TOTAL E&P South Africa

Risk report – Wellhead integrity and risks to remove wellheads in deep offshore environment
1. Executive Summary

Total E&P South Africa (“TEPSA”) is the operator for Block 11B/12B which is situated roughly 100km off the South Coast of South Africa. The proposed drilling area of interest is located in what is classified as deep offshore with a harsh drilling environment. TEPSA is still in the initial exploration phases of the block and aims to drill not more than 10 exploration and appraisal wells should a successful discovery be made in the first well (Brullpadda 1-AX).

Typically these exploration and appraisal wells are abandoned permanently at the end of the drilling operation, unless it is planned to re-use the well(s) in the future for production purposes.

With regards to permanent well abandonment, the current EMPr specifies that the wellhead shall be removed at the end of the operations but also indicates that it might be required to leave the wellhead in situ, depending on the technical context and risk of removing the well head.

The exploration and appraisal wells that are approved for drilling in block 11B/12B are located in what can be typically described as very harsh met ocean conditions due to being in the Agulhas current and in water depths of between 500 - 2 000m. Due to this drilling environment, the typical well architecture consists of robust and thick casings to withstand the conditions of deep offshore operations.

The combination of the normal challenges inherent to wellhead removal operations in deepwater exploration together with the specific metocean challenges that TEPSA will face due to the harsh drilling environment, places a significant amount of risk on the wellhead removal operations. Typical additional challenges may include: requirement to wait on adequate weather window to perform any operation, low reliability of the weather forecast and the risk of rig loss of position. As such, the wellhead recovery operations in the area of interest are anticipated to be much more complex, to require more time than on a normal deepwater operation and to include more risks of failure, which could in return create more damage to the environment than the wellhead itself.

It should be noted that the actual wellhead has no impact on the well integrity once the well is plugged for abandonment, whether left in place or removed. The well integrity is guaranteed by plugging with two independent barriers provided by setting cement plugs in the well, irrespective of the wellhead status. Although it is not foreseen that any future re-entry of the well will be required in a permanent abandonment scenario, it should be noted that by leaving the wellhead in place, it would allow for the opportunity to access to the well for whatever reason in the future. Should the wellhead be removed, no access to the well would be possible again.

A risk comparison was undertaken for leaving the wellhead in place versus performing wellhead recovery operations. The key finding of this risk comparison are provided below:

Scenario: wellhead left in place

- Impact on fishing / trawling activities: risk is the loss of fishing gear and increased fishing effort. Risk is assessed in separate report undertaken by an independent specialist.
- Impact on biodiversity: the spatial impact of the wellhead is very small.
- Impact on future subsea infrastructure for production purposes: the risk relates to potential future infrastructure obstruction. Risk is assessed to have low probability as it would only concern a potential development of the area and the wellhead left in place would be well identified and, if required, detectable by sonar.
- Wellhead integrity: leaving the wellhead in place does not affect the well integrity in any way. Wells are plugged with a two barrier system down hole which does not include the wellhead.

Risk of leaving the wellhead in place is assessed as being acceptable.

Scenario: wellhead removed

Due to the type of operations required to remove the wellhead, they would have to be performed without a riser and Blow Out Preventer (BOP in place). This scenario does not allow the drill rig to cut the string at the seabed should metocean conditions get to a state where the rig needs to disconnect. Due to the specific well architecture, TEPSA would have to cut through three casing strings in order to remove the wellhead.
- The wellhead recovery operation will require at least a minimum of 3-5 uninterrupted days for the operations. Due to the unpredictability of the Agulhas current, no reliable weather forecasts are available to identify a weather window which will allow for 3-5 days interrupted operations.

- Typical difficulties anticipated for the wellhead removal which is standard to any deepwater well includes:
  o Potential failure to remove the packoff seal between the casing and the wellhead leading to possible milling operations with no guarantee of success;
  o Risk of requirement to perform several runs to cut the thick casings which is casted in cement in the well;
  o Potential requirement to conduct high pull tension to retrieve the surface casings which are cemented, leading to risk of parting the drill string which is attached to the rig for this operation.

- These challenges combined with the metocean context, result in a risk that is much higher than normal deepwater drilling and could lead to potential failures of the string which may cause it to collapse.

- Should the above option be unsuccessful, TEPSA may have to consider alternative options to the standard procedure described above in order to cut and pull the wellhead. This could include the use of explosives: This poses a higher technical risk (mainly related to running explosive in open water in the strong Agulhas current) and as such is not recommended as a solution.

- The casings cutting operations are performed in open water and require that the cutting tools are anchored inside the casing strings. The high current and the low current forecast reliability exposes the rig to increased risk of losing position which could lead to the parting of the string and losing the string – the risk is assessed as being sever:
  o If the string parted close to the seabed, then access to the wellhead would be lost (for example to install a corrosion cap) and there would be more equipment/debris left at the seabed;
  o If the string parted on the rig side, then it could result in significant equipment damage and potential impact on the safety of the drill rig and its crew (if personnel are exposed)

Wellhead recovery operations may lead to significant risks which could in particular lead to losing access to the wellhead to complete capping operations.

