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The Year Ahead

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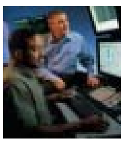
Liner tie-backs stop casing leaks in Libya completions
Mideast site tests fiber-optic corrosion monitoring system
Monitoring, analysis show rapid GOM seafloor recovery

see more



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OIL&GAS JOURNAL®

Jan. 1, 2007
Volume 105.1

The Year Ahead

Regular Features

Cover

With oil and gas markets expected to remain strong, 2007 promises to be a year of technical advances across the whole spectrum of petroleum industry operations. In the report beginning on p. 18, Oil & Gas Journal's specialist editors preview highlights of the year ahead in exploration and development, drilling and production, processing, and transportation. Cover and special report art by Kay Wayne.

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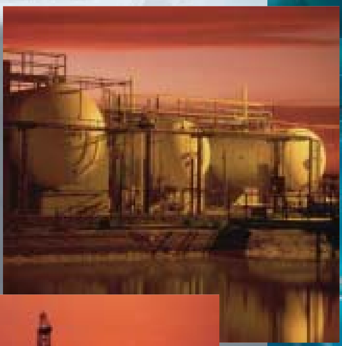

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General Interest — *Quick Takes*

Venezuela energy minister resigns

Venezuela Energy Minister Rafael Ramirez resigned after President Hugo Chavez requested the resignation of all his cabinet ministers.

Chavez told reporters in Venezuela that the ministers will stay in their posts until replacements are approved.

Ramirez has been minister since 2002 and was appointed president of state oil company Petroleos de Venezuela SA in November 2004. He did not resign as PDVSA president, PDVSA told Business News Americas. PDVSA officials confirmed that Ramirez had resigned as minister.

N. Sea decommissioning to cost $42 billion

Companies operating in the North Sea are expected to spend $42 billion on decommissioning infrastructure, said Wood Mackenzie Ltd., Edinburgh.

About 48% of decommissioning costs will be spent in Norway and 40% in the UK, WoodMac said.

North Sea operators say the UK government needs to clarify the regulation, tax, and decommissioning liability rules that will help them close deals faster on transferring ownership rights over their acreage. The UK Offshore Operators' Association and the Independent Oil & Gas Association have been lobbying the government to make progress on this issue, said WoodMac.

The companies are concerned about changes to the UK tax regime that could affect the levels of tax relief they can claim against decommissioning costs. "However, the UK industry would welcome change to current liability and financial security requirements," the analyst added.

WoodMac anticipates the majority of future decommissioning expenditure to be in 2015-31 with a spending plateau of about $1.5 billion/year. However, operators are expected to have some success in extending the life of existing fields beyond current plans.

To date 40 fields have been abandoned—23 in the UK, 11 in Norway, and 6 in the Netherlands—and an additional 66 fields are being decommissioned or await abandonment.

Countries sign energy efficiency accord

The US, China, India, Japan, and South Korea agreed on Dec. 15 to work together to boost energy efficiency, to diversify their energy sources, and to guard against emergencies in the face of rising oil prices.

In a joint statement, energy ministers from the countries said they face a common challenge to obtain "sufficient, reliable, and environmentally responsible supplies of energy with reasonable prices."

The statement said in recent years global oil price fluctuations and increases have hurt the world economy, especially developing countries.

The ministers said the collective efforts of their countries, which consume about 47% of the world's energy, are of great significance for the stability of the international market for oil and other sources of energy, as well as for enhancing global energy security.

Total to cut gas flaring in half by 2012

Total SA plans to cut its gas flaring by 50% at its operated facilities in the Gulf of Guinea and other places by 2012 to reduce climate change and promote energy efficiency and sustainability.

Total said it reduced gas flaring by 40% during 1998-2005 at its operated facilities despite boosting gas production levels. Associated gas flaring accounted for 23% of its greenhouse gas emissions in 2005.

"We will look at reinjecting gas back into oil fields," a spokesman said. Total also wants to send gas to the proposed 5 million tonne/year Angola LNG project, operated by Chevron Corp. Total plans to use otherwise flared gas for electric power generation in Nigeria and is keen to produce methanol, he added.

Total is a member of the World Bank's Global Gas Flaring Reduction partnership. Established in August 2002 by the World Bank, the public-private partnership facilitates and supports national efforts to use currently flared gas. Partners include governments of oil-producing countries, state-owned companies, and major international oil companies.

In 2000, Total set a "zero flaring" policy for its projects.

New Zealand to meet IEA inventory target

New Zealand Energy Minister David Parker announced that, effective Jan. 1, New Zealand would meet its International Energy Agency obligation to hold oil stocks representing 90 days of net oil imports.

New Zealand's oil stocks have dipped to volumes as low as 60 days of net oil imports as a result of increasing demand and declining domestic oil production, he said. In May, criticized New Zealand's inventory levels.

The government has arranged contracts that provide options for New Zealand to buy petroleum and diesel in case of an IEA-declared emergency. The contracts cover petroleum and diesel stored in Australia, the Netherlands, and the UK from BP PLC, Royal Dutch Shell PLC, and Total SA.

The New Zealand government signed bilateral arrangements with the governments of Australia, the UK, and the Netherlands to enable the stocks to count toward New Zealand's IEA obligations. ✦

Industry Scoreboard

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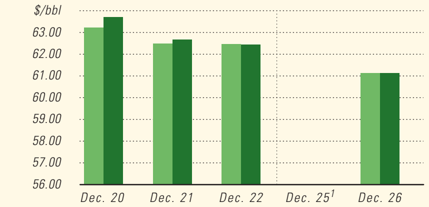
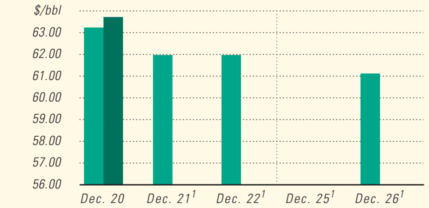
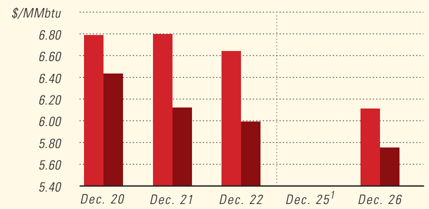


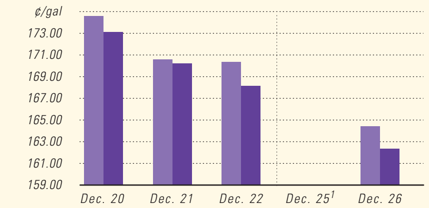
WTI CUSHING / BRENT SPOT



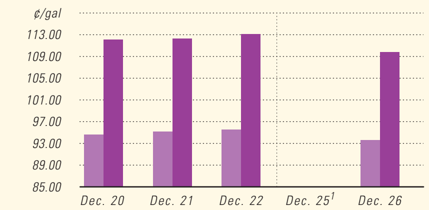
NYMEX NATURAL GAS / SPOT GAS - HENRY HUB



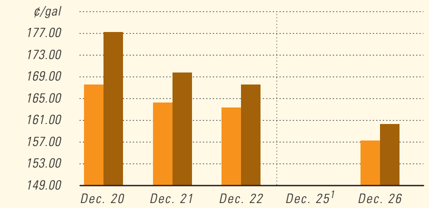
IPE GAS OIL / NYMEX HEATING OIL



PROPANE - MT. BELVIEU / BUTANE - MT. BELVIEU



NYMEX GASOLINE / NY SPOT GASOLINE[2]



[1]Not available.
[2]Nonoxygenated regular unleaded.

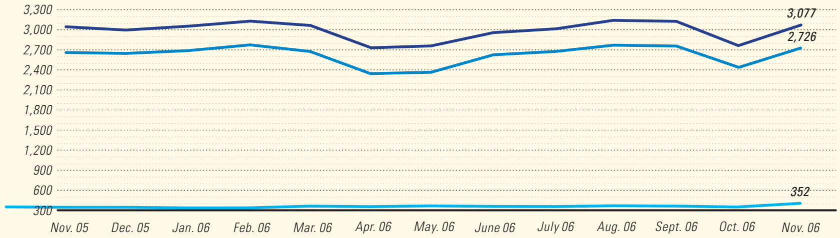
US INDUSTRY SCOREBOARD — 1/1

Latest week 12/15	4 wk. average	4 wk. avg. year ago[1]	Change, %	YTD average[1]	YTD avg. year ago[1]	Change, %
Demand, 1,000 b/d						
Motor gasoline	9,852	9,212	6.9	9,834	9,157	7.4
Distillate	4,266	4,210	1.3	4,165	4,118	1.1
Jet fuel	1,638	1,692	–3.2	1,607	1,679	–4.3
Residual	536	1,003	–46.6	709	920	–22.9
Other products	5,155	4,974	3.6	4,966	4,925	0.8
TOTAL DEMAND	21,447	21,091	1.7	21,281	20,799	2.3
Supply, 1,000 b/d						
Crude production	5,285	4,916	7.5	5,137	5,179	–0.8
NGL production	2,269	1,534	47.9	2,239	1,717	30.4
Crude imports	9,624	10,100	–4.7	10,196	10,074	1.2
Product imports	3,067	3,683	–16.7	3,406	3,588	–5.1
Other supply[2]	1,174	1,142	2.9	1,096	1,162	–5.6
TOTAL SUPPLY	21,419	21,374	0.2	22,075	21,720	1.6
Refining, 1,000 b/d						
Crude runs to stills	15,177	15,039	0.9	15,151	15,220	–0.5
Input to crude stills	15,493	15,246	1.6	15,570	15,479	0.6
% utilization	89.4	89.0	—	90.4	90.4	—

Latest week 12/15	Latest week	Previous week[1]	Change	Same week year ago[1]	Change	Change, %
Stocks, 1,000 bbl						
Crude oil	321,473	325,799	–4,326	324,623	–3,150	–1.0
Motor gasoline	199,821	200,121	–300	203,646	–3,825	–1.9
Distillate	135,212	136,630	–1,418	129,856	5,357	4.1
Jet fuel	38,359	39,021	–662	43,553	–5,194	–11.9
Residual	44,353	43,764	590	38,347	6,007	15.7
Futures prices[3]						
Light sweet crude, $/bbl	62.08	62.29	–0.21	60.31	1.77	2.9
Natural gas, $/MMbtu	7.50	7.69	–0.19	14.46	–6.96	–48.1

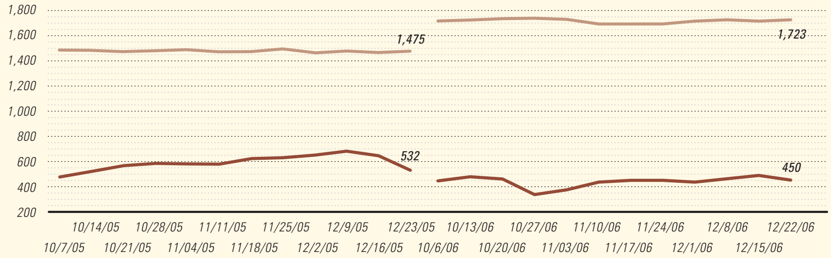
[1]Based on revised figures. [2]Includes other hydrocarbons and alcohol, refinery processing gain, and unaccounted for crude oil.
[3]Weekly average of daily closing futures prices.

BAKER HUGHES INTERNATIONAL RIG COUNT: TOTAL WORLD / TOTAL ONSHORE / TOTAL OFFSHORE



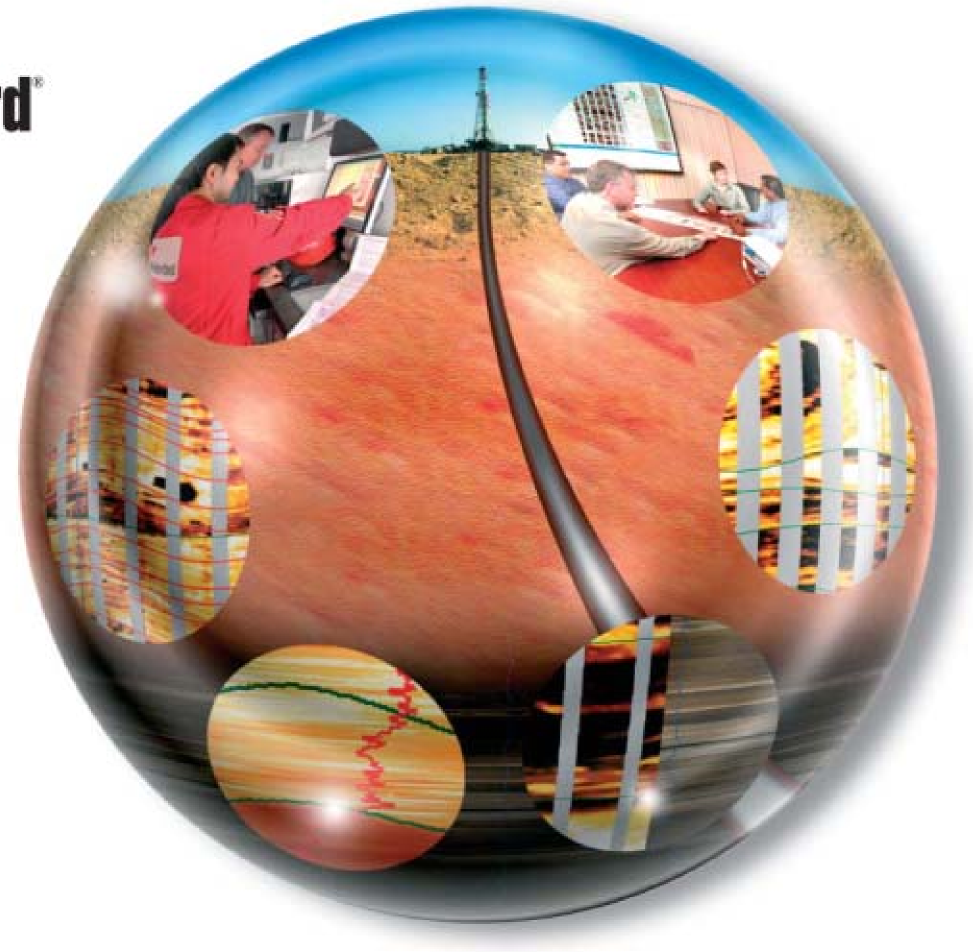
Note: Monthly average count

BAKER HUGHES RIG COUNT: US / CANADA



Note: End of week average count

Weatherford



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Exploration & Development — *Quick Takes*

Shell, Plains E&P make GOM oil find

Shell Offshore Inc. has made an oil discovery on its Friesian prospect on Green Canyon Block 599 in 3,800 ft of water in the Gulf of Mexico, about 200 miles south of New Orleans.

The discovery well was drilled to 29,414 ft TD and encountered more than 120 ft of net oil pay. The well is prepared for completion and temporarily abandoned.

Shell, operator, and Plains Exploration & Production Co. each own a 50% interest in the project.

Leases issued for five oil shale projects

The US Department of the Interior has issued research, development, and demonstration (RD&D) leases for five oil shale projects in Colorado's Piceance basin, the US Bureau of Land Management said Dec. 15.

C. Stephen Allred, assistant Interior secretary for land and minerals management, signed the RD&D leases for projects proposed by Chevron USA Inc., EGL Resources Inc., and Shell Frontier Oil & Gas Inc.

The leases grant rights to develop oil shale resources on tracts up to 160 acres for a 10-year initial term, with an extension option of up to 5 years with proof that diligent production levels have been pursued.

The leases also contain a preferential right to convert the RD&D acreage, plus as much as 4,960 acres of adjacent land, to a 20-year commercial lease once commercial production levels are achieved and all requirements are met, it added.

The tracts were identified in proposals submitted by the companies in June 2005. The leases contain project-specific requirements for permitting, monitoring, and environmental mitigation.

Target shales are in the Eocene Green River formation, which lies under parts of Colorado, Utah, and Wyoming, and according to BLM might hold 800 billion bbl of recoverable shale oil. More than 70% of the formation lies under federal land.

Husky finds gas, oil in Jeanne d'Arc basin

Husky Energy Inc., St. John's, Newf., and Norsk Hydro Canada Oil & Gas have made a hydrocarbon discovery during delineation drilling in the Jeanne d'Arc basin, off Newfoundland and Labrador.

The West Bonne Bay F-12 well was drilled in significant discovery license (SDL) 1040, about 320 km southeast of St. John's, and near the Terra Nova oil field. Under a farm-in agreement with Norsk Hydro, operator of SDL 1040, Husky drilled the well using the Rowan Cos. Inc. Gorilla VI jack up rig.

The F-12 well was drilled to TD 4,666 m. A sidetrack well F-12Z was drilled to further delineate the structure and to gather additional reservoir information. In both wells hydrocarbons were encountered in the Upper Hibernia formation. Further analysis of core, fluid samples, and wire line log data is continuing to estimate the resources in this pool.

Husky served as operator for the drilling program and holds a 27.78% interest in the West Bonne Bay well. Norsk Hydro is operator of the SDL and holds a 72.22% working interest.

Indonesia awards PSCs to 18 companies

Indonesia has awarded production-sharing contracts to 18 companies in an effort to boost the country's dwindling oil production. The government wants to increase oil production to 1.3 million b/d by 2009 from the current 1.04 million b/d.

Indonesia invited companies to bid on 41 oil and gas blocks onshore and offshore Sumatra, Kalimantan, Sulawesi, and Java.

The winning bidders must drill as many as 32 wells over the next 3 years at a total cost of about $235.78 million.

Companies that secured exploration rights in frontier areas will receive 80% of the net oil production, while those operating in nonfrontier areas will receive 65% of net production.

Winners included ConocoPhillips and partner Statoil ASA, which obtained rights to explore for oil and gas on the Kuma Block in western Sulawesi. Also CNOOC and its partner PT Gregori Gas Perkasa won rights for the Batanghari Block in central Sumatra.

PetroLatina to develop Serafin gas project

PetroLatina Energy PLC, formerly Taghmen Energy PLC, has initiated development of the 1991 Serafin gas discovery in Area B of the Tisquirama License in Colombia. Gross reserves are estimated at 4-8 bcf.

The Serafin well is north of PetroLatina's Los Angeles field and 3.5 km from a main gas pipeline. PetroLatina holds a 50% interest in the project, and PetroSantander Inc. holds 50%.

PetrLatina will reenter and work over the well this month and test results will determine the design of a tie-in to the pipeline. PetrLatina expects commercial gas deliveries to start in second quarter.

Development cost, including pipeline and tie-in, is estimated at $1.36 million.

Recent increases in the price of gas in Colombia to about $3/Mcf will enable the project to pay out in 5 months, PetroLatina said. Local industries will buy the gas.

Texas Petroleum Co. drilled the Serafin well, which encountered a gas-bearing sand in a stratigraphic trap of the Miocene Real Group. Logs indicated 18 ft of pay with porosity of 28% and a water saturation of 27%. The well flowed at rates of up to 16 MMcfd from a 4,582-98-ft zone on extended tests. Reservoir pressure is 1,978 psi, and the gas is over 97% methane.

PetroLatina is using 3D seismic data to identify further prospects. ✦

Drilling & Production — *Quick Takes*

Azeri Shah Deniz field comes on stream

Commercial gas production has begun from Shah Deniz gas-condensate field in the Caspian Sea off Azerbaijan. Consortium partner Total SA said Shah Deniz field's Stage 1 gas production plateau is expected to be 300 MMcfd.

Shah Deniz covers about 860 sq km about 70 km south of Baku in 50-600 m of water (map, OGJ, June 27, 2005, p. 61). BP PLC is technical operator of the field and an associated onshore terminal, and Statoil ASA is commercial operator, responsible for gas sales, contract administration, and business development (OGJ, May 15, 2006, Newsletter).

In addition to BP and Statoil, which hold 25.5% interest each, Shah Deniz shareholders include State Oil Co. of the Azerbaijan Republic, Total, Naftiran Intertrade Co. Ltd., and LukAgip NV—each holding 10%—and Turkiye Petrolleri Anonim Ortakligi, 9% (OGJ, Mar. 17, 2003, Newsletter).

The field, which has gas reserves pegged at 25-35 tcf, is expected to produce 8.6 billion cu m/year of gas in Stage 1 and 37,000 b/d of condensate, which will be shipped to Ceyhan, Turkey, for processing (OGJ, Aug. 21, 2000, p. 68).

Gas is being exported to Azerbaijan, Georgia, and Turkey via the $1.3 billion, 700 MMcfd South Caucasian Pipeline. The BP-operated line extends 430-miles from Baku to Tbilisi, Georgia, and Erzurum in eastern Turkey, paralleling the Baku-Tbilisi-Ceyhan crude oil pipeline.

Beyond Erzurum, there currently is no place for the remaining gas to go, but Georgia has agreed to place some of the gas in storage until Erzurum can be integrated into the Turkish gas network. Turkish state-owned Petroleum Pipeline Corp. will assume gas transportation at the border, and will build a new pipeline to tie in to the existing Turkish distribution network at Erzurum.

Petrobras starts up P-34 FPSO off Brazil

Petroleo Brasileiro SA (Petrobras) has brought online the P-34 floating production, storage, and offloading vessel, establishing first-phase production of Jubarte field off Espirito Santo, Brazil.

P-34 flow will rise to nominal capacity of 60,000 b/d, including 15,000 b/d of 17° gravity oil from the Jubarte-4 horizontal well and output from three other wells.

Production from the second production well, ESS-110, could start by yearend.

Dalia oil field starts production off Angola

Oil production from Dalia field off Angola started Dec. 15 and will reach 250,000 b/d by next summer, field operator Total SA reported.

Dalia field, which lies on deepwater Block 17, 135 km offshore in 1,200-1,500 m of water, holds 1 billion bbl of recoverable oil (map, OGJ, Feb. 14, 2005, p. 24). Oil is being produced from 37 wells, all of which are tied in to 9 manifolds. The field also has 3 gas-injection and 31 water-injection wells.

Subsea installations include 40 km of insulated flowlines linked to 8 flexible risers specifically manufactured for the project. The risers take fluids to a floating production, storage, and offloading vessel, which can store 2 million bbl of oil.

According to Total, Dalia is the largest deepwater development to be brought on stream in 2006 and among the largest projects of its kind in the world.

Total holds 40% interest in Block 17. Partners are Esso Exploration Angola (Block 17) Ltd. 20%, BP Exploration (Angola) Ltd. 16.67%; Statoil Angola Block 17 AS 13.33%, and Norsk Hydro Dezassete AS 10%.

Firms clash over Yacheng gas supply outlook

CLP Holdings Ltd., Hong Kong, rejecting claims by natural gas suppliers, China National Offshore Oil Corp., BP PLC, and Kuwait Foreign Petroleum Exploration Co. (Kufpec), that Yacheng gas field off Hainan Island has sufficient reserves to supply Hong Kong through 2036, decided to build an $8 billion (HK) LNG terminal on the Soko Islands southwest of Lantau after an independent assessment in 2002 concluded that the field's reserves would be insufficient to meet increased demand for gas in Hong Kong.

