Spirit Energy Scrutiny Session

1 Field Overview and Subsurface

- *The Grove field is located in the Southern North Sea, and the existing development infrastructure consists of a small NUI platform with 4 slots and 1 subsea tieback.*
- *The target of the scrutiny session is the Grove NE concept well design which targets the Grove NE prospect and extract from a previously undeveloped part of the field. There is an appraisal element to the well objectives that requires data gathering to evaluate reservoir conditions. Based on the characteristics of the reservoir at TD, a potential deep OH sidetrack is being considered to access the higher sands.*
- *The chosen high-level concept is a shallow sidetrack from an existing well slot and with a relatively high lateral step-out and an extended tangent section at 62deg inclination through the Zechstein. Subsea tieback options were considered to mitigate the requirement for the complex well trajectory but was deemed uneconomical due to the cost of the subsea tieback infrastructure required.*

Session Feedback:

- General acknowledgement that subsea tieback infrastructure can be more expensive than platform well sidetracks.
- With the fact that a new rig (potentially cold stacked) is being brought in, it is important that a thorough rig intake process and alignment is made before undertaking this challenging well scope. If the rig to be selected is a smaller rig, detailed pit and/or deck planning should be done in advance for utilization of contingency measures (freshwater pills, contingency slot recovery tools etc.)
- Consider evaluating the economics – it was noted that a subsea tieback has been previously drilled. Has the historical cost of this been used in the economics? Investigate the likelihood and cost possibility of the sidetrack and either bake into the economics or flag to subsurface/asset. Understand any failure costs upfront and strategies and how the economics play into this.
- With the drilling risks and avoidance of the Zechstein raft has consideration been placed on going slimhole with the design? This negates the ability of a contingency hole size. If there is good confidence a slimhole design would allow significant cost savings. There is a potential risk that with the current design the options include fully slim-hole at 4-1/8” or 4-7/8” hole or go to 6” hole, but these designs include a hit on any long lead items already procured and so may not be feasible in the current timeline.
- Thoroughly understand any impact on COVID on supply chain especially for long lead items and timelines.

2 Rig Move and Slot Recovery

- *The NUI has previously hosted 3 different jack-up rig visits over the last 10 years, with the most recent rig visit in 2016.*
- *The existing G3X well is a 7 string design with 30” conductor, 20” surface casing, 13-3/8” intermediate casing (from the previous motherbore which this*

well has been sidetracked out of), 9-5/8" production casing, 7" drilling liner and 4-1/2" production liner with an existing 4-1/2" completion.

- *The P&A and slot recovery operation includes cutting the completion above the packer, setting a balanced plug in the 7" liner and cutting and recovering the 9-5/8" and 13-3/8" casings to allow access for an OH sidetrack out of the 20" shoe. This plan assumes a successful log of the cement quality behind the 7" liner.*

Session Feedback:

- Check the jack-up rig location strategy – either slot the legs into existing footprints or target away from old footprints to mitigate the risk of slipping into old holes inadvertently. With the gap between the last visit and the planned well scope, there may be some changes in the soil conditions. Check the as-left survey and consider a survey prior to the next visit. Concerns were raised that one of the legs for the proposed rig location sat on a previous imprint.
- Check if any pre-work with regards to rig prep or P&L can be completed. For this scenario unfortunately the crane has limited capacity (~1.5ton) and as such an offline P&L probably can't be completed.
- For the abandonment – consider cutting the tubing and using the completion as the cement stinger for setting a balanced plug in the 9-5/8" casing prior to pulling out of hole.
- Consider investigating the 7" liner cementation further to ensure sufficient evidence to support calling it an effective barrier.
- Consider measures to perform through tubing abandonment strategies
- All slot recovery contingencies and scenarios should be planned for in advance including any tools or equipment required as no pre-rigscope surveillance is planned – slot recovery and the associated abandonment has yielded lots of 'on-the-fly' planning in the past so try to mitigate this.

