# OFFSHORE WELL INTERVENTION CONFERENCE REPORT

## CONTENTS:

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXECUTIVE SUMMARY</td>
<td>3</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>4</td>
</tr>
<tr>
<td><strong>ENI CASE STUDY:</strong></td>
<td></td>
</tr>
<tr>
<td>Gulf of Mexico Mississippi Canyon Gas Well Intervention</td>
<td>5</td>
</tr>
<tr>
<td><strong>VESSEL DEMANDS:</strong></td>
<td></td>
</tr>
<tr>
<td>Subsea Well Intervention Markets</td>
<td>10</td>
</tr>
<tr>
<td><strong>RISK MANAGEMENT &amp; WELL DATA ANALYSIS:</strong></td>
<td></td>
</tr>
<tr>
<td>Tools to Support Well Intervention Decisions</td>
<td>13</td>
</tr>
<tr>
<td><strong>MACONDO’S LESSONS LEARNED:</strong></td>
<td></td>
</tr>
<tr>
<td>Impact in Oil and Gas Good Practices</td>
<td>15</td>
</tr>
<tr>
<td><strong>FUTURE CONSIDERATIONS:</strong></td>
<td></td>
</tr>
<tr>
<td>Offshore Well Intervention &amp; The UKCS</td>
<td>17</td>
</tr>
<tr>
<td><strong>REFERENCES</strong></td>
<td>20</td>
</tr>
</tbody>
</table>
FIGURES AND TABLES:

FIGURE 1:
Single recomplet with indicating MS Valves and Radio Flow Valve............. 6

TABLE 1:
Cost Analysis of the RLWI in comparison with the MODU and HP Riser System.................................................................................................................. 7

FIGURE 2:
RLWI System overview.................................................................................. 7

FIGURE 3:
Green-Yellow-Red Watch circles dictating the shut down and quick disconnect operations......................................................................................... 8

FIGURE 4:
Illustration of Modified BHAs........................................................................... 10

FIGURE 5: Contingency BHA, an Assembly with a Stroker Tool...................... 10

FIGURE 6: Demand for Subsea Development Wells......................................... 12

FIGURE 7: Number of Vessels for Intervention Types........................................ 13

FIGURE 8: Vessel Days Per Region...................................................................... 13

Disclaimer:
Whilst every effort has been made to ensure the accuracy of the information contained in this publication, neither Offshore Network Ltd nor any of its affiliates past, present or future warrants its accuracy or will, regardless of its or their negligence, assume liability for any foreseeable or unforeseeable use made thereof, which liability is hereby excluded. Consequently, such use is at the recipient’s own risk on the basis that any use by the recipient constitutes agreement to the terms of this disclaimer. The recipient is obliged to inform any subsequent recipient of such terms. Any reproduction, distribution or public use of this report requires prior written permission from Offshore Network Ltd.
EXECUTIVE SUMMARY:

The purpose of this essay is to discuss several of the main topics, themes and considerations presented during the Offshore Well Intervention Europe Conference.

Following a short introduction, the first topic to be reviewed is the ENI Gulf of Mexico well intervention case study. Next, subsea well intervention vessel demands and Macondo’s lessons learned will be discussed. The final topics will review the use of risk management in the industry, along with a short conclusion covering some of the future challenges of not only well interventions, but for the United Kingdom Continental Shelf in general.
1.0 INTRODUCTION:

During the Offshore Well Intervention Conference various important themes were discussed. As representatives from the Robert Gordon’s MBA in Oil and Gas management student body, several of the topics directly helped our understanding of the industry’s key technological and economic contributors. Therefore, the subjects chosen to be discussed in this essay reflect the key learnings obtained throughout the two-day conference. To be specific, ENI’s case study of offshore well intervention work was an excellent insight into examples and lessons learned from global intervention operations. In addition, the topic of uniquely designed vessels for intervention purposes, and the future subsea trends was also very interesting. Finally, the consideration of core risk management, contract improvements incorporated form the Gulf of Mexico’s Macondo disaster, and also the briefly mentioned, yet just as important consideration, for labour and UKCS challenges was also highly applicable and helpful to our understanding of the well intervention industry.
2.0 ENI CASE STUDY: Gulf of Mexico Mississippi Canyon Gas Well Intervention

Background

In 2012, an up-hole recomplete was performed on a gas well with depth 2,600ft (790m) in Mississippi Canyon, which entailed a single intervene with a dual frac pack. The aim was to produce through dual stacked frac packs, each with a hydraulic valve operated. The well was turned on in early 2013 and it was observed as not flowing from the lower zone. In other words only the upper zone was contributing.

