# Oil & Gas Brazil

2006 – Issue 1

Ultra-deep frontiers

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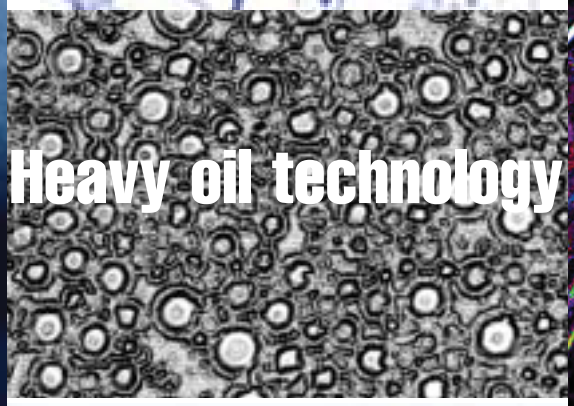
Drilling advances



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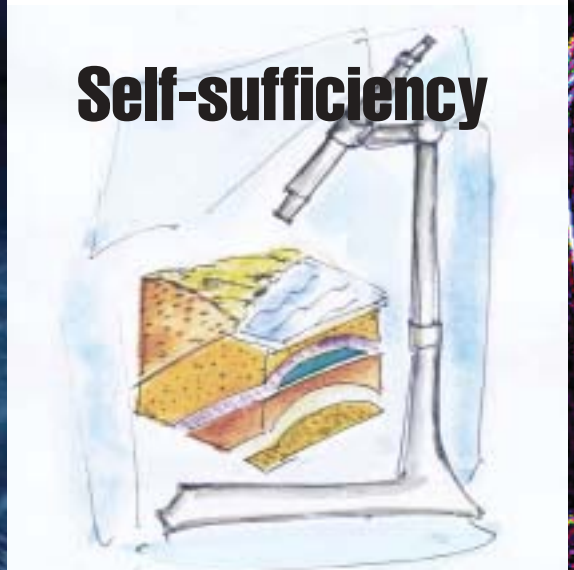

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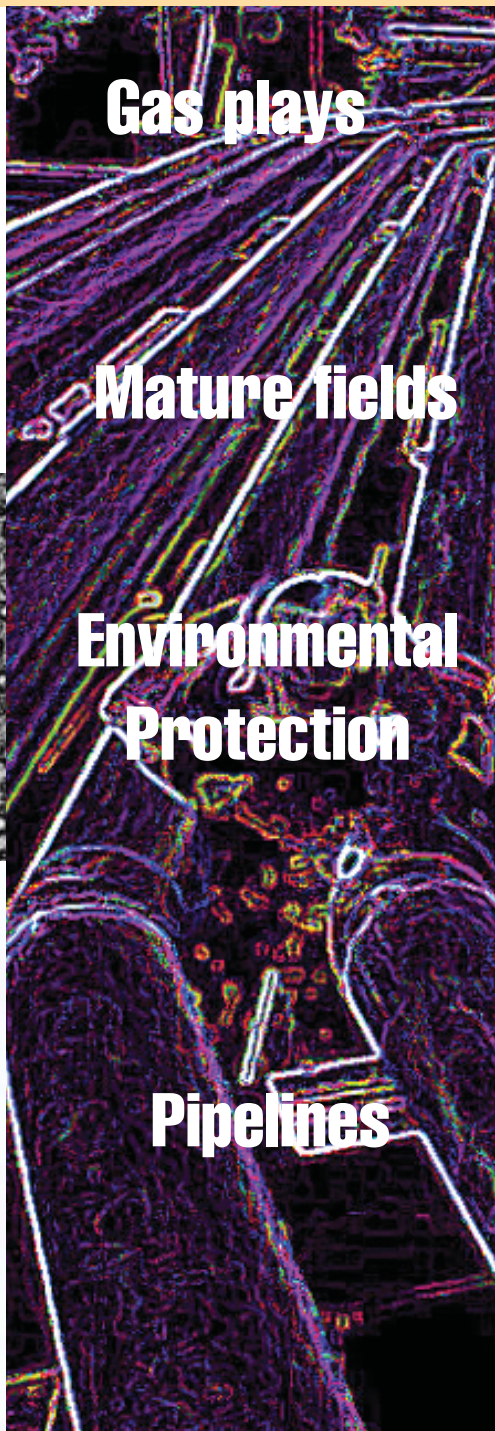

Gas plays

Mature fields

Environmental Protection

Pipelines

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EP Rasheed Publications
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**EDITORS**
Wajid Rasheed
George Hawrylyshyn (Brazil)
John Bradbury (Intl)
JC Cunha (Technology)
Mauro Martins

**PUBLISHER**
CEO Wajid Rasheed
wajid.rasheed@ttnrg.com

**ARTISTS**
Alexandra Bruna
Neuza Marcondes
Jair Mendes
Layout: Bob Roxburgh

Oil & Brazil Gas

# CONTENTS



Brazil Oil & Gas
London
England
Tel: (44) 1753 572257

Brazil Oil & Gas
c/o Easyline
Prado Junior 78
Copacabana – RJ
Tel: (55) 21 2275-5090

Ad Sales
Monica Placido, mplacido@braziloilandgas.com
Tel: (55) 21 92130629
Ana Felix, afelix@braziloilandgas.com
Tel: (55) 21 97148690

INTRODUCTION

# Self-sufficiency in sight

1,790,000 is the magic number. That's the bopd figure that Petrobras expects to reach when self-sufficiency occurs this year.

During the last decade, Petrobras has pursued an aggressive E & P agenda which has seen exploratory frontiers being opened, deepwater assets modularised and new platforms built. All told, Brazil's dependence on oil imports for national demand fell from 80% to 10% within two decades.

"The P-50 will guarantee Brazil's self-sufficiency in oil in 2006," Petrobras President Sergio Gabrielli said at a ceremony at the Mauá Jurong shipyard just outside Rio de Janeiro.

As Guilherme Estrella, E&P Director for Petrobras, once said, "Self-sufficiency is an emblematic and inescapable goal. Wrapped up with it, is Brazil's sense of self esteem. It will be an historic milestone." With today's high oil prices, self-sufficiency means economic freedom. Coupled with Brazil's successful financial management of its national economy, self-sufficiency carries economic benefits as Brazil will not need to buy approximately 180,000 bopd on the international petroleum markets.

> 'With today's high oil prices, self-sufficiency means economic freedom.'

Beyond the numbers are the myriad oilworkers from both the service companies and operators that make production targets happen. In this way, self-sufficiency is also a tribute to these people, Brazilian and visitors.

For me, it is both an honour and pleasure to have worked on this inaugural issue of Brazil Oil & Gas. We are delighted to have Brazil's veteran industry reporter George Hawrylyshyn write for us. George writes about the Campos Basin's domination of Brazil's E & P scene. He also writes about Petrobras as the big winner of the latest 7th licensing round.

It is also an honour to have interviewed Joao Figueira, Executive Manager, Petrobras International and Farid Shecaira, Manager PRAVAP. Both these gentlemen talk exclusively to Brazil Oil & Gas about Petrobras activities.

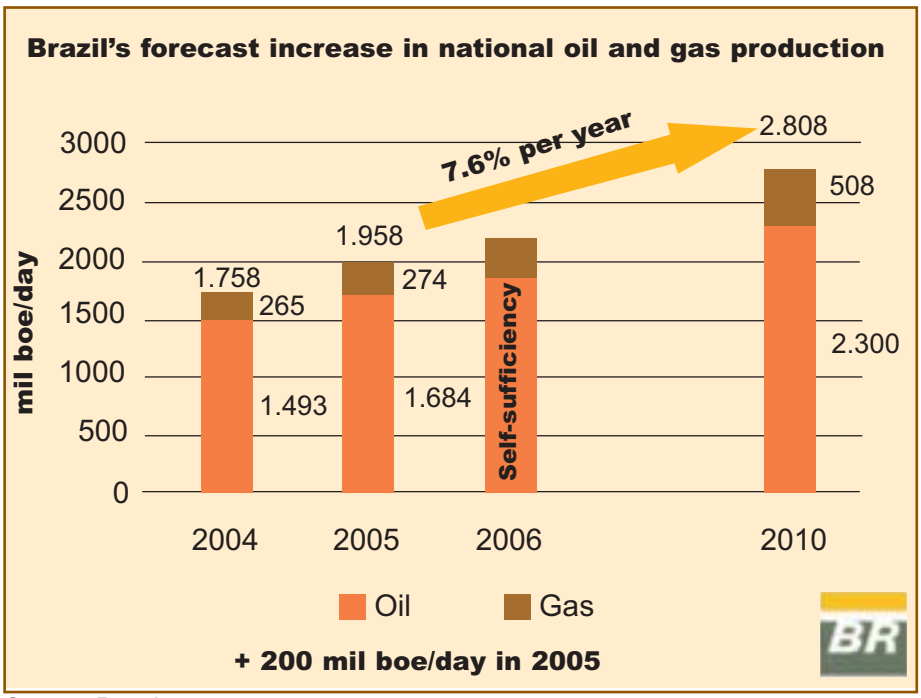
It is a pleasure to note that Brazil Oil & Gas will be published biennially. It was originally meant to be an annual publication, however due to the interest shown we will publish twice a year.

Looking ahead to Issue 2 we have interviews with Marcelino Guedes, Pipelines and Terminals Director, and with Jose Luiz Marcusso, Executive Manager of the newly formed Santos Basin Business Unit – based in Sao Paulo. There is also a special article on Petrobras E & P Director Guilherme Estrella.

Kazuioshi Minami and Eduardo Faria talk to Brazil Oil & Gas about Petrobras' PROCAP 3000 and geophysical programs, respectively.

These two technology special features are about technology that delivers value: increased recoverable reserves, lower finding and development costs, and building a safer and cleaner working environment for generations to come.

Last but not least, I would like to thank everybody involved in publishing Brazil Oil & Gas, and Petrobras press officers Glaucio Henmann and Taisa Fortes for their help.




*Source: Petrobras.*

**Wajid Rasheed,**
Publisher,
Brazil Oil & Gas.

INTRODUCTION

# Fast tracking self-sufficiency

*By George Hawrylyshyn**

In one way or another, the Brazilian oil and gas sector, which basically still means Petrobras, has been on the fast track for about half a century. It all started with the pro-monopoly "The Petroleum is Ours" movement and went through various phases, the latest being fast tracking the long held nationalist dream of oil self sufficiency.

Way back in the early 1950s, the Brazilians came out on the streets in massive demonstrations pressing for the creation of an oil monopoly and a state controlled oil company. In 1953, Petroleos Brasileiros SA- PETROBRAS was created as a state controlled company with the Constitutional mandate to administrate the oil monopoly for the Federal Government, and assure the supply of hydrocarbons for the populace. From the start the Brazilian state oil company was unique in as much as it was established as a mixed capital company with shares traded on the local Stock Markets. The distribution of oil products and gas, was not monopolised and the existing small, private, refineries were allowed to continue operating.

It was back then that the concept of self-sufficiency in oil cropped up and although not part of the main documents, it was well understood that that was the objective and dream of nationalists, a dream that would take more than 50 years to be realised. But it is finally happening and in early 2006 Brazil's domestic production is programmed to surpass the 2 M bopd mark, which will be more than consumption, therefore reaching technical self-sufficiency.

## Starting from scratch

One of the arguments to establish a national oil company in Brazil was that the then 'Seven Sisters', among them Shell and ESSO, had been in the country since the beginning of the century but had concentrated on the no-risk distribution sector and shown little interest in looking for oil in the country.

Except for some isolated cases of Brazilian nationals and a few foreigners, nothing much was being done in the way of E&P here and Petrobras had to practically start from scratch and was under pressure to do it fast. So the country's first fast tracking operation was rushing to establish a company with staff that are practically running a crash-course in the basics of the oil industry. Transfer of technology is well established with the priorities of scholarships for learning about the oil industry abroad, and increasing local technical and academic institutions.

## Innovation and daring

By the '60s, aside from having gained academic knowledge and a decade of field experience (not only onshore but also offshore, albeit in shallow waters) the Petrobras specialists had mastered the basics of the oil industry and started

## Big 36

In the first six months of 2006, Petrobras' petroleum production may meet and even exceed consumption levels in Brazil, with the prediction of an annual average production of 1.91 million barrels per day. This production is considered sustainable as the company has a portfolio of projects already in development, which will increase annual production to 2.3 million barrels in 2010, without taking into account future discoveries.

As the objective is not only to achieve this target, but also to maintain production growth levels, Petrobras has planned for 36 big projects, among them:

### In 2006

☐ Platform P-34, with 60 thousand barrels/day, in the field of Jubarte; in Campos Basin.

☐ SSP-300, 20 thousand barrels/day, in the field of Piranema, in Sergipe.

☐ Golfinho Phase one, 100 thousand barrels/day, in the field of Golfinho, in Espírito Santo Basin.

### In 2007

☐ RJS-409 Field of Espadarte, 100 thousand barrels/day, in Campos Basin.

☐ Golfinho Phase two, 100 thousand barrels/day, in the field of Golfinho, in Espírito Santo Basin.

☐ Platform P-52, 180 thousand barrels/day, in the field of Roncador, in Campos Basin.

☐ Platform P-54, 180 thousand barrels/day, in the field of Roncador, in Campos Basin.

### In 2008

☐ Platform P-51, 180 thousand barrels/day, in the field of Marlim Sul, in Campos Basin.

☐ Platform P-53, 180 thousand barrels/day, in the field of Marlim Leste, in Campos Basin.

### In 2009

☐ Field of Frade, 100 thousand barrels/day, in Campos Basin.

☐ Golfinho (EES-156), production to be defined, in Espírito Santo Basin.

### In 2010

☐ Golfinho FPSO 3, in definition phase

☐ Platform P-57, 180 thousand barrels/day, in the field of Jubarte, in Campos Basin.

☐ Platform P-55, 180 thousand barrels/day, in the field of Roncador, in Campos Basin.

☐ Field of Albacora, complemental phase, with the production to be defined, in Campos Basin.

# Petrobras achieves high market growth in petroleum sector

Petrobras' market value grew 70% to November 2005 when compared with 2004. It has consolidated its position as the 8th highest valued company of the sector and the highest valued in Latin America. This reflects its exceptional operational, financial and market performance

Petrobras went up 68 positions in Business Week's ranking. The magazine evaluates global companies according to their market value, based on publicly held companies listed in the index of Standard & Poor's Global 1200.

According to the criterion of Business Week, Petrobras went to 56th place in the ranking, after considering its market value in November 2005, which was US$ 72 billion, compared to November 2004 when it was US$ 42 billion. This place in the ranking shows the sustainable advances of the company in all its areas of performance in one year, in which its results were highly positive. In the activity of exploration and production record levels of oil and natural gas extraction were registered, with the operational start of the new P-43 and P-48 platforms.

Records in the area of refining were also achieved by maximizing the processing of national petroleum and quality improvement. Along with all oil companies, Petrobras benefitted from internationally high oil prices.

The result shows Petrobras' commitment to increasing shareholder value while strengthening its role as an integrated energy company with a strong international presence and a leader in Latin America, while maintaining social and environmental responsibilities.

innovating and being daring. It was this combination that led them to the first discovery in Campos and set the way for Petrobras to become a big player, indeed a pioneer and a major in the offshore industry. The first eight wells drilled in offshore Campos came up dry and Petrobras executives didn't want to spend any more money on an apparently non-oil region. But one of the company geologists argued that as there was time left in the contract, why not drill one last well?

There was a big argument alleging the 'waste' of money, but eventually the geologist won, Petrobras drilled again and that 'last well' discovered Garoupa, the first commercial field in what turned out to be the prolific Campos Oil Province.

Also daring was the solution adopted to face the First Oil Shock in the early 70s, when the price of crude doubled and the country was importing about 80% of its demand at the time.

The decision was daring as it placed the bets on offshore exploration – that was before the discovery of Campos – and on fuel alcohol, unknown at the time but now all the cars in Brazil use up to 20% of the home-grown ethanol.

## Campos Basin

Campos was discovered in '74 at the Garoupa field, but soon afterwards there were a series of other strikes, eventually including the giant deep water fields. Soon it had more oil than was imagined.

