped with the economics but also contributed to the great safety record. In such a standardised assembly line approach people can focus far better on their actions and the equipment they are dealing with and pay more attention to the safety aspects.”

ROBIN HARTMANN
BC-10 Wells Project Manager Phases 1 & 2
People

PASSION, TEAM SPIRIT AND CONNECTEDNESS

Processes, plans, standards and technologies are only as good as the people applying them. The Wells team, connected disciplines and contractors working on the BC-10 well campaigns, jointly embraced a continuous improvement spirit – aiming to progress from better to best in terms of safety and performance. Every individual had the right and the obligation to speak up and challenge the status quo to make it better and thus take ownership for success.

As a global leader in deep-water operations, Shell has a wealth of expertise in drilling and completions under difficult conditions. The team working on the BC-10 drilling campaign could draw on knowledge from their colleagues in the global deep-water wells organisation – allowing them to leverage and replicate best practices. In turn, they have passed on their insights and learnings to Shell’s global deep-water community, so that other Shell projects can build on these proven best practices.
JOURNEY MILESTONES

PHASE 1
April 2008 – March 2010

- Leveraging global deep-water expertise
- Constant and frequent interaction between Front-End Engineering Design team and Operations on the ground
- Inclusive approach from day one: everyone involved acting as one team

PHASE 2
April 2012 – January 2014

- Pride and sense of achievement on- and offshore nurtured by collective drive for improvement and acknowledging and balancing needs of the parties involved

PHASE 3
January 2014 – August 2014

- Continuing with a winning team – leveraging the well-sized and trained Noble Bully II rig crew and other contractors
- Celebrating success
- Knowledge and best practice sharing and transfer to other Shell deep-water projects
“Staff develop passion and energy for what they do when they feel involved and inspired. They want to be part of a successful project. We didn’t only allow every individual to make suggestions for improvement but expected it. People felt they could challenge themselves and the people around them. That puts a bit of tension into the system — what I call “positive tension” — and that enables further development.”

SUHEYL OZYIGIT
General Manager Wells Brazil at the time of the BC-10 well campaigns

“I’m most proud of the way the entire team has pulled together to really make a difference to the business bottom line. I think demonstrating to the industry as a whole that we can consistently deliver ultra-deep-water development wells in 25 days and installing lower completions and upper completions in deep water in 6 days without hurting people is just amazing.”

DIogenes Angelidis
BC-10 Wells Project Manager Phases 2 & 3

STEPHEN JONES
Senior Well Engineer
Shell’s Wells organisation applies structured performance management techniques. The BC-10 well delivery team developed a “continuous improvement culture” to never settle for “good” performance, but to go for the best. Benchmarking against others was an important element throughout the journey and inspired the team to jump higher hurdles from phase to phase, until they set a new benchmark for others to attain.

Simple goals, acting on leading performance indicators, and keeping visibility and focus within weekly team accountability sessions maintained the momentum for delivering bottom line impact and allowed the team to take advantage of numerous opportunities.
JOURNEY MILESTONES

PHASE 1
April 2008 – March 2010
GETTING STARTED
- Selective benchmarking against local projects
- Cost-focused Contracting & Procurement (CP) strategy

PHASE 2
April 2012 - January 2014
FORCING THE PACE
- External, global benchmarking, targeting top quartile (TQ)
- Project-value-focused CP strategy
- Building opportunity staircases: structured identification of improvement opportunities and plans for implementation including blowout preventer (BOP) testing and submerged time (6 months)
- Development of opportunity staircases and individual performance improvement (“better to best”) projects

FINE-TUNING & PERFECTION
- Extended focus on micro key performance indicators (KPIs) to stay on track across all construction steps with fine-tuned performance contracts
- Structured approach to manage non-productive time (NPT) and invisible lost time (ILT) – detailed view of components
- ILT average reduced by 30% compared to Phase 2
- Acceleration: multiplier effects of batched operations in areas like concurrent preparatory work and drilling, hourly checks on drilling, connection and casing running times, BOP testing, well suspension, checking trip times and other active flat time targeting
“Value creation is a structured way to ensure continuous improvement. At BC-10 we held value creation events – a particular Shell workshop method – that are built into the Well Delivery Process. They are the primary technique that we use to drive input and creativity.