3 Well Design Concept and Drilling Challenges

- *The well concept consists of:*
  - *16" section through the Chalk, Cromer Knoll and Bunter Shales using 9.5ppg WBM to base chalk and 10.5ppg OBM to 16" TD. Inclination building to 63deg. 3 BHA runs are planned with a kick-off motor BHA and TCI bit and 2 RSS BHA runs with a hybrid bit.*
  - *13-3/8" casing with shoe set in top Zechstein.*
  - *12-1/4" section through Zechstein using 13-5-14.5ppg OBM and with well trajectory steering to avoid the Zechstein lower pressure raft. Inclination mostly at 63deg.*
  - *9-5/8" x 10-3/4" liner and 9-5/8" tieback with shoe set in lower Zechstein.*
  - *8-1/2" section through Rotliegent and to reservoir section using 10-10.5ppg OBM. Trajectory building to 69deg inc to hit reservoir target and subsequently dropping to 49deg inc.*
  - *7" x 4-1/2" cemented production liner.*
  - *Well TD at 11619 ftTVDBRT / 17873 ftMDBRT.*
- *The main subsurface hazards identified includes:*

- *The high lateral step-out and high inclination through both the 12-1/4" section (overburden, Zechstein) and the 8-1/2" reservoir section with the associated hydraulics, hole cleaning and borehole stability risks inherent in this trajectory. This is the highest inclination proposed for the Grove field to date.*
- *Well control and salt risks through the Zechstein consistent with SNS wells but exacerbated due to the trajectory and mud weight requirements.*
- *Wellbore stability in the Rotliegentes through the reservoir section as well as potential loss/gain scenarios.*

Session Feedback:

16" Section / Intermediate Casing

- During the approach to the Zechstein, ensure high degree of awareness is placed on entry with the appropriate SNS salt drilling practices in place especially with the higher inclination (string limits, stuck pipe procedures, jar and accelerator calculations, fresh water pill placement procedures, supervision in the doghouse prior to entry etc.)
- General agreement in the session for the 16" section that using WBM through to base chalk and OBM into the red clay was the right approach.
- Consider pulling the hybrid bit after drilling through the chalk and using a PDC bit through the Bacton / lower shales and through to 16" TD.
- Consider using a whipstock as opposed to a KOP sidetrack as this may lead to time savings as opposed to WOC / risk of no sidetrack etc.
- Consider consolidating to a two BHA run – if a hard formation is prognosed in the top-hole, consider using a PCF and agitator to improve ROP. Consider using mechanical specific energy calculations for optimizing ROP.
- Consider maintaining mud weight once through the shales as pressure fluctuations can destabilize the shales.
- Consider slimming down the BHA and replacing drill collars with HWDP to mitigate potential differential sticking risk. For example, both 16" and 12-1/4" hole can swap drill collars to 6-5/8" HWDP and also includes handling time advantages vs drill collars that require handling subs. This advantage needs to be weighed up with cost if this HWDP comes at additional rental and not included with in-built rig rental.
- Consider pulling the motor kick-off BHA as early as possible and go in with an RSS assembly to optimize overall section ROP and steerability.

12-1/4" Section / Production Liner-Tieback

- Although the current strategy avoids the pressure raft, look into contingency options in case the pressure raft is hit – look into salt saturated systems etc.
- Ensure the previous shoe set in competent salt and avoid a stringer to enable the target FIT to be achieved. Consider performing a LOT at the 13-3/8" shoe depth to give the highest potential window for drilling the Zechstein. An alternative that is also used is to perform an FIT but consider the actual LOT to be higher (as an example, one operator performs FITs to 2.1sg but assumes the LOT can be considered at 2.24sg based on offset knowledge).

