Multilateral completions on rise with Shell Expro

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SHELL UK EXPLORATION and Production (Shell Expro), to reduce cost per barrel of oil, continues to foster the evolution and utilization of multilateral wells and associated new technologies to develop both new and maturing reservoirs in all sectors of the North Sea.

Multilaterals with Technical Advancement of Multilaterals (TAML) junction levels 1 through 4 have been applied in 6 fields to date and will be applied to an additional 7 fields within the next 2 years. Multilateral wells have provided a means to optimize slot usage, commercially develop lower-quality reserves within the Brent sequence, and combine appraisal objectives with economical development targets.

THE SHELL VISION

Shell Expro is continuing to evolve their well design strategy with a vision of wells in the 21st century. The wells of the future incorporate a balance of new technologies and are called "smart wells". These smart wells would combine special drilling technologies, including underbalanced drilling and multilateral systems, with an intelligent well capability incorporating downhole monitoring, control, and oil/water separation and gas compression capabilities.

The following sections look at several examples where Shell Expro has fostered multilateral technology.

GALLEON: LEVELS 1 AND 2

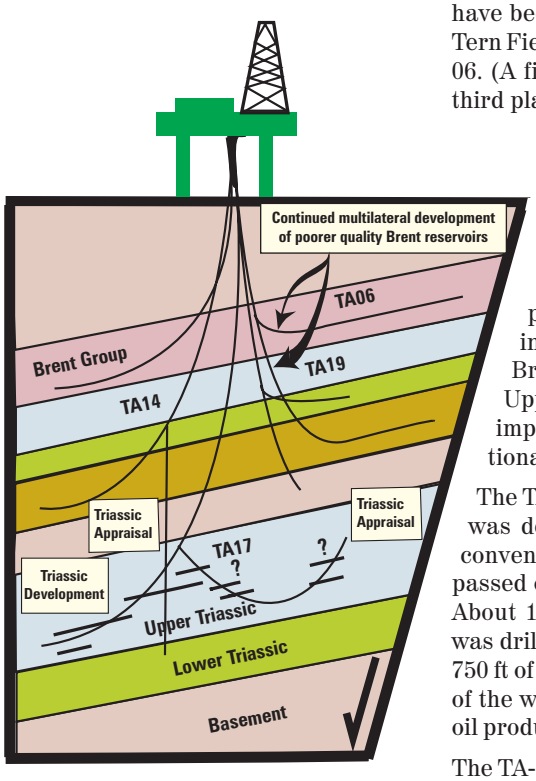
Shell Expro's Gas Supply Group in the southern North Sea has taken a stepwise approach in applying not only multilateral technology, but underbalanced drilling also.

Multilateral technology was identified as a means of increasing reservoir exposure and the chance of hitting "sweet spots", and reducing CAPEX and OPEX. Also, underbalanced technology were chosen to reduce drilling-related impairment.

2 tracks were simultaneous followed. The first was the evolution towards multilateral horizontal wells, and the second was towards full underbalanced drilling operations within the reservoir.

In September 1998, the multilateral well Galleon PG-02 was successfully drilled underbalanced as planned. Initial well tests look promising, but further long-term testing is needed to confirm and quantify benefits.

Following the success of the PG-02 well, another underbalanced multilateral well was planned for early 1999. Overall plans call for 20+ multilateral wells in the southern North Sea during the next 6 years.



4 TAML Level 4 multilaterals were successfully installed in Shell Expro's Tern Field by early '99—TA-14, TA-19, TA-17, and TA-06. The 5th multilateral, TA-16, then had only 1 lateral.

TERN FIELD: LEVEL 4

The Tern Field is located in the UK sector of the northern North Sea. From its start up in 1989, oil production was focused on the Etive sand. It is the most prolific of the Middle Jurassic deltaic sands in the Brent Group in the Tern. Although less than two-thirds of the reserves are in the Etive, it contributes over 80% of the production. With the conventional wells focusing on Etive production, the contribution from the lower-quality formations was marginal at best.

Thus, in mid-1996, a field development strategy incorporating multilateral technology, evolved to enhance production from lower quality Upper Ness and Rannoch formations. Factors driving this strategy were platform slot constraints, maximizing profitability, and increasing production levels.

To date, 4 TAML Level 4 multilaterals have been successfully installed in the Tern Field, TA-14, TA-19, TA-17, and TA-06. (A fifth multilateral, the TA-16, the third planned in the sequence, has only 1 lateral drilled to date.)