Throughout our well campaigns in Brazil these events were key milestones in bringing well project teams together, getting clarity on the plan and for motivating and energising the group. At the heart of our performance approach was an ethos that looks to draw out the knowledge, energy and creativity of the collective team that was working on the BC-10 well campaigns. It was embraced, there was energy in the workshops, and people took actions they committed to.”

ROBIN HARTMANN
BC-10 Wells Project Manager Phases 1 & 2

“The learnings from one well were applied immediately to the next one, and the team was learning from the previous operation and applying it directly to the next one. So there was no time lost in between, and it was fresh in everybody’s minds.”

SUHEYL OZYIGIT
General Manager Wells Brazil at the time of the BC-10 well campaigns

“I am extremely proud of the team and their outstanding achievement, reducing the average well cost by 40% from Phase 1 to Phase 3. When we talk about continuous improvement, this is what we mean, and it is a prime objective of our deep-water ways of working.”

KENT STINGL
Vice President Deep-Water Production & Development Brazil
Phase 3 development comprises three separate heavy oil reservoir sands, which are mildly over-pressured, and involving greater technical risk to develop due to thin, disconnected channel sands with internal shale barriers, that could impact sweep and ultimate recovery (UR). Also, unlike Phases 1 and 2, Phase 3 reserves were comparatively smaller, making it an economically marginal deep-water project.

Using smart new technology such as the Noble Bully II drillship with its innovative features, and modern geosteering technology, which allowed the well path to be optimised, turned out to be important enablers for successful drilling campaigns.
**JOURNEY MILESTONES**

**PHASE 1**  
April 2008 – March 2010

- Use of Arctic 1, a 3rd generation semi-submersible rig
- Use of surface blowout preventers (BOPs) and prelay moorings
- Deployment of sub-sea equipment to seabed by wire from an anchor handling tug supply (AHTS) vessel

**PHASE 2**  
April 2012 – January 2014

- Deployment of brand new Noble Bully II dynamically positioned drillship densely packed with new technology
- Multi-Purpose Tower (MPT) with enhanced offline capability to perform preparatory work and drilling at the same time
- Piloting of innovative technology for optimal steering of the drill bit
- Focused preparation and testing and specialist support allowing the blowout preventer (BOP) to be kept submerged and “hop” it between wells safely and efficiently

**PHASE 3**  
January 2014 – August 2014

- Perfected use of enhanced offline capability of the MPT in all drilling and completion phases of construction
- Perfected application of geosteering technology leading to better-than-expected net-to-gross ratio and overall field ultimate recovery
- Perfected BOP hopping sub-sea – over 12 rig moves, and safely increasing intra-field transit distance to 5.6 km
“The combination of innovative technologies, smart design and procedures allowed for optimal performance. The GeoSphere technology from Schlumberger for example is a tool that you run in your bottom hole assembly. It consists of transmitters and receivers, and it effectively identifies contrast boundaries of resistivity so you can see the top or the base of your reservoir, in this case. It allowed us to design our well path to come in at steeper angles towards the top of the reservoir. This tool can identify around 30 metres true vertical depth away the top of the reservoir, so as you are coming down you can actually see where it is, and then, proactively adjust your well path to land very effectively, reconciling any uncertainties in where the reservoir is going to come in.”