With the objective of finding a cost effective and quick solution to achieving full production as soon as possible, the riserless well intervention system was adopted. The main idea was to go in with the riserless system, open the MSV valves and consequently the radio flow valves (figure 1) to ensure the well could flow, then evaluate the contribution from the upper and lower zones and eventually secure the well and handover to the production team.

Figure 1: Single recomplete with indicating MS Valves and Radio Flow Valve

Reasons for adopting the Riser Less Well Intervention system (RLWI)

Typically ENI has been performing well interventions with the utilization of either a rig or a High Pressure (HP) riser system, due to so much time slots every year on HP riser vessels. The RLWI was chosen based on the fact that the upcoming slot for the HP
riser system was only available at the end of the year and there was the need to receive full production as quick as possible. In addition there was no intended need for coil tubing considering the well was basically young with dry gas. Hence there wasn’t much anticipation for hydrates, scale or other problems. Also ENI’s partnering companies had previously utilized the riserless systems in deeper waters with relative success. The cost analysis below (table 1) indicates that the riserless system was the most cost effective and efficient choice of getting production back on as soon as possible.

Table 1: Cost Analysis of the RLWI in comparison with the MODU and HP Riser System

<table>
<thead>
<tr>
<th>System</th>
<th>Cum Time Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODU</td>
<td>17</td>
</tr>
<tr>
<td>HP Riser System</td>
<td>8</td>
</tr>
<tr>
<td>RLWI</td>
<td>6</td>
</tr>
</tbody>
</table>

- MODU ~ 6.5 Million
  - Avg. rate 500K/day
- HP Riser ~ 3 Million
  - Avg. Rate 380K/day
- Riserless ~ 1.5 Million
  - Avg. Rate 250K/Day

The system utilized was an Interchangeable riser less Intervention system (figure 2) with a rated working pressure of 10,000psi capable of being deployed at a water depth of 10,000 ft and could handle various sizes of E-line and Slick line (5/16”, 9/32” and 7/32”).

Figure 2: RLWI System overview
The System consisted of a Pressure Control Head, similar to most systems in the North Sea. The Pressure Control Head also utilizes a grease head for a dynamic seal and pack offs for static bi directional check valves. In addition, the standard lubricator section had a tool trap to prevent loss of tools down hole.

Finally, the well control package comprises of the gate valves, shearing rams and a blind ram. To ensure this as a safe practise in deeper waters, the watch circles were essentially used to the availability of the Blue Ocean systems for emergency shut in and emergency quick disconnect (figure 3). Measures were also taken to ensure no seawater ingress due to the gas well and the fear of hydrate formation.

**Figure 3: Green-Yellow-Red Watch circles dictating the shut down and quick disconnect operations**

---

**Challenges**

Some of the important challenges addressed ahead of time were:

- The water depth concerns ENI management at the GoM had as the riserless systems are considered to be most suitable in shallow waters: The greatest concern the ENI management had was how the RLWI could be made suitable for deep-water applications. Having worked with the vendor, specific operating criteria were set up based on the water column analysis such as the current loading on the lubricator, line clashing and the stack bending moments. In addition similar issues with utilizing a rig were equally addressed with the RLWI system.
• The Inexperience of crews: The service vendors were not used to the riserless systems. The biggest challenge and most non–productive time were associated with the inexperience of most vendors comprising the E-line, Slick line, Coil, ROV and the Chemical vendors. Utilizing the RLWI was a large learning curve for most of the vendors particularly with the ROV crews who were used to dealing with x-mas trees and BOPs, and flow lines. Hence it took a while for the crews to get up to speed with the operations. It was also realized more appropriate spotting of equipment on the vessel could have been done to facilitate the operations, as well as the unanticipated delays in the opening and closing of the moon pool deck due to bad weather or the crane being tied up.