Demand growth for gas on Hainan Island, rising by 23%/year, is expected to create a shortfall during 2006-10 because supplies are forecast to increase by only 18%/year.

CNOOC, however, said it plans to invest $80 million on drilling 3-4 production wells after 2009, lifting the total number to as many as 15 and expanding the exploration area to 322 sq km.

CNOOC owns a 51% stake in Yacheng, while BP and Kufpec share the remaining 45%. Yacheng reserves are pegged at more than 100 billion cu m.

CLP consumes 2.5 billion cu m/year of gas, or 83% of Yacheng's annual output. ✦

Processing — *Quick Takes*

Ireland refinery producing renewable diesel

ConocoPhillips has begun commercial production of renewable diesel from soybean oil and other vegetable oils at its 71,000 b/d Whitegate refinery in Cork, Ireland.

Whitegate is producing 1,000 b/d of renewable diesel using its existing equipment. Unlike biodiesel, the renewable diesel is blended and transported with petroleum-based diesel. ConocoPhillips said renewable diesel involves different processing methods than biodiesel. Renewable diesel also is different chemically from biodiesel. Use of the renewable diesel will help reduce carbon emissions, ConocoPhillips said.

Chevron starts up FCC unit at Pascagoula

Chevron USA Inc. has brought online a fluid catalytic cracking (FCC) unit at its 325,000 b/cd refinery in Pascagoula, Miss.

The FCC unit, completed this month during a 75-day project shutdown, will increase the refinery's capacity to manufacture gasoline by about 10% to 5.5 million gal/day (OGJ, Nov. 20, 2006, Newsletter).

Chevron Executive Vice-Pres. of Global Downstream Mike Wirth said, "In the last 2 years, Chevron has increased its gasoline manufacturing capacity in the United States by 6%, or 1 million gal/day."

Dubai condensate refinery upgrade advances

GE Oil & Gas will supply eight compressors and a steam turbine power generation set for an upgrade of Emirates National Oil Co.'s 120,000 b/d condensate refinery at Jebel Ali, Dubai.

Foster Wheeler Energy Ltd. is the engineering, procurement, and construction contractor for the addition of a 36,000 b/sd crude catalytic reformer and a 70,000 b/sd LPG-naphtha hydrotreater.

The project will convert the existing naphtha product to low-sulfur petrochemical naphtha, add a 102 RON reformate stream, and enable the refinery to operate at full capacity on sour condensate. Other new products are LPG, butane, and sulfur.

The generator to be supplied under the GE contract will use steam from the refinery. The compressors—five centrifugal and three reciprocating, all driven by electric motors—are for the new hydrotreater and reformer.

The project is scheduled for completion by yearend 2007 ✦.

Transportation — *Quick Takes*

Plains confirms offshore oil pipeline leak

Plains All American Pipeline LP said a crude oil leak was detected Dec. 24 on its High Island Pipeline System off Texas City, Tex., 30 miles south of Galveston in the Gulf of Mexico. No injuries were reported.

Earlier that day, Plains said the pipeline had experienced a pressure loss and was shut down. The cause of the incident is being investigated.

The company said it is working with federal and state officials to minimize the consequences of the incident.

Firm presses plans for Indonesian gas line

Indonesia's PT Bakrie & Bros. (B&B) Pres. Bobby Gafur Umar said the company plans to proceed with construction of a 1,115-km pipeline to transport natural gas from East Kalimantan to Central Java despite adverse comments by Indonesian Vice-President Jusuf Kalla about the project's feasibility.

Kalla earlier said the government might cancel the $1.26 billion project due to a change in domestic gas markets, with Java likely to get fresh supplies from Cepu gas field in Central Java.

Kalla said gas output in Kalimantan is showing signs of depletion.

Umar, however, said the pipeline was in line with the program proposed to upstream regulator BP Migas, which awarded BB the tender to build the project (OGJ, Feb. 20, 2006, Newsletter). Construction has been scheduled to start in early 2007and to complete in 2009.

B&B has a 25-year contract from the government to operate the transmission pipeline, and it has been seeking cooperation with Mitsui of Japan and Daewoo of South Korea to build the line, which will transport 1 bcfd.

PDVSA plans Caribbean-Pacific oil pipeline

Petroleos de Venezuela SA (PDVSA) plans to build a pipeline through Nicaragua to transport oil from the Caribbean to the Pacific, bypassing the Panama Canal.

Officials of the Nicaraguan-Venezuelan oil firm Alba Petroleos de Nicaragua (Albanic), which is managed by Nicaragua's Sandinista-controlled Association of Nicaraguan Municipalities, confirmed the plans.

Albanic Pres. Jose Pena mentioned PDVSA's additional interest in building a refinery in Nicaragua to supply Central America with products.

Pena said the plans will be part of an accord to be signed by Venezuelan President Hugo Chavez and Nicaraguan President-elect Daniel Ortega after the latter is sworn in as president Jan. 10.

Albanic Vice-Pres. Dionisio Marenco, mayor of Managua and a Sandinista member, said the Panama Canal is too narrow to allow passage of large tankers. He said the pipeline would be used to boost the export of oil products made in Nicaragua from Venezuelan crude to China and Japan as well as the Pacific Coast of Central America. Nicaragua's only refinery is Esso Caribbean & Central America's 20,000 b/d facility in Managua.

In May, Ortega and Chavez signed a cooperation initiative enabling Venezuela to sell oil to Nicaragua on credit.

Venezuela will accept 60% of payment within 90 days of shipment, while the remaining 40% will be paid off over 25 years at 1%, to include a 2-year grace period.

The creation of Albanic is widely seen as a sign of Ortega's growing political alliance with Chavez. ALBA is the Bolivarian Alternative for the Americas, a Latin American integration initiative started last year by Cuba and Venezuela, which aims to counter US efforts to promote hemispheric free-trade integration.

Fast-track plans outlined for Iranian LNG plant

Perth-based Liquefied Natural Gas Ltd. plans to accelerate development of its 3.45 million tonnes/year Qeshm LNG project in Iran.

The Qeshm Island liquefaction plant, expected to deliver its first LNG shipment in first quarter 2010, is being developed in partnership with Civil Pension Fund Investment Co. Iranian.

The plant will be developed in three phases. The first phase calls for a 1.15 million tonnes/year train in first quarter 2010.

Developers are working with Iranian authorities to select a plant site and finalize an LNG sales agreement.

Gorgon LNG plan clears environmental hurdle

Western Australia has cleared the way for a final investment decision on the Chevron Australia group's $15 billion (Aus.) Gorgon LNG project off the state's northwest coast.

However the group must commit an additional $60 million (Aus.) to conserving and monitoring the flatback turtle population, which annually lays eggs on Barrow Island near the plant site, and comply with stringent conditions concerning dredging, quarantine, greenhouse gas reinjection, short-range endemics and subterranean fauna.

The group also will be required to contribute $40 million (Aus.) toward resolving environmental issues in the Pilbara and West Kimberley regions, including rehabilitation of Dirk Hartog Island.

The project needs final environmental approval from the Federal Minister for Environment Ian Campbell before it can proceed.

Chevron and partners ExxonMobil Corp. and Shell Australia will have to weigh the costs of these latest conditions against the economics of the project.

The group has already invested $1 billion in development preliminaries, including $40 million for a carbon dioxide data well on Barrow Island to investigate the feasibility of geosequestering Gorgon's 12% CO_2 content in reservoirs.

Chevron says that an indication of whether the two-train, 10 million tonne/year LNG plant would go ahead could be given in mid-2007. ✦

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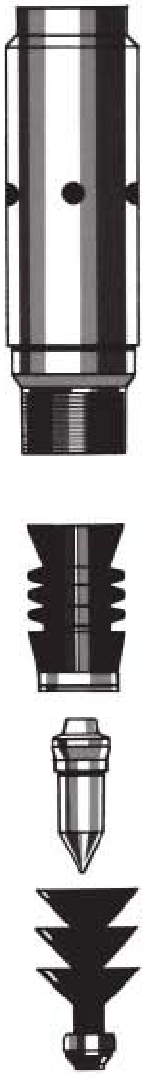

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2007

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Offshore Asia Conference & Exhibition, Kuala Lumpur, (918) 831-9160, (918) 831-9161 (fax), e-mail: oaconference@pennwell.com, website: www.offshoreasiaevent.com. 16-18.

✦GTLtec Conference, Doha, (65) 6345 7322, (65) 6345 5928 (fax), e-mail: cynthia@cmtsp.com.sg, website: www.gtltec.com. 22-23.

Power-Gen Middle East Conference, Manama, (918) 831-9160, (918) 831-9161 (fax), e-mail: registration@pennwell.com, website: www.pennwell.com. 22-24.

API Exploration and Production Winter Standards Meeting, Scottsdale, Ariz., (202) 682-8000, (202) 682-8222 (fax), website: www.api.org. 22-26.

Deepwater Operations Conference & Exhibition, Galveston, Tex., (918) 831-9160, (918) 831-9161 (fax), e-mail: registration@pennwell.com, website: www.deepwater-operations.com. 23-25.

SPE Hydraulic Fracturing Technology Conference, College Station, Tex., (972) 952-9393, (972) 952-9435 (fax), e-mail: spedal@spe.org, website: www.spe.org. 29-31.

Underwater Intervention Conference, New Orleans, (281) 893-8539, (281) 893-5118 (fax), website: www.underwaterintervention.com. Jan. 30-Feb. 1.

FEBRUARY

NAPE Expo, Houston, (817) 847-7700, (817) 847-7704 (fax), e-mail: nape@landman.org, website: www.napeonline.com. 1-2.

IPAA Small Cap Conference, Boca Raton, Fla., (202) 857-4722, (202) 857-4799 (fax), website: www.ipaa.org/meetings. 5-8.

IADC Health, Safety, Environment & Training Conference & Exhibition, Houston, (713) 292-1945, (713) 292-1946 (fax); e-mail: info@iadc.org, website: www.iadc.org. 6-7.

Russia Offshore Oil & Gas Conference, Moscow, +44 (0) 1242 529 090, +44 (0) 1242 060 (fax), e-mail: wra@theenergyexchange.co.uk, website: www.theenergyexchange.co.uk. 7-8.

Multiphase Pumping & Technologies Conference & Exhibition, Abu Dhabi, (918) 831-9160, (918) 831-9161 (fax), e-mail: registration@pennwell.com, website: www.multiphasepumping.com. 11-13.

SPE Middle East Oil & Gas Show & Conference (MEOS), Bahrain, +44 20 7840 2139, +44 20 7840 2119 (fax), e-mail: meos@oesallworld.com, website: www.allworldexhibitions.com. 11-14.

International Petrochemicals & Gas Technology Conference & Exhibition, London, +44 (0) 20 7357 8394, e-mail: Conference@EuroPetro.com, website: www.europetro.com. 12-13.

IP Week, London, +44(0)20 7467 7100, +44(0)20 7580 2230 (fax); e-mail: events@energyinst.org.uk, website: www.ipweek.co.uk. 12-15.

Pipeline Pigging & Integrity Management Conference, Houston, (713) 521-5929, (713) 521-9255 (fax), e-mail: info@clarion.org, website: www.clarion.org. 12-15.

CERA Week, Houston, (800) 597-4793, (617) 866-5901, (fax), e-mail: register@cera.com, website: www.cera.com/ceraweek. 12-16.

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✦Pakistan Oil & Gas Conference, Islamabad, (92-21) 6634795, (92-21) 6634795 (fax), website: www.pakoil-gas.com. 18-20.

SPE/IADC Drilling Conference and Exhibition, Amsterdam, (972) 952-9393, (972) 952-9435 (fax), e-mail: spedal@spe.org, website: www.spe.org. 20-22.

AustralAsian Oil Gas Conference and Exhibition, Perth, (704) 365-0041, (704) 365-8426 (fax), e-mail: sarahv@imexmgt.com, website: www.imexmgt.com. 21-23.

Pipe Line Contractors Association Annual Meeting, Aventura, Fla., (214) 969-2700, e-mail: plca@plca.org, website: www.plca.org. 21-25.

International Conference and Exhibition on Geo-Resources in the Middle East and North Africa, Cairo, 00202 3446411, 00202 3448573 (fax), e-mail: alisadek@mailer.eun.eg, website: www.grmena.com.eg. 24-28.

Laurance Reid Gas Conditioning Conference, Norman, Okla., (405) 325-3136, (405) 325-7329 (fax), e-mail: bettyk@ou.edu, website: www.lrgcc.org. 25-28.

CERA East Meets West Executive Conference, Istanbul, (800) 597-4793, (617) 866-5992 (fax), e-mail: register@cera.com, website: www.cera.com. 26-28.

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MARCH

✦Natural Gas Conference, Calgary, Alta., (403) 220-2380, (403) 284-4181 (fax), e-mail: jstaple@ceri.ca, website: www.ceri.ca. 5-6.

Gas Arabia International Conference, Abu Dhabi, +44 (0) 1242 529 090, +44 (0) 1242 060 (fax), e-mail: wra@theenergyexchange.co.uk, website: www.theenergyexchange.co.uk. 5-7.

SPE E&P Environmental and Safety Conference, Galveston, Tex., (972) 952-9393, (972) 952-9435 (fax), e-mail: spedal@spe.org, website: www.spe.org. 5-7.

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Journally Speaking

Gulf of Mexico recycling

Nina M. Rach
Drilling Editor

"Recycle the Gulf" is a comprehensive recycling program that recovers waste from offshore oil and gas operations and shore bases and provides support for the Association of Retarded Citizens (ARC), New Iberia, La.

Several operators (Shell Exploration & Production Co., BP PLC, and BHP Billiton Ltd.) and drilling contractors (Noble Drilling US Inc. and Transocean Inc.) support the program, which reduces landfill volume and provides social benefits to local communities.

In 2006, the fourth full year of the program, these companies have recycled more than 500,000 lb of materials from gulf operations. The three operators together reclaimed about 100,000 lb of recyclables during January-October 2006. The two drilling contractors are recycling on 20 rigs and two shore bases and together reclaimed about 400,000 lb of recyclables January-November 2006.

History

The program began in 2002, spearheaded by Shell and Noble. Transocean and BP joined in 2003.

Shell runs the program on four tension leg platforms in the gulf: Auger, Brutus, Mars, and Ursa, which produced more than 40,000 lb of recyclables during January-October 2006. It has installed recycling equipment on the Cognac platform (Mississippi Canyon Block 194) and may also bring on the Ram Powell TLP (Viosca Knoll Block 956).

BP first implemented the program at two deepwater truss spars: at Horn Mountain field on MC Blocks 126/127 and Holstein field on Green Canyon 645. The company added two recycling points in mid-2006: the Atlantis production semisubmersible (GC 699) and Mad Dog truss spar (GC 782) as well as GlobalSantaFe Corp.'s Development Driller II semisub at yearend.

BP's facilities produced more than 31,000 lb of recyclables in 2006, through September. In 2007, BP plans to begin the recycling program at the semisub producing from the largest field in the gulf—Thunder Horse (MC 776, 777, 778).

BHP started the program on GSF's Development Driller I semisub when it came under contract in July, producing more than 27,000 lb of recyclables in only 5 months. BHP also began sorting and recycling on the GSF C.R. Luigs drillship in November 2006.

Transocean and Noble have implemented the program across their whole fleets. By yearend 2003, all of Transocean's floating rigs in the Gulf of Mexico were participating. They produced 28,132 lb of recycled materials in January 2004. Transocean had 10 rigs (6 semisubs and 4 drillships) operating in the gulf as of December 2006. The company recovered nearly 250,000 lb of recyclables from its rigs and Amelia shore base during the first 11 months last year.

Noble joined the program in 2002 and is currently running the program on its entire gulf fleet of eight floating and two jack up drilling rigs as well as its Bayou Black shore base. Noble recovered more than 156,000 lb of recyclables last year. In 2005, the US Minerals Management Service recognized Tommy Travis at Noble for "outstanding initiative in organizing and implementing one of the first comprehensive recycling programs in the offshore industry."

Recycling

The Recycle the Gulf program has reclaimed about 2 million lb of materials since its inception in 2002. It's a complete recycling program that entails collecting recyclables at the source, removing them from the general waste stream, and sorting them into commodity categories (cans, plastics, paper, cardboard). Recyclables are compacted on the rigs and shipped to dock facilities. Tech Oil Products Inc., based in New Iberia, provides training, equipment, storage facilities, and a handling system (www.enviro-pak.net).

Bags of compacted recyclables are periodically delivered to Tech Oil Products. The company tracks recyclables from each rig so contributions can be reported via a web-accessible database. Green bags are used for recyclables to distinguish them from white bags used for general waste.

Benefits

Recycling reduces pollution, conserves natural resources, conserves energy, decreases the cost of disposing of waste in landfills, and creates jobs.

The Recycle the Gulf program is not only environmentally friendly, it also provides work and funds to the handicapped clients of ARC Unlimited. The recyclable commodities are donated to ARC of Iberia, which processes and resells the materials to a recycling plant.

Tamara Juckett, coordinator of Recycle the Gulf, said the program enables handicapped and disabled people to develop self-reliance by allowing them an employment opportunity that might otherwise be unavailable.

Recycling is only one element of ongoing environmental efforts by the companies involved. We hope to see more environmentally aware operations worldwide. ✦

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Editorial

Restraining government

Governments historically err on energy policy by governing too aggressively, especially on fuel choice. There are two basic reasons for this. Nothing in their nature makes governments better at fuel choice than fuel users are. And because politics dominates their decisions, governments inevitably make fuel decisions that help favored constituencies at the expense of energy consumers. Governments serve public energy interests best by letting markets work and ensuring that they do so freely and fairly, by setting and enforcing reasonable environmental standards, and by otherwise restraining themselves. Congress and the Bush administration should apply this perspective as they assess a late-2006 set of proposals by a group called the Energy Security Leadership Council.

Oil dependence

The council—a group of retired military flag officers, corporate executives, and government leaders—wants to enhance energy security by lowering US dependence on oil. Its agenda is balanced and thoughtful. Unlike most recommendations born of alarm over oil's domination of the energy market and origins in politically unstable regions, the council's prescriptions are not patently antagonistic toward petroleum. They even call for expanded leasing of the Outer Continental Shelf and Arctic National Wildlife Refuge Coastal Plain. The recommendations collapse, however, around a basic flaw. They put government at the core of energy decisions.

They call for strengthened vehicle fuel-efficiency standards, "substantial government incentives" and research spending for biofuels, mandates that vehicles be able to burn 85:15 ethanol-gasoline blends, and tax credits to help "family-owned service stations" install fuel tanks and pumps able to store and dispense ethanol. They include new government support for use of biomass as petrochemical feedstocks and for enhanced oil recovery. They urge "significant financial incentives" for domestic manufacture and use of "highly fuel-efficient vehicles." They seek a review of US and International Energy Agency policies on strategic oil stocks. Programs like these aren't cheap. Funding can come only from taxpayers and energy consumers. If the programs have merit, the market will support them. So why raise public spending and fuel costs?

The council apparently doesn't trust markets. One of its principles states: "Pure market economics will never solve this problem" of oil dependence. Then this: "Government intervention is necessary." In the cover letter conveying its recommendations "to the President, the Congress, and the American People," the council further reveals its orientation by asserting, "For more than 2 decades, federal energy policy has been afflicted by paralysis." That, of course, would be the period of oil and gas markets free of price controls.

The council's analysis looks back fondly at imposition of corporate average fuel economy (CAFE) standards in the mid-1970s, for example, yet ignores the coincident phaseout of oil price and allocation controls. It thus repeats the common mistake of attributing vehicle fuel-efficiency gains of the period wholly to government energy-use controls and ignoring market effects. Airline and air courier executives on the council's board should know better. Aircraft manufacturers greatly improved the efficiency of jet engines in the 1980s without CAFE-type regulation. They did so in response to the commercial pressures exerted by elevated jet-fuel prices. "Pure market economics" does indeed solve problems. It solves them better than government interventions do.

Splendid era

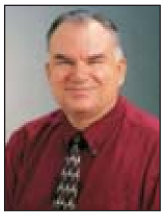
The quarter-century since oil-price deregulation has been a splendid era for energy consumers, an era of ample supply and low average prices. Even at recently elevated levels, oil and gas prices are—dare anyone say so?—affordable for most consumers.

The council frets that during the low-price years US dependence on imported oil rose and that vulnerabilities appeared in the global distribution system. Both observations are valid. But so are the observations, which the council failed to make, that oil trading is now much more flexible than it used to be and therefore better able to handle disruption, that large producers able to influence marginal supply fear demand destruction at least as much as they do low price, and that interdependencies between buyers and sellers provide a large measure of security that receives too little notice.

The US has energy problems. But too little intervention by government isn't one of them. ✦

Exploration & Development: New thinking confronts the 'brain drain'

Alan Petzet
Chief Editor-Exploration



Expect 2007 to be a strong year for exploration and development worldwide.

Among the challenges: Discovering economic oil and gas fields, profitably developing existing discoveries, tapping technology to improve exploration and recovery economics, contending with the so-called brain drain in the geosciences, and dealing with the rise of national oil companies. Some explorers believe most discoveries will come in areas previously off-limits to exploration. Others believe they will occur in areas already drilled and written off for sound reasons. These finds, they say, will be the product of new exploration thinking.

The size of the resource base seems to be the least of problems. The world target is estimated at 3-4 trillion bbl of conventional and nonconventional oil.

The challenge, said ExxonMobil Corp., is to combine investment, technology, and public policy in a way that enables companies to successfully explore for and produce those supplies and deliver them to market efficiently. The effort requires the participation of industry, government, and consumers.

The International Energy Agency estimated that the industry needs to invest more than $200 billion/year through 2030 to meet demand, and Lehman Bros. Inc. has projected 2007 exploration and production spending worldwide at $292 billion (see story, p. 25).

Geophysical contractors foresee further hikes in exploration outlays. Demand for seismic surveys already exceeds capacity, especially offshore. Some companies report record backlogs.

Late-year surveys showed that many large and small oil and gas companies plan to moderate capital and exploration spending in 2007. Some overspent their 2006 budgets by a margin larger than the capital spending increase they plan in 2007.

The vast majority of E&P companies say drilling economics is better than acquisition economics, but most of them still plan to purchase reserves when the price is right.

Giant oil fields are still being discovered—but not as many as in earlier decades. The more recently discovered giant fields have not been as large on average as those found in earlier years, and their peak production rates are therefore not as great.