That was the time to switch fast track priorities to offshore production technology. The oil was there but the country couldn't wait the usual four to five year period to develop and bring in new oil. So it was back to the necessity of invention. First it was the adaptation to local conditions of the North Sea ERS – Early Recovery System. That is, using a jack-up to produce newly discovered oil sooner.

Eventually this led to producing from an exploratory well and in deeper waters the use of the Floating Production Storage and Offloading (FPSO) – which saved time and money by being converted from the hulls of old Petrobras oil tankers – and eventually the first Dynamically Positioning FPS – Floating Production Systems for ultra-deep waters. In between were such innovations as reusable wellheads, Wet and Horizontal Christmas Trees, diverless and wireless installations to name a few.

These and other methods led Brazil on the so-called 'March to the Depths' with a series of ever deeper and ever bigger discoveries, all of which were leading the way for self-sufficiency.

As a consequence of these discoveries, mainly in Campos, Petrobras started setting a series of deepwater production and other world records. Petrobras was also rewarded twice for its pioneering efforts, with the industry's most coveted prizes, the OTC Technological Development Award.

## End of the monopoly

Heeding to the 'Winds of Change' – a world-wide trend for privatization – the Brazilian government ended the Petrobras monopoly in 1997, leaving the company with the areas it was producing or developing and retaining its mixed capital status with the government remaining as the majority stock-holder. Other than that, Petrobras was given the mandate to operate as a private company, including participation in the E&P concession bids on the same terms as all the other bidders. That is, the same terms but with an unmatched knowledge of the geology operating methods in the country.

Petrobras carried out its instructions from the government so well, that some of the private companies are complaining the state company is using the concession bids to buy back much of the acreage it owned when it held the monopoly. Another complaint from the private side cannot be blamed on the state company. By coincidence, the series of giant field discoveries that Petrobras had in the early 90s finished with the end of the monopoly. And many of the discoveries made later were not only small but also of heavy oil.

## Self-sufficiency

In most countries oil self-sufficiency is considered something 'nice' if production is rising and 'bad' if it's falling.

In Brazil, where production is rising, self sufficiency is a symbol of national pride especially for politicians and oilmen. Petrobras is budgeting millions of dollars to advertise the fact that sometime this year domestic production of oil will surpass demand. Although admitting this might not last one year, Petrobras marketing people feel it is beneficial to spend this money on advertising.

Officially, Petrobras calculates self-sufficiency is expected to be reached in the first half of 2006, probably in April. Company projections expect that month's production should reach a high of 1.90 mln bopd, while domestic consumption is expected to be 1.79 mln bopd. But it will still take a few years before the surplus of domestic supply stabilizes, as according to government projections, this year's surplus will only last until October when consumption will return to surpass production.

But aside from its symbolic value, self-sufficiency on the way up is good for the economy and for the self-esteem of oilmen and politicians. But this raises the question of what to do with the extra oil? There is a nationalistic tendency arguing to save the extra oil in the reservoirs for future use, but foreign and private Brazilian companies, as well as numerous Petrobras specialists, favour the tendency to pump, sell the surplus abroad and continue exploring, rather than saving the surplus crude to assure future domestic demand.

**** George Hawrylyshyn is the Founder of BRASIL ENERGY and BRASIL ENERGIA***

CAMPOS BASIN

# Campos Basin still dominates

By
George Hawrylyshyn

The Campos Basin continues to dominate the Brazilian oil field, despite some highly promising strikes in the Santos Basin – south of Campos – and the Espirito Santo Basin – to the north.

Covering a total of about 100,000 sq.km, the Campos Sedimentary Basin has 43 Exploration and Production (E&P) concessions being worked by nine oil companies, occupying about 20% of the total area. Production of oil now stands at about 1.4 M barrels of oil per day, almost all of it by Petrobras, and still growing.

Summing up the reservoirs that have already been discovered in the Campos Basin and some of the probable reserves to be discovered, Petrobras estimates that Campos will continue to be their leading oil province at least through to 2015.

But the Campos' heyday appears to be over, unless there is a new breakthrough, one of which could be the ultra-deep, sub-salt oil formations being tested now, or striking more gas. From 1994 to 2004, Petrobras drilled 225 exploration wells in the region, 90 of which struck oil. These probes resulted in the discovery of the giant fields of Marlim and Roncador, as well as the promising Parque das Baleias area.

In those ten years, the proven reserves in Campos have almost tripled, from 3.7 B boe in 1994 to 10.7 B boe in 2004. The equivalent production of oil barrels went from 496,000 b/d to 1.203 M b/d.

## Petrobras was the big winner in the 7th round as well

Rio de Janeiro, Brazil – As on previous occasions, Petrobras was the big winner of the 7th Round of Brazil's E&P Concession Bids.

In October's bids, Brazil's state oil company picked-up an additional 96 blocks, operating independently or in partnership with others making up a total bonus of US$ 236 million.

They also made the highest bid for a single block, US$ 71 million, which Petrobras (60%), split with British Gas (40%). This sum was paid for the Santos Basin, S-M-508 block, where the Brazilians, and the British, were betting on the very deep, sub-salt, frontier formations.

While Brazil's national petroleum agency, ANP, called this round a "great success", for Petrobras the annual bids have become something of a routine opportunity to re-build its portfolio and regain some of the blocks it had before the end of its oil monopoly in 1997, when the national oil company held all the sedimentary basins in the country.

According to the ANP, this round tallied close to half a billion US dollars in bonus totals, from the 251 blocks sold of the 1,134 offered. The ANP says this is more than in any of the previous rounds and that the block sales success rate of 22% was a good result by offshore industry expectations. The ANP was also excited about the fact that aside from the total bonus earnings, of US$ 484 million, commitments for exploratory work in the blocks sold could amount close to US$ 2 billion, over the next few years.

The ANP, which is promoting the participation of private Brazilian companies in the local oil business, had a double reason for satisfaction; the increase of participation in the bids by medium and small size Brazilian companies and a good turn-out for the agency's first attempt to auction small marginal fields.

Small and medium-sized Brazilian bidders picked up another 96 blocks, albeit much smaller and less costly areas than those acquired by Petrobras.

### Marginal fields

The 7th Round also served to show how the oil business is different in Brazil. It introduced bidding rounds for small and mostly non-producing fields, something practically non-existent in Brazil, because Petrobras – the long time sole operator – was seldom interested in these very small operations. Whereas the oil industry in North America started with marginal deposits – often stripper wells – more than a century ago, the local circumstances are such that Brazil is only moving into marginals now, half a century after the first commercial oil strike here. In this round more than 100 small and medium-sized companies, many new to the oil business, competed for the 17 marginal fields offered and bought up all but one of them.

A total of 114 blocks went to foreign companies, as operators or associates (note the total number of blocks sold doesn't match the sum reported here because blocks with minority partners are counted more than once):

Amerada Hess, BG, Devon, ENI, EnCana, Koch, Newfield, Shell, Repsol YPF, Statoil, and the recently created small Canadian company BrazAlta were the foreign companies that walked away with blocks. But there were some majors that participated in previous Brazilian rounds but did not take part this time. Exxon, BP, Total and Chevron were absent.

The most sought-after basin was Santos. The first very deep sub-salt probes are being made here, and the recent discovery of the huge Mexilhao gas field has added to its attraction.

ANP officials had promoted bids for specially selected areas with gas prospects, and that worked. Not only in the region of the giant Mexilhao field in the Santos Basin but also elsewhere. This effort worked even though Brazil's Gas Law has not been passed yet and there was concern that bidders would not want to invest in a market that didn't have well defined rules and regulations.

Another well disputed area was the surging new oil province of Espirito Santo Basin, where Petrobras got three blocks and Shell got four.

The 1,134 blocks offered this time, included 625 offshore and 509 onshore, spread across 34 sectors, covering an area of 397,600 sq.km.

RIGS

# Petrobras gets drilling rigs cheaper

*By George Hawrylyshyn*

In the last part of 2005, day rates for drilling rigs spiralled along with the prices of crude. But after being slow at the start and losing 4 ultra-deep water drill ships, Petrobras learned fast and rapidly picked up 24 rigs, renewing its rig fleet at rates well below current market values.

The package deal includes direct negotiations for new, long range - 2 to 5 year – charters, and renewal of the Petrobras drilling fleet. It is believed to be the largest deal of this kind for the offshore sector and it has certainly been financially beneficial for Brazil's national oil company. While some rigs are going for as much as US$ 405,000 per day, the highest rate Petrobras paid was US$ 254,000 per day. Indeed, only 2 of the rigs chartered by Petrobras, — for Noble's deepwater semis Paul Wolf and Dave Beard – surpassed US$ 200,000 per day, well below going day rates elsewhere.

The Brazilians adapted direct negotiations with the drillers after three calls for conventional bids had poor results: few participants and very high prices.

> ‘ longer terms gave Brazil a competitive advantage over the short time spot market rates more common elsewhere... ’

The decision for direct negotiations was taken in March and involved not only contracts expiring in 2005 but also those maturing later. These longer terms gave Brazil a competitive advantage over the short time spot market rates more common elsewhere, as well as the fact that concentrating units in Brazil spared the cost of frequent movement over long distances.

Of the 24 rigs secured by Petrobras, 17 are semis and 7 are drill ships, with their water depth drilling capacity ranging from 600 m to 3,000 m, although only 6 have capacity beyond 2,000 m. Most of the contracts were renewals, but there were 5 new rigs: Pride Portland, Pride Rio de Janeiro, Peregrine I, Noble Therald Martin and Dave Beard, the latter under construction. The companies involved in the deal were renowned international names such as Transocean Pride, Noble and Diamond, as well as the Brazilian companies Petroserv, Queiroz Galvão and Schahin Oil & Gas.

Petrobras' initial slow reaction to spiralling day rates resulted in the failure to renew the charters for 4 deep-water rigs. Transocean's, Legend and the Sedco Express have already left the country and are operating abroad for BP, while the Deepwater Frontier and Deepwater Expedition will leave the country by the first quarter of 2006.

Without these units, and having 2 semis with 3,000 m capacity – the Paul Wolf and the Dave Beard – available only in 2007 and 2008, Petrobras is reworking its ultra deep-water drilling program: rescheduling it to 2008 and giving priority to shallower waters.

DRILLING

# Campos Slender Wells

## Drilling and completing wells in ultra deep water using Slender Well technology

*By W. Rasheed*

Since 1970, the Campos Basin has been something of a test ground for new drilling and production activities. During this time, vast amounts of information and know-how have been generated enabling the testing of promising technologies without causing losses to the company or damage to the environment.

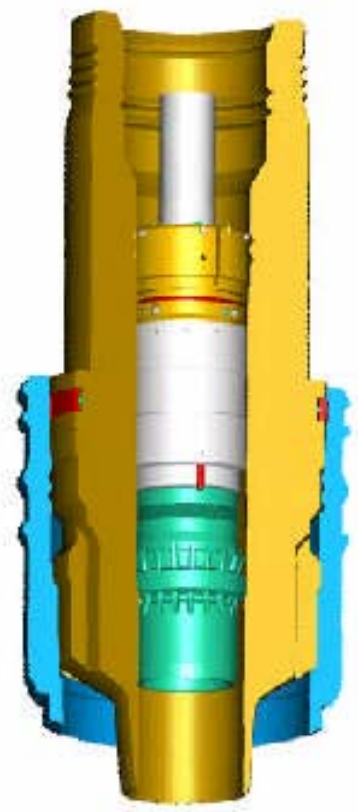
One such promising technology is the 'Slender well', an integrated project encompassing drilling, completion and workover for wells in deep and ultra-deepwaters.

Reducing the drilling riser's diameter and consequently rig deck load is the main goal of slimming down wells. This makes it possible for rigs with lower deck load capacity to operate in water depths greater than their original design and this has major benefits. For example time-consuming rig upgrades can be avoided. Also, more rigs that can work in deep and ultra-deep waters at a lower cost are made available. This means that second and third generation rigs can be used in markets that had previously been restricted to fourth and fifth generation rigs.

Beyond improving rig availability, slender technology offers a host of other potential benefits. These are currently being explored by Petrobras in order to reduce drilling, completion and workover costs. In an integrated project that covers well, rig and everything in between, Petrobras is investigating the use of slender well configurations as well as slender equipment such as wellheads, risers, tubing hanger and the drill pipe riser.

With this working philosophy, the first step was to change the conventional well design (casing strings: 30" x 20" x 13 3/8" x 9 5/8") to the slender well design (casing strings: 30" x 13 3/8" x 9 5/8").

A conventional well in the Campos Basin comprises four phases or casing strings: 36" or 30" x 20" x 13 3/8" x 9 5/8" casing,



*Slender wellhead.*

and in some cases a 7" liner can be used. This casing configuration has been adopted since the first 30" casing was jetted in 1993 in the Barracuda field. The conventional configuration was already an evolution in well design as previously the 46" or 42" casing usually 12m to 14m in length was a structural casing string that was no longer used.

Petrobras engineer Luizao said: "Petrobras has a lot of experience in the Campos Basin, acquired from the development of several fields. This permitted us to understand a key parameter for well design; pore-pressure profile. Accurate pore pressure profiles enabled the concept of the slender well, which meant the removal of a casing string, in this instance the 20"casing. Furthermore, it was possible to go deeper with the 13 3/8"casing safely and without the need to run the BOP stack. This depth is the same or in some cases deeper than the 13 3/8"casing shoe of the conventional wells. All this is a consequence of the knowledge of the pore pressure profile in the Campos Basin. Therefore, it is very important to point out that the application of this technology is recommended for known areas, rather than uncharacterized exploratory areas."

Offering different well configurations depending on the type of completion required, slender wells offer unprecendented integration between drilling and completions. Casing strings can be offered as liners (or not) and the sealing between casing strings is guaranteed by the cementing job or the cementing job plus a wellhead pack off. This kind of sealing has been extensively used in the Campos Basin and still provides excellent results today.

Luizao explains: "The slender well project has greatly improved the efficiency of operations by reducing time. It fits the exploration goals, by providing fast answers to Geological needs. Nowadays, the slender well is a success. Drilling and completing the well using three casing strings is a very common way of meeting the objective in a cost effective manner. Currently, slender wells drilled in the Campos Basin have three phases, these are Jetting the 36"or 30" casing, and drilling with and without returns."

### PHASE 01: 36"/30" Jetting

Due to the soil profile of the Campos Basin, three joints of 30" casing are usually enough to support the weight of the 13 3/8" casing, which is the next casing string. In some cases, it is necessary to run four or even five joints.

During this phase the Jet Cam Tool, developed together by Petrobras and another service company allows us to save considerable rig time since it permits drilling ahead after the jetting operation. This saves time, which is always welcome in deep and ultra-deepwaters.

### PHASE 02: Drilling without returns

Drilling of the next phase begins soon after the 30" casing has been jetted. The drilling BHA is made up with a 16" bit

☞

> ' Reducing the drilling riser's diameter and consequently rig deck load is the main goal of slimming down wells. '

due to presence of the LWD, which doesn't obtain good results in larger diameter holes. On the other hand, this diameter can cause some problems during the 13 3/8"casing run. The best option focusing on landing and cementing the casing would be to use 17" bit to drill this phase.

The length of this phase varies from 600m to 1200m, with the casing shoe being positioned at almost the same depth as in conventional wells. This phase is drilled faster since it uses either a 16" or a $17^{1}/_{2}$" bit instead of a 26" drill bit. Additionally, drilling a well with a smaller diameter guarantees better wellbore stability.

After drilling this phase, the $13^{3}/_{8}$" casing is run coupled to the stress joint at the bottom of the 16" high-pressure housing. Following this the casing is cemented and the BOP is run.