In addition, the E-lines and slick lines were used to surface lubricators and the first time running in a subsea lubricator and matching the deployment or retrieval speed of the lines with the crane was an issue. One of the BHAs had broken as a result of rope socket separation that occurred twice during the operation. The lines were visually marked and used as a baseline for the wireline crew.

• The highly deviated wellbore of 63 degrees: There was the major concern of difficulties getting down the well with E-line or slick line due to the deviation. Several steps were taken to mitigate and ensure a successful campaign. One of the biggest measures was modelling all the tool strings and BHAs that went down hole. The modelling was done successfully with no issues regarding wire friction or weight. Only a bowstring centralizer had to be adjusted. Rollers were added to the BHAs (figure 4) as a measure to ensure getting down hole. In addition the vendors modified the gauge rings and added bevels to help with some of the unanticipated tight spots encountered during the operation.

The E-line was planned as a contingency in the case the slick line failed, The E-line was successfully tested in the shop at a worst case scenario i.e. at a horizontal of 90 degrees to confirm the sleeves could be shifted. On the long run the Slick line was successfully utilized.
• Also due to the gas well at relatively high pressure, there were concerns with hydrates that could cause some problems. Two best amongst four possible techniques were to remove the free and dissolved water from the system and inject some inhibitor to prevent hydrate formation and then prior entering the well, close the safety valve and try to inject as much as possible methanol from the safety valve through the wing of the tree. Also Meg was utilized as a testing fluid and a flushing fluid all through the operations to prevent hydrates. All the tool systems as well as the make and break connections were checked to ensure no fluid ingress.

**Figure 4: Illustration of Modified BHAs**

![Illustration of Modified BHAs](image1)

• Issues with pulling crown plugs had been experienced in all interventions performed in the past even with the HP riser systems. With the aid of Blue Ocean and other vendors, the difficulty encountered on retrieving the crown plugs was addressed with the use of a stroker tool (figure 5) to successfully pull both crown plugs as a contingency to utilize the standard BHAs and jars.

**Figure 5: Contingency BHA, an Assembly with a Stroker Tool**

![Contingency BHA, an Assembly with a Stroker Tool](image2)
Other Considerations

Other factors taken into consideration were the actual runs of the E-line and slick line at various speeds through the Pressure Control Head, tested at 10,000psi. Essential logs of tight spots and wires were kept to gain better confidence of not hanging up on the wire down hole. In addition Schlumberger’s digital slick line was utilized for the purpose of getting real time data for better monitoring the wire tension, gauge pressure and temperature, casing collar logs, the gamma ray and also the digital release in the case of getting stuck down hole.

Final Considerations

Overall, the operation was considered a success as ENI’s 1st RLWI system. Production was achieved 6 months ahead of time irrespective of the challenges encountered. On the whole the case success provides better level of confidence that the RLWI could be utilized in deep water where applicable specifically in light interventions with significant cost savings attained.

3.0 VESSEL DEMANDS: Subsea Well Intervention Markets

Historically subsea well intervention has been executed from drilling rigs with an 18-3/4” BOP and 21” marine riser, as this was the only means of access with adequate well control (HELIX Energy Solutions, 2014). This was an extension of a rig’s role in drilling and completing wells (Aker Solutions, 2014). However, the extremely high day rates resulting from the increased demand over the last two decades has made such operations extremely expensive, while rig availability remains limited (Aker Solutions, 2014), due to the increased development of deep-water fields over the past fifteen years.

To enable development, a significant number of deep-water drilling units and more cost effective systems to access deep-water wells are required (Aker Solutions, 2014; HELIX Energy Solutions, 2014); both ship-shape and semi-submersible options have been built and are being built at present, with a water depth range of around 3000 metres (Zijderveld et al. 2012).
Even though greater water depth capacities for deep-water drilling units are available, the reality (based on the below graph) shows that the demand for subsea development wells is increasing, with depths up to 2500 meters securing the majority of the share.