Nevertheless, one industry database contains information on more than 2,000 undeveloped oil and gas discoveries worldwide. Many are small or remote, but

About this report

In this look ahead at a new year, Oil & Gas Journal's specialist editors examine strong and immediate trends in the operating areas they cover. Among the topics: a brain drain in the exploration and development disciplines, smart wells and increasingly powerful rigs in the world of drilling and production, refining capacity deficiencies and a looming LPG surplus in the processing industries, and benefits to the industry of growing attention to pipeline integrity.

they have a better chance for development with the innovative production schemes being applied in recent years.

The high oil and gas prices that stimulate so much exploration also aggravate the brain drain. Among other things, high prices prompt experienced geoscientists to resign positions in established companies to set up their own businesses, often in oil and gas E&P.

"Within BP," said Tony Meggs, the company's group vice-president, technology, "most of our younger staff has been attracted to the company because of our stand on the environment—and they hold our feet to the fire if it ever looks as though we are failing to live up to those commitments."

The exploratory effort has little to do with the political goal of energy independence, argues Chevron Corp. Chairman David O'Reilly, who pointed out recently that not one of the world's 193 countries is energy-independent. He said government policies that focus on independence are counterproductive because they create demand uncertainty and discourage producing countries from making the investments needed to supply markets.

International oil companies plan large capital and exploration spending increases in 2007 even as oil and gas operators in general look toward spending a larger share of their budgets outside the US.

The trend will intensify concerns about corruption and security. ✦

Drilling & Production: Powerful new rigs drill in tough conditions

Nina M. Rach
Drilling Editor

The drilling industry this year will use newer, more-efficient, and more-powerful rigs and tools to test new plays and develop reserves in challenging environments such as arctic conditions and deep, high-temperature, high-pressure regimes. Service companies and academia will continue to develop new ideas and technologies to support operators' programs.

Rig fleets are growing and gaining in quality worldwide with mostly incremental improvements. Interesting new designs in conventional and coiled-tubing land rigs will continue to appear.

Rig renovation programs are even more prevalent than the newbuilds being touted; almost all will encompass new automated systems that make the drilling workplace safer and more environment-friendly. Zero-discharge equipment is being slimmed down.

Tool development to drill in high-pressure and high-temperature environments is under way, and a 20,000 psi BOP soon may be proved commercial.

Operators are testing the depth and reach limits of existing equipment, especially on Sakhalin Island in Russia and in Alaska.

Mooring systems are changing. There are new requirements for additional mooring lines in the Gulf of Mexico following the 2004-05 hurricanes and damage from wayward rigs. Brazil has already implemented a dynamic positioning-only regime to protect its subsea equipment. The use of dynamically positioned floaters in US waters might expand.

The gulf continues to be the hotbed for floater technology, featuring spars, tension-leg platforms, and production semisubmersibles. Petrobras's commitment in 2006 to try Sevan Drilling's pioneering SSP (Sevan stabilized platform) floater design suggests that some operators are comfortable enough in other regions to directly adopt innovative technologies.

Beyond technology, joint drilling ventures between national oil companies (NOCs) and international operators will continue to expand. For example, Saudi Aramco's 5-year plan to add 50 tcf of gas reserves involves four ventures with non-Saudi companies:

- Sino Saudi Gas, working with Sinopec.
- South Rub Al-Khali Co., with Royal Dutch Shell.
- Luksar, with Lukoil.
- Enirepsa, with Eni SPA and Repsol YPF.

The foreign operators will drill 300 development wells and more than 70 exploratory and delineation wells. In 2006, Saudi Aramco announced deployment of its 100th rig, and the new plan will undoubtedly require additional rigs.

Among other partnerships involving NOCs, National Iranian Oil Co. is working with Austria's OMV on the Mehr Block and with Norsk Hydro on the Anaran Block.

In northern Iraq's Kurdistan region, Turkey's Genel Enerji and Canada's Addax Petroleum have started a three-well drilling program.

In Asia, China's CNOOC Ltd. and PetroVietnam have agreed to joint exploration in disputed waters of the South China Sea. They will drill the first wildcats late in 2007 after reprocessing existing data and shooting a 3D seismic survey in the Beibu Gulf.

And Petrochina is looking for partners to tackle problems in Luojiazhai gas field, Sichuan Province.

In Venezuela, most foreign operators have agreed to modified contracts that give controlling shares to Petroleos de Venezuela SA, allowing activity to resume.

In another business trend likely to continue this year, a flush of profits and the desire to secure access to rigs are encouraging acquisitions among drilling contractors. Norway's Seadrill, which has already acquired privately held Smedvig, Ocean Rig, and Eastern Drilling, has recently raised enough capital for another buying spree and might target a US contractor.

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Norway's Awilco Offshore is buying OffRig Drilling.

And Russian service company Integra is taking over driller Prikaspiyburneft, with land fleets active in Russia and Kazakhstan.

In the US, meanwhile, interesting new plays are being tested. Contractors are using new or renovated land rigs with enhanced capabilities, working with smaller crews. Large and small operators and contractors have been investing in the Rockies. Wood Mackenzie forecasts that more than 43,000 wells will be drilled in the Rockies over the coming 4 years, representing a $25 billion investment. Analysts predict that 130 tcf of gas reserves might be proved in the Rockies by 2030.

In the Gulf of Mexico, small companies continue to drill the Miocene in shallow waters, and the stable regulatory environment attracts foreign operators. An emerging emphasis on the Lower Tertiary trend in deep water, requiring floaters capable of drilling beyond 30,000 ft, has the industry's attention. GlobalSantaFe has extended commitments for the Development Driller I and the CR Luigs drillships to BHP Billiton.

And off Alaska, seismic data acquired recently in the Beaufort Sea in 2006 will lead to more drilling in 2007. Shell has been bringing rigs to the area and will drill this year. ✦

Drilling & Production: Smart wells, 'e-fields' shaping production plans

Guntis Moritis
Production Editor

Technology remains key to how fast and how much of the world's remaining oil and gas resources the industry can produce economically from the varied environments that hold most potential: deep water, arctic regions, coalbeds, partially depleted reservoirs, and deep, tight formations with high temperature and pressure, as well as formations containing heavy oil or bitumen.

The industry has an assortment of technologies at hand or under development, but applying the technology to any given situation is seldom clear-cut. For new technologies, a lag time, often lasting years, still exists for wide use. But high oil and gas prices combined with cost pressures provide incentives for their use. New technologies may cost more than traditional methods initially but can reduce costs over a project's life. In many cases they provide the only means for accessing remaining resources.

Technologies gaining acceptance include smart or intelligent well completions, expandable tubulars, and multiphase pumps and meters. Development and testing continue for subsea processing and compression.

In 2007, King oil field will become the site of the first installation of deepwater twin-screw subsea boosting pumps in the Gulf of Mexico. The field lies in more than 5,000 ft of water.

The industry is working toward more remote control of producing fields under various labels such as "fields of the future" and "e-fields." Software and control equipment are evolving as greater communication bandwidth becomes available. One example is BP America Inc.'s plan to link seven of its Gulf of Mexico fields with an 800-mile undersea fiberoptic system.

BP says this system will provide continuous broadband connectivity to its offshore oil and gas facilities, enhancing operating flexibility and allowing safer production for longer periods when hurricanes enter the gulf. The system also will shorten the time for returning facilities to production after storms pass.

The industry also has heightened its interest in enhanced oil recovery projects. These projects include steam, gas such as carbon dioxide, and chemical injection. Much of the EOR technology exists, but the additional costs of these processes compel the industry to look at ways to optimize their use.

The worldwide allure of sequestering CO_2 emissions also is raising interest in enhancing oil production though CO_2 injection. Fields supplying CO_2 for EOR in the Permian basin of West Texas and New Mexico are at capacity. Investments in additional capacity are being made. There also is talk in the industry about obtaining CO_2 for the Permian basin and elsewhere in the world from other sources such as new integrated gasification combined-cycle power plants.

Unconventional resources continue to attract attention, including gas hydrates and oil shale. The industry is testing various processes to recover these vast resources.

A recent paper discussed laboratory experiments that showed CO_2 injected at high pressure and low temperature into porous sandstone would spontaneously displace methane from naturally occurring gas hydrate. If proved in the field, the process would sequester CO_2 while producing methane, while the water would remain in hydrate form. Field tests of this and other processes for producing methane from hydrates will take place in 2007.

Field tests also continue for removing hydrocarbons from oil shales in various countries. Several companies with in situ tests in the Piceance basin in Colorado say their tests show promise, although commercialization is several years away.

In one Colorado test, Shell Frontier Oil & Gas Inc. uses downhole electric heaters to heat the oil shale to convert organic matter in the shale to oil and hydrocarbon gas. The test features an innovative freeze wall system to prevent groundwater from entering the test area. ✦

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Processing: Refining focus swings from clean fuels to adding capacity

David N. Nakamura
Refining/Petrochemical Editor

Refiners throughout the world will turn their focus in 2007 to expanding crude distillation capacity and expanding the use of renewable fuels. Last year, refiners, especially in the US, concentrated their efforts and capital spending on units for the production of clean fuels.

Any free capital will now go into projects to expand distillation capacity or to add coking or hydrocracking capacity, which will allow refiners to run heavier and less-expensive crudes.

Outside the US, refiners will be concerned with maintaining enough production to keep up with demand, which is growing very quickly in some regions, especially China and India. Other areas, such as the Middle East, are adding capacity to export gasoline and other products.

For the third year running, refiners enjoyed healthy margins in 2006. There is no reason for this to change in 2007 because the supply-demand balance for refined products should again be very tight. Refiners added very little net capacity in 2006, as OGJ reported in its recent Worldwide Refining Survey (OGJ, Dec. 18, 2006, p. 56).

The survey showed only 52,000 b/cd of additional capacity. And for the second year in a row, no grassroots distillation capacity started up. All of the new capacity was due to expansions of existing facilities.

Product demand is expected to continue to outpace capacity growth for the immediate future. The only short-term solutions will be for refiners to raise utilization rates, which already are historically high, or use lighter, more expensive crudes to produce more gasoline.

Because of this tightness, any disruption in the refining industry could produce very high gasoline or diesel prices, or actual short-term shortages. In 2006, no major hurricanes hit the US Gulf Coast, although the area is thought to be in an active hurricane phase.

By 2010, the US should add about 1.1 million b/d of crude distillation capacity. This year, however, little additional capacity is slated to start up.

In June 2006 or earlier, nearly all US refiners started producing ultralow-sulfur diesel, which can contain no more than 15 ppm sulfur at the point of retail sale. Terminals had ULSD by Sept. 1 and retailers by Oct. 15.

Concerns remain that the new emission-control technology in large diesel engines will not tolerate the 500-ppm low-sulfur diesel remaining in the market, so any upsets in the fuel-supply system could damage the trucking industry.

Most pipelines require ULSD at 8 ppm sulfur at the refinery gate, a standard most refiners can meet. But consistent diesel-price strength relative to gasoline indicates a market straining for supply.

Compounding the effects of ULSD implementation is the fact that refiners now must add ethanol to gasoline. In 2006, US refiners were required to use 4 billion gal of the renewable fuel. In 2007, the amount rises to 4.7 billion gal.

Demand for ethanol currently exceeds capacity to produce the fuel, requiring substantial levels of imports. Recently, ethanol spot prices hit a 3-month high of $2.50/gal, which is 80¢/gal more than wholesale gasoline. During the summer of 2006, spot prices hit $3.35/gal for ethanol. According to analysts at Friedman, Billings, Ramsey & Co., imports are economic above $2.35/gal.

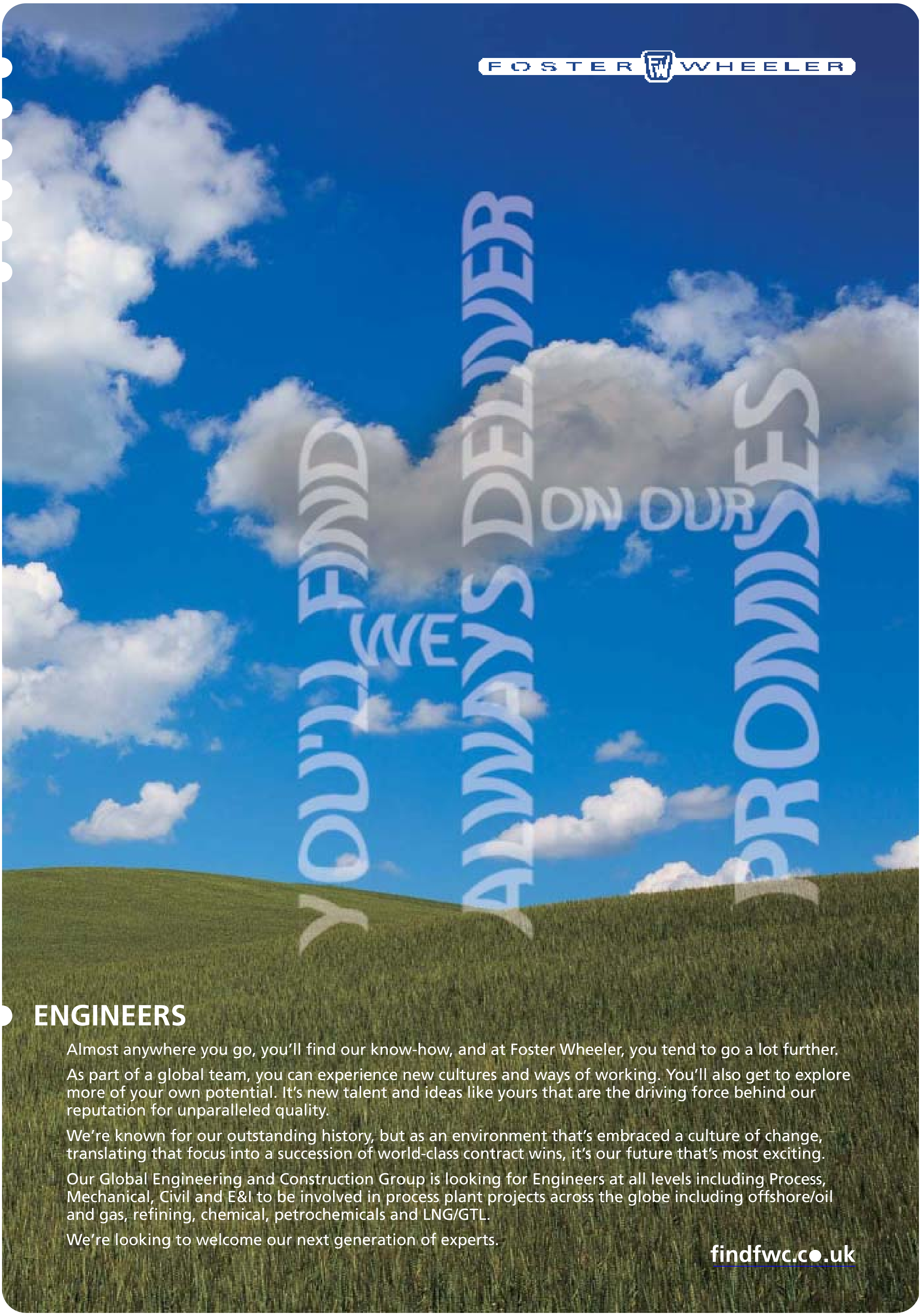
Because ethanol is not transportable with gasoline via pipeline, as was the previously used oxygenate, methyl tertiary butyl ether, refiners must use different methods to move it to terminals. Instead of pipelines, suppliers use trucks and railway cars—trucks that are required to use ULSD. A shortage of ULSD, therefore, has the potential to decrease ethanol deliveries. And because gasoline made for ethanol blending is unusable by itself, any such diesel disruption would become a problem for gasoline supply as well. ✦

Processing: LPG surplus developing in association with LNG supply jump

Warren R. True
Chief Technology Editor-LNG/Gas Processing

Production of LPG—the world's most widely traded NGL—is on the rise everywhere but in North America. That growth is partially tied to an anticipated jump in 2007 in the world's LNG production capacities.

As 2007 gets under way, the outlook for LPG is characterized by high prices and plentiful supply. The consultancy Purvin & Gertz, Houston, in late 2006 said the LPG market has moved in the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last 2 years from being demand-driven to being supply-driven.

Globally high crude oil and natural gas prices are supporting equally high LPG prices. This condition has increased production while dampening demand, especially in developing markets. Middle East production and exports are increasing, moving the global market toward an LPG surplus. In fact, the surplus looks set to expand as several new LPG projects are on the horizon.

Among recent LPG market developments has been a slowing of growth in developing markets. Chinese and Indian markets in particular have begun to level out, a trend Purvin & Gertz believes might be temporary. As witnessed only a few months ago in US NGL storage numbers, summertime surplus has increased.

Volumes in excess of demand, however, do not result from US gas plant or refinery production. Indeed, Purvin & Gertz notes that for 3 consecutive years, US waterborne LPG imports have set records, drawing even Middle East LPG back to the US Gulf of Mexico.

High prices notwithstanding, US LPG production has lagged behind historical levels, at least since 2002, according to Petral Worldwide Inc. (OGJ, Nov. 6, 2006, p. 52).

Focusing on the concept of "full recovery" in US propane production, Petral notes that it has not averaged 900,000 b/d or more since mid-2002 and that by third-quarter, estimated propane production had reached only 805,000-815,000 b/d.

The implications seem clear: The US will import yet more propane along with other liquid hydrocarbons as its natural gas and gas liquids production continues to decline. More broadly, however, the world is fast becoming awash in LPG; Purvin & Gertz says LPG production is increasing in every part of the world except North America.

Expansion of LPG supply worldwide has roots in growth of the global LNG industry. Purvin & Gertz says LPG supply projects are emerging in association with new liquefaction plants.

The timing of the numerous LNG projects, says the consultancy, will greatly affect LPG and natural gas markets over the next 5 years.

That a long-anticipated expansion in LNG supply is in progress seems clear from a look at plant and terminal data compiled by OGJ and GTI, Des Plaines, Ill., and shipping data from EA Gibson Shipbrokers Ltd., London.

Over the next 2 years, industry is poised to start up nearly 50 million tonnes/year (tpy) of liquefaction capacity, commission more than 14 million cu m of LNG shipping capacity among more than 90 vessels, and begin operating nearly 90 million tpy of regasification capacity.

In 2007, slightly more than 22.5 million tpy of liquefaction capacity is to start up. Headlining this surge will be the long-delayed Snøhvit project, the first LNG export project north of the Arctic Circle; Nigeria LNG's Train 6; Equatorial Guinea; and Train 5 of RasGas.

In 2007, as many as 35 LNG carriers will be commissioned at an average capacity of more than 141,000 cu m. This year will also see the world's first 200,000-cu m LNG carrier when Daewoo's hull No. 2245 (210,000 cu m) launches in July. It's headed for Qatar-UK trade.

New regasification capacity in 2007 will exceed 30 million tpy. Excelerate Energy's Teesside Gas Port will take its first cargo in mid-January, followed later in the year by both Milford Haven terminals in Wales. Another Spanish terminal (Reganosa) starts up this year. ✦

Transportation: Integrity management to remain top pipeline concern in 2007

Christopher E. Smith
Pipeline Editor

Integrity management will stay at the forefront of pipeline operators' agendas in 2007. Additional capacity will still be sought. New projects will be announced and expansions planned. But the pursuit of growth will itself hinge increasingly on the ability to demonstrate sound integrity management.

Pipeline projects have long been greeted with suspicion or mistrust by the communities they affect. Concern and public awareness increased after BP's early August discovery of "unexpectedly severe corrosion" in its Alaskan pipeline system. The discovery resulted from stepped-up inspection following a Mar. 2 crude oil spill of 200,000 gal on another segment of BP-operated pipeline on Alaska's North Slope.

It is the unexpected nature of this corrosion that has led to public questioning, editorials, and regulatory investigation about not only BP's problems but also pipeline safety in general. Pipeline operators thus will spend much time and energy reexamining their systems in 2007, strengthening and codifying their integrity-management programs, and making the results of these efforts public.

The effort will produce at least two benefits: 1) assurance of the current and future integrity of existing systems and 2) the public and political goodwill necessary to expand capacity. In the first instance, the issue is one of spending money now on inspection, monitoring, and administration or spending it later on repairs, remediation, and possibly litigation. The expenses involved in the second instance, stemming from the costs of extending project timelines, are no less concrete. Companies offering assessment, monitoring, and mitigation products and services to pipeline operators have already seen an upswing in their business.

Although paying for these services on systems that seem to have nothing wrong might compromise immediate financial results, the increased pipeline-integrity activity shows that many operators are taking a longer-term view.

A new and politically reoriented US Congress soon will convene. The previous session renewed and expanded the Pipeline Safety Improvement Act based at least in part on gas pipeline operating companies' testimony that "the primary benefit of the program is the comprehensive knowledge [we] must acquire about the condition of [our] pipelines" and that "for some operators, the [legislation's] integrity-management program [had] prompted such assessments for the first time." Annually reported pipeline incidents in the US are declining. An increased focus on integrity management in the year ahead will extend this trend and keep individual companies from facing surprises like those encountered by BP in 2006. ✦

Lehman Bros.: E&P spending to see slower growth

After "extremely strong growths" of 20% in 2005 and 30% in 2006, global exploration and production spending is expected to rise at a slower rate of 9% to $300 billion in 2007, with more emphasis on international rather than US projects, said analysts at Lehman Bros. Inc., New York.

That's based on the company's latest E&P Spending Survey of some 300 public, private, and government-owned oil and gas companies, "the largest ever" such study since Lehman Bros. began the semiannual surveys in 1982, said James Crandell, oil service analyst at the firm.

Price determinants

Natural gas prices are still the key determinant for E&P spending in 2007, followed by cash flow, prospect availability, oil prices, and drilling costs, said Angeline M. Sedita, contract drilling analyst at Lehman Bros.

E&P budgets for 2007 are based on commodity price assumptions of $55.50/bbl for crude and $6.70/Mcf for gas. "Importantly, the average price where the companies would reduce E&P budgets is about $42/bbl for oil and $4.80/Mcf for natural gas," Sedita said. "In the event of a decline to an average price of $50/bbl, just 26% said they would cut spending. At an average gas price of $5.50-6/Mcf, 35% of the companies said they would reduce spending."

She said, "There still is some concern about rig availability, although less than last year, with 60% of the companies surveyed saying they're concerned about rig availability. This compared with 85% a year ago, as more land rigs have entered the market." Drilling costs are expected to be up modestly in 2007, but at a slower pace than in 2005-06.

"Survey results indicate the long-term up-cycle in worldwide exploration expenditures and drilling activity, currently in its fifth year, is very much intact but with some important changes," Crandell said in a Dec. 11 telephone conference with financial analysts.

Among those changes is a new choice for the most important technology for E&P companies. "For years 3D and 4D seismic was viewed as the most important technology. But this year, fracturing and stimulation technology took the No. 1 spot as unconventional gas drilling increased in the US," Sedita said.