The TA-14 well was completed in Q3 1996 and combined a successful exploration/appraisal lateral into the Triassic and a subsequent dual lateral producer in the Brent reservoir in one well. Oil produced from the Brent laterals in the Rannoch and Upper Ness showed a productivity improvement of 3 over the conventional well designs.

The TA-19 well, completed in Q1 1997, was designed as a sidetrack from a conventional well with a target of bypassed oil against a major infield fault. About 1,300 ft of oil bearing reservoir was drilled, cased, and cemented. Next, 750 ft of perforations was shot at the toe of the well, which yielded an initial dry oil production of over 2,200 cu m/day.

The TA-16 well was drilled in Q2 1997. It was planned as a producer targeting the lower quality Rannoch and Upper Ness formations. The lower lateral targeted a thin (22 ft) sand in the Rannoch. Geosteering was successfully used to keep the lateral in the top 10 ft of the reservoir. An 800-ft section was perforated and produced at an initial rate of 800 cu m/day. The second lateral was initially planned to be drilled within the next 2 years. However, since the main bore is currently still producing, the deferment of this oil during the reentry and the cost of the recompletion made drilling of the upper lateral uneconomic.

The TA-17 well, completed in Q4 1997, was a Triassic producer. One lateral would drain the proven Triassic re-

serves (TA-14) and the 2nd would appraise the Triassic sands in an adjacent fault block. Both laterals were successfully drilled and the well was completed with selective production and through-tubing reentry capabilities.

The most recent well, TA-06, was completed in Q4 1998. Like TA-16, the objectives were to position one lateral in the Rannoch/Broom sands and the other in the Upper Ness sands. Both laterals were successfully drilled and completed with production from the upper lateral through a ported sub, positioned at the junction. Although drilling problems were encountered, the multilateral operations were successfully completed within planned time and budget.

PELICAN: (LEVEL 4)

The Pelican PU-15, in the northern North Sea, will be Shell Expro's first subsea multilateral oil producer. 2 major considerations affected the decision to make the well a multilateral. First, the existing subsea manifold had only one remaining tie-in, and secondly, the planned targets for the upper lateral had insufficient reserves to justify a standalone well.

The mainbore incorporates a 6,500-ft horizontal section that has 5 targets in the downflank area of Blocks B and C in the Pelican field. The second lateral has 3 targets in the downflank area of Block D in the northern part of the field.

The basic well plan called for drilling the mainbore and lateral, and then running the completion string before perforating. To accomplish this, the multilateral system selected would need to allow for through-tubing access to and isolation of both laterals.

Quantitative risk analysis was performed to determine the optimum multilateral system considering the following:

1. It would be a subsea well drilled from a floater with requirements to minimize wait-on weather delays associated with critical milling operations.

2. The expected pressure differentials during the life of the well, and the well trajectory requirements would require the use of TAML Level 4 junction

3. The system must ensure both hydraulic and mechanical access to both laterals with the capability of accessing and/or isolating either lateral after the completion is run.

The PU-15 well was spudded in September 1998. *[Editor's note: The well was in progress at the time of this writing in late '98. See "About this paper" at the end of the article.]*

TAML LEVEL 6 FIELD TRIAL

The advancement of the Level 6 multilateral technology is on Shell Expro's staircase requirements for HPHT wells to be drilled starting in the year 2001.

The world's first TAML Level 6 ML junction was successfully installed in a new onshore well in Bakersfield, California. It was the first field installation of a level 6 junction. The well was drilled and completed by **AERA Energy LLC** (aka **Shell California**) in September 1998. The junction installed in the AERA well had a 2,500-psi pressure rating.

The junction, configured with a 9 5/8-inch top connection with two 7-in. legs, was

run on 9 5/8-in. casing. The assembly was successfully installed, with minimal extra drag, through the 14-in. casing and into the open hole, including the 13.5°/100-ft build section. The junction was positioned in the horizontal at 93 ft deviation at 1,597 ft MD with the shoe of the first lateral leg at 1,853 ft MD (the pre-formed leg) and the shoe of the second lateral leg set at 1,620 ft MD.

After confirming the orientation of the junction with an electromagnetic MWD, the junction was successfully reformed using a hydraulic swaging system and internally pressure tested. After the reforming string was pulled from the well, the fully re-formed junction and the 9 5/8-in. casing string were cemented in place.