**Recommendation:** request a derogation to leave the wellhead in place at the end of exploration and appraisal well operations

### 2. Typical Well data and plug and abandonment operation

**Well data**
- Typical water depths: 500 – 2 000 m
- Well head relief above ground is +3.5 m
2.2 Plug and Abandonment operations

2.2.1 P&A plan and philosophy

The permanent plug and abandonment program will be detailed in a dedicated program as part of the well design.

The philosophy of the program is to isolate each identified reservoir with two independent barriers. A barrier is qualified as such if it is tested and is composed of either cement plug or mechanical barrier sunk in cement.

Operations to isolate the identified reservoirs with cement plugs will be performed with the BOP (blow out preventer) in place. The BOP is set on the wellhead just above the seabed, and allows closing and sealing on the strings / equipment deployed through the wellhead and can also shear / cut this equipment if the rig cannot keep its position, for instance in case of a current that may be too high.

2.2.3 Wellhead retrieval operations (casing sizes based on typical well architecture)

Operations to retrieve a wellhead are performed after removing the BOP. It consists of cutting the casings below the wellhead (example 13 3/8” casing, 20” casing extension and 36” conductor pipe) and retrieving everything above the cut.

To cut and pull off the top part of the 13-3/8” casing as a minimum two drill string runs will be required:
- The first run is to recover the pack-off (seal assembly) set between the wellhead and the casing. The second run is to cut and pull off the top part of the 13-3/8 casing.

Then, as a minimum, a 3rd run will be required to cut the 20” and 36” casings together. Given the thickness of the casings and the cement between both strings, it is likely that several further runs might be required.

The 36” conductor pipe is cemented to the formation. The 3 m cement section may prevent pulling and retrieving the 20” x 36” strings without very high tension which itself creates a risk of drill string failure, which could lead to exposing personnel on the drill floor to injury.

The casings cutting operation requires anchoring the cutting tools inside the casings. As such if the rig drifts off (e.g. loss of position due to too high current) then the risk could be that the drill string is pulled apart which could result in leaving more debris (drill string) around the wellhead location and would prevent any further access to the wellhead.
2.2.4 Schematics

P&A typical schematic

<table>
<thead>
<tr>
<th>Description</th>
<th>Depth Section</th>
<th>P&amp;A schematic</th>
</tr>
</thead>
<tbody>
<tr>
<td>WH</td>
<td>1459</td>
<td>36” x 30” CP</td>
</tr>
<tr>
<td>Sea bed</td>
<td>1547</td>
<td>20” casing shoe</td>
</tr>
<tr>
<td>26” section TD</td>
<td>1835</td>
<td>Marker X +/- 50m</td>
</tr>
<tr>
<td>17 1/2” section TD</td>
<td>2222</td>
<td>Marker 20A1 +/- 80m</td>
</tr>
<tr>
<td>13 3/8” casing shoe</td>
<td>2525</td>
<td>12 1/4” section TD</td>
</tr>
<tr>
<td>Marker W +/- 80m</td>
<td>2537</td>
<td>22” section</td>
</tr>
<tr>
<td>IZI 1 (water bearing expected)</td>
<td>2842</td>
<td>Marker 17A1 +/- 80m</td>
</tr>
<tr>
<td>Marker 15A1 +/- 100 m</td>
<td>3082</td>
<td>9 5/8” liner shoe</td>
</tr>
<tr>
<td>17 1/2” section TD</td>
<td>3155</td>
<td>Top Reservoir +/- 150m</td>
</tr>
<tr>
<td>8 1/2” section TD</td>
<td>3227</td>
<td>Base of reservoir +/- P50 OWC</td>
</tr>
<tr>
<td>6” section TD</td>
<td>3342</td>
<td>7” liner casing shoe</td>
</tr>
<tr>
<td>8 1/2” section TD</td>
<td>3402</td>
<td>Marker 13A1 +/- 150m</td>
</tr>
<tr>
<td>Top Brulpadda Deep +/- 150m</td>
<td>3493</td>
<td>Top Bruulpadda Deep +/- 150m</td>
</tr>
<tr>
<td>Well TD mode case</td>
<td>3562</td>
<td>Well TD mode case</td>
</tr>
</tbody>
</table>

The above illustration is an example of a well completion diagram – a final can only be determined as reservoirs are confirmed while drilling and logging the well.

Example of potential scenario following drill string failure

Parted drill string
3. **Requirements**

3.1 **EMPr requirement** The EMPr specifies that the wellhead shall be removed at the end of the operation but also indicates that there might be technical and metocean conditions that dictate that a wellhead cannot be removed on completion. In such a case a technical report should be complied and provide a rationale for abandonment of the wellhead in situ. Such a technical report is to be submitted to PASA for approval.