"Interestingly, 75% of the companies view international exploration and production to be good or excellent. About 65% see the US as good or excellent. But only 50% see the economics as good or excellent in Canada," said Sedita. "Still an overwhelming percentage of the companies in all regions believe the economics of drilling are more favorable than purchasing reserves. However, 55% of the companies are still actively seeking to purchase new reserves."

She said 75% of the surveyed companies expect to spend equal or less than their cash flow in 2007. In the previous survey, 33% of the companies expected to spend more than their cash flow on E&P in 2006, while nearly 50% said they would spend less. An "overwhelming percentage" of the companies plan on spending a greater percentage of their offshore budget in deep water, Lehman Bros. reported.

International spending

The surveyed companies said they plan to increase their international E&P spending by 13% to $200 billion in 2007, after a 28% growth in 2006. US spending will grow by 5.1% to $75 billion in 2007, following a 40% boost in 2006.

Canadian spending will be down 8% next year, however, compared with a 19% increase in 2006. "Deteriorating economics are more pronounced in Canada," Crandell said. He also noted "the impact of Anadarko [Petroleum Corp.] leaving the region" and "relatively large declines" in the operations of other large companies such as Apache Corp.

Canadian Natural Resources Ltd. recently agreed to buy Anadarko Canada Corp. for $4.24 billion, but Anadarko maintains interests in the Mackenzie Delta and other Canadian arctic frontier properties (OGJ Online, Sept. 14, 2006). In 2005 Apache and ExxonMobil Corp. completed a series of agreements for transfers and joint ventures across a broad range of properties in Western Canada, the Permian basin, Louisiana, and the Gulf of Mexico Outer Continental Shelf.

Companies significantly overspent their budgets in 2006, particularly on international projects, where 60% of the surveyed companies said they spent more than 10% over their original E&P budgets.

National oil companies will lead the 2007 increase in international spending with the largest spending growth among the Russian oil companies, Crandell said. The five largest Russian companies are expected to hike their international spending by an average of 42% to $24.3 billion, he said.

Other companies estimated to have double-digit gains in international E&P spending include: Chevron Corp., up 34%; Apache, up 20%, India's state-owned Oil & Natural Gas Corp. and Petroleos Mexicanos, up 11% each; Petroleo Brasileiro SA (Petrobras), up 18%; Repsol YPF SA, up 19%; Woodside Petroleum Ltd., up 62%, PetroChina Co. Ltd., Statoil ASA, and Royal Dutch Shell PLC, each up 10%.

However, several other companies are moderating those international gains with "either small declines or small increases," Crandell said. Among those are: Anadarko, flat; BHP Billiton Ltd., up 4%; BP PLC, down 2%; ConocoPhillips, up 5%; ExxonMobil, up 7%; Eni SPA, up 8%; Petroleos de Venezuela SA, up 1%; and Total SA, up 7%.

US spending

The surveyed companies plan a substantial slowdown in the growth rate of their US E&P expenditures in 2007 due to concerns about cash flow and a perception of lower gas prices. Companies responding to the survey said their plans are based on an average gas price of $6.72/Mcf in 2007, "and that's going to increase concern regarding project economics," Crandell said.

Repsol YPF, Eni, Murphy Oil Corp., and Quicksilver Resources Inc. will be making some of the larger cuts in US E&P spending, he said. Other companies indicating "above-average declines" in US spending include Anadarko, Cabot Oil & Gas, Marathon Oil Corp., Newfield Exploration Co., and Plains Exploration & Production Co.

Drilling economics are seen as attractive in the industry; but the percentage is down from last year, said Lehman Bros. analysts. "For the long term, E&P companies were very positive on the outlook for oil and natural gas. Over half view the long-term real price of oil at $50-70/bbl, with half expecting the price to be $50-60/bbl for the long term and half expecting crude to be $60-70/bbl. Companies also are overwhelmingly bullish on natural gas with roughly 85% of respondents saying long-term outlook for natural gas drilling is good or excellent," Sedita said. ✦

FACTS forecasts two gas-price convergence trends

Natural gas prices are converging upward, both in conjunction with rising oil prices and across global gas markets, according to a study of gas trends by Fesharaki Associates Consulting & Technical Services Inc. (FACTS), Honolulu.

"Both trends are unique and define for us a whole new world," FACTS said. "Most buyers and sellers have not yet grasped the implications of these two trends." The study, "Globalization of Gas Prices: When Will It Become a Reality in the East?" was released during the early December Gastech meeting in Abu Dhabi.

Analysts forecast a long-term Henry Hub price of $7-9/MMbtu. Their forecasts point toward "irreversible" higher oil prices worldwide. "We will [still] have cycles, but from a higher price base," the analysts reported.

FACTS analysts expect oil prices could drop slightly during 2007 with an anticipated brief supply boost from outside the Organization of Petroleum Exporting Countries. But long-term oil prices are expected to increase to a level that curbs demand growth.

"What is that price? We feel that real prices have to rise by anywhere from 50-100% (base price of $80/bbl for Dubai crude and $85/bbl for West Texas Intermediate) on the back of moderate economic growth before demand is curbed by much more efficient use and new technologies that will reduce the dependency on oil," FACTS said.

Analysts foresee oil price equilibrium at $60/bbl for Dubai crude. Due to fuel switching, gas prices are bound to rise as well, although they are capped by competition from coal and nuclear power.

Meanwhile, LNG prices will be driven by high construction costs, the reentry of the US into the LNG market, shortfalls of contracted Indonesian LNG supplies, and Qatar's becoming the world's biggest LNG supplier.

"The Qataris know they hold most of the cards in the near term and intend to take advantage of it—asking for higher prices and diverting cargoes to the highest-paying markets—paving the way to become the price setter in the world LNG scene," FACTS said.

Price thresholds

For years, UK gas prices were the lowest, followed by US and European prices, while Asia had the highest gas prices. In 2005, US and European prices converged at higher levels, leaving Asian prices behind.

In 2006, a new trend emerged, with US and UK gas prices converging. Meanwhile, Asian prices have resumed their threshold above US and UK prices.

"With a real linkage in markets, new spot markers in the Atlantic Basin have emerged as the reference price in the East," FACTS reported. Traders rely upon US and UK gas prices as a reference price for Asian and Middle Eastern LNG spot prices.

The Asian LNG market is experiencing increased tightness. Middle East producers can send cargoes to both the

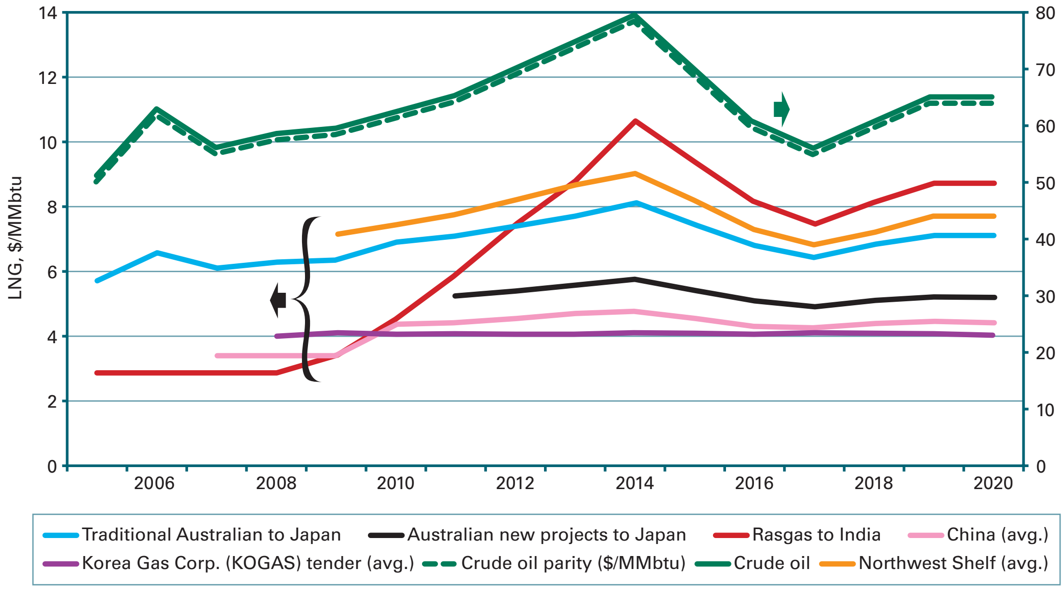
Atlantic Basin and the Asia-Pacific region. New Asia-Pacific supplies can move within Asia and to the US West Coast.

Consequently, suppliers are likely to ask for prices that compete, or more likely exceed the prices they could obtain in the highest-paying market, "be it the Asia Pacific, Europe, or the US," FACTS said. "This essentially means a connection of markets despite the disparate location of the sellers. It also signals a fundamental shift in the global gas markets in both pricing and trade flows."

Asian buyers are negotiating with Qatar for long-term diversions to Asia of western volumes. FACTS questions how much volume initially targeted for western markets can be redirected to the East. South Korea and Japan, both short of supply, are negotiating for additional Middle East supplies.

Total diversions could reach 15-20 million tonnes by 2012 for Japan, South Korea, and Taiwan, but more volumes could be diverted to China and India if international prices are paid, FACTS said.

PROJECTED ASIAN LNG PRICES*



*Delivered ex ship: Seller responsible for transportation.
Source: FACTS Inc.

Tight supply

FACTS analysts believe gas consumers in Japan, South Korea, Taiwan, and the US will have no choice but to pay $7-9/MMbtu or higher.

"Some Asian countries are being asked to pay $8-12/MMbtu today to divert volumes from the West to the East. Can the Chinese and Indian consumers pay such prices? Can fertilizer producers pay such prices? The answer is highly uncertain," FACTS said.

Given limited supply, new buyers seeking near-term gas supply will face high prices.

"With the exception of Qatar, the Middle Eastern suppliers are all booked. In the Asia Pacific, the realistic potential suppliers by 2015 are: Russia's Sakhalin-2 (Train 3), Indonesia's Tangguh (Train 3), Australia's Northwest Shelf, Gorgon, Pluto, Scarborough, and Browse basin," FACTS said.

LNG buyers probably will resist making long-term commitments at high prices, but they will have to come to terms with that, FACTS analysts forecast. ✦

New group to develop energy policy recommendations

Nick Snow
Washington Correspondent

Energy consumers and producers, including six oil and gas trade associations, have formed what former US Sen. John Breaux (D-La.) termed "a coalition of coalitions" to develop national energy policy recommendations.

Called the Energy Initiative, the group intends to examine all aspects of energy, including global climate change, organizers told reporters at a Dec. 15 briefing.

"Only when you bring all sides together with a legitimate balance discussion can you solve problems America faces. Energy clearly is one of those problems," said Breaux, who cochairs the EI with Beverly O'Neill, a former mayor of Long Beach, Calif., and former president of the National Council of Mayors.

O'Neill added, "We have to address this issue head-on. The cities of the United States have taken it on to determine what can be done locally, and their efforts are important. But a guiding national concept is needed."

Following the briefing, representatives of the 9 producing and 22 consuming organizations met in three committees addressing transportation, stationary energy consumers, and conservation and efficiency.

"This coalition is a unique endeavor,

A look back at 2006

"Fast away, the old year passes.... Hail the new, ye lads and lasses!" But before saying goodbye to 2006, a look back at the year's more remarkable moments in US oil and gas politics seems apt.

Several moments were amusing. A few were significant. All hereby receive a "Watchy," the annual award introduced in this column a year ago (OGJ, Jan. 2, 2006, p. 29). Recipients include the following...

US President George W. Bush, who in his annual State of the Union address on Jan. 31, earned a "Bully Pulpit" Watchy when he said, "America is addicted to oil, which is often imported from unstable parts of the world. The best way to break this addiction is through technology." The accompanying switch in federal emphasis from conventional to alternative energy research and development accelerated a process that was under way. But it also runs a risk of not funding, and finding, new ways to recover more domestic oil and gas.

Next, an "Uh, oh! My bad!" Watchy goes to unnamed bureaucrats in the US Minerals Management Service who omitted price thresholds from those deepwater Gulf of Mexico leases in 1998 and 1999. If anyone tries to collect the award, we'll immediately notify MMS Director Johnnie Burton, who probably would like to thank them personally.

On a lighter note

A "Lead Balloon" Watchy goes to Senate Republicans for responding to rising retail gasoline prices on Apr. 27 with a bill to provide motorists a $100 tax rebate. "Consumers are feeling pain at the pump and Republicans are moving aggressively to address their concerns," Majority Leader William H. Frist (R-Tenn.) said. They moved even more aggressively away from the idea when voters responded with howls of laughter.

Rep. Devin Nunes (R-Calif.) receives a "Tell It Like It Is" Watchy for calling the Arctic National Wildlife Refuge's coastal plain "a barren slope" during the final hour of House floor debate on a bill to open the area to oil and gas leasing on May 25. It was a refreshing contrast to ANWR leasing opponents' characterizations of all parts of the refuge as a pristine national treasure to be preserved for future generations.

A "Stop the Presses!" Watchy goes to the 109th Congress's Joint Economic Committee for concluding in an Oct. 31 report that the Organization of Petroleum Exporting Countries has been trying to manipulate world oil prices.

Last, but not least

Finally, a "Never say die!" Watchy goes to Louisiana's congressional delegation for its eventually successful struggle to get immediately adjacent coastal states a share of federal offshore royalties.

Louisiana has said it will spend the money for coastal restoration and hurricane protection. But the provision's inclusion in the final bill also establishes a precedent for other coastal states reconsidering whether to allow oil and gas activity off their shorelines. ✦

which is what is needed to move things forward," said American Petroleum Institute Pres. Red Cavaney. He noted that API is aware of a general public lack of understanding regarding energy production, particularly oil and gas, and expressed hope that the EI could help improve the situation.

EI will develop broad recommendations, which Breaux hopes to deliver to the administration of President George W. Bush and the 110th Congress by mid-2007. "I don't think we will be responding to specific legislation or issues," he said.

Donald F. Santa, president of the Interstate Natural Gas Association of America, said that the time is ripe to address wider energy questions. "All too frequently, when it comes to specific energy projects—whether a wind turbine, a pipeline or [an LNG] terminal—citizens and their elected officials adopt a not-in-my-backyard, don't-build-it-here mentality," he observed.

The Association of Oil Pipe Lines, Domestic Petroleum Council, Independent Petroleum Association of America, and National Ocean Industries Association also are participating.

Environmental organizations are represented through the Apollo Alliance, a coalition of labor and organizations and environmental groups, including the Sierra Club and National Wildlife Federation. Most US environmental groups want the US to diversify its energy sources beyond oil, gas, and other fossil fuels, and the group will present that view, according to the alliance's Pres. Jerome Ringo.

Breaux said he expects global climate change to be a major part of EI's deliberations. "I don't think you can address energy now without it. The changes in the new Congress suggest that there will be climate change discussions there. We would like to be part of that," he said.

O'Neill said she hoped EI could produce worthwhile recommendations for a national energy strategy. "For a decade now, states and organizations have formulated energy policies, but the federal government has provided no guiding policy," she said. ✦

Statoil, Norsk Hydro to merge in $30 billion deal

The boards of Norway's Statoil ASA and Norsk Hydro ASA have agreed to merge their oil and gas operations in a deal valued at about $30 billion, creating the world's largest offshore operator.

In other recent company news:

- OAO Gazprom signed a protocol with Royal Dutch Shell PLC, Mitsui & Co. Ltd., and Mitsubishi Corp. to bring Gazprom into the Sakhalin Energy Investment Co. Ltd. (SEIC) as the leading shareholder. Gazprom will acquire a 50% stake plus one share in SEIC for $7.45 billion. The announcement was expected (OGJ Online, Dec. 12, 2006).
- TransCanada Corp. plans to acquire ANR Pipeline Co. and ANR Storage Co. and an additional 3.55% interest in Great Lakes Gas Transmission Ltd. Partnership from El Paso Corp.
- EXCO Resources Inc., Dallas, has agreed to acquire Anadarko Petroleum Corp.'s oil and natural gas producing properties, acreage, and other assets in Vernon and Ansley fields in Jackson Parish, La., for $1.6 billion.

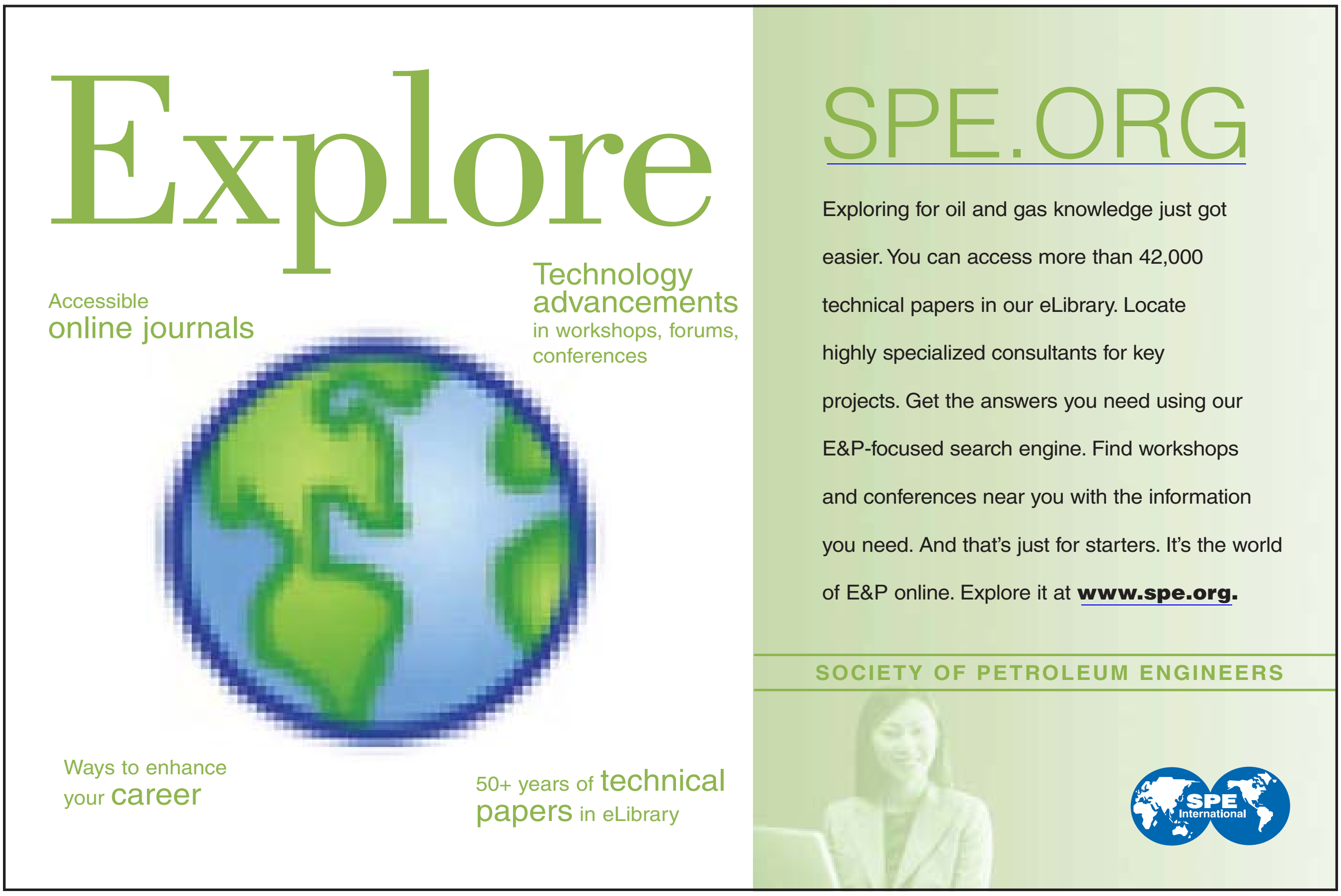
Statoil-Hydro merger

Combined production of the new company—yet to be named—will be 1.9 million b/d in 2007. The combined company's proved oil and gas reserves will be 6.3 billion boe. Hydro, meanwhile, will continue as a global aluminium company.

Hydro's shareholders will hold 32.7% of the new firm, while Statoil's shareholders will hold 67.3%. Hydro's shareholders will receive 0.8622 share in the new company for each Hydro share and continue as owners of Hydro. Statoil shareholders will maintain their holdings in the new company on a one-for-one basis. The Norwegian state will hold about 62.5% in the merged entity.

The new firm will have operations in almost 40 countries. The companies' boards propose that Eivind Reiten will become chairman of the new company, while Helge Lund is proposed as president and chief executive officer.

Following the transaction, the new



WATCHING THE WORLD

Eric Watkins, Senior Correspondent

Putin's oil grab

Russian President Vladimir Putin is not good for his country's oil industry. If you doubt that, consider some of the stories that have been emerging from his—and we use that term advisedly—country over the past several months.

We have, of course, been following reports of Mikhail Khodorkovsky, the jailed head of the bankrupt oil major OAO Yukos. Not content to throw him behind bars on trumped up charges, Putin's government has proceeded to harass the former oil mogul even in his jail cell.

Last April, Khodorkovsky spent several weeks in isolation after he was slashed in the face by a fellow inmate while sleeping. That was after he had been placed in solitary confinement three times for allegedly breaking prison rules.

Abramovich worries

In the latest move, Khodorkovsky and an associate, Platon Lebedev, have been moved to a detention center in the eastern Russian city of Chita to face possible new charges, according to his lawyer, Natalia Terekhova.

She did not mention what charges were being considered by Russian prosecutors, but as we are coming to learn, any and all charges are possible in Putin's Russia. The ability to make money is about only thing needed to incur the wrath—or greed—of the Putin regime.

Roman Abramovich, who made his fortune from oil when Russia's public utilities were privatized in the 1990s, seems to recognize that trend and is putting distance between himself and Putin.

Effective Jan. 1, Abramovich—who last year sold his stake in oil company Sibneft to Gazprom for $13 billion—hopes to be finished as governor of the remote region of Chukotka, having submitted his resignation to Putin.

Observers say Abramovich's resignation is a sign of his plan to depart from Russia altogether. In fact, they say the 40-year-old oil tycoon has sold off most of his assets at home and now spends most of his time in western Europe.

Shell suffers

Still, he apparently wants to stay on the good side of Putin, whose government stands accused of assassinating political opponents—even those who live abroad. While resigning, Abramovich will still fund several "patriotic" sporting projects.

Russian oilmen are not the only ones suffering at the hands of Putin's henchmen.

Royal Dutch Shell PLC Chief Executive Officer Jeroen van der Veer is also in a tough spot after having to do a deal with Putin's regime, which has finally reduced his company's stake in the beleaguered Sakhalin-2 project.