**Figure 6: Demand for Subsea Development Wells**

![Graph showing the demand for subsea development wells from 2004 to 2014.](image)

*Source: Infield Systems Ltd*

Current increasing deep-water trends show that a dedicated market is developing for vessels capable of intervening subsea wells, at a lower cost than the existing deep-water drilling units, to extend the life of deep-water developments; granting operators additional profits and ensuring they adhere to the minimum field production requirements, which is a growing requirement by the North Sea authorities (Zijderveld et al. 2012). The same can be seen on below graph when analyzing the demand on vessel days by the type of subsea well intervention. On the same graph it can also be observed that medium to heavy intervention is roughly accountable for half of the total requirements. Finally, based on the graph trend; light well intervention is expected to maintain its market position with the biggest volume and share of well intervention operations going forward.
Figure 7: Number of Vessels for Intervention Types

![Number of Vessels for Intervention Types](image1)

Source: Infield Systems Ltd

With the increasing age of existing subsea wells however, demand for medium and heavy interventions is also expected to increase, fuelling the need for larger semi-submersible specific well intervention vessels to carry out more complicated intervention activities (Infield, 2014).

Figure 8: Vessel Days Per Region

![Vessel Days Per Region](image2)

Source: Infield Systems Ltd
Finally, based on the above graph, when geographically analysing the subsea well vessel demand, Europe is projected to have the highest market share, with the activity primarily focused on the well-established UK and Norwegian markets. Also the African and Latin American markets (with their increasing number of deep and ultra deep-water discoveries) are expected to account for the highest increase in well intervention demand, as these discoveries will need to be developed with subsea infrastructure (Infield, 2014).

**Overall Considerations**

The more subsea wells that are drilled, developed and brought to operation will directly influence the demand for subsea well intervention - increasing at an equal rate. From what has been discussed above, it can be derived that a substantial demand for capable well intervention vessels is required to cover the forthcoming subsea well intervention demand - especially for deep and ultra deep-water areas.

**4.0 RISK MANAGEMENT & WELL DATA ANALYSIS: Tools to Support Well Intervention Decisions**

The continuous depletion of existing oil reserves and the future rising energy demands are forcing operators to explore and develop harsher offshore environments and maximise the recovery from mature fields. Therefore, well maintenance intensity and associated expenditures on interventions are also estimated to rise in the future. To meet this demand, the availability of well stock data, detailed operating history and integrity status becomes critical for the efficient prioritisation and planning activities necessary to support intervention decisions over a well’s lifecycle.

Successful case studies showed that robust data analysis contributed to efficiencies across operations and reduced the risk profile of offshore well programmes. Moreover, the recognised importance of data to be a source of competitive advantage suggests the need to utilise historical data (specifically related to repairs on component failures), ideally in one holistic dedicated database, available to operators during the life cycle of a well (from the Design & Construction to the Well Abandonment Phase). Hence, this allows increased visibility of well integrity trends across assets, to help
prioritise candidates for well intervention and to define operational changes based on data trends and empirical evidence of past failures.

Furthermore, additional case studies have demonstrated that the development of a risk management culture and risk based processes within any company reinforces preventive and curative decision making related to well intervention. This also leads to benefits at all stages of the well lifecycle. In particular, the application of fault tree analysis allows one to identify a sequence of events leading to well failure, and supports the criticality assessment of each component by quantifying its importance to the function of the whole well. This analysis contributes to the knowledge base within the company, allowing them to exploit and maximise the value of the available data to support operative decisions.

In order to exploit the benefits of data monitoring, analysis and by the application of risk management approaches and techniques, it is important for operators to be able to access relevant data and information related to component reliability in different production environments and processes. At the moment, the databases such as WellMaster, RIFTS ESP and RIFTS PCP contain data related to few wells in comparison to the potential amount of information available from the actual active wells worldwide (+ 2,000,000 in 2013). Hence, as highlighted by Tullow Oil, it is important that operators should start to share more data in order to reduce risks and potentially decrease the frequency and costs of work-overs, improve safety, well economics, and to maintain the defined production/injection levels.

This can be reached by expanding the existing well failure databases through Joint Industry Programmes, by making use of SINTEF blowout database (to assist in likelihood estimations of hydrocarbon releases), sharing more information on abandonment issues and lessons learned from past projects. It is important to notice that the Industry Technology Facilitator (ITF) moved in this direction by launching The Joint Industry Partnership, aimed to create a worldwide well failure database containing information related to different types of wells (e.g. ESP, dry and subsea) and components - this is estimated to be functional in one to two years. Overall, several international and major oil companies are interested in this initiative.
and henceforth the involvement of additional operators would increase the potential benefits for the entire industry.

