



tion of the injection zone prior to running multilateral equipment.

The well proved up the concept of using a multilateral well as a viable alternative for deepwater subsea field development, and has been used as an injector since 1999.

## LEVEL 5 BARRACUDA WELLS

Two level 5 multilateral wells were drilling in the Barracuda field, one a milled window system and the other with a pre-milled window system. The Barracuda field is in approximately 800-1,100 m of water in the Campos Basin and required a water injection program.

The purpose was to drill and complete the main and lateral directional wells for water injection into the sandstone reservoir using gravel packed 5 ½-in. and 3 ½-in. lateral bores. A milled window system level 5 junction and a 5 ½-in. upper tubing string were planned. A subsea tree will be installed and the well tied to the Barracuda floating production unit in the future.

The junction was installed successfully and the well temporarily abandoned as a future injector. Prior to abandonment the main and lateral wells were evaluated and the injectivity index achieved the reservoir requirements.

The second Barracuda multilateral injection well was drilled for the same purpose as the first well. The well features were identical except for the junction, which was Petrobras' first experience with a pre-milled window system.

While the junction was successful, this second well failed due to a number of reasons. Evaluation of the main bore was considered satisfactory but the lateral bore was much lower than the expectation due to a very high skin factor. An acidizing job was performed but the injectivity increment was still unsatisfactory. It was decided to flow the well to improve the injectivity index, however, the lateral bore frac-pac failed and sand from the gravel pack and formation were produced, requiring sand cleaning using a coiled tubing unit. Hard luck continued as the coiled tubing broke and the fishing operation became too complex to economically complete. The well was abandoned.

## LESSONS LEARNED

Numerous lessons were learned for future multilateral applications as a result of the Bonito, Voador and Barracuda wells.

- Different approaches to remove debris were tested and the solutions utilized still require some evolution to reach the optimal point of risk reduction.
- The washover/mill-through operation has been performed with satisfactory results but some improvements to reduce rig time is necessary
- Junction completion was performed successfully but proper space-out of the tools at the junction is very important.
- Many interfaces surrounding the multilateral well require the right people with the right knowledge in the right place to avoid drastic consequences.
- Careful attention should be given to workover operations that require running coiled tubing or wireline after installation of the multilateral completion.

Petrobras says that multilateral technology still requires improvement but the fact that the Voador completion is still injecting since February 1999 and saved \$10 million by not drilling a second horizontal well shows that it is possible to take advantage of the present stage of the technology.

On the other hand, the experience with the workover of the Barracuda well shows the importance of risk assessment and the need for multilateral equipment that is friendlier to workover operations.

Meantime, Petrobras is planning a level 6 multilateral well on a 9 5/8-in. casing in an onshore well in preparation for a level 6 application offshore.

## REFERENCE

This article is based upon a paper presented at the 2001 SPE/IADC Drilling Conference by **Gabriel Sotomayor, Ronaldo Oliveira** and **Ivan Alves** with Petrobras 