After weathering months of blackmail from Russia's environmental authorities, who shut down construction work on the project, Van der Veer—along with colleagues at Mitsui & Co and Mitsubishi Corp.—finally gave in.

The terms under which Shell and partners surrendered to Gazprom control of the Sakhalin-2 project have still not been fully revealed. That leaves Van der Veer the unenviable task of explaining to shareholders the consequences of their investment in Putin's Russia. ✦

company will employ 31,000 people. The companies said personnel reductions in overlapping functions are expected to be "limited and take place through internal replacement or natural turnover."

The proposed merger is subject to approval by general meetings of Statoil and Hydro and by regulatory authorities. General meetings of both companies are slated for second-quarter 2007, and final closing is expected to be in next year's third quarter.

The new firm will be based in Stavanger. Group functions will be in both Stavanger and Oslo, however, and the chief executive officer will operate out of both locations.

Gazprom buys into SEIC

Existing SEIC partners each will dilute their stakes by 50% interest. Shell will retain a 27.5% stake, Mitsui 12.5% interest, and Mitsubishi 10% interest. SEIC will remain operator of the Sakhalin-2 project.

Gazprom will be the majority SEIC shareholder, and Shell will continue its role as technical advisor.

The consortium's focus is completion of Sakhalin-2 on schedule, allowing LNG to be delivered to Japan, Korea, and the North American West Coast. All existing LNG sales contracts will remain effective.

Alexey Miller, Gazprom chairman, said, "Gazprom is implementing the strategy of strengthening its positions on LNG markets. Entering Sakhalin-2 project that involves production and marketing of LNG is an important step towards this objective."

Gazprom and existing SEIC shareholders plan an Area of Mutual Interest arrangement covering future Sakhalin oil and gas exploration and production opportunities as well as the building of Sakhalin II into a regional oil and LNG hub.

Separately, Shell, Mitsui, and Mitsubishi reached agreement with the Russian Ministry of Industry and Energy as the authorized state body for the supervision of production sharing agreements regarding Sakhalin-2.

The project had been under pressure from the Russian government, which withdrew key environmental permits from Shell and its Japanese partners. As a result of the withdrawn permits, construction on the project had effectively come to a halt (OGJ Online, Dec. 7, 2006).

Daniel Barcelo, an analyst with Banc of America Securities, said terms call for Gazprom to be considered a partner from the start of the project, which means it could be retroactively held responsible for any environmental liabilities.

"In our opinion, the environmental regulator, RosPrirodNadzor, is unlikely to find against Sakhalin Energy in its ongoing audit nor delay the project further," Barcelo said.

He noted that the Sakhalin agreement demonstrates the Russian government is in a position "to extract concessions from the international oil companies utilizing environmental and budgetary approval as levers."

Environmental groups withheld judgment on the transaction, said spokesmen for Sakhalin Environment Watch and Pacific Environment.

TransCanada-ANR deal

TransCanada Corp. plans to acquire ANR Pipeline Co. and ANR Storage Co. and an additional 3.55% interest in Great Lakes Gas Transmission Ltd. Partnership from El Paso Corp.

The total purchase price is $3.4 billion, subject to closing adjustments, and includes $457 million of assumed debt. The sales are part of El Paso's efforts to reduce debt.

TransCanada Chief Executive Officer Hal Kvisle said, "With the acquisition of ANR, TransCanada's wholly owned natural gas pipeline network will extend more than 59,000 km and offer our customers unparalleled connections."

ANR operates 17,000 km (10,500 miles) of pipeline with a peak-day capacity of 6.8 bcfd. It transports natural gas from fields in Louisiana, Oklahoma, Texas, and the Gulf of Mexico to Wisconsin, Michigan, Illinois, Ohio, and Indiana.

It also owns and operates underground gas storage facilities in Michigan with a total capacity of 230 bcf.

After closing, TransCanada will have interests in 360 bcf of storage capacity. Pending regulatory approvals, the acquisition is expected to close in the first quarter of 2007.

Great Lakes owns and operates a 3,400 km (2,115 mile) interstate gas pipeline system with a design capacity of 2.5 bcfd.

With the acquisition of an additional

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WoodMac: Gulf of Mexico key for merging Statoil-Norsk Hydro

The merger of Statoil ASA's and Norsk Hydro ASA's oil and gas businesses will create an upstream player whose most important future international operations will be in the deepwater Gulf of Mexico, Wood Mackenzie analysts said.

"For both companies exploration, particularly in the deep water, has been a key focus," WoodMac said in a research note. "In particular, the US deepwater Gulf of Mexico is a key target area for each."

Both Statoil and Hydro recently acquired assets in the gulf. Statoil had exited the gulf previously and then returned to the deepwater gulf in 2004 through a transaction with Chevron. Later, Statoil acquired Encana Corp.'s deepwater assets for $2 billion and Anadarko Petroleum Corp.'s assets for $900 million (OGJ, Nov. 10, 2006, p. 36).

"The acquisitions have given Statoil stakes in the world class Tahiti project as well as other high profile potential developments such as Knotty Head, Big Foot, and Jack," WoodMac said. "Norsk Hydro also significant increases its interests in the deepwater GOM area with the $2.45 billion acquisition of Spinnaker."

Spinnaker's assets included the producing Front Runner field and a number of development projects in the Independent Hub platform area. Hydro acquired Spinnaker in 2005 (OGJ Online, Sept. 19, 2005).

Analysts expect that more acquisitions could be forthcoming once the merger is completed.

"In our view, we expect to see further moves to develop and grow the international business," WoodMac said. "With the much improved economies of scale, there will be increased opportunities to leverage off its strong domestic frontier and international deepwater credentials to compete for new projects."

The combined company has commercial interests in 15 countries outside Norway. In Africa, this includes stakes in onshore Algeria, deepwater Nigeria, and Libya.

"Other key assets include the Sincor heavy oil project in Venezuela's Orinoco Belt and the deepwater Chinook project in Brazil," WoodMac said. "In addition, Norsk Hydro's stake in the Azar oil discovery in Iran offers good upside."

Statoil and Hydro also have extensive acreage in the UK North Sea, the Norwegian North Sea, and the Barents Sea. Analysts said the Barents Sea offers excellent potential although it is technically challenging and considered high risk.

3.55% interest in Great Lakes, TransCanada will directly own 53.55% of Great Lakes and will become the operator. Great Lakes now is operated by a company jointly owned by affiliates of El Paso and TransCanada.

In a separate transaction, TC PipeLines LP will acquire 46.45% of Great Lakes from El Paso for $962 million, subject to closing adjustments, including

$212 million of assumed debt. TransCanada is the General Partner and a common unit holder (13.4% interest) of TC Pipelines LP.

EXCO to buy Anadarko assets

EXCO Resources Inc., Dallas, has agreed to acquire Anadarko Petroleum Corp.'s oil and natural gas producing properties, acreage, and other assets in Vernon and Ansley fields in Jackson Parish, La., for $1.6 billion. The transaction is expected to close in March, subject to customary approvals.

EXCO will acquire an average working interest of 91.1%, with an average 70.2% net revenue interest.

The acquisition consists primarily of proved developed producing gas properties, with current net production of about 190 MMcfd of gas equivalent from about 350 producing wells, of which 96% are operated. The properties produce from the Lower Cotton Valley formation.

Proved reserves are pegged at 466 bcf, of which 446 bcf is proved developed and 20 bcf is proved undeveloped. EXCO will continue evaluating the properties to identify additional exploitation and development opportunities.

Total acreage to be acquired is about 66,000 net acres, of which 15,000 net acres are undeveloped.

The acquisition also includes gathering systems, compression units, and treating plants.

In connection with the acquisition, hedges for a large portion of estimated production for 2007, 2008, and 2009 will be assumed by EXCO.

The acquisition will be financed with a new revolving credit facility and a bridge loan from EXCO's banking group. EXCO expects to finalize its financing plans in January.

EXCO Chief Executive Officer Douglas H. Miller said cash flow from the Vernon and Ansley assets will be used to accelerate development of EXCO's 1,100 drilling sites in the area and will also produce accelerated activity on its 85,000 net acres of undeveloped leaseholds.

In East Texas and North Louisiana, with the Vernon and Ansley assets, EXCO will have about 300 MMcfd of gas equivalent of current production and more than 1 tcf of proved reserves, the company said.

The company's total current production with the Vernon and Ansley assets will approach 400 MMcfd of gas equivalent and total proved reserves will be 1.8 tcf of gas equivalent. ✦

Trap types can be instructive in Gulf of Mexico shelf search

F.R. Haeberle
Consulting Geologist
Delaware, Ohio

Most exploration on the Gulf of Mexico shelf off Louisiana and Texas has been based on the search for the types of traps in which oil and gas have previously been found.

The first question that arises is which types of trap have been the most successful for oil and gas reserves in the gulf, and the second question is what reservoir properties can be expected in those trap types.

All oil and gas traps in a series of data published by the University of Texas Bureau of Economic Geology[1] may be classified as structural or stratigraphic traps.

TRAP TYPES, CODE NUMBERS

Table 1

Code no.	Trap type description	Type
1	Faulted anticlines	Structural
2	Normal faults	Structural
3	Flank traps on salt or shale diapirs	Structural
4	Sediments overlying domes	Structural
5	Rollover anticlines	Structural
6	Updip facies changes	Stratigraphic
7	Updip pinchouts	Stratigraphic
8	Anticlines	Structural
9	Permeability traps	Stratigraphic
10	Reverse faults	Structural
11	Turtle structures	Structural
12	Patch reefs	Stratigraphic

Structural traps accounted for 93% of the reported traps on the gulf shelf, 94% of the released oil reserve data, and 91% of the released gas reserve data. Stratigraphic traps accounted for 7% of the reported traps, 6% of the released oil reserve data, and 9% of the released gas reserve data.

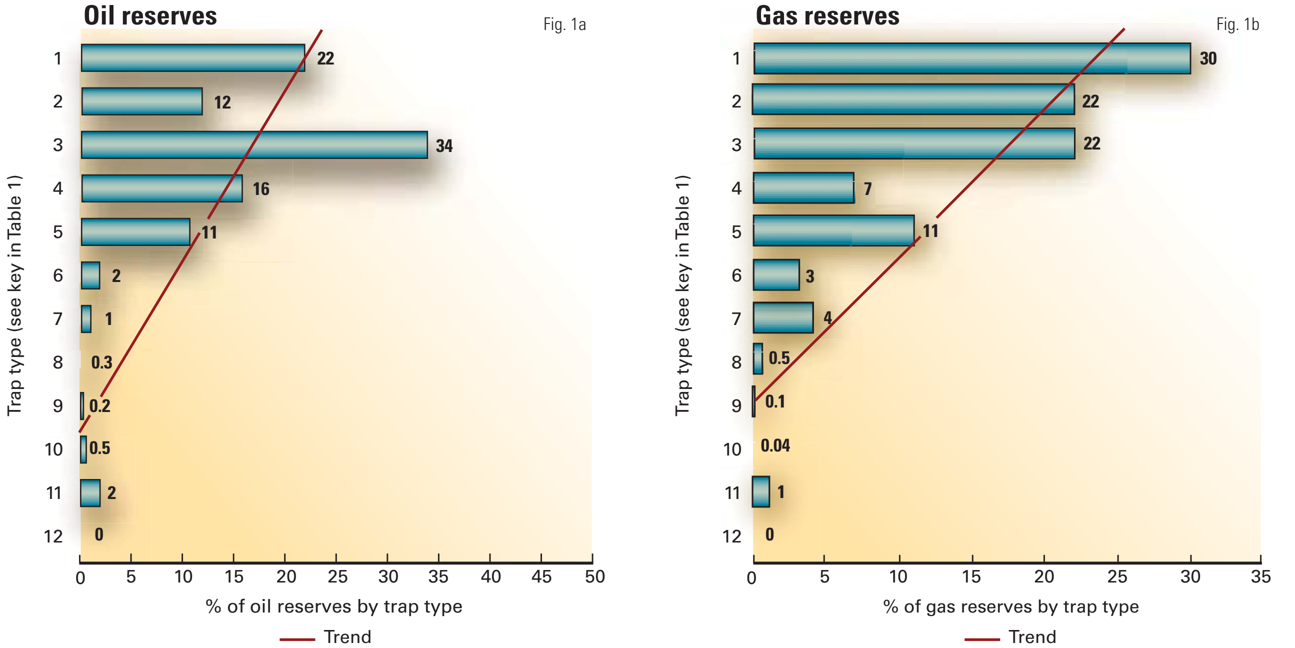
Twelve types of traps in the Gulf of Mexico have information about reservoir properties publicly available, and 11 types have information about oil and gas reserves. One type of trap, patch reefs, has no oil or gas reserves published, so only property values were included.

Table 1 shows the types of traps the BEG listed with the code number used in this article for each type of trap in the following graphs and the classification whether structural and stratigraphic.

The most common trap type is the faulted anticline, 32% of the total, followed by normal fault traps with 18%,

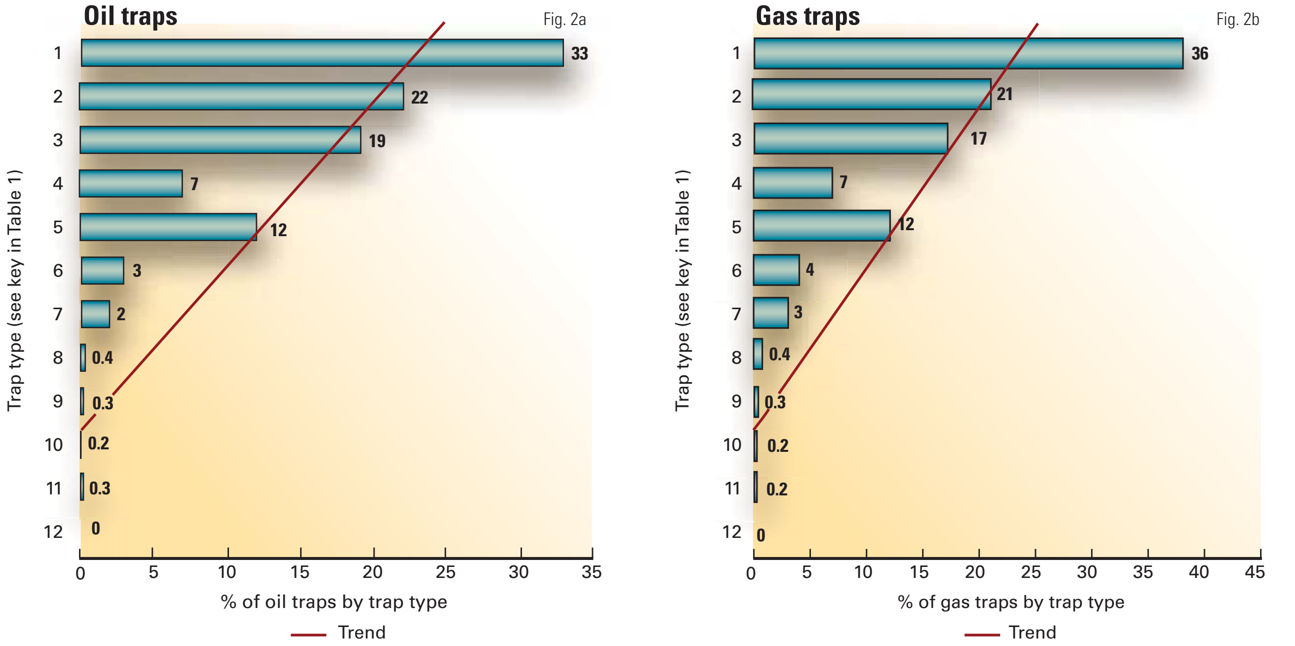
GULF SHELF RESERVES BY TRAP TYPE

Fig. 1



GULF SHELF TRAPS BY TRAP TYPE

Fig. 2



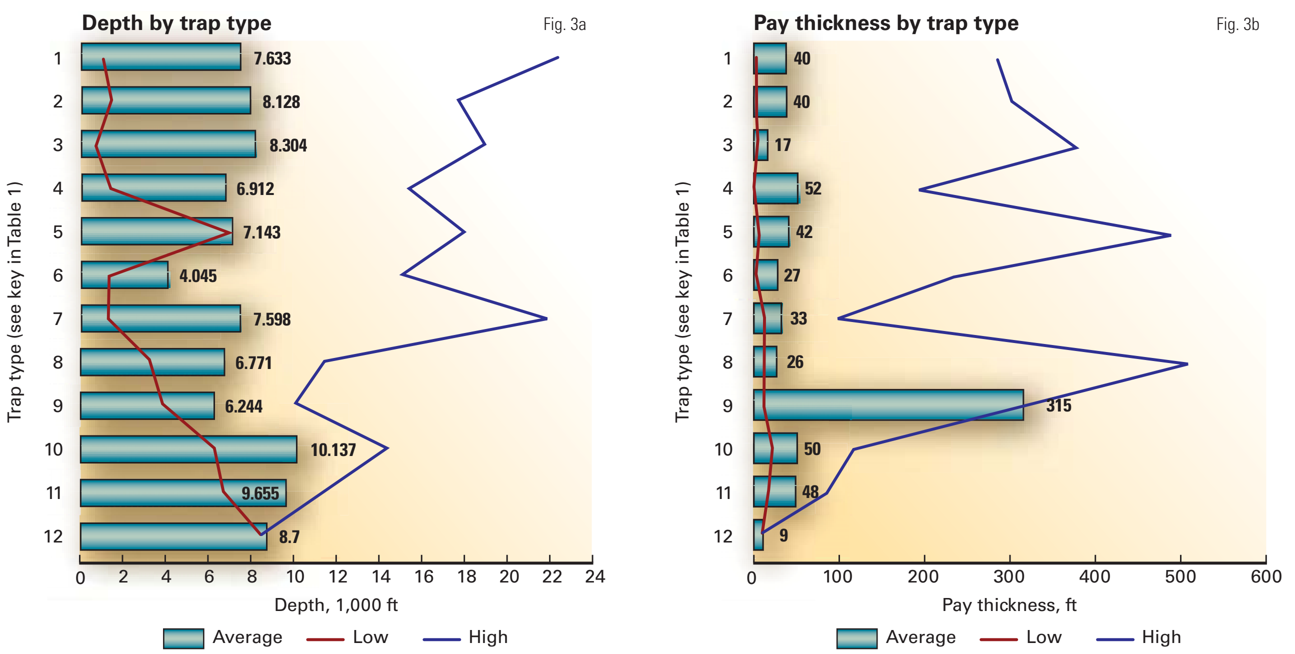
flank traps on salt or shale diapirs and traps in sediments overlying domes each with 14%, and rollover anticlines with 13%. These five types account for 91% of the BEG-reported traps.

A total of 35 lease areas has been recognized in the gulf for which data have been published. Table 2 shows the areas, types of traps, and number of each type in each area. These areas include fields, reservoirs, and pools, but they were not separated on that basis.

Most common trap types in these areas were traps with normal faults (Type 2) found in 18% of these areas. Traps in faulted anticlines (Type 1) and flank traps on salt or shale diapirs (Type 3) were found in 16% of the areas. Traps in sediments overlying domes (Type 4) were found in 14% of these areas. Traps in rollover anticlines (Type 5) were

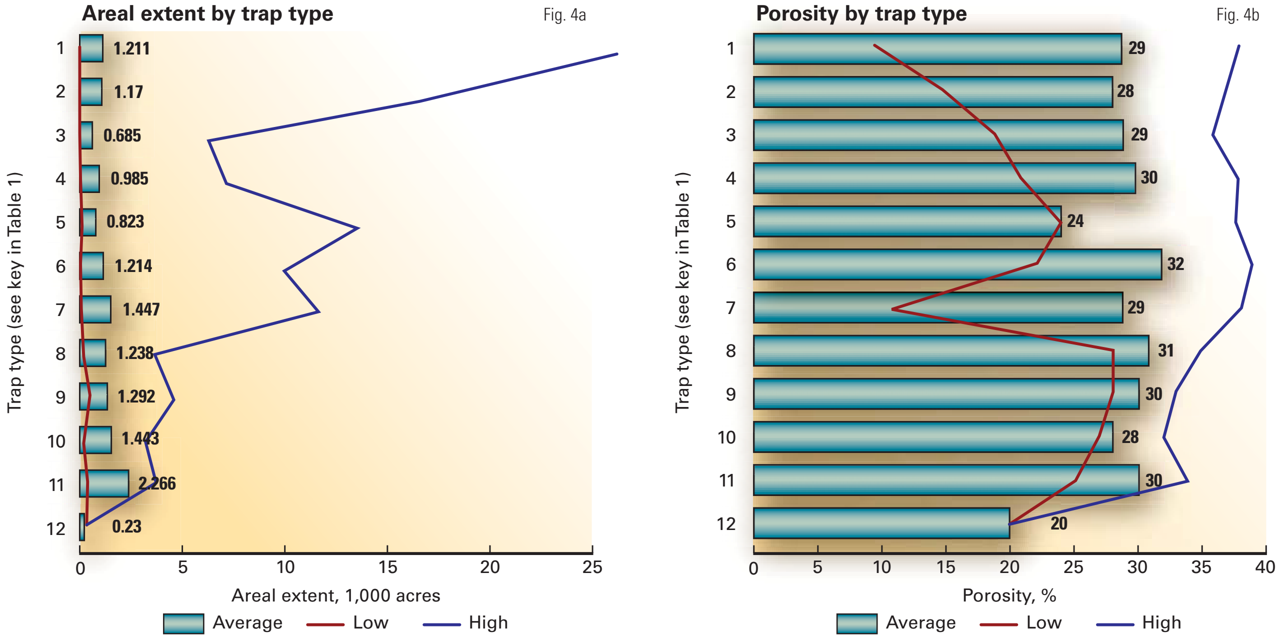
GULF SHELF TRAP DEPTHS AND PAY THICKNESSES

Fig. 3



Gulf shelf traps by areal extent and porosity

Fig. 4



found in 10% of the areas.

The High Island area had nine types of trap. The areas known as Galveston, Main Pass, and South Timbalier had eight types of trap each.

Patch reefs (Type 12) were found only in the Main Pass area, and reverse faults (Type 10) were found only in the Ship Shoal area.