5.0 MACONDO’S LESSONS LEARNED: Impact in Oil and Gas Good Practices

Background

The oil and gas industry presents intrinsic hazards since it processes elements that are naturally volatile. With new challenges to face: deeper water operations, high pressure-high temperature wells, etc. there are new concerns rising from a health, safety and environmental perspective, provoking both higher public pressure and more complex operational risks (E&Y, 2013). In response, the industry has developed good oil practices, recommended guidelines, safety cases and HSE standards that are recognised by many of the industry’s regulators, with the intention to ensure safe operations, the environment and the assets’ integrity. However, the Macondo’s case has caused substantial economic, human and environmental losses and it has affected the current operating, contracting, insurance and general risk management practices (Cameron, 2012). In lieu of this contrasting situation, this section presents the main findings discussed in the Offshore Well Intervention Convention in regards to the oil and gas industry good practices adapting after HSE major incidents.

Good Oil Practices

In the early years of the oil and gas industry, accidents were not publicised outside the industry and there was a lack of concern for environmental pollution. Recognised as good oil practices, offshore regulations and industry standards were developed to improve operating safety and have been continually revised, adding safety lessons learned (Visser and others, 2011). However, even if these good oil practices are prescriptive regulations as the America Petroleum Institute have demonstrated in the US, or principle/outcome-based system as in the North Sea (Bunter, 2012); these are not a formula to avoid risks and there will always be a human side interpreting data and variables. “The oil good practices will depend upon circumstances and will also change as technology changes” (Gordon et al., 2011).
New challenges are now possible to undertake due to new technologies. The industry is going deeper, hotter and harsher and standards are not capable to change at this pace. Every year the definition of deep waters and ultra deep waters changes and although the standards and good practices are still relevant, they cannot be just a checklist that supposedly guarantee the safety of the operations.

**Recommendations from Offshore Well Intervention Convention**

The presentation from Arne M Enoksen (PSA) highlights the importance of risk management in well control activities. It is important to be prepared for the unknown, having better procedures to manage change related to technical requirements and improve communications and leadership in the field. Operators must do safety cases, Hazard Identification Analysis (HAZID), Hazard Operability Analysis (HAZOP), Job Safety Analysis (JSA) and Incident Investigations to increase safety levels and improve lessons learned.

Tullow Oil presented how the industry had adapted to every major event, starting from the Santa Barbara blow out (1969) and the creation of API standards and the first subsurface safety valve (SSSV) patent to Macondo, and the development of the ISO full well lifecycle. The presentation highlights the importance of using relevant software, having integrated procedures and online status available in the organisation’s database. Overall, the conclusion states the importance of operators working in collaboration, sharing lessons learned through joint industry projects that would provide substantial economic benefits for well interventions.

The International Well Control Forum (IWCF) presented its new training courses and certifications that were implemented after Macondo and the new OGP report 476 “Recommendations for enhancements to well control training, examination and certification” published in Oct 2012. Furthermore, IWCF is focused on improving the human factors for well interventions, providing critical theory and practical knowledge. In addition, the Global Industry Response Group (GIRP) recommendations will improve four key areas: Wells incidents Database, BOP reliability and technology, Human Factors training development and International Standards.
Final Considerations

Offshore risk exposes operators and contractors to events that could end with dramatic consequences such as death of personnel and serious environmental pollution (IPE, 2003; Inkpen and Moffett, 2011). These risks are increasing since IOCs are undertaking more complex projects and are operating in even harsher conditions with more exposure to HSE accidents.

Competent Certified Personnel at field, Reliable Equipment, Good Oil Practices and Standards seem to be the framework needed to face the industry’s new challenges in general and specifically in well intervention. The industry must continue to collaborate between operators and their supplier network to ensure lessons learned and good oil practices up to new challenges preventing operating risks.