STEPHENV JONES
Senior Well Engineer

“The Multi-Purpose Tower, or MPT for short, is one of the many innovative features of the Noble Bully II rig that were deployed in the BC-10 well campaigns as of 2012 when it became available from the shipyard. The design and placement of this tower allows the ship to be shorter and lighter than comparable capacity drillships. While that is certainly a great advantage when it comes to fuel consumption and cost, etc., more importantly it allows preparatory work to be carried out on one side of the tower, while drilling continues on the other side. You can also rack back bottom hole assemblies, casing, tubing, screens, and any tubulars that you run in hole. So when you do have your blowout preventers and riser attached to your well, you have still got a huge amount of work that can be done without hitting your critical path. The crew perfected the procedures in BC-10 over time resulting in enormous time saving. This perfection is now travelling with the ship and crew on to new projects.”

MARTIN VOS
Vice President Wells Operated
Success requires all parties involved to aspire to the same goals so everyone can win – be it safety or performance. Given the technical challenges and commercial demands of the BC-10 drilling campaigns it was critical to identify suppliers that can offer fit-for-purpose and innovative solutions. These were necessary to overcome specific challenges and actively support and apply Shell’s strict quality, safety and performance requirements.

Strong alignment to deliver the wells safely and efficiently, in support of the overall success of the project, was supported by a contracting approach that acknowledged and synchronised the needs of the operator and contractors.

In addition, the BC-10 team implemented a special collaboration model between the operator and suppliers: Shell staff and some contractors were co-located in the same office, so as to create a sense of community across organisational boundaries.
PHASE 1  
April 2008 - March 2010
- Component and service-cost-driven contracting strategy for start-up
- Dedicated Contracting & Procurement group as part of the project team
- Co-location of Shell and some contractor staff in the same office

PHASE 2  
April 2012 - January 2014
- Project-value-driven contracting strategy
- Pay for Performance: introduction of a win-win incentive contract strategy to improve the business bottom line for the BC-10 Consortium and contractor profitability in combination with key new technology enablers
- Recognition awards, promoting technology and communication outwardly in industry forums

PHASE 3  
January 2014 - August 2014
- Fully established sense of being one team aiming to achieve a common goal together
- Fine-tuned Pay for Performance contracts
INSIDER INSIGHTS

“We, as suppliers, and Shell, as customer, synchronised our needs to establish a win-win situation. That made a major difference and led to a compensation model that was based on performance rather than day rates for equipment and services using only baseline unit prices. We established a baseline for performance and compensation and incentives for delivery that went further. At the same time we were actively involved in identifying the best technical and procedural solutions for all kinds of challenges and could bring them forward. One could say the we really had skin in the game.”

ALEX KLETZKY
Director International Oil Company Accounts, Schlumberger

“Once we started engaging after the initial start-up, the ideas floated - coming from senior management down to management on the rig down to the crane operators down to the guys working on the deck and actually utilising the equipment to enhance what we could already do and to make it easier and more efficient.”

ED SCHREINER
Rig Manager Noble Bully II
Shell’s well delivery journey through the three phases of the BC-10 project truly culminated in a demonstration of affordability and profitability in deep water. The concerted expertise and efforts in all relevant areas – from well design, project management, technology, supply chain and performance management – all carried out by highly competent and motivated people with a constant eye on safety built a solid basis for sustainable production for each project phase.

While the BC-10 well campaigns benefited from global learnings, the team transformed itself into a rich source of know-how, developing practices to be passed on to and replicated in future Shell deep-water projects.
**Achievements**

JOURNEY MILESTONES

**PHASE 1**
April 2008 – March 2010

- 169 Goal Zero days recorded
- Three top-quartile wells
- Average well delivery time of 50 days
- Top-quartile* 41.5 days

* TQ = Top-Quartile (days on location) for a 2,500m deep-water well against Rushmore Benchmark

**PHASE 2**
April 2012 – January 2014

- 187 Goal Zero days recorded
- Seven wells delivered top-quartile against Rushmore benchmark
- Average well delivery time of 42 days
- Top-quartile 39.5 days

**PHASE 3**
January 2014 – August 2014

- Goal Zero on personal and process safety
- Campaign finished 40% ahead of ambitious schedule
- All wells delivered best-in-class against Rushmore benchmark
- Average well delivery time of 25 days
- Top-quartile 38.6 days
“Credibility, competitiveness and affordability are the cornerstones of success for the joint venture partnership. At every turn we need to demonstrate value for money. There is a risk of losing sight of the fact that we are pursuing overall profitability. The Phase 3 drilling campaign set a new bar in terms of deep-water performance through careful planning and outstanding execution. This performance has resulted in significant cost savings which help improve overall project value for the joint venture...”