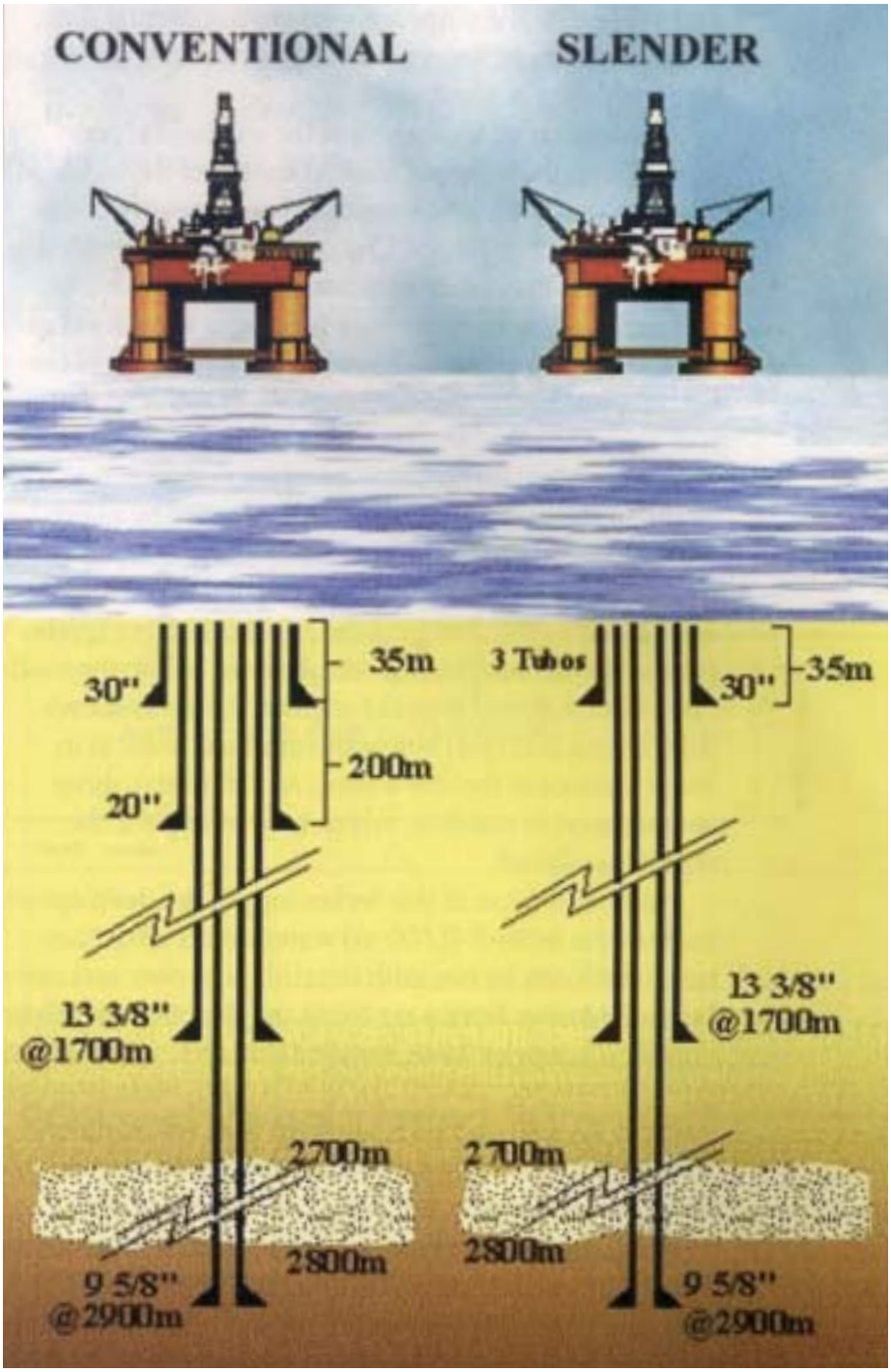
## PHASE 03: Drilling with returns

The following phase is drilled with a $12^{1}/_{4}$" bit. In this phase all the main and secondary pay-zones will be drilled. The well is planned in such way that all the main targets are concentrated in the third phase. This allows reduced drilling time for the previous phase without compromising operational safety.

The structural strength of the wellhead system is created by the united low and high-pressure housings and the structural casing, which, in this case, is the 36"/30"casing. The loads generated by the riser system, BOP and currents act on this wellhead system in the form of bending moments, compressive axial loads and horizontal shear forces on the wellhead system. However, the axial resistance is provided by the 36"/30" and $13^{3}/_{8}$" casing together with the cement between these casings. Therefore, it is concluded that the 30"casing jetting operation is vital for the wellhead system stability.

As a premise it was assumed that the slender wellhead should permit drilling and workover operations using the 21" or the $18^{5}/_{8}$" standard riser and also the 15" OD slender riser. Consequently the external shape of the high-pressure housing was kept the same as the standard 16" x 10 Ksi Petrobras wellheads.

This wellhead is designed to receive two casing hangers: the $9^{5}/_{8}$" and the rarely used $7^{5}/_{8}$". In a standard slender well the $9^{5}/_{8}$" casing hanger/casing is often run for safety measures, because it is difficult to evaluate wear in the $13^{3}/_{8}$"casing string. However, if there is confidence that the $13^{3}/_{8}$"casing has seal integrity, the $9^{5}/_{8}$" casing can be run as a liner.




> ‘ The structural strength of the wellhead system is created by the united low and high-pressure housings and the structural casing.’

> ‘ Another important point to be considered in this design is the effect of cement levels relative to the mudline.’

The Slender well design does not foresee the use of a 20" casing string. As a result a stress joint was designed to enable the connection between the $13^{3}/_{8}$" casing and the high-pressure housing. This stress joint is welded to the bottom part of the high pressure housing utilizing a $13^{3}/_{8}$" BDS thread for the casing connection. This stress joint allows ‘soft’ changes in diameter but

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‘ It was in the Marlim field that the slender drilling proved its value. Four slender wells have been ranked among the five best in the field.’

avoids the build up of stress in a particular area.

The stress joint design is critical because large diameter changes occur and consequently induce high stresses. Additionally, as this stress joint must fit any kind of slender wellhead it was necessary for it to be compatible with standard and pre-load high-pressure housings. Analysis of the two housing models showed that the first is less robust as the gaps that exist between housings overload certain parts of the high-pressure housing. The first design step was to evaluate the loads acting at the top of the wellhead. This was done by using in-house software ‘Overpull’ and ‘WH-Stiff’. The software uses environmental data, material characteristics and the BOP and flex-joint characteristics as input data.

With the resultant loads at the top of the wellhead a non-linear static analysis of the wellhead is performed. This analysis takes into account the non-linearity of the soil using the P-y, T-z and Q-u curves as recommended by API guidelines RP-2A. In this analysis the high pressure housing is considered as fixed to the low pressure housing. The lower part of the housing has a conical stress joint with BDS (Buttress Double Seal) thread that will connect to the 13 3/8” casing string.

A finite element software programme is then run to evaluate the performance of the stress joint by using the output data from the non-linear static analysis of the wellhead assembly. Another important point to be considered in this design is the effect of cement levels relative to the mudline. Levels above or below the mudline create different types of stresses. Analysis shows that cement 5m below the mudline result in lower stresses at the stress joint. At 10m those stresses tend to stabilize, which is beneficial for the slender wellhead.

Another feature of this technology is the 2500m-water depth Christmas Tree that has been developed. This tree can be run with the Drill Pipe Riser and can be worked-over from a rig using the Slender Riser (15” OD x 14” ID).

## Drilling in DP Units using Surface Blow Out Protectors (BOP)

In 1998, based on Unocal’s experience in Indonesia, Petrobras decided to study the use of surface BOP in moored rigs. The study was conducted by a group of Petrobras engineers together with Stamark Offshore. The rig selected for the studies was Petrobras P-XIII, a submersible moored rig. The idea was to upgrade the rig for usage in 1800m water depth. Additionally, the upgrade would enable drilling with a 13 3/8” riser without a sub-sea disconnect system but using a 13 3/8” x 10000 psi surface BOP. The results of the analysis showed that the idea is feasible but the project was interrupted because a different task was assigned to the rig.

The need for a safer, more efficent and faster ultra deepwater exploration program has revived the upgrade program. The same reasons apply; to avoid running traditional and complex BOP, which normally causes a lot of downtime and to broaden the use of upgraded third generation rigs in a market hitherto exclusively the preserve of fourth and fifth generation rigs.

In order to achieve this goal, Petrobras has started a series of studies such as: 1) risk assessment, 2) riser analysis, 3) riser and connector selection, 4) contingency plans, 5) standard drilling procedures adjustments and modifications and 6) a definition of sub-sea shut off system to improve safety issues.

## Benefits of slender wells

Luizao said: “The first Slender well drilled in the Marlim field, March 1998 took the record for Campos Basin drilling, taking a total of 7.6 days from the jetting to the final depth. Such performance was due not only to the slender well design – which was the main factor – but also to the excellent performance of the team on the planning and execution of the well operations. Ever since that first slender well, high performance has been a constant in the Campos Basin. Up to now 198 slender wells have been drilled, 62 exploratory and 136 development. From those 82 were vertical, 79 directional and 37 horizontal. Those wells are in Roncador (25), Barracuda (8), East Albacora (5), Caratinga (11), Espadarte (6), Marimbá (6), South Marlim (27) and Marlim (48) in water ranging from 692m to 2777m. All these slender wells demonstrated a considerable efficiency compared to the conventional wells (casings 30” x 20” x 13 3/8” x 9 5/8”).

It was in the Marlim field that the slender drilling proved its value. Four slender wells have been ranked among the five best in the field. Not only does the record for the fastest drilled well in the Campos Basin go to a slender well (it was drilled in a total of 6.9 days from jetting to final depth), the same well also holds the record for unproductive time: only two hours were lost.

This comparative analysis between conventional and slender wells considered productive versus non-productive time. Productive time was defined as drilling and non-productive as tripping, cementing, logging, etc.

Additionally, the time taken to complete all four casing strings of the conventional well and the time taken to complete the three strings of the Slender wells were noted. This was done because the slender drilling concept eliminates a casing string but reaches the same depth as the conventional.

Sixty-five of the best conventionally drilled wells in the Marlim field were compared to slender wells. The conclusion was overwhelmingly convincing; slender wells reduced drilling times by approximately 17%.

It is worth highlighting that slender well technology is well suited for characterized areas since well control and safety can be planned on offset wells.

‘ The conclusion was overwhelmingly convincing; slender wells reduced drilling times by approximately 17%.’

ROTARY STEERABLE SYSTEMS

# RSS hit the right note

This article looks at the rotary steerable systems of Schlumberger, currently the industry's top 'DD, MWD and LWD' company as ranked by analysts 'Spears and Associates'.

*By W. Rasheed*

Operators have long sought the quality and performance associated with rotary drilling. Consequently, 'rotating' is a preferred mode of drilling in many applications. By combining rotary drilling with fixed and variable gauge stabilizers oil companies were able to realise high quality wellbores and high penetration rates. But these were limited to two dimensional directional well plans as bent housing motors and 'sliding' were still required for azimuthal corrections. A decade ago, after much research and funding, 3D rotary steerable systems (RSS) were commercialized by the major directional companies. However, it is only recently that gains in RSS reliability have really made the technology 'game-changing'.

Guy Arrington serves as Global Business Manager – Drilling Technology, Schlumberger and Peter Edghill serves as Sales & Marketing Manager, Latin America South, Schlumberger. They spoke to Brazil Oil and Gas about how their company's RSS technologies are cutting costs and creating 'newfound' value to oil company portfolios.

Arrington said: "We can provide for 'push' and 'point' the bit applications. It's just the nature of the steering system that changes. What's important is that, in all of our rotary steerable systems, everything rotates all of the time, and we offer the only fully-rotating systems on the market. Our RSS achieved cumulative drilling of 7+ million feet in 2005 alone. It is truly versatile – and can be run in geosteering applications with PDC bits and in abrasive formations-where it can be run with PDC or impregnated bits. We have tools available for hole sizes from $5^{3}/_{4}$" to 22". While a $3^{1}/_{8}$" tool is being developed for TTRD and other slimhole applications. Several models are available today."

*Hole quality can be improved with 100% rotating RSS. See fig opposite.*

## '3 R's – Rotation, Reliability, ROP'

Arrington said: "Our RSS family offers solid reliability – with mean-time-between-failure that is approaching downhole motors. Motors are the industry benchmark. So we have comparable performance as well as the benefits of a system that is rotating 100% of the time. Full rotation is appealing as you reduce torque and drag while improving weight transfer to the bit. What this means is improved ROP and hole quality. This rotational aspect also provides our RSS family with an ability to be run with both underreamers and bicentre bits."

## Bicentre synergies

Increasingly, operators seek to underream. Whether driven by cementing tolerances, ECD improvements, pore pressure fracture gradients, production increases, swelling shales/salts or setting sand screens, underreaming is sought after at all stages of field development. Steering that is largely independent of borehole contact allows the use of bicenter bits to increase hole gauge. Directional drilling is possible because the system does not rely on gauge hole to push the eccentric reamer against the formation when steering.

Edghill said: "The ability to open the hole while rotary steering provides advantages in extended-reach and deepwater applications where directional drilling techniques are often required. In a recent run for a GOM operator, the tool helped drill a high-quality borehole and this provided good LWD data. On previous wells, several runs were required to get comparable LWD data. The tool enabled time savings and provided for good steerability with an $8^{1}/_{2}$" to $9^{7}/_{8}$" bicentre bit." This application has been proven to reduce risk and cost in diverse well construction applications and therefore offers a viable alternative to underreamers.

## Open hole sidetracking

Edghill said: "Because it does not push against the borehole to build angle, our RSS system is very effective for steering in soft formations and where overgauge or washed-out hole is present. Hole angle is built with minimal dependence on the borehole for deflection. In a recent application, the tool improved drilling efficiency resulting in a 52% reduction in total well costs. It also reduced trip time while drilling the longest well in the field. For the first time the sandstone section was drilled (13,689 ft) in one run".

"The above 52% reduction in costs worked out as a $1.5 million reduction in total well costs. This convinced a Middle East operator to replace conventional motor technology throughout the company's ongoing field program. During the

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## Rugged design

The internal steering mechanism limits tool exposure to extreme borehole conditions. As a result, the RSS system is much less susceptible to wear in sandstones and other highly abrasive environments. Tool life is also enhanced by stationary internal seals that are not exposed to fluids containing abrasive cuttings. The steering system operates equally well in all types of fluid environments.

To further enhance tool capabilities in extreme environments, this system is designed to operate in wellbore temperatures as high as 302ºF [150ºC].

second phase of the multiwell program, the operator needed increased capability to overcome obstacles in the laterally variable sandstone reservoir. Nearly 90% of these wells require openhole sidetracks for geological realignment. The available seismic data defined the heavily faulted area".

## Maintaining verticality

Edghill said: "Our RSS for vertical applications automatically maintains a wellbore's verticality and eliminates the potential for costly correction runs. It requires minimal or no rig-site supervision or interaction and is an optimal drilling solution. It can use surface or downhole power, or both and minimizes the potential for lost-in-hole.

"It also provides effective hole cleaning because everything rotates at drill-string rpm. It permits reaming, back-reaming and shoe drillout and can be run independently of MWD systems, if required. It's rewarding to note the surprise in people's eyes when they see the surveys come back. We routinely get surveys showing 0.5° – 0.2° verticality with this tool".

## Enhanced drilling

Edghill said: "This RSS model offers extra torque capacity which allows for a higher weight on bit for increased ROP and cost-effective drilling. Compared with conventional RSS, the technology gives you higher revolutions per minute, resulting in longer runs. An integrated power section increases bit rpm while decreasing drillstring rotation. This reduces stick-slip and other damaging vibration modes common to conventional rotary drilling. All available energy is used to drill the hole optimally.

"Casing wear and drillstring fatigue are reduced in sections with high dogleg severity, lessening the chance of drillstring or casing failure. All external parts rotate at drillstring speed, reducing drag. The rotation also helps clean and condition the hole, lowering the risk of differential or mechanical sticking. On a rig that lacks the power to rotate the drillstring during conventional directional drilling, the system increases the rig's operating envelope, allowing RSS techniques to improve directional performance".

## Harsh Application

Edghill said: "We have proved drilling applications in some very harsh environments. Our RSS was designed to be rugged and is successful where externally steered mechanisms have reached their performance limits. Because it has a totally enclosed internal steering mechanism and field-proven electronics, the tool is extremely reliable in abrasive, hot-hole and high-shock applications.