6.0 FUTURE CONSIDERATIONS: Offshore Well Intervention & The UKCS:

In the 1960’s Aberdeen was known as a relatively poor and remote fishing, farming and textile city. It wasn’t until 1969 when oil was first discovered in the United Kingdom Continental Shelf (UKCS) that Aberdeen grew into a destination of low unemployment, thriving investment, and a centre for offshore technological expertise. Furthermore, the UK oil and gas (O&G) industry remains the largest economic and corporate tax provider to date; answering up to 67% and 53% of the UK’s O&G demand respectively, and with taxes amounting to £6.5 billion from 2012 to 2013 (O&G UK, Oil Reserves, 2013).

Yet despite the UKCS’s significant economic contributions, concerns over reduced production levels and high capital expenditure question the industry’s future stability (IEA, 2013). The UKCS has far surpassed its production peak, and has between 12 to 24 billion barrels of oil equivalent (boe) remaining out of previously produced 43 billion boe (DECC, E&P Field Data, 2014). The UK government, historically shown to be reactive in nature, has only recently responded and addressed the declining UKCS performance through fiscal regulations and tax reductions. However, despite recent O&G tax reductions, investments and exploration levels are still concerningly low (KPMG, 2014).
Additional areas of interest for the industry include mature asset decommissioning, technological advancement for further exploration and production (E&P), advanced well intervention technologies, rig availability and labour shortages - all of which will impact well-work and the future development of the UKCS.

One group formed to address such issues, called The PILOT (Payment-In-Lieu-Of-Taxes) is one of many collaborative advisor committees with the aim to address upcoming UKCS challenges. Reflecting the voice of the industry and the 2014 Wood Report, PILOT’s Key focus areas for the UKCS development include (O&G UK, Framework for Success 2013):

- **Technology Improvements:** Increased and Extended Reach Oil Recovery Group formed to promote highly technical projects and increase incentives for smaller operators to invest in continued research and development. Priority areas identified for future development include low salinity water flooding, chemical enhanced recovery injections and low cost subsea developments.

- **Address Skills Shortages:** Despite almost 440,000 people working in the UK O&G industry, trends suggest that it will be difficult to recruit skilled workers to fill 10,000 jobs in the next five years (KPMG, 2014). Manpower supply has long been reactive and behind current demands. Reviews are under way to widen entrants and subsidies for technical apprentices, promote more women in the workforce, and target recruitment for exmilitary personnel.

- **Better Access to Capital:** Initiate investor events and promote smaller operator requirements to *ready accessed equity* and *debt-based finance*. In addition, fiscal policies should be critically reviewed to argue measures that promote great development activity (Reed, pp 31, 2014).

- **Infrastructure Synergy:** Acceleration efforts and work programmes are currently enforced to identify critical infrastructure, ensure robust stewardship across all industry players, and promote improved supply-chain infrastructure (Kingham, pp 28, 2014).
Without addressing the above recommendations and taking responsibility over controllable measures such as tax and decommissioning relief, promoting youth, student involvement and sharing lessons learned, the future success of the UKCS would remain at question. Overall, and despite declining production rates, investment for the future development of the UKCS remains strong. Large business growth opportunities are readily available for marginally cost-driven operators, the service and the supply chain sector.

The 23 bboe still left to produce, a new decommissioning market, and rapidly expanding well intervention market coming on-stream will not go unnoticed, and significant efforts made by the government fiscal regime have been put in-place to ensure continued UKCS operations up until 2040 (O&G UK, 2014). However, in order to realise the full economic and resource potential of the UKCS, serious challenges such as rising capital cost, market and fiscal stability, rig or vessel availability and skilled labour shortages must be addressed and improved upon.
REFERENCES:


OFFSHORE NETWORK WOULD LOVE TO HEAR FROM YOU...

Offshore Network Ltd. is an independent business intelligence & conference provider catering specifically to the offshore oil & gas industry. We exist to facilitate a safe and efficient future for the exploration and production of oil & gas around the globe. We do this by uniting the most influential figures in the industry to challenge the status quo and share cutting edge innovations. This all happens at our industry leading conferences and through our original content.

If you would like to contribute to this discussion or are interested in taking part in a future Q&A or article, please contact Offshore Network (www offsnet.com) today:

- info@offsnet.com
- UK Telephone: (0)203 411 9937
- US Telephone: 713-5706-576
- Join the Offshore Engineering Group on LinkedIn
- Follow Offshore Network on Twitter