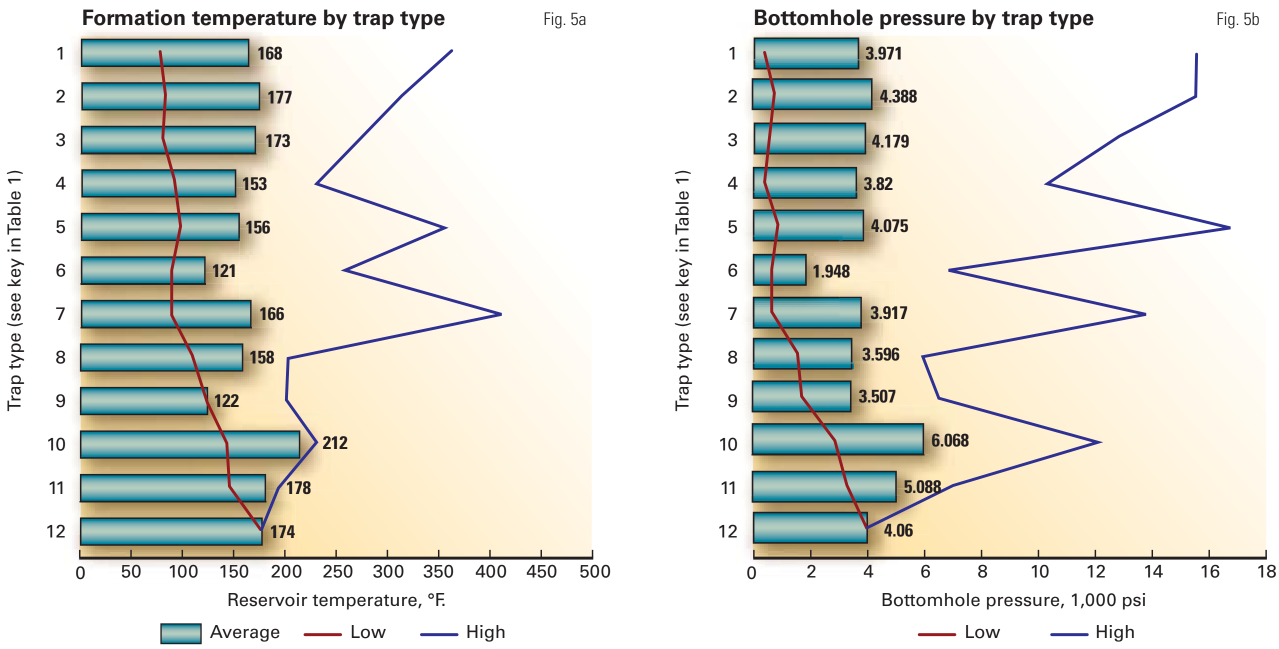
Nine areas had only one type of trap reported. These areas are Atchafalaya Bay, Coon Point, East Breaks, Garden Banks, Light Point, Rabbit Island, Sabine Pass, Tiger Shoal, and Timbalier Bay.

Several of the reported areas such as Eugene Island, Vermilion, and West Cameron do not have complete data as numerous oil and gas reserves were reported with no trap type listed.

Eight of these areas had their largest oil reserves in traps on the flanks of salt

Gulf shelf traps by temperature and pressure

Fig. 5



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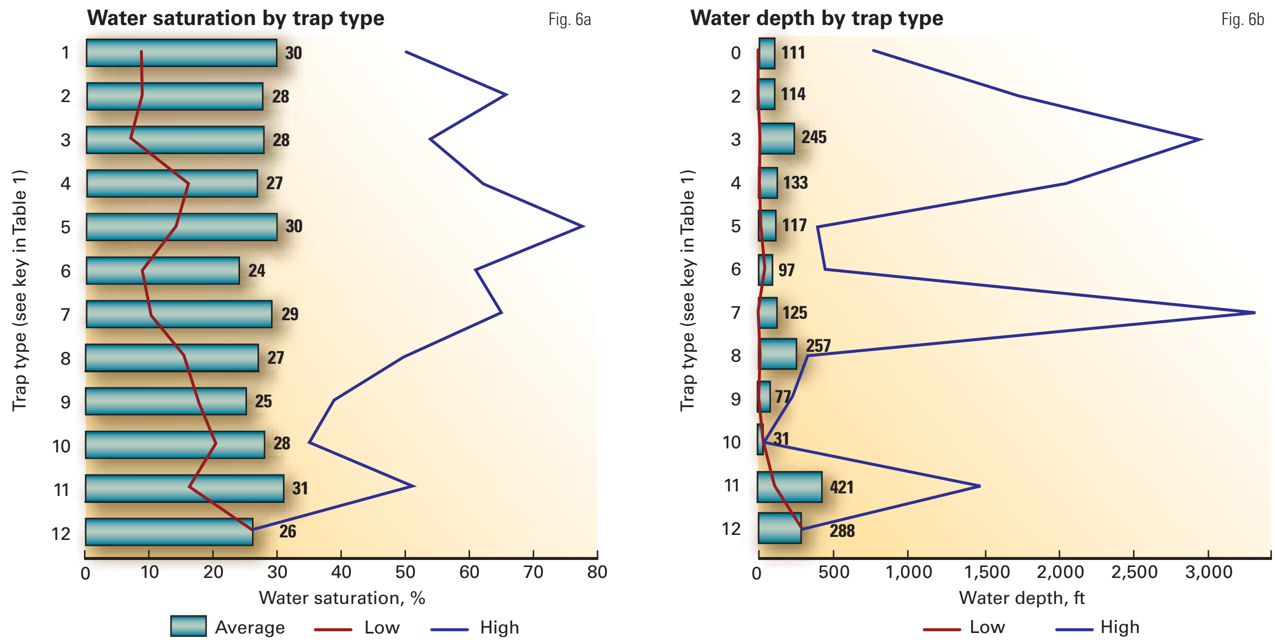
GULF SHELF TRAPS BY WATER SATURATION, WATER DEPTH

Fig. 6



or shale diapirs (Type 3). These include Eugene Island, Garden Banks, Green Canyon, Main Pass, Mississippi Canyon, Ship Shoal, South Pass, and Viosca Knoll. Only one, South Marsh Island, had its largest oil reserves in traps in updip pinchouts (Type 7).

Four of the areas, High Island, Matagorda Island, Ship Shoal, and South Timbalier, had their largest gas reserves in faulted anticlines (Type 1). Three of these areas, Eugene Island, Garden Banks, and South Marsh Island, had their largest gas reserves in traps on the flanks of salt or shale diapirs (Type 3).

Two of the areas, Mobile and Vermilion, had their largest gas reserves in updip pinchout traps (Type 7), one area, Mississippi Canyon, had its largest gas reserves in traps in normal faults (Type 2), and one area, West Cameron, had its largest gas reserves in rollover anticlines (Type 5).

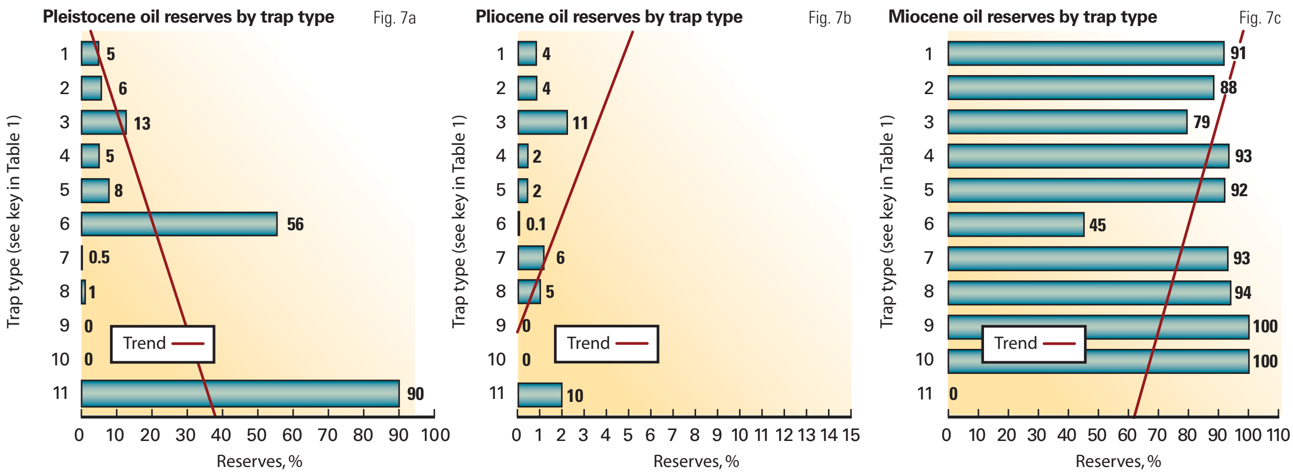
In the Gulf of Mexico, little study has been released of the variations in reservoir properties even though such knowledge can assist in future planning and producing activities for oil and gas fields, reservoirs, and pools. The following sections sum up reservoir properties separated by trap types for all data available.

Only 62% of the released data disclosed oil reserves, and only 68% of the released data disclosed gas reserves.

Reservoir properties reviewed in-

GULF SHELF OIL RESERVES BY GEOLOGIC AGE

Fig. 7



Number of traps

Table 2

Area/field	[1]1	[1]2	[1]3	[1]4	[1]5	[2]6	[2]7	[1]8	[2]9	[1]10	[1]11	[2]12	Total
	Trap type												
Atchafalaya Bay				x									1
Bay Marchand			x	x			x						3
Brazos	x	x	x										3
Breton Sound	x	x		x			x						4
Chandeleur		x		x		x	x						4
Coon Point	x												1
East Breaks				x									1
East Cameron	x	x	x		x	x	x						6
Eugene Island	x	x	x		x	x	x	x					7
Ewing Bank			x	x			x						3
Galveston	x	x	x	x	x	x	x	x					8
Garden Banks			x										1
Grand Isle	x	x	x				x		x				5
Green Canyon	x	x	x	x									4
High Island	x	x	x	x	x	x	x	x	x				9
Light Point		x											1
Main Pass	x	x	x	x	x	x	x					x	8
Matagorda	x	x			x		x						4
Mississippi Canyon	x	x	x	x							x		5
Mobile	x					x	x		x				4
Mustang Island	x	x			x								3
N. Padre Island	x	x											2
Rabbit Island				x									1
S. Marsh Island	x	x	x	x	x	x				x			7
S. Timbalier	x	x	x	x	x	x	x	x					8
Sabine Pass					x								1
Ship Shoal	x	x	x	x	x	x					x		7
South Pass	x	x	x	x			x						5
South Pelto	x	x	x										3
Tiger Shoal		x											1
Timbalier Bay				x									1
Vermilion	x	x	x	x	x	x	x						7
Viosca Knoll		x	x			x							3
West Cameron	x	x	x	x	x		x						6
West Delta	x	x	x	x	x		x						6
Total	23	25	21	20	14	12	17	4	3	1	2	1	

[1]Structural trap. [2]Stratigraphic trap. See Table 1 for trap types.

cluded production depths, thickness of pay zones, productive area, and producing formation porosity, temperature, and pressure. Unless data are released about deepwater reservoirs in the gulf, reviews must be limited to wells drilled to 22,600 ft or less in 3,300 ft of water or less.

Field demographics

Published data on reservoir properties in the Gulf of Mexico are limited and show considerable variation.

For the published properties, the depth of production averaged 7,842 ft and ranged from 750 ft to 22,600 ft.

Pay thickness averaged 47 ft and ranged from 2 ft to 490 ft.

Productive area averaged 1,070 acres and ranged from 5 acres to 26,404 acres.

Porosity averaged 29% and ranged from 5% to 39%.

Formation temperature averaged 171° F. and ranged from 80° to 414° F.

Formation pressure averaged 4,084 psi and ranged from 520 psi to 15,938 psi.

Water saturation averaged 29% and ranged from 7% to 80%.

Water depth of traps averaged 133 ft and ranged from 3 ft to 3,318 ft.

For comparison, average data for each reservoir property value along with low and high values were determined for each trap type.

Oil reserves

Fig. 1a shows the distribution of oil reserves by trap type for areas on which data had been released. Structural traps include types 1, 2, 3, 4, 5, 8, 10, and 11. The largest share of oil reserves was 34% in traps on the flanks of salt or shale diapirs (Type 3).

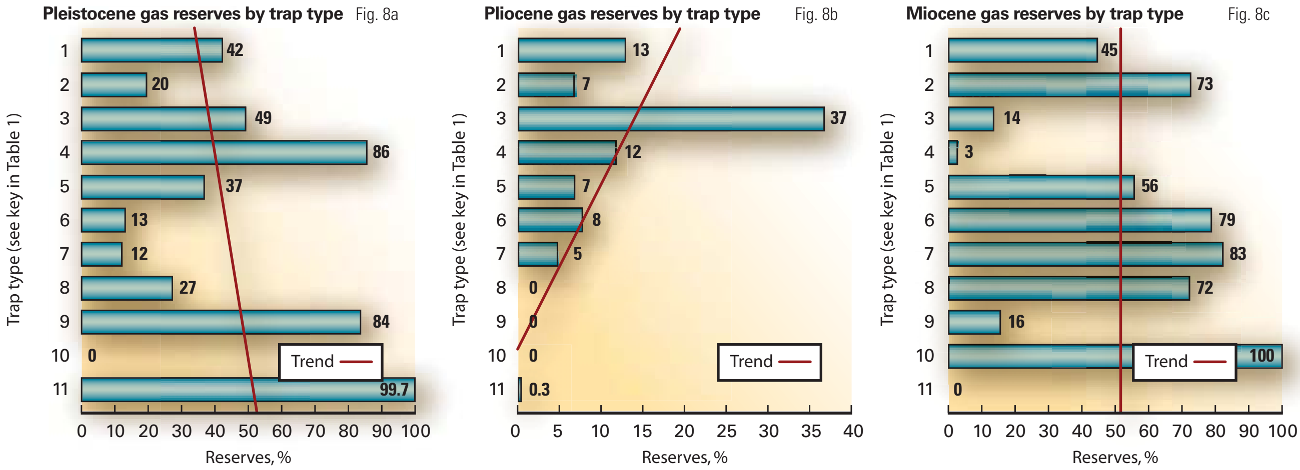
Traps on the flanks of salt or shale diapirs (Type 3), faulted anticlines (Type 1), and traps with normal faults (Type 2) had 68% of the total oil reserves.

Stratigraphic trap types 6, 7, and 9, had 7% of the oil reserves.

Fig. 1B shows the distribution of gas reserves by each trap type released. The largest share of gas reserves was 30% of the total in faulted anticlines (Type 1). Three trap types, faulted anticlines (Type 1), normal faults (Type 2), and flank traps on salt or shale diapirs (Type 3) had 74% of the total gas reserves. Stratigraphic traps had 7% of the total gas reserves. Percent of oil and gas reserves for Oligocene and Jurassic traps were not shown on the graphs.

GULF SHELF GAS RESERVES BY GEOLOGIC AGE

Fig. 8



Trap distribution

Fig. 2a shows the distribution of oil traps by trap type. Largest share of oil traps was in faulted anticline traps (Type 1). The three main structural oil traps made up 74% of the oil traps.

Stratigraphic traps had 5% of the oil traps. Fig. 2B shows the distribution of gas traps by trap type. Largest percent of gas traps was in faulted anticlines (Type 1). The three main structural traps had 74% of the total gas traps. The three largest stratigraphic traps had 7% of the gas traps.

Trap depth, thickness

Fig. 3a shows the average, shallowest, and deepest depth for each trap type for all data available. Shallowest average depth was 4,045 ft for Type 6 traps, and the deepest average depth was 10,137 ft for Type 10 traps. Shallowest depth recorded was 750 ft in Type 3 traps, and the deepest depth recorded was 22,600 ft in Type 1 traps.

Fig. 3b shows average pay thickness and thinnest and greatest pay thickness for each trap type. The smallest average pay thickness was 9 ft for Type 12 traps, and the greatest average pay thickness was 315 ft for Type 9 traps. The smallest pay thickness recorded was 1 ft in Type 4 traps. Largest pay thickness recorded was 510 ft in Type 9 traps.

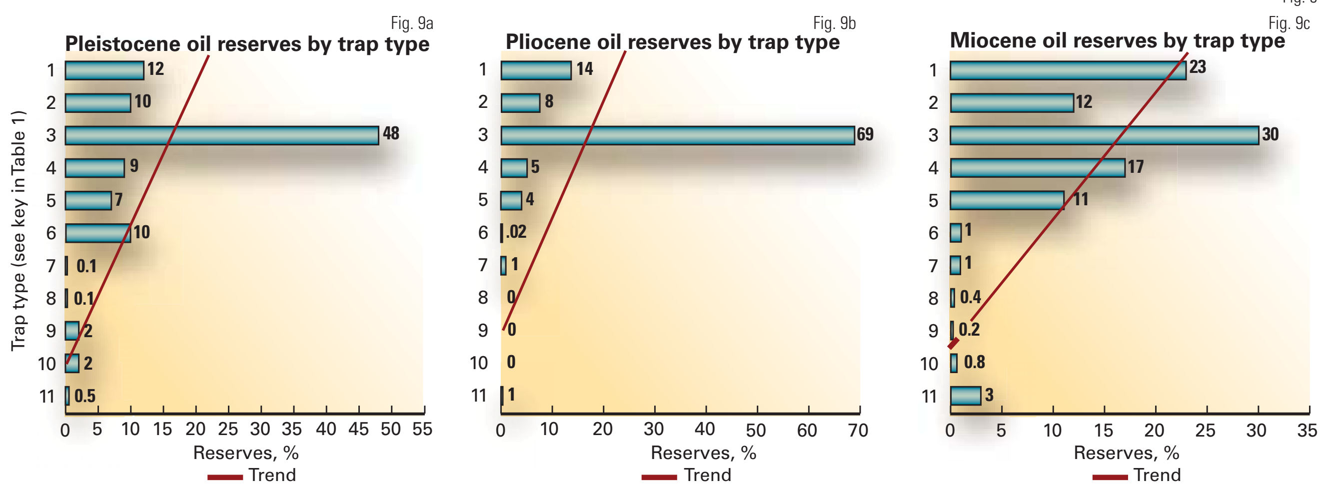
Areal extent, porosity

Fig. 4a shows the average acres and lowest and highest values for each trap type. Smallest average area was 230 acres for Type 12 traps, and the largest average area was 2,266 acres for Type 11 traps. Smallest acreage was 5 acres in Type 1 traps, and the largest acreage was 26,404 acres in Type 2 traps.

Fig. 4b shows the average, lowest, and highest porosity values for each trap type. Lowest average porosity was

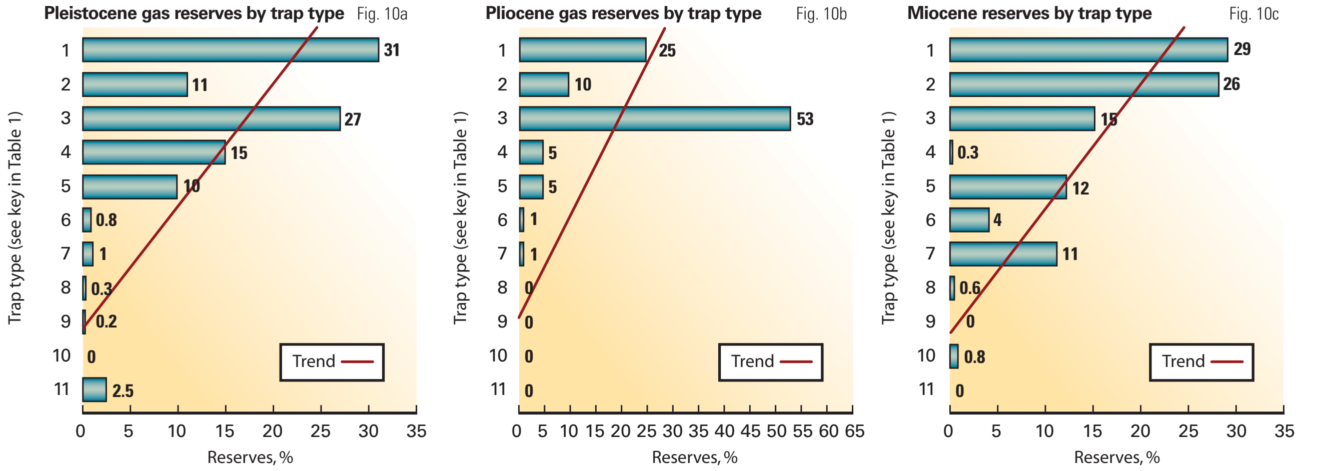
GULF SHELF OIL RESERVES BY AGE AND TRAP TYPE

Fig. 9



GULF SHELF GAS RESERVES BY AGE AND TRAP TYPE

Fig. 10



24% in Type 5 traps, and the highest average porosity was 32% in Type 6 traps. Lowest porosity was 5% in Type 6 traps. Highest porosity was 9% in Type 7 traps.

Temperature, pressure

Fig. 5a shows the average formation temperature and low and high values for each trap type.

Some of the information released about formation temperatures is questionable. A reported temperature of 80° F. at a depth of 7,182 ft and a reported temperature of 83° F. at a depth of 10,289 ft are obviously incorrect.

The lowest average temperature was 121° F. in Type 6 traps, and the highest average temperature was 212° F. in Type 10. Lowest temperature was 80° F. in Type 1 traps, and highest temperature was 414° F. in Type 7 traps.

Fig. 5b shows the average, low, and high formation pressure values for each trap type. Lowest average formation pressure was 1,948 psi for Type 6, and the highest average formation pressure was 6,068 for Type 10 traps. Lowest formation pressure recorded was 520 psi in Type 4 traps. Highest formation pressure was 15,938 psi in Type 5 traps.

Water depth, saturation

Fig. 6a shows the average water saturation and the low and high values for each trap type. Lowest average water saturation was 24% in Type 6 traps, and the highest average water saturation was 31% in Type 11 traps. Lowest water saturation was 7% in Type 3 traps. Highest water saturation was 78% in Type 4 traps.

Water depth has no effect on the type of trap but gives some indication of the location of traps in the Gulf of Mexico.

Fig. 6b shows the average water depth and low and high water depths by the type of trap found. Lowest average water depth was 37 ft in Type 10 traps, and highest average water depth was 421 ft in Type 11 traps. Lowest water depth was 3 ft in Type 1, 2, 4, 7, and 9 traps. Deepest water depth was 3,318 ft in Type 7 traps.

Although published data by trap type for different ages are limited, they do give a hint as to what to expect in reserves.

Traps of Pleistocene age had 42% of the oil reserves, traps of Pliocene age had 26% of the oil reserves, and traps of Miocene age had 32% of the oil reserves. Traps of Pleistocene age had 38% of the gas reserves, traps of Pliocene age had 11% of the gas reserves, traps of Miocene age had 44% of the gas reserves, and traps of Jurassic age had 5% of the gas reserves. Traps of Oligocene age had less than 1% of the gas reserves.

Reserves layout

Fig. 7 shows the distribution of oil reserves in each trap type by Pleistocene, Pliocene, and Miocene ages. Fig. 8 shows the distribution of gas reserves in each trap type by Pleistocene, Pliocene, and Miocene ages. These two figures give an idea of the importance of oil and gas production from each age and stress the prominence of Miocene reservoirs.