"For example, for a N Sea operator we set a daily footage record (2619ft), had a factor 4 reduction in drilling vibration and eliminated the need for a wiper trip. Because the tool has a reduced dependence on wellbore contact for steering, it is ideal for openhole sidetracking in overgauge hole or soft formations. It can also be run with bicentre bits for directional drilling with minimal wellbore dependence."

Edghill said: "The durability of the Xceed system is a major advantage in high-shock-load applications such as drilling through laminated hard rock formations. The system shares a common electronic architecture with the Schlumberger PowerPulse* MWD telemetry system, which has an operating life in excess of a 1000 hours. Together this system provides real-time toolface, inclination and azimuth data. It also delivers high DLS in interbedded or consolidated formations that are equivalent to a steerable motor".

## Cost-savings

Arrington said: "Onshore we are delivering value. Clearly, we have to look at applications from a commercial perspective. We deployed tools where they generate a return, the research and development involved with this technology has meant there is a large paid in cost base which has kept us out of certain market segments. However, RSS are increasingly coming online in more and more land applications. Even with lower rig costs, the improvements in wellbore quality and directional profiles puts greater value into client's portfolios".

Edghill added: "For sure, our RSS have proved themselves in complex well paths and high cost environments with the majors. But smaller operators in different parts of the world are making pretty impressive savings. That makes the use of RSS more compelling in low cost drilling environments such as onshore or mature fields."

# The importance of rotating 100% of the time

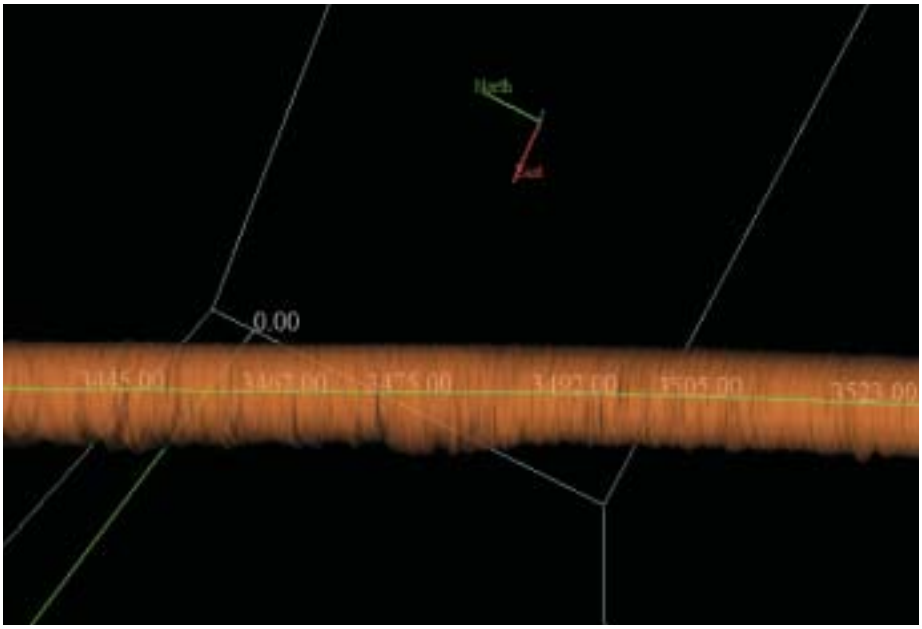
A fully rotating design provides valuable benefits:

■ The flow of drilled cuttings past the bottomhole assembly (BHA) is enhanced because annular bottlenecks are not created in the wellbore.

■ Efficient cuttings removal increases penetration rates because cuttings are not being reground while drilling.

■ Penetration rates are also improved because there are no stationary components to create friction; this improves drilling efficiency and reduces BHA 'anchoring' in the hole.

■ Mechanical and differential sticking of the drillstring are reduced because there are no stationary components contacting the casing, whipstock, or borehole. There is also a reduced chance for the BHA to pack off.




*RSS provides smoother wellbores.*

***References: SPE 85285, 71396, 92623 Acknowledgements; the author would like to acknowledge Mary Jo Caliandro of Schlumberger.***

DRILLING

# The salt challenge

## Prevalent worldwide, massive salt sections add to well construction challenges.

*By W. Rasheed*

Several deepwater blocks in the GOM and West Africa (Congo Basin) are characterized by salt provinces. For example, sub-salt wells have been drilled with total depths exceeding 30,000 ft and salt sections exceeding 8,000 ft. Production companies such as Anadarko, BP and Chevron who hold sub-salt acreage face a combination of imaging and deepwater drilling problems. Other operators in deepwater areas, such as Brazil, which has had relatively limited salt challenges to date, may also need sub-salt strategies as exploration reaches salt provinces.

In some cases, spanning over half a well-bore's true vertical depth, salt can present sizeable difficulties. Where salt is just 'salt' things are relatively simple. But where salt sections are heterogenous containing halite, anhydrite, sedimentary channels, flows or rubble zones things become complex. This makes the mapping and imaging of salt a difficult process with subsurface phenomena often going unseen. Seismic data cannot always represent salt flows or channels with many anomalies only truly characterized through drilling.

Anomalies - represented or not - create drilling problems that range from loss scenarios with pore pressure regressions below salt, loss of directional control, stuck-pipe due to salt closure and vibration induced by alternating salt/sediment bedding.

Hole stability can be affected by active salt tectonics. Intermediate sections can be subjected to geo-hazards such as faulting and fluid seepage. Salt closure increases the loads on the casing and its cement as both must be able to withstand forces applied by the salt as it expands radially and pinches the well. Simultaneously drilling and casing the well may be a good way of overcoming this.

Maintaining directional control in salt is not straightforward as there is a tendency for well-bore deviation. Certain salts require higher weight-on-bit to drill as compared with sediments. Consequently, the higher weight-on-bit, the greater the tendency for the bottom hole assembly (BHA) to build inclination. In an attempt to counter the build tendency, weight-on-bit may be reduced causing penetration rates to drop. A successful approach has been a rotary steerable assembly and a bicentre bit. This type of BHA can maximize ROP in the salt, minimise vibrations due to inter-bedded formations, control wellbore direction and maintain certainty of enlarged hole. It can also help maintain gauge hole which is as important as high penetration rates.

> ' Where salt sections are heterogenous ... things become complex. '

Costly deep-water rig rates mean that operators are right to require high performance levels. Consequently, more rigorous QA/QC standards are demanded of downhole tools to permit sections to be drilled in single runs at high penetration rates.

Salt sections have higher fracture gradients (when compared with sediments located at the same depth) enabling longer sections and reduced well-control problems associated with permeable formations. However, predicting pore pressure and fracture gradient in sediments below the salt is tricky. While a regression below the salt will often dictate casing depth.

It is known that synthetic oil-based-mud (SOBM) can be the most effective salt drilling fluids as they avoid borehole enlargement and well-bore instability. Additionally, SOBM permit higher penetration rates and lubricity which can reduce levels of overall mechanical vibration. If total losses are expected, then a salt saturated water-base-mud (WBM) can be used to minimize borehole instability. Salt precipitates can result in mud related problems by clogging surface lines and pumps. As solids precipitate fluid densities drop which can create potential well-pressure control problems.

Mud densities also change when salt formations are drilled. At higher temperatures, more salt becomes part of the mud, but on surfaces where lower temperatures exist, excess salts can precipitate. Another problem is the limited solubility of salt when another salt is present. This can lead to increased concentrations of undesirable salts, precipitates and ultimately altered chemical compositions of drilling fluid unable to serve their original application.

Unsaturated seawater pills have been shown to improve penetration rate in the salt saturated water-base fluid without leading to excessive washout. Pumping these pills in differing volumes, with and without polymers while using an acoustic caliper to monitor hole gauge can generate valuable data. This can be used to refine subsequent salt drilling techniques.

Drilling performance in salt can be improved by minimizing polymer additives to a salt saturated WBM as this helps minimize available "free water" in the salt saturated system.

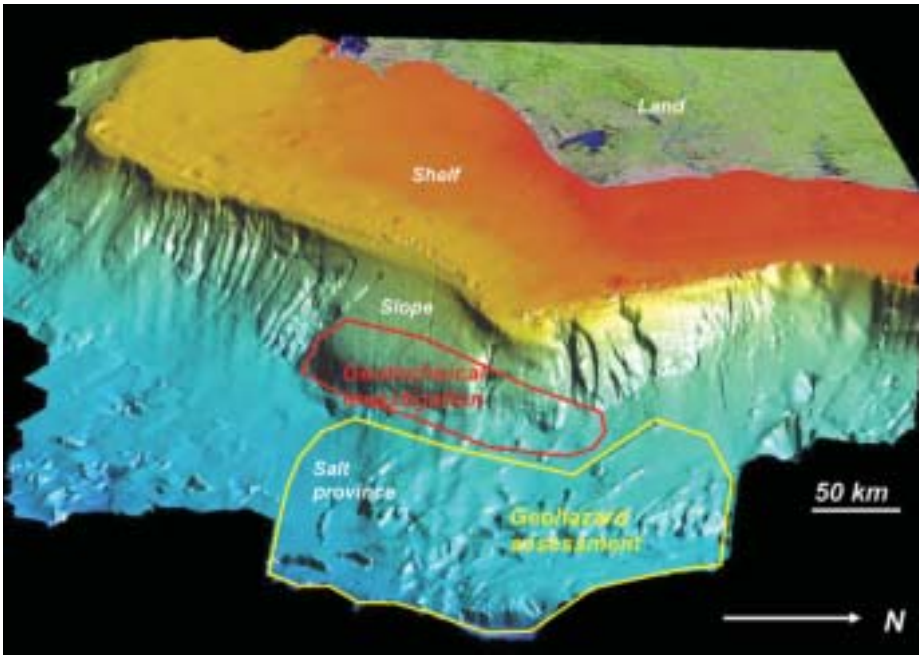
Performance can also be improved by using formation inhibitors prior to drilling the rubble zone and allowing salt concentrations to drop to 20%, where the salt zone has been cased and gas hydrate inhibition does not require higher concentrations of salt.

Although many risks associated with salt can be reduced through pre-drill seismic, look-a-head tools and real-time pore pressure profiling, there are still plenty of 'unknowns' to keep everyone excited.

*The author acknowledges SPE papers 71363, 16688, 74546*

GEOPHYSICAL

# Data key to cutting risk




*Seafloor under investigation in the Campos Basin.*

By acquiring and interpreting geotechnical and oceanographic data much risk can be removed from exploration activities. Geophysical data plays a crucial part in supplying deepwater asset teams in the Campos, Santos and Espírito Santo basins with seabed and water column information. This information is necessary for well construction and production activities. Petrobras research projects encompass a wide range of E & P activities including geophysical data.

> ‘ In water depths beyond the base of the slope...active salt tectonics play an important role in shaping the seafloor ’

One of these projects has been named as the ‘slope and ultra-deep water seabed geo-hazard’. It involves the acquisition, processing and interpretation of detailed regional geophysical and seabed sample data (piston cores). This data is acquired in order to identify and characterize potential geo-hazards. The database for this project includes exploratory seismic 3-D, regional surface and high resolution deep-towed side-scan sonar, swath and multibeam bathymetry, subbottom profiler seismic and seabed samples. Exploratory seismic 3-D will be used for seafloor rendering, amplitude extraction and analysis of underlying structures while seafloor texture will be mapped using side-scan sonar imagery. Piston cores will be utilized to ‘ground-truth’ geophysical interpretation and date geological events.

In the Campos Basin, where the continental slope was regionally assessed for geohazards during Procap 1000 and 2000, the studies will concentrate on mapping salt structures. In water depths beyond the base of the slope (>2000m water depths) active salt tectonics play an important role in shaping the seafloor. In this location, structural styles, regional salt trends, salt induced topography and gradients, salt related controls on sedimentation and instabilities and fluid seepage will be investigated. Salt induced vertical seafloor displacement rates will be tentatively modeled. In the other basins, continental slope areas will be the focus of geohazard assessment. Fault movement, mass wasting activity, fluid seepage and oceanic current-induced seabed erosion are the main issues.

The aim of characterizing and analyzing slope stability & seabed sediments is to identify the geotechnical properties of soils. This has been achieved through geotechnical surveys and the integration of geological data. Modeling this data will help analyze aspects of slope stability. This project is being carried out in the Roncador, Albacora Leste, Marlim Sul, Marlim Leste and Jubarte/Cachalote deepwater oilfields in the Campos and Espírito Santo basins. Water depths in these basins can reach 2100m and oilfields are mainly located on the lower continental slope where seafloor gradients are relatively high (>10 degrees) and evidence of mass wasting has been observed. Soil shear-strength profiles will be used for optimizing mooring, manifold installation and jetting. Geotechnical and geological data will be integrated and serve as input for slope stability modeling with the purpose of defining safety factors.

During the generation of ‘oceanographic data for production’ project oceanographic data will be collected from specific areas of the Santos, Campos and Espírito Santo basins in water depths up to 3,500 metres. This is a multifaceted project that will supply asset teams with vital information. This information will cover the retrieval of existing oceanographic data from other organizations, multi-sensor mooring deployment, sea surface temperature (SST) and sea surface height (SSH) monitoring satellite images, collection/interpretation of high-frequency radar (CODAR) data, ocean circulation numerical modeling, analysis of extreme currents and database input/integration. The three multi-sensor moorings will include current meters and temperature sensors and will operate for a full year in each location.

Initially, two pairs of antennas will be installed in the Campos basin for the collection of high-frequency radar (CODAR) data with the purpose of measuring the sea surface currents in real time. This information, along with pre-existing data, will validate oceanic circulation numerical models. As a result, extreme currents will be analyzed to identify instabilities of the Brazilian currents in South Eastern Brazil. All this information will be incorporated into an in-house database.

PETROBRAS INTERNATIONAL

*By W. Rasheed*

# The world

Joao Figueira, Executive Manager, Petrobras International talks exclusively to Brazil Oil and Gas about Petrobras' operations abroad.

Today, Petrobras already has a presence in more than 15 countries, among them: Iran, Libya, Tanzania, Angola, Nigeria, United States, Mexico, Venezuela, Colombia and almost every country in South America. In 1999, Petrobras' strategic plan increased production targets from 60,000 to 300,000 boe for 2005. "Our plan has an emphasis on three geographic areas. These are South America, the GOM and West Africa. These represent new exploration frontiers. Our vocation is to find petroleum. But we must also maximise the value of our portfolio. For example, as production falls in certain areas, we have responded by pruning. In the UK, we realigned our portfolio by selling off UK assets. These assets required high levels of attention but the reward in terms of production was not proportional," Figueira said.

Figueira said: "Know-how and technologies enable us to accelerate production. And we of course, have exported our deepwater expertise from Brazil to other deepwater provinces.

"For example, the PROFEX system allows Petrobras to effectively model geological basins, this stimulates geologists to look for new exploratory areas. PROFEX has been very useful in deepwater asset development. While the acquisition of Perez Companc was a match of exploration knowledge with mature asset know-how. Perez Companc made its living by picking up marginal or older fields and applying secondary and tertiary recovery techniques. This skills set came with the Perez Companc staff and perfectly matched knowledge in Petrobras own mature field technology program - PRAVAP. (See Interview with PRAVAP Manager Farid Shecaira p26)

## ARGENTINA

Figueira said: "In Argentina, Petrobras' operations mirror those of Brazil albeit on a smaller scale. Argentina contributes 40% of Petrobras' total production. We recognize that we operate in privileged areas. These international locations show our strong presence in the frontiers of pure exploration. Looking forward to the future, we are positioning ourselves to book more reserves by exploring new frontiers."

### Exploration and Production

In Argentina, Petrobras participates in four different blocks, with three still being explored. The Aguarague Block is the only one in production. With the purchase of Petrolera Santa Fé, which was controlled by the Devon Energy Corporation and Perez Companc until 2002, the Petrobras' Exploitation & Production portfolio in Argentina now has 16 exploratory blocks with good exploration potential. After the acquisition of Perez Companc, which was subsequently named 'Petrobras Energia S.A.', the oil and gas production of the Company jumped from 20,000 bopd in the country in 2002 to 91,441 daily barrels.


### Refining, transportation and commercialisation

Figueira said: "Petrobras and Repsol-YPF concluded negotiations that relate to the terms of the agreement for the exchange of assets in December 2001. Repsol-YPF transferred 99.5% of the EG3 oil company to Petrobras, which was the owner of a refinery and nearly 700 petrol stations among self-owned and franchised ones.