- If using a previously cold-stacked rig for this well, ensure robust stuck pipe procedures through the salt and consider using stuck pipe training for the rig crew.
- Consider adopting ERD style practices for hole cleaning / tripping to maintain the best possible hole condition. In addition, consider using third party (or in-house if this is possible) observation teams to monitor hole conditions and modelling with regards to annulus cutting loading, T&D, hydraulics etc. Consider using external consultancies if unavailable in-house that can provide these real-time and modelling services particularly for this designer well.
- Rather than a second hanger/packer for the 9-5/8" tieback, consider using a tieback cement job / tack cementation.
- Consider running a non-integral packer/liner hanger system (run tieback packer as a separate run) if there are concerns about cementing window – this may lead to better ECDs and more options for manoeuvring and working in the liner to TD in case of poor borehole quality.
- General agreement in the higher mud weight and OBM system vs offsets for drilling through the Zechstein at the higher inclination.
- Investigate inflow testing the 9-5/8" liner after deployment as part of the PBR dress mill run prior to running the tieback.
- Consider using a check trip prior to running the liner once at TD. Consider allowing sufficient stabilization time 12-24hrs of the open hole with BHA at shoe prior to performing the check trip. Ensure an agreed tripping criteria for this.

8-1/2" Section / Production Liner

- Drilling window in the reservoir section was prognosed to be relatively narrow – consider checking the assumptions in the drilling window and the offset logs/FIT/LOT data. There is potential to increase the FG with the right WBS (sizing/material) and stress caging strategies through collaboration with the drilling fluids service company. This will require logs from offsets to ascertain particle sizes. Two approaches can be performed – passively dosing WBS in the OBM or pumping WBS 'pills' and locking them into the loss zones matrix.
- Although offset wells used 10.5ppg through the reservoir section, higher mud weights may be required due to the higher hole angle in the overburden to mitigate borehole collapse. Consider investigating the mud weight in conjunction with the above WBS-related feedback.
- Consider looking at a real-time mechanical earth model updated with logs and leak-off data to get a better understanding of fracture gradient at the shoe. Test the mechanical earth model on prognosis and use the model in real time for determination of more realistic PPFG profiles and ECD corrections during drilling. Use this and show on a daily basis during drilling to the rig drilling and geology teams.
- Consider using dynamic pumping models at section TD (or calibrate with PWD) to show the maximum hole strength prior to liner running and cementing operations.
- Investigate any risk of crossing faults across the reservoir and the potential for loss gain scenarios.
- Consider de-risking and slimming down the BHA design with regards to LWD suite in the section. Consider a dedicated wash down run or wireline run after the hole has been successfully drilled.

- Consider evaluating the geological depth uncertainty with respect to the reservoir entry point (due to high inclination and target of entering the reservoir). Consider re-evaluating the trajectory to hit the target at a lower inclination for a higher chance of success. Consider using a polygon target for the trajectory rather than a point and radius as this designer trajectory is complex – using the largest possible polygon would potentially give more room in execution.

4 Completion Design Concept and Perforating Strategy

- *The completion concept can be summarized as:*
  - *4-1/2" upper completion with SSSV, downhole gauge for reservoir performance modelling, sliding sleeve and 7" production packer set in the 7" portion of the 7" x 4-1/2" production liner.*
  - *10ppg NaCl brine completion fluid (~200psi overbalance)*
  - *Coil tubing perforating (2-7/8" guns) with multiple runs planned. Variable perforation interval based on reservoir sand interval observed in the section.*
  - *Base plan is for a rig based well test spread. An opportunity is being evaluated to enable flow to host using a depleted and shut-in donor well to mitigate requirement for full well test to clean up N2 and solids.*

Session Feedback:

- If coil tubing perforating is selected, consider pressure deployment – general consensus that there is good experience for pressure/reverse deployment strategies to minimize the number of runs (currently 4-5 planned). Also consider swapping to 30ft guns to minimize connections. Understand there may be risks related to coil tubing pressure/reverse deployment and associated NPT. Some operators use a shallow orbit valve or alternative shallow barrier to enable entry.
- Consider cemented completion concepts – 4-1/2" tubing to bottom which would offer significant cost savings. This negates the ability to run a gauge.
- Consider slotted liner completion concepts with a breaker fluid for the OH filtrate cake and a formation isolation valve.
- Consider re-evaluating the strategy for coil tubing perforating. Is there an opportunity to perform wireline perforating and evaluate the modelling in the high inclination of the production liner? Look into using tractor/roller bogie set-ups.
- Consider challenging the requirement for a DHPG. If a DHPG is required for life of well monitoring and optimization, ensure this is placed above the minimum required abandonment horizon to enable future through tubing abandonment strategies.