Fig. 9 shows the distribution of oil reserves in each trap type for each of the three main age groups. Largest trap types in the Pleistocene were Type 3 with 48% of the Pleistocene total oil reserves, followed by Type 1 traps with 12% of the Pleistocene oil reserves.

Largest Pliocene oil reserves, 69%, were in Type 3 traps, followed by 14% of the Pliocene oil reserves in Type 1 traps.

Largest Miocene oil reserves, 30% of the Miocene oil total, were in Type 3 traps, followed by 23% of the Miocene oil reserves in Type 1 traps.

No reserve data have been published about oil reserves in traps in formations of Oligocene or Jurassic age.

Fig. 10 shows the distribution of gas reserves in each type trap of the three age groups. Largest Pleistocene gas reserves, 31% of the Pleistocene gas total, were in Type 1 traps, followed by 27% in Type 3 traps.

Largest Pliocene gas reserves, 53% of the Pliocene gas reserves, were in Type 3 traps followed by 25% in Type 1 traps.

Largest Miocene gas reserves, 29% of the Miocene gas reserves were in Type 1 traps, followed by 28% in Type 2 traps.

Data analysis

Low values of depths and porosity tend to climb with increases in trap types from 1 to 11. Low values of pay thickness and areal extent tend to remain the same with increases in trap types from 1 to 11. High values of all four properties tend to decrease with changes in trap types from 1 to 11.

Average value of depths and areal extent tend to remain the same with changes in trap types from 1 to 11. Average pay thickness tends to increase and porosity values tend to decrease with changes in trap types from 1 to 11.

Highest values of water saturation and average water saturation tend to decrease as the trap numbers increase; lowest values of water saturation tend to increase as the trap number increases.

Highest water depths tend to decrease as the trap number increases; lowest and average water depths tend to increase as trap number increases. The only two property values that seem to make much difference in reserve sizes were pay thickness and productive acreage.

Largest Pleistocene, Pliocene, and Miocene oil reserves were in traps on salt or shale diapirs. Pliocene oil reserves were absent in traps in simple anticlines, permeability traps, and reverse faults. Miocene oil reserves were absent in traps in turtle structures.

Pleistocene gas reserves were absent in traps on reverse faults. Pliocene gas reserves were absent in traps on simple anticlines, permeability traps, and traps with reverse faults. Miocene gas reserves were absent in traps on turtle structures.

Most Pleistocene gas reserves were in traps with faulted anticlines followed by salt or shale traps on diapirs. Most Pliocene gas reserves were in faulted anticlines, followed by traps on normal faults. ✦

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China

Husky Energy Inc., Calgary, plans to drill an exploration well in 2007 on Block 04/35 in the East China Sea.

Acquired in 2003, the block covers 4,835 sq km in an average of 100 m of water 350 km east of Shanghai (OGJ Online, Nov. 6, 2003). The work program requires a single exploration well to 2,500 m depth.

Libya

Verenex Energy Inc., Calgary, has an indicated discovery at its first well on Block 47 in the Ghadames basin, northwestern Libya.

The A1-47/02 well reached 10,300 ft and found indications of multiple oil-bearing sandstone reservoirs in Silurian Lower Acacus, the well's primary target. The well had shows in Acacus while drilling and on wireline logs. Production tests are planned early in the first quarter of 2007.

Drilling was to continue to 10,600 ft to test the Ordovician Memouniat formation.

The Lower Acacus, topped at 9,010 ft, 12 ft higher than prognosis, is 63 ft higher than in Shell's 1962 B1-70 well 1.2 km northwest. That well found hydrocarbons on a flank of the structure and was never produced.

Verenex operates 6,182 sq km Area 47 with 50% interest, and PT Medco Energi Internasional Tbk has the other 50%.

New Mexico

High Plains Petroleum Corp., Boulder, Colo., discovered several shallow oil reservoirs while drilling a development well in Rio Puerco field in the eastern San Juan basin.

San Isidro 16-8, in 16-20n-3w, Sandoval County, found oil in the Menefee member of the Cretaceous Mesaverde formation, the Point Lookout sandstone, and the Mancos shale.

The well encountered oil and gas in a 188-ft interval of Mesaverde and in three sands at the top of Mancos.

The sands in the Mancos represent a new oil producing zone for the basin, High Plains said, and immediate development is planned. San Isidro 16-8 will continue drilling to the fractured Gallup formation.

High Plains and partners hold more than 3,900 acres of leases that have Gallup potential.

Drilling

Liner tie-backs stop casing leaks in Libya completions

Wathik M. Alhashimi
Arabian Gulf Oil Co.
Benghazi, Libya

A project in which existing 7-in. liners were tied back to surface then cemented stopped casing leaks in the Sarir and Messla oil fields in Libya.

Many wells operated by Arabian Gulf Oil Co (AGOCO) in the fields have 7-in. liner completions.

Water containing H_2S from the Paleocene zone between 5,500 and 6,000 ft caused corrosion that resulted in the 9⅝-in. casing losing about ⅛-in./year in its wall thickness and eventually led to casing leaks. The water influx into the wellbore dumped water into the producing reservoir, killing it and causing H_2S bacteria to spread in the sweet crude reservoir.

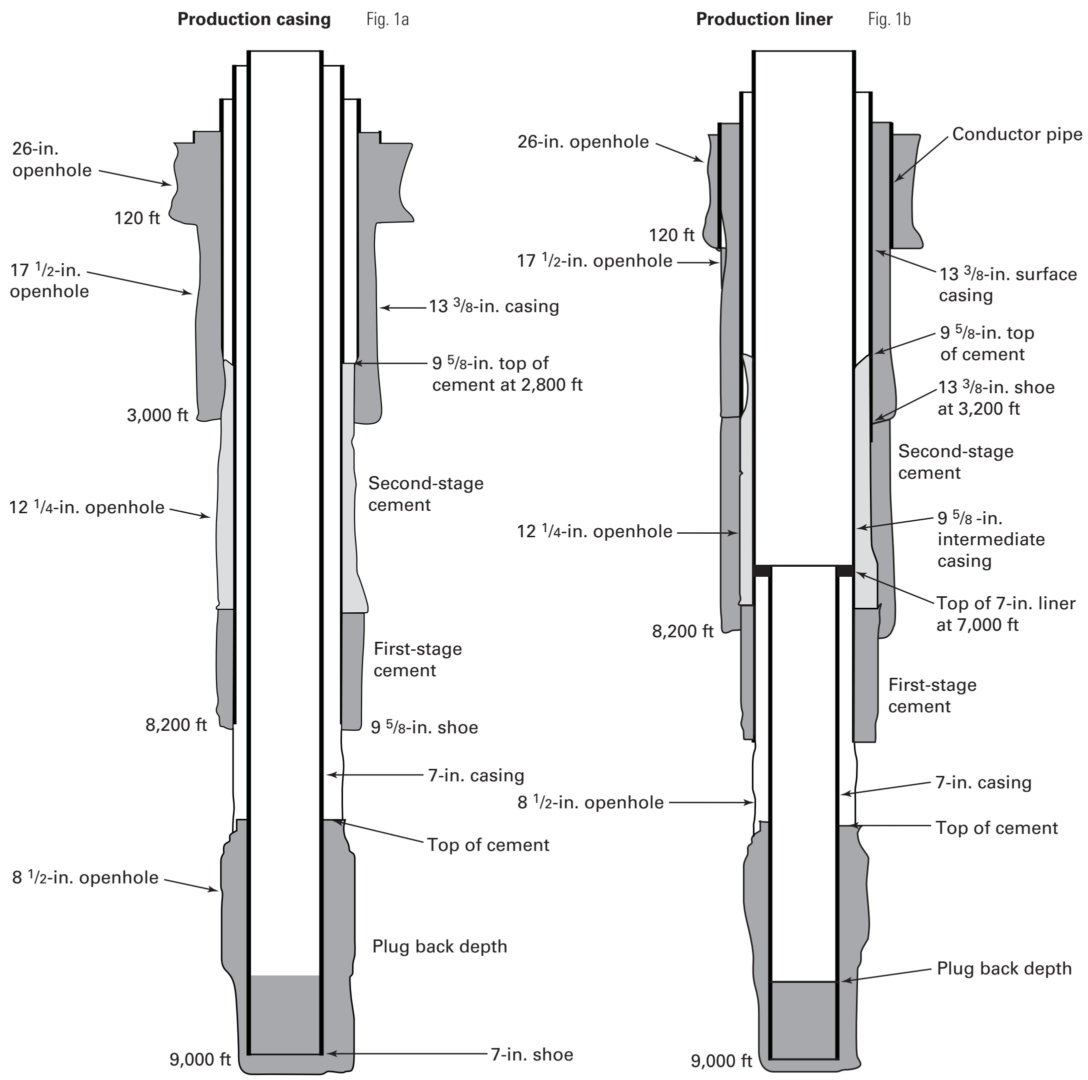
Squeeze cementing of these leaks proved to be only a temporary or difficult solution; hence AGOCO initiated the tie-back project.

Well configuration

Wells in Sarir and Messla fields have 20-in. by 13⅜-in. by 9⅝-in. by 7-in. casing configuration (Figs. 1a and 1b). The wellheads are

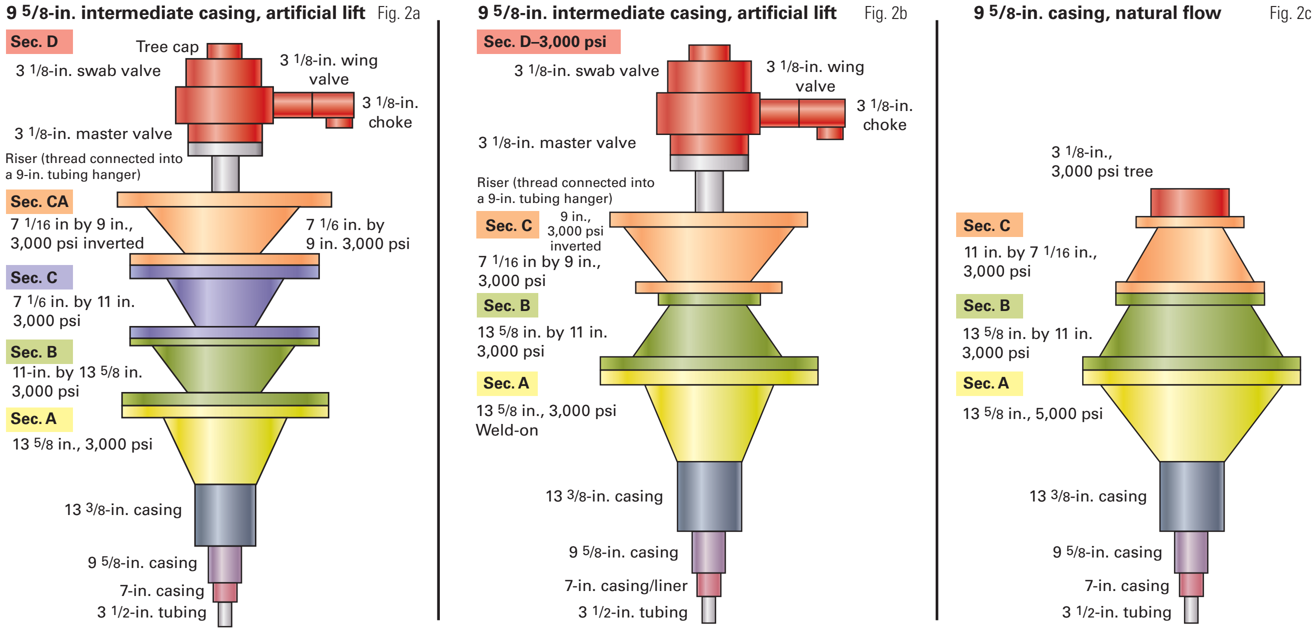
WELL CONFIGURATION

Fig. 1



WELLHEAD CONFIGURATION

Fig. 2



13⅝-in. by 11-in. by 7¹⁄₁₆-in. by 3⅛-in. (Figs. 2a-2c).

These wells were drilled in about 45 days and cost about $3 million/well. They either flow naturally or have an electric submersible pump (ESP) for artificial lift.

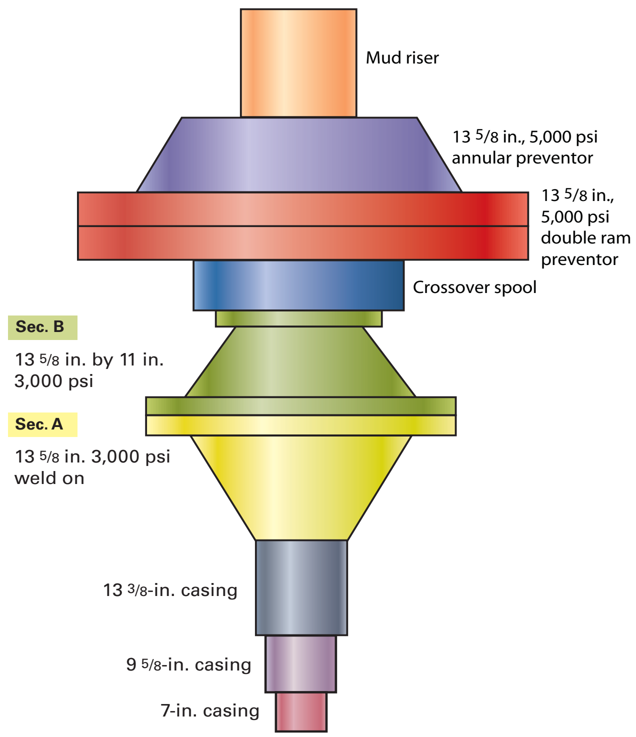
To accelerate the drilling plan and reduce well costs, the program began installing 7-in. production liner completions.

A major concern was drilling the 12¼-in. hole and running and cementing the 9⅝-in. intermediate casing across a thief zone in the Paleocene below an H_2S water zone (8.6 ppg equivalent mud density). This area had complete loss of drilling fluid into the thief zone that required drilling blind and resulted in H_2S water dumping from the water zone into thief zone. The zone also caused problems in running and cementing the 9⅝-in. intermediate casing.

The completion program employed two-stage cementing with limited success. The first stage brought the cement top to the top of the Paleocene. The second stage was pumped after waiting on the first-stage cement to set.

BOP SYSTEM

Fig. 3



A modified program also included annular casing packers (ACP) in the casing string, just below the stage collar for eliminating the waiting on cement time and to mitigate potential problems after the first-stage cement. Having large OD ACPs, however, caused this casing in many instances to stick off bottom, forcing the casing to be cemented higher than planned.

Faulty 9⅝-in. casing cement jobs or cement deterioration over time caused the Paleocene water to come in contact with the 9⅝-in. casing. The water corroded the casing and eventually caused casing leaks that allowed water into the wellbore and into the producing reservoir.

The company employed various approaches to repair such leaks, such as squeeze cementing, matrix cement, and setting ESP packers below leaky intervals. The ESP packers worked for a limited time but problems recurred or other problems developed, such as the inability to unset the ESP packer for workovers because of sediment brought along with the dumped Paleocene water.

The workovers in these wells with stuck ESP packers required the cutting of the production tubing string and ESP cable before running an overshot to jar free the ESP packer.

The leaks work like a nonreturn valve. In other words, when a job attempted to squeeze inside the 9⅝-in. casing, the leak would not take any fluid or the squeeze pressure would simply bleed off. This made squeezing cement even at excessive surface pressures almost impossible. During swabbing operations, however, such casing leaks profusely produced Paleocene water.

To seal off the leaks, stop dumping Paleocene water into the reservoir, and bring the wells back into production, AGOCO initiated the tie-back project to repair about 60 completions.

Well preparation

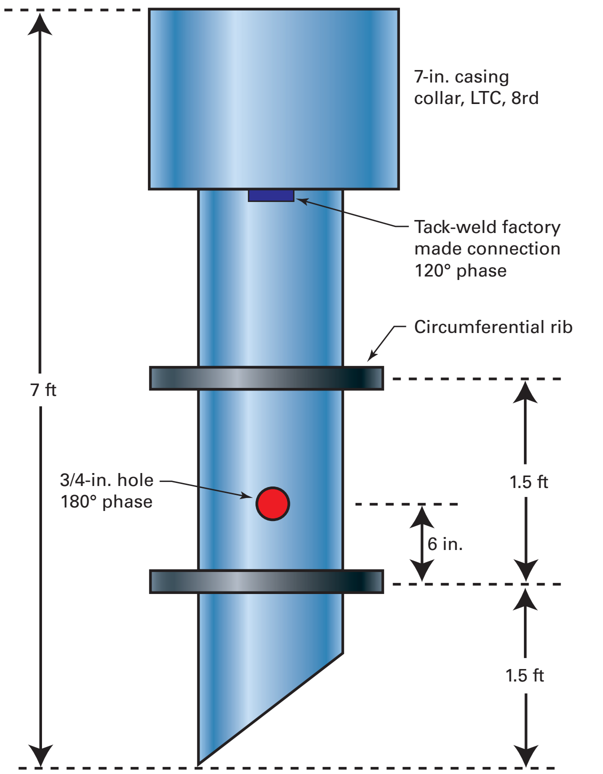
The tie-back jobs involved mobilizing a workover rig and killing the wells with established procedures.

The jobs included installing an 11-in., 5,000 psi blowout-preventer stack after removing the tree and Sections C and B (Fig. 3). The next step involved running an 8½-in. bit and 9⅝-in. casing scraper on 4¾-in. drill collars and 3½-in. tubing to the top of the 7-in. liner, normally set at about 6,500 ft.

A 7-in. casing scraper cleaned the 7-in. liner to about 100 ft below the 7-in. top of liner. A 7-in. drillable bridge plug run and set just below the 7-in. top of liner isolated the perforated intervals during the subsequent operations.

Home-made tie-back stringer

Fig. 4



An 8½-in. taper mill run cleaned the entrance of the 7-in. liner hanger receptacle, about 4 ft in length and milled out about 2 in. of steel to ensure entrance for the tie-back stinger. Next, a 7⅜-in. polish mill run cleaned inside the receptacle. The polish mill can go about 4 ft deeper than the 8½-in. taper mills.

Running tie-back

The tie-back stinger (Fig. 4), prepared locally, consisted of a 7 ft, 7-in. casing joint with a collar at the top and a 45° inclined beveled cut for easy reentry, two 7⅜-in. OD circumferential ribs spaced 1.5 ft apart for centralizing the stinger, and two ¾-in. ID holes drilled through the casing walls and placed 6 in. above the lower rib for tell-tale purposes.

The tack-welding on the factory made-up collar connection ensured the string's integrity while cleaning out the tie-back string.

The 7-in. tie-back string (Fig. 5) includes two float collars, spaced one joint apart. These collars ensured the success of cementing in case of a failure in the float in one of them. Thread-locking in the stinger connections and the two float collars ensured their integrity while cleaning out the tie-back string.

The string included the first of the three cased-hole centralizers placed just above the stinger collar with the second centralizer floating above the first float collar, and the third floating above the second float collar. These centralizers center the tie-back string for reentry and ensure a good cement sheath around the bottom of the tie-back string.

The jobs called for filling the tie-back string every five joints during running operation to prevent the string from floating. This eliminated the possibility of trapped air inside the casing prior to circulating and cementing.

Upon the string reaching the top of the existing 7-in. production liner, the job proceeded to run the stinger all the way to the bottom of the 7-in. receptacle before circulating at a high rate. After a drop was noticed in the standpipe pressure that suggested that the stringer holes were out of the receptacle, the procedure called for picking the tie-back string up more than 6 in. to ensure that the bottom circumferential rib was out of the stinger so that no stingers pump out of the receptacle while circulation and cementing.

Circulating continues until the fluid reaches a stable circulating temperature. At this point, cementing of the tie-back string can proceed.

Cementing

AGOCO used three approaches for

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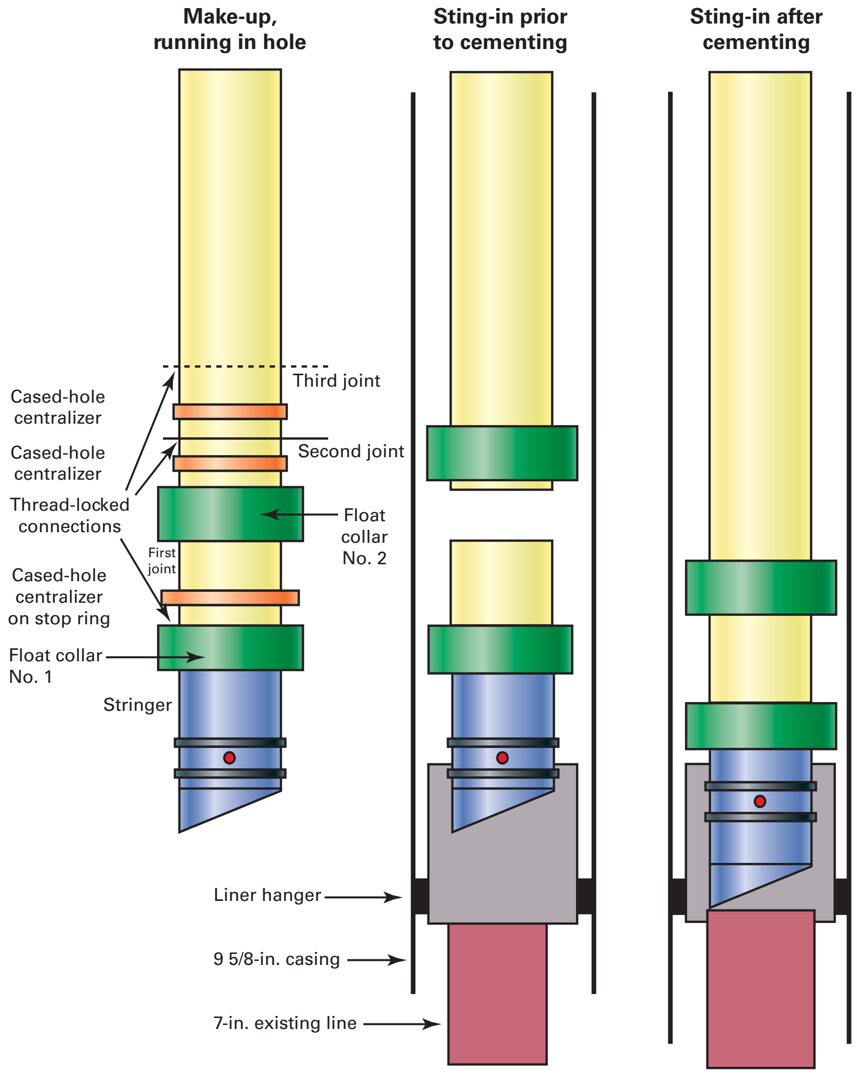
TIE-BACK STRING

Fig. 5



cementing the 7-in. tie-back string based on the respective well situation and the severity of the leak in the 9⅝-in. casing.