With the end of the acquisition process of Perez Companc in 2003, the Refinement and Petrochemicals segment counted thereafter with another five industrial and manufacturing units for rubber, liquid fertilizers, and polypropylenes, among other petrochemical inputs. Petrobras operates three refineries in Argentina: Ricardo Eliçabe in Bahía Blanca, a refinery in San Lorenzo, and the Refinería Dei Norte, all of them acquired by the purchase of the stockholder control of Perez Companc."

### Gas and Energy

Figueira said: "In this segment, Petrobras has a participation of 34% in the capital of the company Mega, whose total investment was of US$ 715 million. Our business is formed by a natural gas separating unit in Loma La Lata – a 600 kilometer long gas pipeline – and a fractionation unit in Bahía Blanca, apart from tank filling and shipping of products for exportation. Another substantial Petrobras company in Argentina is Transportadora de Gas dei Sur [sic] (TGS), with 7.4 thousand kilometres of gas pipelines and a capacity to transport 62 daily cubic metres of gas. The company still has a natural gas processing plant in Bahía Blanca with a capacity to process 42 million daily cubic metres of gas. Petrobras' electricity assets can be found all along the productive chain in Argentina. By participating in three power plants and one gas thermoelectric power plant, Petrobras is responsible for 6.5% of the energy production in the country."

# of Petrobras

‘Our vocation is to find petroleum. But we must also maximize the value of our portfolio.’

– Joao Figueira, Executive Manager, Petrobras International

## BOLIVIA

### Exploration and Production

In Bolivia, Petrobras participates in the San Alberto, San Antonio, Monteagudo, Ingre and Rio Hondo blocks. In the gas fields of San Alberto and San Antonio, where the Company is the operator, the greatest natural gas reserves in the country were discovered. The oil and natural gas production is currently around 54 thousand daily barrels of oil. In August 2001, Petrobras acquired the Irenda block. For the area that is favorable to oil exploration, the block presents tested reserves equivalent to 800 million barrels of oil.

### Refinement, transportation and commercialisation

Figueira said: “The Empresa Boliviana de Refinación (EBR) – which Petrobras controlled after the acquisition of Perez Companc – is the owner of the Gualberto Villaroel (Cochabamba) and Guillermo Elder Bell (Santa Cruz) refineries. Those units process a combined average of 32,600 bopd, with sales of 31,690 bopd. EBR’s sales operations of basic lubricants to markets in Paraguay, Peru and Chile are also significant, as well as gasoline exportations to Paraguay and Brazil, apart form the exchange of oils with EG3 in Argentina.”

### Gas and Energy

Figueira said: “Regarding gas transportation, the gas pipeline from Yacuíba to Rio Grande stands out. Operated by Transierra S.A., a company in which Petrobras has participations, it allows the production outflow from San Alberto and Sábalo fields.

It is within these fields that Petrobras has a participation in two gas processing plants with the capacity to process 13 million cubic metres of gas each.

Constructed by Petrobras, the San Marcos gas pipeline will transport the necessary gas to supply the thermoelectric plant in Puerto Suárez, under construction at the moment, and with estimated power of 86 MWe.”

## ANGOLA

In Angola, Petrobras participates in two marine blocks. In Block 2, Petrobras is partnered by Texaco (operator), Sonangol and TotalFinaElf, it has 20 production fields. In Block 34, which is still being explored, Petrobras’s partners are Sonangol (20%), Norsk Hydro (30%), Phillips (20%) and Shell with 15%. Currently, the production in Angola is approximately 4,000 bopd.

## COLUMBIA

Figueira said: “In Colombia, Petrobras operates 13 blocks and participates in 15 of them in land, whereby eight of them are under production phase. With reserves of around 120 million daily barrels and under Petrobras’ operation, the Guando field declared its tradeability. Currently, this field presents an initial production of 10,000 bopd forecast to reach of 30,000 bopd in 2006. The current production in the country is equivalent to 16,000 bopd.” Petrobras also has links with the Tayrona Block which covers an offshore area of 45,000 sq.km. Water depth reaches 3,000 metres and the block offers great potential. It is operated by Petrobras (40%) in partnership with ExxonMobil (40%) and Ecopetrol (20%)

## ECUADOR

In Ecuador, Petrobras operates through Petrobras Energía SA. It has two blocks whereby one is for production and the other for exploitation. In 2003, four wells were drilled for development in Block 18 and two for exploitation in Block 31, both oil discoverers [sic]. Current production is equivalent to 11,152 daily barrels of oil.

## US AND MEXICO

Figueira said: “In the USA, Petrobras assets have grown through organic growth and through the bit. We have made good use of our deepwater knowledge gained in Brazil by applying this to GOM offshore acreage.”

Petrobras has links with 277 offshore blocks in the US Water of the Gulf of Mexico. Of these 80 are shelf blocks

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## PETROBRAS INTERNATIONAL

while 197 are deepwater blocks.

Cottonwood is a well operated by Petrobras in the Garden Banks 244 block (GB 244-3). The well was drilled to a total vertical depth of 6,037m (19,807ft) and high quality gas bearing reservoirs with a total thickness of around 40m (130ft) were encountered.

Petrobras has an 80% participating interest and is the operator of the block. Mariner Energy, Inc. holds the remaining interest.

It also participates in the discovery of the Cascade prospect via the Cascade-1 well. The oil and gas production in the U.S.A. is approximately 4,000 boe. In México, Petrobras has a market presence via the Master Service Contracts, these comprise 2 blocks in the Burgos basin."

> ‘ Petrobras has links with 277 marine blocks in the Gulf of Mexico ...most are in deep and ultra-deep waters.’

## PERU

Petrobras' operations in Peru began in 2003 after the control acquisition of the Argentinean company Perez Companc, having thus participation in two blocks. One block is under operation and the other under exploitation. The company's current product in Peru is equivalent to 14,000 boe.

## VENEZUELA

Figueira said: "This is another country in which Petrobras was able to operate after the acquisition of Perez Companc. It has six blocks, four of which are producing and two of which are still being explored. After Argentina, Venezuela is Petrobras International's second largest operating unit, with production averaging 46,804 bopd. "

## NIGERIA

Figueira said: "In Nigeria, Petrobras participates in the OPL 216 exploratory block, whose partners are Chevron-Texaco and the Nigerian company Famfa. The block is located in the Niger Delta where the Agbami field was discovered, which is under the elaboration phase of development studies. The reserves of this field could reach 750 million barrels. A participation in the OPL 246 block was acquired in 1999, whose partners are Total and the Nigerian company Sapetro. Also located in the Niger Delta, the Akpo field was discovered in this block, whose reserves nearly reach 450 million barrels, and also with development plans under elaboration.

Regarding the discoveries in the Agbami and Akpo fields, the forecast is that Nigeria will produce nearly 55 thousand daily barrels of oil by 2008.

In 2005 and currently without production, Petrobras' investments in this country will be of US$ 350 million."

## CHINA, IRAN ANDTANZANIA

Petrobras recently signed agreements to operate in these countries and the company is in the early stages of planning.

Figueira said: "In Tanzania, Petrobras was awarded blocks 5 and 6 covering an area of 10,000 km2. Here Petrobras is conducting geological modeling as we have 100% operator ownership. In Tasmania we had been studying gas plays since 2000 which had been neglected due to the search for oil. We found indications of oil near Madagascar. This led us to further study. Considering tectonic plate movements we can see Madagascar was next to Tanzania and by coupling this information with the little seismic we held, we are able to locate a new petroleum province. Our vocation is to find petroleum."

In Iran, the Company is getting ready to begin exploration activities in the Tusan block which covers approximately 6,000 km2 in Iranian waters of the Persian Gulf."

## LIBYA

Petrobras formalised an agreement with the state-owned National Oil Corporation of Libya which ensures oil and gas exploration rights in the Libyan sector of the Mediterranean Sea. Four blocks comprise the area and it offers good discovery perspectives. The signature of the agreement signals Petrobras' return to exploration activities in the country,

## 50-50 refinery design

**Petrobras has begun several initiatives with Petroleos de Venezuela S.A. (PDVSA). Among these are a '50/50' arrangement for the design of a refinery in Pernambuco ( Brazil) able to process 200,000 bopd. Refining will be schematized to maximize the production of diesel oil and petroleum liquefied gas.**

**In the United States, Petrobras America presented the highest number of winning bids (53, with a total value of US$ 30.1 million) in the auction promoted by the North-American regulatory body; in western Africa, it obtained operatorship of an explanatory block in Nigerian waters.**

**Petrobras America also discovered high quality gas in its first operated well in the deep waters of the Gulf of Mexico (US Waters). The total investment to be allocated by the Company in Gulf of Mexico (US Waters), is expected to reach US$ 1.5 billion from 2006-2010.**

**Petrobras is gearing up to achieve average production of 3.4 mln boe per day, in Brazil and abroad, in 2010.**

> ‘ The forecast is that Nigeria will produce nearly 55,000 barrels of oil per day by 2008.’

where it was present during the 70s and the beginning of the 90s.

## URUGUAY

Figueira said: "Petrobras's activities in Uruguay started with the acquisition of shareholder control of Conecta SA, the Uruguan concessionaire for natural gas distribution. The company operates a pipeline network of 300 kilometres and has exclusive supply rights to small and medium sized consumers inland. Currently, Conecta has 4,200 clients of which 4,100 live in private residences".

### Investments Abroad

According to Petrobras' Business Plan, US$ 7.1 billion will be invested in the international area until 2010. Nearly 80% of this amount is concentrated in Exploration and Production projects. Latin America receives approximately 40% of this investment, closely followed by West Africa, mainly Nigeria, and the Gulf of Mexico, where Petrobras had exploration success.

Expectations regarding the development of large discoveries are that oil and gas production will grow to 12.1% a year, and tripling by 2010.

Currently, the volume produced by Petrobras abroad is 263, 000 boe, an amount which is expected increase to 545,000 in 2010. International reserves amount to 1.9 billion barrels.

# Petrobras International: a company profile

Petrobras' wide-ranging international operations complement its Brazilian activities as it seeks to lead the oil, natural gas, and derivatives markets in Latin America. After a spate of recent acquisitions, the company established a strong presence in the petrochemicals area.

Beyond Latin America, the main focus remains on West Africa and the Gulf of Mexico.

In 2006 Petrobras expects to invest a total of US$ 2.05 billion inetrnationally, of which 46% will be in Latin America, 40% in West of Africa and 14% in the U.S.

These investments are distributed as follows: US$ 1.6 billion in Exploration and Production, US$ 0.16 billion in Refining, Transport and Trading, US$ 0.08 billion in Gas and Energy, US$ 0.04 billion in Distribution and US$ 0.03 billion in Petrochemicals.

Performance improvements and a diversified international portfolio are seen as the key to achieving sustainability for Petrobras.

Today, Petrobras already has a presence in more than 15 countries, among them: Iran, Libya, Tanzania, Angola, Nigeria, United States, Mexico,

**PETROBRAS RESERVES** (at 31/12/04)

| | | |
|---|---|---|
| Bolivia | 681 | 36% |
| Argentina | 393 | 21% |
| Venezuela | 281 | 15% |
| Nigeria | 237 | 13% |
| Peru | 105 | 6% |
| Ecuador | 85 | 5% |
| Columbia | 42 | 2% |
| EUA | 36 | 2% |
| Angola | 12 | 1% |
| TOTAL | 1.872 | |

Venezuela, Colombia and almost every country in South America.

While the company is consolidating it's position as a leading energy provider in the Southern Cone in the areas of Gas and Energy.

In 2006, investments are being made in the areas of health, environment and operational security, in project integration, in information technology and telecommunication and building brand value.

# The Easy

**Contact details**
Luiz Albanese
EASY LINE TOUR 2
AV. PRADO JUNIOR,78 LOJA B - COPACABANA
- RIO DE JANEIRO - BRASIL
PHONES :55 21 2275-5090 - 55 21 2275-4234 -
FAX. 55 21 2275-6645
CEP. 22011-040 -
E-MAIL : *luiz.easyline@uol.com.br*
visite nossa pagina: *www.easylinetour.com.br*

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*Photos courtesy of Mauro Martins.*

MATURE FIELDS

# The road to recovery

Petrobras's advanced oil recovery program was formed in 1993. It is growing in importance as greater numbers of assets pass into maturity having produced more than 50% of recoverable reserves. Program leader Farid Shecaira talks to Brazil Oil and Gas about Petrobras brownfield programs.

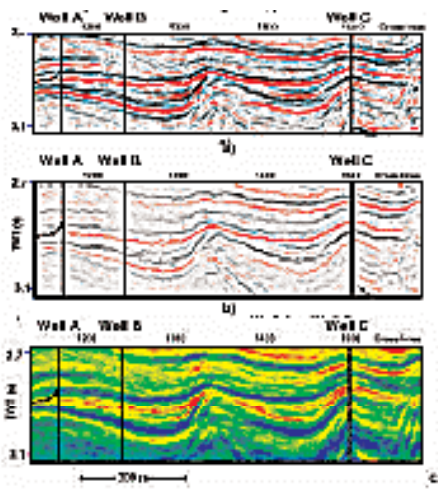
*By W. Rasheed*

PRAVAP has grown immensely since its early days. Until 1999, PRAVAP was concerned with tertiary or enhanced oil recovery techniques and mostly onshore locations.

Since 1999 and the gradual move to maturity of offshore assets such as Enchova, Namorado, Cherne, Bonito, Congro, Carapeba, Vermelho and Viola, most of them in shallow waters; PRAVAP has shifted focus to offshore applications. The program also widened to include any technology that could improve recovery.

Petrobras' technology development falls into four main programs: PROCAP, PROPES, and PRAVAP, PRODUT. Under the PRAVAP umbrella today's 9 major programs range from Enhanced Oil Recovery to water Management to Intelligent Wells. Eight of these programs are under way and one being initiated.

Shecaira said: "The question of when an asset becomes mature is complex. This is because for offshore fields such as Marlim Sul and Roncador, Petrobras has had to employ a modular approach to life-cycle management. As modules are developed and in time become mature, there can be several parts of a single asset that are mature while others are still being explored. Reaching maturity are the deepwater (800-1200m) giants Albacora and Marlim fields. Marlim, whose production begun in the nineties, has an oil whose API varies from 19 to 21."




*Seismic sections with different processing workflow.*

> 'The goals of the PRAVAP program, are to improve recovery factor – using imaging as a way of identifying remaining oil pools and improving the efficiency of water injection'

More important than a exact definition of which field is mature or not, is to consider that some aspects of reservoir maturity, such as increased water production, are common to fields who enter maturity and yet more relevant in heavy oil fields, as these tend to produce more water and therefore water management has to be considered very early on.

The goals of the PRAVAP program, are, therefore, to improve recovery factor – using imaging as a way of identifying remaining oil pools and improving the efficiency of water injection; and to mitigate the water associated problems, such as souring and scaling, thus decreasing the lifting costs of old fields.

## Water management

One of the main programs is water management. Besides the mitigation of problems, this program is concerned with the increase of the recovery factor, which is achieved with actions such as improving the areal sweep through correct evaluation of fracture direction under injection.

Petrobras is shifting from water injection to water re-injection, with the means of correctly managing water considering environmental needs. To ensure smooth transition from lab technology to field application, Petrobras runs pilot programs. For example, currently a pilot water re-injection program is being initiated in Marlim. Pargo and Carapeba have a similar pilot under way. Here old water (from the reservoir) is re-injected to maintain reservoir pressures.

According to Shecaira, the volumes involved in water management are huge. "To get an idea of the volumes manipulated; we handle today an average water injection volume of 2 million barrels per day and half of it is produced."

Shecaira said: "We also plan to construct a prototype system for 'raw' water injection. This system is placed over the seabed and is used to capture and filter water prior to injection. It has a good application on mature fields or fields whose small platforms are often space limited".

A decade after the North Sea has had to

☞

> 'We handle today an average water injection volume of 2 million barrels per day'

come to terms with souring, Petrobras too has had to implement Sour Gas and H2S Management strategies. The HSE implications of water injection were well understood as injection had been started as early as 1988 in the Namorado field, Offshore Campos Basin. Souring was not a problem at the beginning as expected, but for in the Marlim field, where water injection begun in 1994, a H2S breakthrough occurred in 2003.