JOHN BOYD GORST
BC-10 Phase 3 Business Opportunity Manager

“The BC-10 well campaigns demonstrate both affordability and profitability in the deep-water business. These performance practices will travel and be replicated in other projects and enable Shell to compete as the most competitive energy company and a preferred partner in deep-water opportunities.”

JEFF WAHLEITHNER
Vice President Deep-water Wells

“Replication, team integration and innovation are three elements that spring to my mind when describing the foundation of the success of the BC-10 wells campaigns. The Phase 2 and Phase 3 campaigns benefited from the experience built up in the previous phases. Well designs and execution procedures were kept the same where possible. Sub-surface, wells and execution teams worked together in a seamlessly integrated way. Changes were only introduced where they would add significant business value and only with rigorous management of change procedures.”

ALBERT PAARDEKAM
BC-10 Phases 1 & 2 Business Opportunity Manager
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JOURNEY MILESTONES

GETTING STARTED

BC-10 PHASE 1 WELLS TOP QUARTILE RESULTS

Quarter Performance Curves for Days at wellsite
WD>1000 meter, Max angle 85 degree, Development Wells
Data source: Rushmore Global Deepwater 2000-2009

Locator & multilateral wells have been excluded
FORCING THE PACE

BC-10 PHASE 2 WELLS TOP QUARTILE RESULTS
Quartile performance curves for days at wellsite vs. drilled interval (m)

- Phase 2: April 2012 - January 2014
  - External, global benchmarking, targeting top quartile (TQ)
  - Project-value-focused Contracting & Procurement (CP) strategy
  - Building opportunity staircases: structured identification of improvement opportunities and plans for implementation including blowout preventer (BOP) testing and submerged time (6 months)
  - Development of opportunity staircases and individual performance improvement (“better to best”) projects

- Phase 3: January 2014 - August 2014
  - Extended focus on micro key performance indicators (KPIs) to stay on track across all construction steps with fine-tuned performance contracts
  - Structured approach to manage non-productive time (NPT) and invisible lost time (ILT) – detailed view of components
  - ILT average reduced by 30% compared to Phase 2
  - Acceleration: multiplier effects of batched operations in areas like concurrent preparatory work and drilling, hourly checks on drilling, connection, and casing running times, BOP testing, well suspension, checking trip times, and other active flat time targeting
Performance Management

JOURNEY MILESTONES

PHASE 1
April 2008 – March 2010
- Selective benchmarking against local projects
- Cost-focused Contracting & Procurement (CP) strategy

GETTING STARTED

PHASE 2
April 2012 - January 2014
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FORCING THE PACE

PHASE 3
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FINE-TUNING & PERFECTION

BC-10 PHASE 3 WELLS TOP QUARTILE RESULTS
Quartile performance curves for days at wellsite vs. drilled interval (m)

Rushmore database for horizontal wells, <3000m BML, >1000mhz section (including conductor)
"The combination of innovative technologies, smart design and procedures allowed for optimal performance. The GeoSphere technology from Schlumberger for example is a tool that you run in your bottom hole assembly. It consists of transmitters and receivers, and it effectively identifies contrast boundaries of resistivity so you can see the top or the base of your reservoir, in this case. It allowed us to design our well path to come in at steeper angles towards the top of the reservoir. This tool can identify around 30 metres true vertical depth away the top of the reservoir, so as you are coming down you can actually see where it is, and then, proactively adjust your well path to land very effectively, reconciling any uncertainties in where the reservoir is.

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MARTIN VOS
President Wells Operated