Two 6 1/8-in. (2,000 ft± each) legs were subsequently drilled. A 4 1/2-in. slotted liner was installed in both legs.

The main problem was that the effective drift through the junction into each lateral was less than the planned 6 3/8-in. Reducing the stabilizer and bit ODs used and modifying the 4 1/2-in. liner hanger assembly effectively solved the problem.

CONCLUSIONS

Multilateral applications are on the uptake within Shell Expro since the first one was drilled in 1994. Multilateral technology can be applied to new and mature North Sea fields.

Long-range technological visions should be planned to evolve through intermediate steps, identified by specific deliverables. This allows early payoff from incremental benefits and learning while the risks are kept at an acceptable level. This was demonstrated in the Tern Field.

Use of multiple new or unused technologies may ultimately be more cost effective if done in parallel, as in the Galleon Fields.

Use of the QRA process to select technologies and vendors allows the total risked cost of ownership to be the key factor, instead of the basic equipment and service cost.

ABOUT THIS ARTICLE

This article was adapted from "Multilateral Well Utilization on the Increase" (SPE/IADC 52871), presented by the authors at the 1999 SPE/IADC Drilling Conference, held 9-11 March in Amsterdam. ■

DRILLING CONTRACTOR

DRILLING SERVICES

Tesco drills to 6,500 ft with casing

TESCO CORP'S CASING Drilling Group recently announced drilling with casing to approximately 6,500 ft in Wyoming. The 9 5/8-in. surface casing was drilled to about 900 ft, and the 7-in. production casing was drilled to 6,480 ft, the company said. The well was directional and encountered lost circulation, sloughing shale and hard, abrasive rock.

The main challenge was to ensure the casing could be run in high compression loads without damaging the connections, Tesco said. The solution was a proprietary Tesco-developed centralizer designed to ensure no casing or coupling where. Another problem was developing underreamer cutting structures that could cut through rock at rates comparable to conventional rotary drilling. Tesco says this has been achieved for hard rock. A solution for soft to medium rock is now begin tested. The third challenge involves the reliability of the bottomhole assembly conveyance system. Today, this system has been 100% successful while running, but only 70% successful in retrieving mode, according to Tesco. Most of the problems center around 3rd-party underreamers not allowing the arms to collapse due to mechanical difficulties and the strength of wireline required to retrieve heavier assemblies. Tesco's Gris Gun Division bas begun to manufacture its own underreamers. To date, all 3 runs in the Wyoming well using this tool have been successfully retrieved. ■

Schlumberger sets subsea record

SCHLUMBERGER RECENTLY announced setting a new world water depth record for subsea completion tree systems with its SenTREE 7 at 3,400 ft in **Texaco's** Gemini Field in the Gulf of Mexico. With this new record, Schlumberger began a 3-year contract to provide well-control services for all Texaco completions in the GOM. The company expects to set future subsea completion tree records under existing contracts for SenTREE 7 with other operators.

SenTREE 7 is a 7 3/8-in., 10,000-psi subsea completion tree system capable of operating in water depths to 10,000 ft, according to Schlumberger. This new, modular design subsea completion tree is used in conjunction with horizontal Christmas tree tubing hanger systems. The device allows control of live wells under various conditions. It can operate from either anchored or dynamically positioned vessels. ■

Grant Prideco, RTI Energy put Ti drillpipe to work

GRANT PRIDECO AND RTI Energy Systems put titanium drill pipe into commercial use for the first time, following years of testing. **Torch Drilling Services** drilled the curved section of a short-radius horizontal well in Greeley County, Kansas, with a hybrid steel and titanium drill string, Grant Prideco announced. The BHA comprised 4 joints of 2 7/8-in. titanium alloy upset pipe with a rotary steerable horizontal drilling system.

The projected well path was a 60-ft radius of curvature to a target azimuth of 90°. The actual well tracked a 58-ft ROC to a 93° azimuth. The pipe was rotated at 50-80 rpm while building angle.

Grant Prideco says titanium is well suited for short-radius, extended-reach and ultra-deep wells because the material is physically robust, chemically resistant, long-lived and half the weight of steel pipe with double the flexibility.

The titanium was manufactured jointly by Grant Prideco and RTI and fitted with Grant Prideco steel tool joints. ■