"We were very quick to learn how to inject nitrate to mitigate the problem and to simulate the reservoir behavior of H2S generation processes to define, for the fields under development, which strategy to adopt.". The approach depends on the forecast of how much H2S is involved and when it is being produced.

According to Shecaira, "We can decide what is the solution, if any is required. If none or very low H2S volumes are expected – there is no need to act; if there are medium levels, we may select metallurgical improvements; also sulphate removal for scaling treatment may mitigate some of the souring problems. If levels are high we must inject nitrates. To test the effectiveness of nitrate injection we have two filed pilots one re-injecting water and the other injecting sea water, both using nitrate".

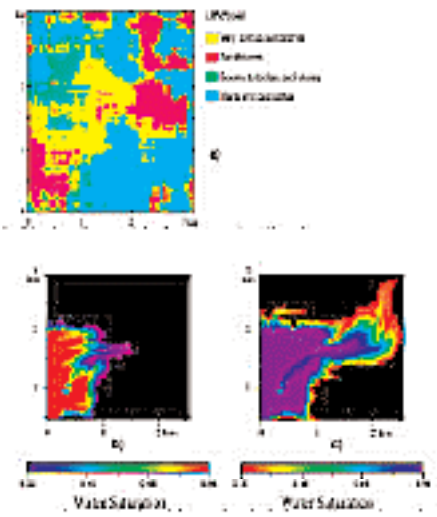
This project is being developed in conjunction with service and research companies. OilPlus and Aquateam, for example, are performing laboratory tests to help to determine the simulation parameters of H2S generation in the reservoir.

Offshore operations have also been researching solutions to salt and scale problems. This can occur in perforations, tubings, subsurface and surface equipment.

Shecaira said: "Remote operations have been used successfully to perform interventions such as well cleaning and squeezing of scale inhibitors into the formation. This has been done in the Marlin complex and also the Linguado field. Satellite wells using wet xmas trees are employed in all Brazilian deepwater fields, and with remote handling we avoid incurring high rig costs for intervention. The problems of metallurgy and any effects on subsea installations are carefully considered".

## Geosciences

Petrobras has a dual geoscience programs of Seismic for reservoir characterization and also 3D geological modeling



*Reservoir geophysical acquisition trends.*

> ' Onshore fields have seen good results from EOR, with 20,000 barrels a day being produced due to cyclic or continuous steam injection. '

Shecaira said: "Seismic for reservoir characterisation is a main issue. An acquisition project started in 2005 with the objective of acquiring base 4-D time-lapse data of the whole Marlim Complex (Marlim, Marlim Sul and Marlim Leste fields). We hope it will give new insights which will direct our infill drilling program beginning in 2006 and extending to 2008. These infill wells will be drilled to produce remaining oil".

The Multi-component 3D/4C acquisition program for Roncador field last year has now been processed to give definition of the internal heterogeneity of Roncador reservoirs – this is an area of approx. 30 sq km. This is a pilot project which was conducted in 1,700m sea water depth.

Interpretation is made by geophysicists and geologists assisted by service companies. Petrobras has a '4D- room' where geologists and engineers can visualise geological phenomena.

> ' Petrobras has a '4D- room' where geologists and engineers can visualise geological phenomena.'

Shecaira said: "As far as the 3D geological modeling project is concerned, Petrobras do not expect record breakthroughs; the idea is to provide Petrobras with state of the art technology for Non-conventional reservoirs, sealing faults, real time modeling modification and conventional logging. Also the modeling plays a crucial part in understanding and reducing uncertainties in geological modeling- it considers how wrong images can be and whether estimated volumes maybe higher or lower. It is very useful from that perspective."

Regarding the depositional heterogeneities for Brazilian reservoirs, this modeling reveals such things as the depositional features of turbidites and reservoir geometry. Knowledge of the depositional environment can help explain key reservoir characteristics such as gross size and volumes, channels".

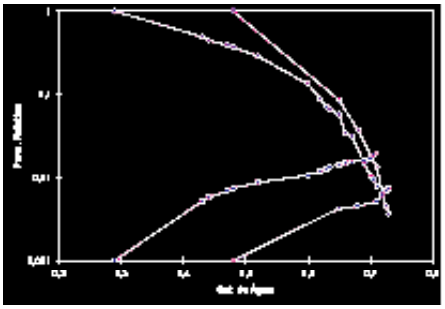
## Onshore fields

If water injection is the only method envisioned for the nest few years, this is not the only option in onshore fields. Onshore fields have seen good results from EOR, with 20,000 barrels a day being produced due to cyclic or continuous steam injection. Applications in the Fazenda Alegre, Espirito Santo basin, have seen production rates improve in horizontal wells due to the introduction of thermal recovery methods.

Several research projects are testing theories and feasibility of in-situ combustion. Shecaira says: "Petrobras is also considering variations of in situ combustion and steam injection. The old vertical injector–vertical producer scheme is being substituted by innovative geometries, for example, a vertical well to inject and horizontal to produce. Another alternative is to associate steam with solvents. This technology was recently applied in a field in the Espírito Santo basin to mobilise oil which had not responded to steam injection alone."

Another front is Microbial EOR. Microbial applications in the Sergipe field, North Eastern Brazil is based on water and bacteria. First, the water and bacteria is pumped down which is followed by nutrients. The bacteria develop a biomass that clogs the porous medium and subsequently increases viscosity of water and new pathways will divert flow thereby increasing production.

Shecaira said: "The use of chemicals to control water is another area of interest. Water shutoff control in more than 200 wells has been achieved with the injection of a patented polymer – SELEPOL – a relative permeability modifier. Several formulations were attempted, the more recent is based on tiny pieces of hydrophilic gel".



*Relative permeability curves before and after SELEPOL treatment.*

# The road to recovery

"There have been several offshore applications but the results were not as good as onshore applications; today, we are using the 4th generation of this technology."

Drilling in carbonates or tight sands is another area of interest. The stimulation technology plays a central role. There have been 5 fractures in a weel drilled in the Enchova field, a shallow water, low permeability, light oil bearing carbonate. A new exploratory approach main bring into focus a new family of reservoirs of this kind, previously intended to be marginal in Brazil.

New projects have also come into PRAVAP. The Intelligent fields initiative which is a functioning program has moved to PRAVAP from PROCAP. It's most important pilot application has been in the Carmopolis field, Sergipe Basin. Here there have been a pilot with 7 wells – 6 production and 1 injection. 4 wells were installed with fibre optic temperature and pressure sensors. At 4 points in the well, one can shut and open flow valves. This system was 100% developed in conjunction the with the Catholic University (PUC).

"The novel gas management program in PRAVAP is designed to characterize gas reservoirs, principally for the tight sandstone Mexilhao field, in the Santos offshore basin. The development of a province of producing gas at the Santos basin, south of Campos, was recently annouced by the company. The project is focused on stimulating flow in low permeability porous media. Mexilhao is still being studied by engineering and may probably receive one platform although the project is very much at an incipient stage," Shecaira said.

In the end, all fields become mature one day so PRAVAP's technology development will continue for many years to come.

SUBSEA

# Petrobras subsea

For a company with such a long history of subsea completion production systems, the constant development of new subsea equipment is a must in order to meet new water depth challenges while keeping costs low.

The main purpose of this systemic project is to extend the use of existing technology and to develop new concepts of subsea equipment in order to:

■ Produce and support the next phases of Marlim Sul and Roncador, Marlim Leste and Albacora Leste, all of which are in water depths greater than 1,000m and present different fluid characteristics and reservoirs;

■ Make production feasible from new discoveries in water depths up to 3,000m;

■ Reduce Capital Expenditures in production developments in water depths beyond 1,000m.

One of the major technological bottlenecks associated with ultra-deepwater subsea equipment are the installation loads and very expensive day rates for vessels.

In a conventional subsea production system there is a wet christmas tree pipeline connection system, and in some cases, manifolds. Petrobras has started work on a research project that has been sub divided between horizontal wet christmas tree for use at 2,500m water depth and the subsea pipeline connection system for use in water depths greater than 3,000m. Both sub-projects have now been concluded with some of the main results presented here.

## Horizontal Wet Christmas Tree 2,500m

After Horizontal Wet Christmas Trees had been designed and proven for use up to 2,500m water depth, their usage was then focused on application in water depths reaching 3,000m.

Subsea Flowline Connection System 3,000:

This development involved upgrading the original Vertical Connection System for 1,000m water depth.

Due to the heavy pipeline loads involved in ultra-deepwater installations, the multibore philosophy used in the 1,000m water depth design had to be changed to a single bore. Although this decreases the operational loads, it increases the size and weight of subsea equipment essentially the manifold and wet christmas tree).

Studies have shown that water depth increases the dynamic amplification and motion of the Vertical Connection Module. As a result, ultra-deepwater operations necessitate heave compensation systems in order to minimize the risk of damage due to water depth effects on vertical motion and to increase operational efficiency.

In 2000, some offshore tests were performed using a passive heave compensation system. These tests have shown that it is feasible to extend the original concept for usage in 3,000m water depth range.

Three further sub-projects are continuing. These are described below:

■ Completion Riser 3000m;

■ Subsea Equipment Installation By Cable in 3,000m Water depth;

■ Water Injection Wet Christmas Tree to be installed by a pipe-laying vessel.

## Completion Riser 3000m

Undoubtedly ultra-deepwater operations are always associated with very expensive rigs and high flow rate subsea wells. This means workover riser efficiency and the need for subsequent interventions play an important role in reducing both capital and operational expenditures. For instance, conventional workover riser running methods mean that 10 days may be required to deploy a subsea tree and tubing hanger in water depths of 3000 m.

SUBSEA

# equipment for ultra-deepwater

Accordingly, the workover riser for 3000 metres should be devised in such a way that it make completions feasible at 3000m water depth in a most efficient and reliable manner.

Petrobras has been using the so-called 'Drill-Pipe-Riser' to perform completions and workovers at water depths reaching 2000 m. Although far more efficient than the conventional completion riser, operational experience showed that it was worthimproving some components. The weak point is the control umbilical and related equipment such us hang-off equipment and clamps. These elements had shown problems that were deemed to be of critical importance in 3000 m water depth.

Control umbilicals require careful handling, particularly during the tubing hanger mode when the hanger has to be deployed inside the marine riser. This significantly delays deployment time and poses the risk of dropping clamps inside the well, which can lead to lengthy and complicated fishing operations.

Another relevant point is linked to the fact that the Drill Pipe Riser utilizes an electro multiplexed control system, which requires strict control of fluid cleanliness levels. This may be difficult to achieve when performing work-overs in old Christmas trees.

Overcoming these problems was among the key requirements for the development of the work-over Riser for use in 3000m water depth. Another challenging objective of this project is devising a work-over system, which is also competitive in shallower water depths, as, for the moment, there are no Brazilians oil fields located in water depths beyond 2200 m.

Every new development brings associated problems, which are not easy to predict. In order to minimize technological risks, it has been decided to divide the Riser project into two phases. The first, the so-called project definition phase, was recently concluded and was meant to investigate all possible options, select the best one and deliver a Technical Specification.

> ‘ Every new development brings associated problems, which are not easy to predict.’

The selected concept includes lots of new ideas and state-of-the-art technology that offers real potential to increase the efficiency of work-overs and completions, not just in ultra deepwaters but in shallower waters too.

## Subsea Equipment Installation via Cable in 3,000m Water depth

The purpose of this project is to develop technology that is suitable for the deployment of heavy subsea hardware (up to 200 ton) in 3000m water depths. The idea is use a more cost effective means as compared to conventional wisdom which is typically associated with the utilization of a new deepwater rig.

Consequently, a new method was developed and successfully employed on in mid 2002. In this successful field application a 175-metric ton subsea gas lift manifold (MSGL) was landed at 1885 metres (6184 ft) water depth in the Roncador field. In spite of utilizing a drilling rig with a nominal limitation of 1000 metres water depth (due to its marine riser system), such a procedure allowed the MSGL installation at 1885 metres water depth. It is recognized that depths beyond this could be reached.

As axial resonance was likely to occur at a certain manifold depth, it was necessary to replace the rigid hang off with a compliant hang off on the semi-submersible side. This was accomplished by activating both the drilling riser tensioning system and the drill string compensator.

This unique procedure utilized by the oil industry proved to be more cost effective when compared to the costs associated with the utilization of a new deepwater rig capable of operating in similar water depths. Moreover, the scarcity of drilling rigs with ultra-deepwater capability acts against their employment in activities other than drilling and completion. Conversely, the availability and relative low cost of conventional rigs warrant their choice as the preferred alternative for such operations.

## Water Injection Wet Christmas Tree to be installed by pipe laying vessel

This sub-project was approved at the end of 2002, but has not yet started. The vision is to design a Water Injection Wet Christmas Tree that can be installed by a pipe-laying vessel. This in turn will reduce the cost of the installation procedure and avoid the need for a deepwater rig to complete installation.

## Ultra-deepwater Export Risers, Flowlines and Control Umbilicals

Petrobras is focussing on riser verification that are independent of the floating unit system, especially for use in water depth in 3000 m. Therefore, the technical feasibility of alternative risers that are proposed in-house (e.g. subsurface buoy risers) or those recently developed worldwide (e.g. FSHR, riser tower, and pipe-in-pipe riser) is being investigated under the R&D program Riser and Flowline System and Installation Method for usage in 3000m water depth. Within the scope of this program, studies are being conducted in order to verify possible riser catenary configurations for SCR or flexible risers for ultra deepwater. Also, installation methods, criteria, and equipment (vessels) are focused under this program. At the end of the program, Petrobras intends to have a range of risers, flowlines, and control umbilicals that could be applicable for ultra-deepwater. The program will concentrate on local and global fatigue analysis.

MAINTAINING TRADITIONS

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INTELLIGENT WELLS

# Automating mud logging data for drilling

*Authors: This article was based on work conducted by Rogério Martins Tavares, Ricardo Pelaquim Mendes and Celso Kazuyuki Morooka University of Campinas, São Paulo and João Carlos Ribeiro Plácido of Petrobras.*

Offshore drilling is often complex, costly and requires highly qualified drilling staff. Today, much importance is placed on optimizing drilling performance while maintaining safety standards. Over the past two decades, technological advances in Directional Drilling, Measurement-While Drilling (MWD) and Logging While Drilling (LWD) Systems and the development of drilling capabilities for deep and ultra-deep water show how much progress has been made in petroleum exploration.

This article outlines a data collection system based on mud-logging technology. Often, mud-logging technology does not collect large amounts of data. However, much valuable information is not being used effectively. The main goal of the proposed system is to take advantage of potential valid information contained in the database, which is not being completely used.

Potentially, the proposed methodology has two applications. The first is related to performance analysis and investigation of non-scheduled events. In this sense, the tool could carry out further analyses of the time spent on drilling each well in a field, and to determine how much time a given phase of drilling took as a fraction of total operational time. The second is related to the implementation of a computer system to produce an on-line report of the executed stages in the rig, and this report would present the precise time measurements as the mud-logging data.

Similar initiatives for the development of automated supervising systems in other fields were observed for mining engineering problems. The system was developed at Unicamp, in the Lab of Artificial Intelligence Applied to Petroleum (LIAP). The LIAP team has been working over the past few years to develop intelligent and automated systems for the oil and gas industry.

## Mud-logging System

During drilling operation many mechanical and hydraulic parameters are measured and monitored and many systems work together on a rig to accomplish drilling tasks. Mud-logging is one of these systems, and it is used to measure and monitor mechanical and geological parameters.

The use of mud-logging systems was introduced in Brazil in the 1970s. At that time, only a few parameters were monitored. Since the 70s, with advances in instrumentation, the number of measured parameters has increased and the use of mud-logging systems has become common practice.

Deep and ultra-deep water drilling also contributed to the progress of mud-logging techniques in Brazil. Deep and ultra-deep water environments require very accurately controlled drilling operations. Any failure or negligence may cause human injury and economic losses. To control processes accurately, enhanced mud-logging was required.