Petroleum Agency SA requirement Doc ref Number:12/03/60 dated 09 October 2014

Title: RE: OBJECT: BRULPADD-1A (3522C-12-3-67-1):WELL HEAD REMOVAL

**Extracted statement:**

"Please be advised that the commitment made on the EMPr pertaining to well completion is that the well bore would be plugged down hole using permanent barriers, wellhead removed and casings cut below sea floor. Furthermore, the EMPr indicates that technical and weather conditions may require a wellhead to be left *insitu* on abandonment and this would require a submission of a technical report for Agency’s consideration”

**Total internal COMPANY Rule**

Ref Total EP FP 424 Rev5

For offshore wells, company rule provides the following standard requirements:

a) In water depth ≤ 500 m: the wellhead and all casings shall be cut at 2m minimum below sea bed and removed;

b) In water depth between 500 & 2,000 m, a risk assessment shall be performed to decide if the wellhead and casings removal shall be required or not.

c) In water depth ≥ 2,000 m the wellhead and casings removal shall not be required.
## Appendix 1 – Risk Assessment

TEPSA risk assessment: risk analysis of leaving the wellhead in place and of the wellhead retrieval operations

<table>
<thead>
<tr>
<th>#</th>
<th>TASK</th>
<th>HAZARD</th>
<th>Assessment</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Risk of fishing net trapped around well head</td>
<td>Based on the specialist Fisheries Assessment, it is understood that of the five fisheries that operate within immediate or immediately adjacent to the approved drilling, only the likely future expansion of demersal trawl operations are expected to be affected by leaving wellheads on the seafloor within the drilling area. The impact on the possible future fishery operations is considered to be of Medium intensity but low significance due to low probability of expansion. With the implementation of mitigation (i.e. having the over-trawlable structure in place), the impact is deemed to be <strong>INSIGNIFICANT</strong>.</td>
</tr>
<tr>
<td>1.1</td>
<td>Fishing operations: demersal trawl fishery</td>
<td>Risk of fishing net trapped around well head</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Potential loss of the trawler</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>‘- Potential cost for net replacement</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fishing effort increased by having to avoid seafloor obstruction</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Potential works associated with equipment deployed on sea bed</td>
<td>Risk of contact with wellhead and foreign object</td>
<td>No foreseen interest to deploy electrical &amp; communication cables on sea bed. Pipe line/electrical cable could be deployed in event of oil discovery and field production.</td>
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<td>- Well head location is within few meters and communicated to South Africa authorities</td>
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<td></td>
<td>- If the wellhead is left in place, it will be possible to deploy pipe line / electrical-communication cables away from it</td>
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</tbody>
</table>
### Scenario 2: Wellhead removal operations

| 2.1 Wellhead removal operations | Technical operational delay. Delay due to wait on weather  
| - Significant cost impact | Weather context lead to operation strategy based on weather windows (launching an operation when the weather forecast shows there is enough time to perform; the operation)  
The wellhead recovery operation is estimated to last a minimum of 3-5 days which does not fit in the expected reliable weather forecast (<3 days) – risk of wait on weather and of operation duration drifting  
The following issues are possible (many cases in industry for deepwater ops)  
- Inability to retrieve packoff seal between the 13 3/8" casing and the wellhead leading to possible milling operations with no guarantee of success  
- Inability to cut 20 x 36" casings (thick casings and cemented): in one run leading to several runs required  
Alternative to cut and pull could be the use of explosives: higher technical risks (mainly related to running explosive open water in high current vein) => not recommended |

| 2.2 Wellhead removal operations  
20"x36" string retrieval | Technical difficulties (too high tension required to pull strings)  
Part string above seabed  
| - risk to lose access to wellhead and leave more 'steel' above seabed  
| Part string at rig level  
| - potential significant equipment damage on rig  
| - potential risk of injuring personnel | The 36" conductor pipe is cemented against the formation  
This could lead to difficulties to retrieve the 36" x 20" strings after having cut same. Very high tension might be required which could lead to string parting  
- If string parted close to seabed: access to the wellhead lost (ex. to install a corrosion cap) and more equipment/debris left at the seabed, above the wellhead  
- If string parted on the rig side, then it could result in significant equipment damage and potentially HSE risk (if personnel is exposed) |

| 2.3 Wellhead removal operations  
Casing(s) cutting | Part string above seabed  
| - risk to lose access to wellhead and leave more 'steel' above seabed  
| Part string at rig level  
| - potential significant equipment damage on rig  
| - potential risk of injuring personnel | The casings cutting operations are performed in open water and require anchoring the cutting tools inside the casings.  
High current context combined with low weather forecast reliability could lead to the risk of rig loss of position which would lead to parting the string since there is no longer a BOP to shear the pipes.  
- If string parted close to seabed: access to the wellhead lost (ex. to install a corrosion cap) and more junk left at the seabed, above the wellhead  
- If string parted on the rig side, then it could result in significant equipment damage and potentially HSE risk (if personnel is exposed) |