Mud-logging systems have two distinct dimensions, the first one is responsible for collecting and analyzing formation samples (shale-shaker samples), and the second one is responsible for measuring and monitoring mechanical parameters related to the drilling operation. Considering only the second dimension, the mud-logging system could be characterized as a complete instrumentation system.

Generally, mud-logging systems rely on a wide range of sensors distributed amongst rig systems. One important characteristic of this technique is that there is no sensor inside the well, and that measurements are made on the rig. The data collected by the sensors is then sent to a central computer system, where the data is processed and displayed in real time through screens installed in the mud-logging cabin and in the company-man's office. Parameters are visible on display devices and the system allows different parameters to be selected and presented numerically or graphically.

During drilling, an operator will observe parameters for any abnormalities. If an observed parameter presents unusual behavior, the operator immediately communicates this to the driller who will carry out certain procedures to solve the problem. Actually, the system allows the programming of alarms that will sound in the mud-logging cabin, alerting the mud-logger that the value of the observed parameter is outside of the programmed range.

The number of observed parameters may vary according to a particular characteristic of the drilling operation. The most common measured parameters are: Well Depth (Depth), True Vertical Depth (TVD), Bit Depth, Rate of Penetration (ROP), Hook Height, Weight on Hook (WOH), Weight on Bit (WOB), Vertical Rig Displacement (Heave), Torque, Drillstring rotation per minute (RPM), Mud Pit Volume, Pump Pressure, Choke Line Pressure, Pump Strokes per minute (SPM), Mud Flow, Total Gas, Gas Concentration Distribution, H2S concentration, Mud Weight in/out, Drilling Fluid Resistivity, Drilling Fluid Temperature, Flow Line, LAG Time, and Stand Length.

It is noticed that only some of the listed parameters are really measured using sensor devices. Some of them are estimated from measured parameters. The WOB, for instance, is an estimated parameter. It is calculated using the WOH (a measured parameter) and the weight of drillstring elements.

Figure 1 (page 33) shows the sensor that measures the hook height. In this figure, the hook height is being measured through the drawworks revolution. It can be noticed, using Fig. 1, that there is more than one sensor device installed. It has occurred in this specific case because, besides the mud-logging sensor, there is also the rig and the MWD sensors.

Figure 2 presents the sensor for hook weight measurements. In the presented situation the weight is being measured by strain gauges installed in the deadline. As mentioned before, this measurement is utilized to calculate the WOB.

Figure 3 presents a sensor installed close to the mud pump piston. It measures the number of strokes in a time unit. The mud flow rate is calculated using the number of strokes, the geometry of the pump chamber, and the pump efficiency. Actually there is more than one pump operating at the same time, and the total mud flow rate is obtained from the summation of each pump's individual flow rate of.

☞

| Mode | Drilling Operation Stages | Label |
|---|---|---|
| Rotating mode | **Rotary drilling:** In this stage occurs the drilling itself; the bit really advances, increasing the well depth. The drillstring is rotating and there is mud circulation. The drillstring is not anchored in the rotary table causing a high hook weight level. | RD |
| | **Reaming:** In this stage despite the high hook weight level, the mud circulation and the drillstring rotation, the bit does not advance, increasing the final well depth. In this situation there is a reaming of an already drilled well section. | RR |
| Non-Rotating mode | **Drilling (Sliding Drilling):** In this stage, the bit really advances, increasing the well depth. The difference here is that the drillstring is not rotating and the drilling occurs due to the action of the downhole motor. There is mud circulation and a high hook weight level. | NRD |
| | **Reaming or Tool Adjusting:** In this stage the bit does not advance, increasing the final well depth. There is circulation and a high hook weight level. This circulation indicates that a reaming cycle is being executed or that the tool-face of the downhole tool is being adjusted. | NRRA |
| – | **Tripping:** This stage corresponds to the addition of a new section of the drillstring. The drillstring is anchored causing a low hook weight level. The drillstring does not rotate. | T |
| – | **Circulating:** In this stage there is no gain in the well depth. It is characterised by fluid circulation, high hook weight level and a moderated rotation of the drillstring. | C |

Figure 4 presents the choke line pressure sensor. This sensor device is installed in the choke manifold at the rig floor.

Early kick detection is a major function of the mud-logging system and is based on observation of mud pit volume, mud weight, and shale density. The mud-logging data can also be used to monitor formation pore pressure and formation fracture gradient. The formation pore pressure can be estimated using correlations that involve drilling parameters like Weight on Bit (WOB), Rate of Penetration (ROP), Mud Flow, etc.

The mud-logging monitoring services are generally provided by a specialized company. At the end of a drilling operation, the company makes a report relating occurrences associated to the completed operation. During the drilling parameters monitoring, a huge amount of data is usually generated. Due to difficulties of data storage, these data are summarized into smaller files. The common practice is to reduce the sampling frequency of the measurement from second basis to minute. If it solves the problem of file sizes, on the other hand it represents the loss of a great amount of information. There are some events that may occur and last only few seconds, like the drag occurrence in tripping out. When the data is summarized the information about the drag occurrence could be lost.

Another important question related to mud-logging system is the redundancy of measured parameters. Besides the hook height, others parameters have been usually measured by more than one instrumentation system. It is common to find rigs where the same parameter is being measured by the mud-logging company and by the rig system itself. And it is not rare to observe cases where the measurements taken do not show the same absolute value. This behavior has raised discussions about the future of mud-logging system.

## Classifying Individual Drilling Stages

Drilling is not a continuous process. On analysis it is noted that drilling is a sequence of discrete events. These events are referred to as 'drilling operation stages'.

Six basics stages associated to the drilling operation were identified to build the proposed classification system. Table 1 presents a brief description of each considered stage and the labels adopted.

## Description of drilling stages

The six stages described in the table above represent a first effort to individualize the basic components of a drilling operation. The stages were detailed considering the drilling phases with mud return to the surface. The drilling technology considered was drilling using mud motor and bent housing. This classification may not be satisfactory for the initial drilling phases and for special operations, like fishing. In the same way, if other drilling technologies are considered, small adjustments in the stages will be required. For instance, using rotary steerable systems, it doesn't make sense to distinguish between rotary drilling and oriented drilling stages, because these systems are supposed to drill all the time using drillstring rotation.

## Architecture of the Classification System

In order to identify a given drilling stage in execution, the system needs some of the information monitored by the mud-logging system. This work suggests the use of: Bit Depth, Weight on Hook – WOH, Stand Pipe Pressure – SPP and Drillstring Rotation – RPM.

After reading the information; the data are interpreted according to a set of pre-established rules. As result, the system will associate an operation stage to each set of data according to the rules.

The classification obtained using the system could be used to automatically generate a logging of the executed stages.

# INTELLIGENT WELLS

It is important to notice the parameters reading can be done either from previous stored mud-logging files or from mud-logging systems in real time. It means that the system could be used either to carry out classification in a database of drilled wells or to generate an on-line report in the rig.

## Architecture of the Classification System

The automated processing of the data is vital due to the great volume of information involved. If we consider a sampling data second by second, for just one hour of operation would be produced 14400 (4 x 3600) parameters value what makes the manual classification a very time consuming task.

The system knowledge is represented by a set of rules. In this sense, human knowledge was represented in a programmable language. In this work, the operational knowledge is represented by a set of If - Then rules.

In order to build these rules, human knowledge regarding characteristics of each stage and the relation of each stage with the four parameters measured by the mud-logging system was required. From the relation between stages and chosen parameters six independent rules were formulated, resulting then in one rule for each stage. Table 2 presents the rules used in this work.

## System Rules

The stage “Tripping”, for instance, is characterized when there is no well depth variation, no drillstring rotation, and there is low hook weight and low pressure levels in the stand pipe.

The labels “High”, “Low” and “Null” used in Tab.1, actually correspond to a range of values. The ranges vary according to the rig and parameter considered. For example, for a particular rig, a High WOH level can be a value above 250 klbs, while a Low level would be a value below 250 klbs.

The rules presented in Table 2 are a first effort to build a more complex system able to classify a larger quantity of stages. If additional technical knowledge about stages is added, it will make possibly to obtain a more refined set of rules able to classify more stages.

## Conclusion

The classification system presented can be used either to classify stored mud-logging data of a database of drilled wells or to classify mud-logging data on-line and onboard in a rig. Due to the detailed level regarding each executed stage provided by the classification system, it can be help analyze the individual drilling performance of each well. Information about the total time spent on each stage combined with related economic costs can be used to assess the real cost reduction benefit caused by optimized drilling programs and introduction of new technologies.

Information concerning individual drilling performance can also be used to build benchmarking analysis. In this sense, a petroleum company could use this information to compare the performance of different divisions. On a minor scale, the company could compare performance of rented rigs and identify weak points as part of ongoing improvement process. The results produce by the proposed system may help in the design of new wells. The information about the time spent to execute a determined stage could be used for planning new wells in the same region providing cost estimates.

**Table 1. Description of the considered stages.**

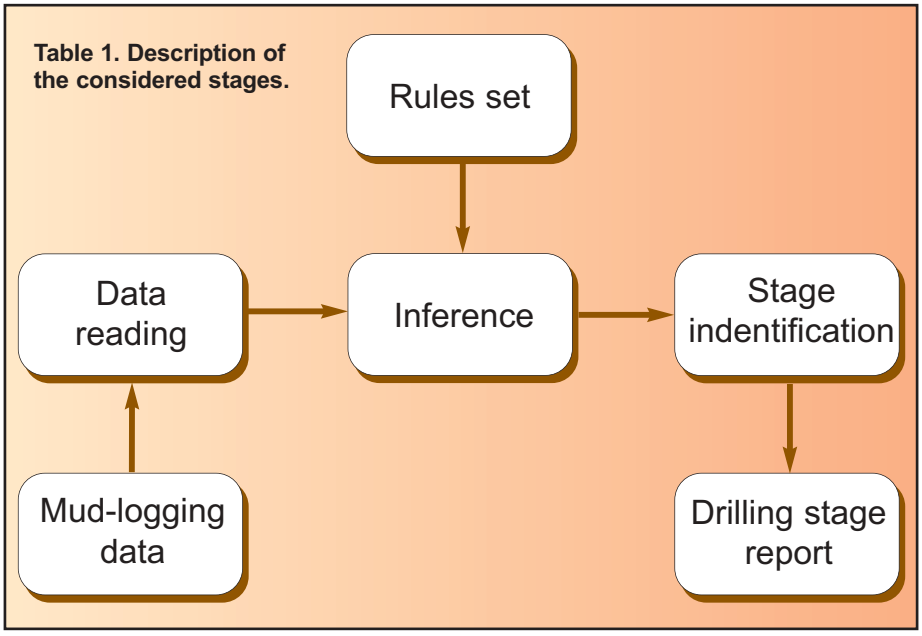




*Fig 1. Assembly of the hook height sensor at the drawworks*

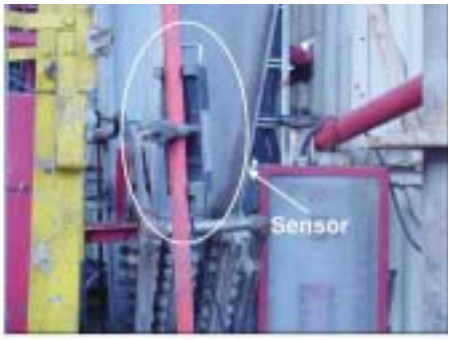



*Fig 2. Assembly of the hook height sensor at the deadline.*


*Fig 3. Assembly of the strokes sensor at the pump piston.*


*Fig 4. Assembly of the pressure sensor at the choke manifold.*

***Acknowledgements***

***The authors would like to thank Petrobras, CNPq and CTPetro for supporting the automated mud logging system.***

REFINING

# Refinery investment to total R$ 3.2 bn

In the area of refueling, Petrobras will invest R$ 5.1 billion of which R$ 3.2 billion will be for a Refining complex, R$ 1.2 billion in Pipeline transport, R$ 200 million for Sea Transport, R$ 300 million for petrochemical projects and R$ 200 million for other activities.

The refining area is to be constructed in 2006, with an upgrade of the Alberto Pasqualini Refinery (REFAP S.A.) and the beginning of a new delayed coking unit in Duque de Caxias Refinery.

Alberto Pasqualini - Refap S/A, the youngest company in the Petrobras system, was incorporated in January 2001 as part of the asset exchange between Petrobras and Repsol-YPF. It operates the refinery, which started production on September 16, 1968, and whose name pays tribute to senator Alberto Pasqualini (1901-1960) from Rio Grande do Sul, of the project to create Petrobras in 1953. The refinery is located on land that used to belong to the old Brigadeira Estate, and the main early 20th-century manor still stands. It has a capacity of 189,000 bopd. And its main products are diesel fuel, naphtha petrochemical, gasoline, LPG, jet fuel, fuel oils, bunker, kerosene, asphalt and solvents.

The Duque de Caxias refinery is Petrobras' most complete refinery having been inaugurated in 1961, with only six plants, plus the powerhouse. In the early 1970s, the first lube plant was built there. In 1979, it was already running the second lube and paraffin plant, with six new units. The 1980s saw the arrival of natural gas. In the 1990s, the units were designed on quality and diversification of products and environmental protection, such as, for example, the jet fuel hydrotreatment and diesel unit, and another for sulfur recovery. The ongoing upgrading process has contributed toward today's line of 52 Reduc products and a capacity of 242,000 bopd. Its main products are lubricants, gasoline, diesel fuel, jet fuel, LPG, bunker and petrochemical naphtha.

> ‘ The refining area is to be constructed in 2006, with an upgrade of the Alberto Pasqualini Refinery and the beginning of a new delayed coking unit in Duque de Caxias Refinery. ’

The continuity of the other projects in the refining area that is foreseen for the next year is destined to the improvement of gas and diesel quality. The investment also aims to adapt the profile of petroleum through amplification and modernization of the distillation unit, and increase the refining amount of nationally produced petroleum.

The joint implementation of a new refinery in Pernambuco, with Venezuelan state-owned petroleum company PDVSA, which is in the early stages of project planning; essential for establishing cargo, market and capacity parameters.

The investments in pipeline and transport are assigned to a logistics base in São Paulo and projects include:

■ the improvement of São Sebastião Terminal along the North Coast of São Paulo

■an increase in capacity handling of petroleum and derivatives in the South and Southeast regions.

an alcohol draining system connecting Ribeirão Preto and Paulínia Refinery (SP), to Ilha D'água Terminal (RJ)

■ the construction of the Pecém Terminal in Ceará, and investments in industrial, environmental, security and other smaller projects.

The vast majority of resources for Sea transport will be allocated to the program of modernization and expansion of shipping, with an investment of US$ 1.2 billion until 2010.

The investments in petrochemical activity envisage the implementation of an Integrated Petrochemical Complex. This will produce basic petrochemical products and derivatives from the heavy petroleum. The project of a new Petrobras Nitrogen fertilizer units also includes the beginning of Paulínia Petrochemicals work, a project for the production of polypropylene jointly with BRASKEM.

Resources allocated for 2006 also involve other plans and projects related to the strategic positioning of the company to the department, like the possible amplification of the participation in Rio Polímeros and other petrochemical undertakings.

> ‘ The ongoing upgrading process has contributed toward today's line of 52 Reduc products and a capacity of 242,000 bopd.’

# Refining capacity

Petrobras controls 16 refineries, 11 of which are in Brasil, 2 in Bolivia and 3 in Argentina. The total installed capacity of Petrobras's refining operations both home and abroad is 2 million 83 thousand barrels per day. This puts Petrobras in the fifth place of the largest petroleum refiners amongst public companies.

## Installed capacity of refining Brazil

## (thousand barrels/day)

| Refineries | Installed capacity | Processed volume | Use |
|---|---|---|---|
| **Paulínia – Replan** Paulínia (SP) | 352 | 329 | 93% |
| **Landulpho Alves – Rlam** Mataripe (BH) | 306 | 213 | 70% |
| **Duque de Caxias – Reduc** Campos Elísios (RJ) | 242 | 204 | 84% |
| **Henrique Laje – Revap** São José dos Campos (SP) | 226 | 198 | 88% |
| **Alberto Pasqualini – Refap** Canoas (RS) | 189 | 106 | 56% |
| **Presidente Vargas – Repar** Araucária (PR) | 189 | 192 | 102% |
| **Presidente Bernardes – RPBC** Cubatão (SP) | 170 | 154 | 91% |
| **Gabriel Passos – Regap** Betim (MG) | 151 | 128 | 85% |
| **Isaac Sabbá – Reman** Manaus (AM) | 46 | 45 | 98% |
| **Capuava – Recap** Mauá (SP) | 53 | 44 | 83% |
| **Northeastern Lubrificants and Petroleum Derivates Plant –** Lubnor Fortaleza (CE) | 6 | 6 | 83% |
| **Total Brazil** | 1,930 | 1,619 | _ |

E&P STRATEGY – PETROBRAS

# Petrobras E&P plans

*By Petrobras Press Office*

## 2006 EP strategy

With three more platforms starting operation in 2006, Petrobras should achieve self-sufficiency this year, when it is forecast to reach daily average production of 1,910,000 barrels of petroleum in Brazil. When Petrobras' foreign natural gas and oil production is added, total Petrobras production is predicted to reach 2.5 million of equivalent oil barrels (BOE) per day. The company and its subsidiaries are likely to invest R$ 38.6 billion.

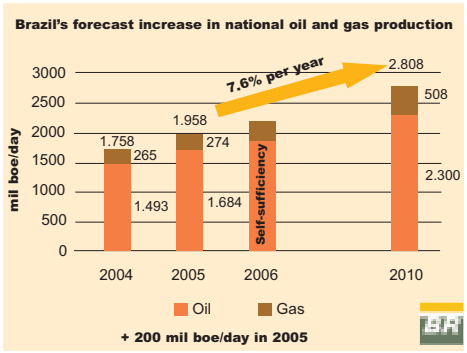
### Exploration & Production

Petrobras' business plan forecasts that in 2010, daily production will be 3,405,000 barrels of equivalent oil (BOE) of petroleum and natural gas, considering both its Brazilian and International activities.

Expectation is that the oil and gas proved reserves in the country, that today total 13.02 billion of barrels of equivalent oil keep growing, by the incorporation of probable and possible reserves, volumes already discovered, exploratory evaluation and with new discoveries in several Brazilian basins, where Petrobras have a portfolio of 131 exploratory blocks granted by ANP.

Investments of R$ 18.9 billion are estimated for this year's E&P in Brazil, where R$ 1.8 billion will be allocated for the construction of platforms. New production will come from platforms coming online in the Campos Basin and elsewhere. The P-50 platform, in the Albacora Leste field has a capacity of 180, 000 bopd and the P-34 platform in the Jubarte field has a capacity of 60 thousand barrels/day. In Sergipe, the SSP-300 platform will start production from the Piranema Field, which has a capacity of 20,000 bopd. Last but not least, Phase I of the Golfinho field, Espírito Santo Basin will have a capacity of 100,000 bopd.

Additionally, the gas field of Manati, in Bahia will start operating with a production of six million of cubic metres per day.




Looking further ahead, platforms P-52 and P-54 will have capacities of 180,000 bopd for the Roncador Field, in the Campos Basin, with production planned for 2007. The P-51 (South Marlim) and P-53 (East Marlim) platforms are also under construction in the Campos Basin; both have capacities of 180,000 bopd with planned commissioning in 2008.

With the acquisition of two new concession contracts of the acquired blocks at the seventh bid, accomplished in October 2005, is foreseen for January 2006. Ninety-six new exploratory blocks were acquired exclusively or by consortium. Among the blocks where they are participating, 73 are located in the ground and 23 in the sea. Petrobras will be the operator in 70 blocks

### Gas and Energy

In the Gas and Energy area, resources of R$ 6.7 million are foreseen for 2006, of which R$ 3.8 billion are designated for gas pipeline projects and participation in natural gas providers. R$ 2.1 billion are appointed to thermoelectric projects, R$ 300 million are assigned to the development of renewable alternative energy projects, and R$ 500 million are set for research and development, energy efficiency and other co-related activities.

## 2005 highlights

● The renewed contract of sponsorship with BMW Williams Formula 1 team.

● Petrobras signs, with the ministry of Mines and Energy and Cities, a covenant for the amplification of the use of natural gas vehicle – GNV in the transport of cargos and passengers in the cities of the Country.

● A new discovery of light oil in the Santos Basin, about 160 km from Rio de Janeiro, was announced in March 11th. In the drilled well (1,322 metres deep) 40 metres of oil reservoir of 33 degrees API were found.

● Petrobras refineries had another processing record in March 9th, with a volume of 1,869,914 barrels/day.

● Signed in Tripoli, capital of Libya, the contract of exploration of oil and gas in that country 200 to 700 metres of depth.

● Announced the purchase of a Thermoelectric Plant of Ceará, owned by the company MPX, for US$ 137 million.

● Signed the contract for expansion and

## 2006 – self-sufficiency draws closer

- ❑ Total production (oil and gas / Brazil and abroad) of 2.5 million of barrels/day.
- ❑ Four platforms with total production of 360 thousand barrels/day of capacity.
- ❑ Total investments of R$ 38.54 billion.
- ❑ Investments of R$ 19 billion in exploration and production in Brazil.
- ❑ Concept planning of Northeast Refinery.
- ❑ Integrated Petrochemical Complex in the State of Rio de Janeiro.
- ❑ Production abroad (oil and gas) of 317 thousand barrels/day (increase of 16% comparing to 2005).
- ❑ Investments of US$ 3.8 billion in projects of gas pipelines and distribution.

modernization of Gabriel Passos Refinery – Regap, located in Betim, in Belo Horizonte, investing US$ 1.01 billion and creating 500 direct and 5000 indirect jobs.

● Signed a long-term contract for the charter of a revolutionary new platform model destined for the Piranema field, in the Continental Platform of the State of Sergipe, for the production of 20 thousand barrels/day of light oil, of 43º API. The new one-pillar type platform will have a double skull and circular shape. It will be possible to store 300 thousand barrels of oil and compress 3.6 million of m3 of gas/day.

● For the first time, the production of petroleum surpassed 1.7 million barrels per day, in April 6th.

● Approves charter of P-53 platform, destined to the field of East Marlim, in Campos Basin, with the capacity to produce 180 thousand barrels per day. The work will allow the creation of 4000 direct jobs in Brazil and should be concluded in 29 months.

● Petrobras inaugurates Diesel 500, with 75% less sulphur, destined for big Brazilian cities. Developed in its refineries, the new diesel will contribute to improving air quality in large urban centers.

● May 12th: for the first time Petrobras surpasses the mark of 1.8 million barrels of petroleum production per day, approaching Brazilian self-sufficiency.

● Record profit of R$ 5 billion in the first quarter of 2005, a commercial surplus of 28 thousand barrels and an increase of 21% in its market value that passed R$ 122.2 billion. The ordinary shares of the company increased in value by 10.3%, while the São Paulo Stock Market index increased only 1.6%, on the first quarter.

● Petrobras is elected the best company in Latin America, prestigiously awarded by The New York Post with the 'Oscar' of the business world.

● P-47 Platform received and operating in Marlim Field, in the Campos Basin, connected to four other production platforms with the objective of treating and storing petroleum, increasing its quality and market value for exportation.

> ' For the second consecutive year Petrobras was elected by the Finances, Administration and Accounting Executives Association, as the Most Transparent Quoted Company of Brazil.'

● Signed contract for petroleum exportation in the field of Marlim to China. Exportation to this country should achieve one billion dollars per year.

● President Luiz Inácio Lula da Silva attends the inauguration of three new units at Duque de Caxias Refinery – REDUC, in Rio de Janeiro.

● José Sérgio Gabrielli de Azevedo is appointed as President of Petrobras, replacing the geologist José Eduardo Dutra who administered the company since January 2003.

● Approved the construction of the new Petrobras headquarters in Espírito Santo, inspired by the architectural concepts of the ancient Penha Monastery. Petrobras forecasts that the state of Espírito Santo will become the second largest Brazilian producer of petroleum in the first term of 2006, with 180 thousand barrels per day.

● In Colombia, the inauguration of Lubrax's lubricants line, with the sponsorship of local company Coexito, which will be in charge of initially distributing 20 different lines of lubricants that will be manufactured in that country. In a second phase, other products will be offered to the Colombian market. The Lubrax brand has more than 120 products in Brazil.

● New record of petroleum production by Petrobras refineries, reaching 1,875,000 barrels in July 27th.

● The economist Almir Guilherme Barbassa, Executive Manager of Corporative Finances and Treasury, has confirmed the Financial and Relations Board with Investors.

● Petrobras achieves the Brazilian record of depth drilling in August 12th, with an inclined well that achieved 6,915 metres beyond the bottom of sea. The well was drilled on BMS-10 block, in the Santos Basin, located 200 km from the south coast of Rio de Janeiro.

● In August, Petrobras America, the United States subsidiary, finished up 53 blocks in the Mexican Gulf by a total amount of US$ 30.1 million, with 100% participation.

● The Move Program – Brazil, which integrates the Petrobras Zero Hunger Program, helped 23,000 adults gain literacy skills, and passed its half way goal of helping a total of 40,000 adults to read and write until 2006.

● Business plan approved for the period of 2006 – 2010 forecasting total investments of US$ 56.4 billion, of which US$ 49.3 is in Brazil and US$ 7.1 is abroad. The combined production of petroleum and gas expected for 2010 will be 3,405,000 equivalent barrels per day.

● Petrobras obtains one more exploratory block from the government of Nigeria, as a deep water operator, in partnership with the Norwegian Statoil and with Nigerian Ask Petroleum. The block, of 1,030 square kilometres, and 1000 to 2000 metres in depth is located in the Niger River Delta next to Lagos city.

● For the second consecutive year Petrobras was elected by the Finances, Administration and Accounting Executives Association, as the Most Transparent Quoted Company of Brazil.

● In September, with both Brazilian President Luiz da Silva and Venezuelan President Hugo Chávez in attendance, covenants and agreements between Petrobras and Venezuela Oil Tankers – PDVSA were signed by the respective company presidents; José Sergio Gabrielli de Azevedo (Petrobras) and Rafael Ramirez.(PDVSA), Rafael Ramirez. The agreements involve the construction of a refinery in Pernambuco and partnerships in exploration and production areas. The refinery will be capable of processing 200 thousand barrels of heavy petroleum per day, half for Petrobras and other half for PDVSA, with 50% participation by each company. The

> ' May 12th: for the first time Petrobras surpasses the mark of 1.8 million barrels of petroleum production per day, approaching Brazilian self-sufficiency. '

## E&P STRATEGY

project expects investments of US$ 2.5 billion, in phase one of technical definitions.

● In October Petrobras Transports – Transpetro, opened a bid for constructing 26 ships of 42 of the Shipping Modernisation and Expansion Program. The ships will be constructed in Brazil with 65% of national content guaranteed. The initiative that will generate 20,000 jobs, is decisive to consolidate the country's shipping construction industry. This industry already occupied second place on a global ranking in the 80's and maintained the position to date.

● As a result of the commitment of the company's administration and all its work force, to conduct business in a profitable way, but with social and environmental responsibility, Petrobras was classified by Moody's Investor Service with an official investment grade. Among the benefits of this new position, are lower capital costs, amplifying the opportunities of development of new projects and the possibility of improved results shareholders, making the company more competitive.

● In October Petrobras was chosen to develop its Corporate University, the pilot project of the initiative program of UNO, called Globally Responsible Leaders, facing the formation of directors of the companies in questions related to social and environmental responsibilities.

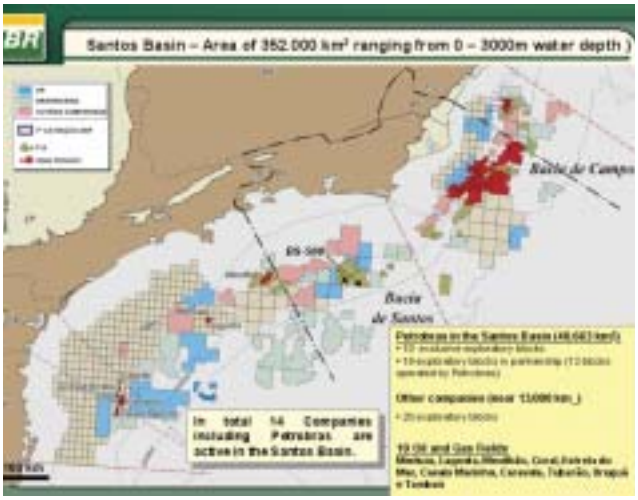
● At 7th Exploratory Blocks Bid, promoted by Petroleum, Gas and Bifuel National Agency (ANP), in October 17th and 18th, Petrobras acquires, with exclusivity or consortium, 96 new exploratory blocks and executed call in 109 of the 1,134 blocks offered. 73 of the acquired blocks are located on the ground and 23 in the sea. Petrobras participates as the operator of 70 blocks.

● 74 new projects published approved by public selection to integrate the Petrobras Zero Hunger Program, which will destine over R$ 18 million for the initiatives to combat social inequality in the Country, by generating employment and profit, improving the education condition and professional qualification, and warranty of the children and teenager's rights. Until 2006, the company will invest R$ 303 million in Petrobras Zero Hunger Program projects, which are earmarked to help more than four million people.

● Petrobras and Transpetro signed covenants with environmental NGOs, to introduce community vegetable gardens in a piece of land with 5 kilometres that covers the pipelines of the company in the cities of Nova Iguaçu and Duque de Caxias, in Baixada Fluminense.

● In the first nine months of the year, Petrobras raised a consolidated net profit of R$ 15.6 billion, 23% higher at the same period in 2004. The excellent operational performance of the Company provided generation of boxes of R$ 34.8 billion from January to September 2005, representing an increase of 30% in relation to the same period in 2004, which make the investments of R$ 16.9 billion possible. The production of petroleum increased 12% and 27% of the exportation in that period. The collection of duties and government contributions were R$ 42.8 billion and the market value of the company increased 54%, achieving R$ 168 billion.

> ‘ In the first nine months of the year, Petrobras raised a consolidated net profit of R$ 15.6 billion, 23% higher at the same period in 2004. ’




● The offer of Petrobras International - Braspetro was the joint winner of the block Moruy II auction, on the second road of the bid for submarine exploration in Bolivarian Republic of Venezuela, called "Project Rafael Urdaneta - Phase B", with the Teikoku Oil Co., Ltd. The Block has 874 km2 of extension, is located in the southeast part of Venezuela Gulf, to the north of Maracaibo Lake, and approximately 450km west of Caracas, the capital of Republic. Petrobras and Teikoku will each have 50% participation and the Brazilian company will be the operator. The investment in the initial exploratory phase is approximately US$ 20 million.

● Petroleum of excellent quality discovered, in the city of Esplanada, in Recôncavo Basin, 170 kilometres from Salvador. Reservoirs of oil and gas were found at 420 metres depth. In accordance with the preliminary geologic interpretation, the company evaluates that the discovery is similar to the situation that occurred in September 2004, in the same exploratory block, in Jandaia Field, where the reservoirs are located 900 metres depth and the current production achieves 2,400 barrels of oil per day.

● Published by the Chief Minister of the Civil House, Dilma Rousseff, in Salvador, Bahia, the Plan of Professional Qualification of Prominp (Mobilization Program of National Industry of Petroleum and Natural Gas). The Plan foresees the investments of R$ 220 million, until the end of 2007, for the formation of 70,000 professionals of university, technical and basic levels to attend the need of 12 states of the Federation, where the projects of investments will be introduced to the sector.

● President Luiz Inácio Lula da Silva participates in the launch celebration of the P-50 platform, at Mauá-Jurong Shipyard, in Niterói (RJ).

● Named as Inhambu, a new heavy oil field (10º API) was declared commercial in Espírito Santo Earth Basin, in the city of Jaguaré, North of the State, about 180 km from Vitória.

● Petrobras receives "Marketing Award 2005", from the Brazilian Association of Business and Marketing. The award acknowledges the professionals and companies that stood for excellence in their business fields.

● Financing approved by the Brazilian Bank for Economic and Social Development – BNDES, for the construction of a platform. Among the social benefits to be provided for the State of Amazonas, 3,400 direct and 10,200 indirect jobs will also be created.