The first approach used single-stage cementing to bring cement to surface. This involved pumping a lightweight, 10-13.6 ppg, lead cement slurry followed by a small volume of 15.6 ppg tail slurry to ensure good cement around the 7-in. stinger and the bottom two 7-in. tie-back string joints.

This procedure called for a top and bottom cement plug preceded by and followed with good spacers. The spacers were fresh water or a chemical wash. Added friction reducer optimized the slurry cementing and displacement pressures. This approach landed the tie-back string as cemented.

The second approach involved two-stage cementing with the first stage having a slurry volume that covered the annulus to above the top of the leak in the 9⅝-in. casing. The slurry consisted of a lightweight, 10-13.6 ppg, lead cement followed by a small volume of 15.6 ppg.

This procedure required an 8-hr waiting on cement time before pumping of the second stage. This sealed off a leaky top of liner or a leaky 9⅝-in. casing. The second stage consisted of lightweight cement circulated to surface.

The third approach was short cementing. When the well had severe losses through the 9⅝-in. casing leak or the 7-in. top of liner, it indicated that the overlap was not cemented and cementing pressure could exceed the formation leak off pressure below the 9⅝-in. casing.

In this case, AGOCO used a short cementing approach in which the cement is brought to 150 ft above the 9⅝-in. casing leak and not high enough to create high pressures (high hydrostatic plus frictional circulating pressures) that may break the formation below the 9⅝-in. casing shoe.

As in the first two approaches, the third included a lightweight lead slurry followed by 15.6 ppg tail slurry to ensure good cement around the 7-in. stinger and up to 150 ft above it.

The following factors determined the cementing procedure:

- *Depth of the existing 7-in. top of liner.* A deeper liner top has higher hydrostatic and dynamic pressures imposed by the cementing operation. This may cause the breaking down of the formation below the 9⅝-in. shoe or losses to a thief zone behind the 9⅝-in. casing, leading to water influx, flash setting, pumping off the 7-in. tie-back string, or pumping off the stinger.
- *Cementing the existing 7-in. liner.* This is influenced by the overlap length and cement condition such as a leaky remedial cement squeeze. Most primary 7-in. casing cement jobs end up cementing only the reservoir zone. Shales above the reservoir may wash out severely while drilling the 8½-in. hole causing channeling of the cement slurry. Poor to no cement above the reservoir exposes the overlap.
- *The severity and depth of the 9⅝-in. casing leak.* The Paleocene H_2S water zone is thick. Some wells have very long leaking zones caused by water migrating up and down the 12½-9⅝-in. annulus.
- *Cement job duration.* The job needs to design a point of departure that accounts for all possibilities while cementing. This may lead to over-retardation, long setting times that may

cause loss of cement or Paleocene water influx.

- *Hydrostatic and dynamic pressures.* Pressures that develop during cementing can affect the liner top and leaky 9⅝-in. casing. This may open the leak further or breakdown the formation below the overlap.
- *Cement mixing water.* The water is from local water wells and has seasonally variable salinity; so the jobs require lab water tests from the respective source well.
- *Paleocene water effect on cement slurry.* Paleocene water influx may contaminate the cement or lead to flash setting of the cement, increasing displacement pressures or deteriorating the cement.
- *Cement spacer.* The design of the spacer should ensure a lengthy protection of the slurry so that it is not contaminated by existing annular fluids that may contain some of the Paleocene water.
- *Prediction of fluid and cement loss in the overlap and the leaky 9⅝-in. casing.* The design should include slurry weight and rheology that optimizes cementing and displacement pressures for mitigating fluid losses and influx. ✦

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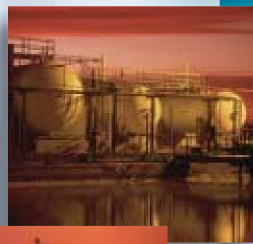

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Modeling, analysis prevent sleeve tool sticking during casing repair

Anhou Long
Shaobin Hu
Daqing Petroleum Institute
Hei Longjiang, China

Xinlin Guo
The Second Oil Production Factory
Daqing Oil Field Co. Ltd.
Hei Longjiang, China

Drilling

Increasing casing failures in Daqing oil field have aggravated damage to wells. A new method to repair these failures removes and replaces damaged casing with a sleeve milling pipe string.

This is an economic and efficient well repair method, particularly for long well sections or wells with multiple casing failure points. It is also useful in small-diameter wells with casing failures that cannot be refitted or strengthened because of the reduced diameter.

But the application and development of this technology is restricted in deep well repair because the size of sleeve tool is relatively large and the annular clearance, relatively small. This leads to the serious problem of sticking the sleeve milling pipe string.

This article derives a mathematical relation between the sticking force and the longest rest time allowable for a sleeve tool in a well. Using computation along with site operation data can guide future operations to prevent sticking the string.

Technology

Using well repair technology to withdraw and replace damaged casing, only a section of failed casing needs to be removed. The failed well section can be rehabilitated perfectly; successful restoration of deep well casing sections in the Daqing field has been nearly 100%. Leakproof pressurization tests after repair produce the same result as that of newly drilled wells. Thus, various augmented injection means can be achieved.

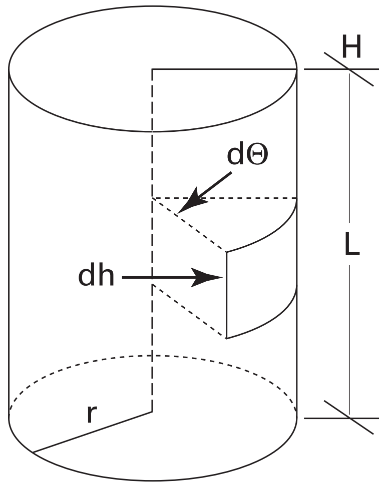
This relatively thorough well repair method will be used more and more widely in oil field development. With increasing experience and maturity, this technology will be refined and eventually applied in production sections or even used throughout the entire wellbore.

Daqing well failures

Statistics from the "eighth five years" period (1991-95) show that there were about 300 casing failures in Daqing wells, the two main types of failure being:

- Corrosion of casing in a shallow surface layer.
- Distortion (necking) and point-shear of nip-off in the nonproducing section of the argillutite (black organic shale) marker bed in the NenEer formation.

MILLING PIPE-BOREHOLE CONTACT Fig. 1



In 1998, there were 664 casing failures in wells. This increased to 700 failures in 1999, and by the end of 2000, the total number of wells with casing failure was more than 6,000.

Seven casing-failure sheet regions emerged (west of central area, west area, north-Duan east, etc.). About 50% of the producing wells in these regions have been subject to casing failure. Therefore, improving the efficiency of repairs is strategically important. The wells must be repaired quickly and effectively in order to improve oil field exploitation.

The reasons for sleeve tools getting stuck are very complex. They relate to loose strata, the reservoir pressure system, the performance of workover fluid, and other factors. The relatively

Equations

$$dA = r \times d\theta \times dh \quad (1)$$

$$\Delta P = (\rho_f g - G_{Dh}) \times h \quad (2)$$

$$dF_f = \Delta P \times dA \times f = (\rho_f g - G_{Dh}) h \times r \times d\theta \times dh \times f \quad (3)$$

$$F_f = \int dF_f$$

$$= \int_H^{H+L} \int_0^{0/2} (\rho_f g - G_{Dh}) \times r \times f \times h d\theta dh \quad (4)$$

$$= \frac{1}{2} \int_H^{H+L} (\rho_f g - G_{Dh}) \times r \times f \times \theta \times h dh$$

$$dF_a = \sigma_a \times dA = \sigma_a \times r \times d\theta \times dh \quad (5)$$

$$F_a = \int dF_a$$

$$= \int_H^{H+L} \int_0^{0/2} \sigma_a \times r \times dh \times d\theta \quad (6)$$

$$= \frac{1}{2} \int_H^{H+L} \sigma_a \times r \times \theta \times dh$$

When $Z' < Z$,

$$\theta = 2\pi - 2\theta_0 = 2\pi - 2 \arccos \frac{(R + Z' - Z - r)^2 + r^2 - (R - Z)^2}{2(R + Z' - Z - r) \times r} \quad (7)$$

When $Z' = Z$,

$$\theta = 2\pi - 2\arccos \frac{(R - r)^2 + r^2 - (R - Z)^2}{2(R - r)r} \quad (8)$$

$$\frac{dV_f}{dt} = \frac{KAP}{z\mu} \quad (9)$$

$$Z = \frac{V_f}{A\left(\frac{C_o}{C_s} - 1\right)} \quad (10)$$

$$V_f = A\sqrt{\frac{2K(\frac{C_o}{C_s} - 1)Pt}{\mu}} \quad (11)$$

$$Z = \frac{1}{\frac{C_o}{C_s} - 1}\sqrt{\frac{2K(\frac{C_o}{C_s} - 1)Pt}{\mu}} \quad (12)$$

$$F_f = \frac{1}{2}\sum_{i=1}^{L} (\rho_f g - G_{Dh}) \times r \times f \times \theta \times (H + i \times 1) \quad (13)$$

$$F_a = \frac{1}{2}\sum_{i=1}^{L} r \times \sigma_a \times \theta \times (H + i \times 1) \quad (14)$$

$$Z = \frac{1}{\frac{C_o}{C_s} - 1}\sqrt{\frac{2K(\frac{C_o}{C_s} - 1)(\rho_f g - G_{Dh})(H + i \times 1)t}{\mu}} \quad (15)$$

$$F = F_b + F_a + F_f \quad (16)$$

$$F = F_b \cos\alpha + F_f \cos\alpha + F_a \cos\alpha + F_b \sin\alpha \quad (17)$$

Nomenclature

L = Length
A = Area
dA = Infinitesimal unit area on contact face
dh = Height of the infinitesimal area
$d\theta$ = Central angle corresponding to the infinitesimal circular arc
R = External radius of milling sleeve
G_{Dh} = Average reservoir hydrostatic column pressure gradient
h = Hole depth (where the infinitesimal surface area is located)
ρ_f = Density of the workover fluid
g = Gravitational acceleration
f = Friction coefficient between the mud cake and the string
θ = Adhesive looping angle
Z = Thickness of mud cake
Z' = Depth of pipe string pressing into the mud cake
R = Radius of the wellbore
K = Permeability
V_f = Percolation ratio
t = Percolation time
P = Percolation pressure
C_o = Volume fraction of solid in mud cake
C_s = Volume fraction of solid in workover fluid
μ = Viscosity of the filter liquor
F_b = Buoyant weight of the string in the workover fluid

high density of workover fluid puts a pressure difference on the pipe string, which is the main reason that casing strings get stuck during withdrawal or replacement.

This article presents a comprehensive mathematical and mechanical analysis of the mechanism of sticking due to the pressure difference. It provides a mathematical model to calculate maximum allowable rest time and suggests corresponding preventive measures in order to prevent a string from getting stuck.

Theoretical modeling

String sticking due to a pressure difference means that a segment of the string squeezes into the mud cake and is held tightly in the mud cake by the positive differential pressure caused by the liquid head of the workover fluid and the reservoir pressure.

As a result of the interaction with mud cake and workover fluid, the string cannot move. This phenomenon mostly occurs in permeable strata, where thick mud cake is prone to develop.

Deriving and constructing a model in which string is prevented from getting stuck under the pressure difference followed these assumptions:

- The borehole face is rigid, and the influence between the string and the borehole face is considered in the friction coefficient.
- The gravitational, frictional, and adhesive forces acting on the string unit are uniformly distributed.
- The string unit for computing is regarded as a spatial circular arc curve.
- The friction coefficient, the adhesive force coefficient, and the density of workover fluid in a certain well section are regarded as constants.
- The string above the upper tangency point contacts consecutively with the borehole face.

Imagine that a section of string with a length, L, contacts the borehole face (Fig. 1). Equation 1 gives the relations based on an infinitesimal surface area dA on the contact face. Equation 2 shows the pressure difference between the workover fluid and the reservoir that acts on dA.

Several factors influence the reservoir hydrostatic column pressure gradient: fluid density, salt concentration, gas strength, and temperature gradient. High salt concentration will increase the hydrostatic column pressure gradient, and the increase of dissolved gas and the rising of temperature will make the hydrostatic column pressure gradient decrease.

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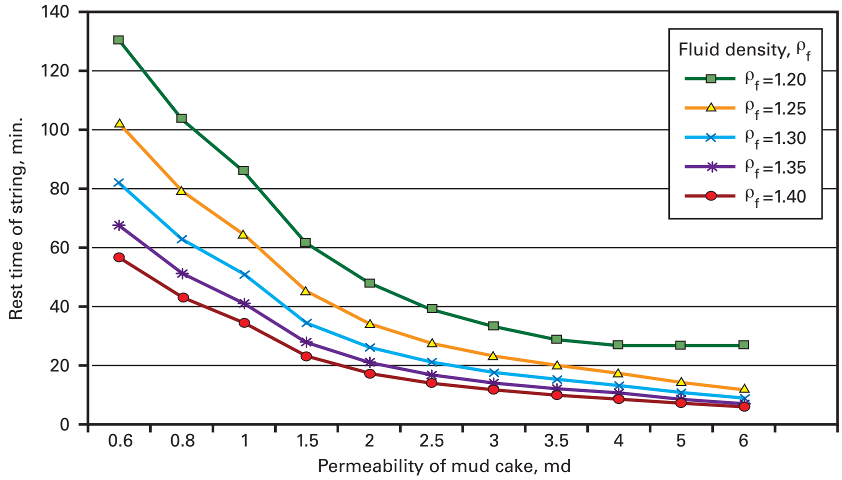
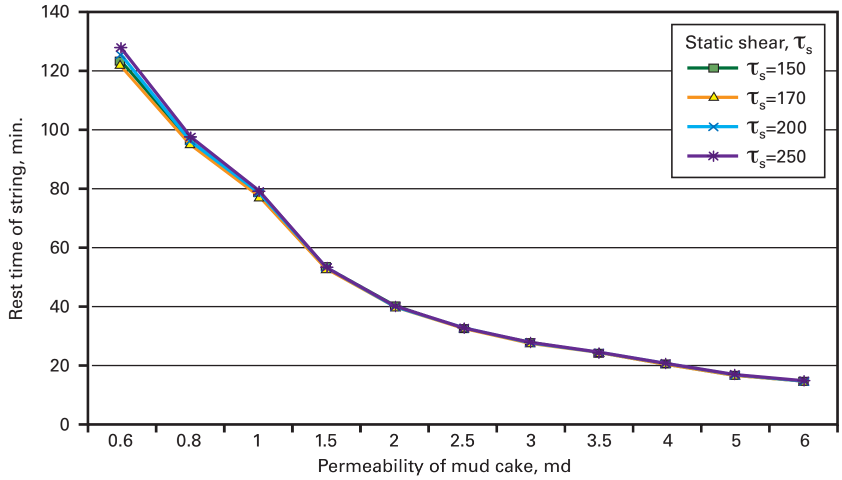
EFFECT OF WORKOVER FLUID DENSITY VARIATION

Fig. 2



EFFECT OF STATIC SHEARING VARIATION

Fig. 3



Thus, Equation 3 shows the frictional force acting on the infinitesimal surface area dA; Equation 4 shows the total frictional force.

Equation 5 shows the adhesive force acting on dA. Equation 6 shows the total adhesive force, in which θ is the adhesive looping angle associated with the thickness of the mud cake and the contact face between the string and the mud cake. With the theoretical analysis and mathematic derivation of the string pressing into the borehole face, the adhesive looping angle θ is given in Equations 7 and 8.

The thickness of mud cake is related to the performance of workover fluid and formation factors, predominantly the permeability. The magnitude of water loss of the workover fluid is the dominant factor influencing the accretion of mud cake.

Under Darcy's formula, the percolation ratio through medium can be expressed as shown in Equations 9 and 10.[1]

According to the relation between the filtrate volume of workover fluid and the solid content, Equation 11 can be drawn.

Inserting Equation 11 into Equation 10 will represent the relation between the mud cake thickness, Z, and the percolation time, t, resulting in Equation 12.

Equations 4 and 6 are the integral forms used to calculate the total friction force and adhesive force acting on the string. In practice, each meter length chosen from the contact face between the string and the borehole face can be used as the integrating block. That is, divide the entire length from top to bottom into L equal units, and the well depth corresponding to the i unit is $h = H + i \times 1 (1 \le i \le L)$. Thus Equation 13 expresses the total friction force, and Equation 14 shows the total adhesive force.

Equation 12, which calculates the thickness of mud cake, is transformed into Equation 15. Equation 16 shows the minimum "unfreezing force" required in order to prevent the string from getting stuck.

If the hole deviation angle is α, the buoyant weight of the string in the

NORTH 1-DING NO. 2-446 WELL

Table 1

Serial number	Added resistance force, kN	Well depth, m	Time interval, string movement, sec
1	30	200	9,348
2	35	352	7,717
3	40	474	5,223
4	50	650	3,866
5	85	751	3,706
6	100	798	3,388

NORTH 1-6-BING NO. 035 WELL

Table 2

Serial number	Added resistance force, kN	Well depth, m	Time interval, string movement, sec
1	20	150	9,517
2	31	335	6,694
3	36	541	4,834
4	63	660	3,990
5	71	714	3,683
6	84	758	3,631

workover fluid will change into $F_b \cos\alpha$. The friction force and the adhesive force that the sleeve tool is subjected to are $F_f \cos\alpha$ and $F_a \cos\alpha$, respectively (Equation 17). Meanwhile, the side force that the string applies on the borehole face will increase the friction force between the string and the mud cake with an increment, $F_b f \sin\alpha$, so that Equation 16 can be rewritten as Equation 17.

Applying theoretical model

First, we must solve for the rest time given the weight on hook (hook load).

The summation of friction force, F_f, and adhesive force, F_a (the added resistance force shown in Tables 1 and 2), can be acquired by use of the maximal traveling hook load obtained in the field and subtracting the buoyant weight of the string in the workover fluid. The value of F_a equals 40-60% of the interacting force between string and mud cake.[2] Then the value of F_f can be easily obtained.

Using the mathematic relation between F_f and the time, the longest rest time of string in borehole (called the "warning" time) can be solved. Operations performed within this time window will minimize, even prevent string sticking.

Tables 1 and 2 list the calculated results based on data obtained from 18 wells (North 1-Ding No. 2-446, North 1-6-Bing No. 035, et al.). The calculations were used to guide site operations. As a result, there was no sticking.

Analyze model

Next, we must analyze factors relating to the stuck string within the theoretical model.

Besides the formation parameters, there are still many significant parameters related to the workover fluid in the theoretical model. The analysis of the relative influential factors can therefore be continued.

- Looking at the effect of the permeability, K, of the mud cake:

The results of computing with the data obtained from two wells: North 1-Ding No. 2-446 and North 1-6-Bing No. 035, in the Daqing oil field show that the permeability, K, affects the rest time of string in borehole to a relatively large extent, especially when K is less than 3.0 md. The rest time will increase (greatly) as K decreases, as Fig. 2 shows.

Fig. 2 shows the relation of the density of workover fluid and the rest time (the value of ρ_f). We observed that at the same permeability, the larger the value of the workover fluid, the shorter the rest time allowed for the string in the borehole, that is to say, the more likely that the string will get stuck. When $K>5$ and $\rho_f>1.25$, for example, the rest time of the string is only 6-9 min.

- Examining the effect of static shearing force of workover fluid:

Fig. 3 shows the relations between the permeability and the static shearing force (the values of τ_s in Fig. 3) of the workover fluid and the rest time. We observed that at the same permeability, the effect of the variation of the shearing force of the workover fluid on the rest time is small. It can be drawn from the comprehensive consideration of the factors influencing the sticking of a string, therefore, that the sedimentation of sand is not the key factor.

Learnings

This article provides a derivation of the mathematical relation between the sticking force and the longest allowable rest time for a sleeve tool in a well.

The authors performed computations using site operation data from Daqing field and showed that the results can successfully guide operations work and prevent the string from getting stuck. The rate of accidentally sticking the work string declined effectively, resulting in an economic benefit and significantly improving the withdrawing and replacing of well casing.

Using both modeling and actual well experience, the authors analyzed the factors affecting the sticking of the string. We determined that the density of workover fluid and the permeability of mud cake were the main factors and that properties of the subterranean formations were of lesser influence. ✦

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Mideast site tests fiber-optic corrosion monitoring system

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Field trials in a Middle East gas processing plant have assessed a new approach to monitoring wall thickness loss caused by corrosion or erosion processes. The fiber-optic-based monitoring system was developed by Fiber-Optic Systems Technology Inc. (FOX-TEK), Toronto, and jointly field tested by the Saudi Arabian Oil Co.

The work, conducted during a joint industry program between FOX-TEK and Saudi Aramco, was designed to investigate the use of fiber-optic sensors (FOS) as a corrosion-monitoring system for hard-to-reach areas or remote locations in oil and gas installations such as gas-oil separation plants, pipelines, gas plants and refineries.

The primary objective of this program was development of a sensor system and software tool capable of monitoring WT losses, temperature, pressure, ground movement, stress corrosion crack propagation, and leak detection through laboratory testing and field trials.

The system was installed on a 12-in. x 20-in. reducer, connecting a gas feed line into a large pressurized vessel. This reducer represents one of the most difficult and complex shapes to monitor and analyze because the diameter change from top to bottom produces nonuniform stresses and there is a nonuniform thickness along and across the wall.

Ultrasonic testing (UT) technology was used to determine a baseline for the initial WT and subsequently to validate periodically the fiber-optic sensor measurements. Although the monitoring took place over the relatively short period of 6 months, a trend of WT losses was demonstrated with both technologies.

It is important to point out that the WT loss measured during the monitoring period is within the accepted error range of the UT technology. Therefore, the precision of the FOS can be verified when the thickness loss exceeds the UT error range or during destructive testing of the reducer.

The average value of remaining WT obtained by FOS measurements is a slightly lower thickness than the values obtained by UT. Nonetheless, the trend of the thickness loss is consistent for each sensor location when compared to initial and final UT readings. Therefore, these results clearly show that the FOS technology can measure WT loss and it should be used for this purpose on critical areas that require continuous or periodic monitoring.

Fig. 1a (left) shows a general view of the selected 20-in. x 12-in. reducer; Fig. 1b shows the fiber-optic sensors attached on the reducer.

Conventional technique

Most onshore and offshore oil and gas facilities, including upstream and downstream plants such as gas-oil separation plants, pipelines, and refineries rely on conventional corrosion-monitoring techniques or periodic inspection as a means of corrosion management.

In general, accuracy, frequency of data collection, and cost are significant factors for the overall corrosion monitoring or corrosion-management program. With regards to conventional corrosion-monitoring techniques, users normally rely on corrosion coupons made from materials similar to the pipes that are intended to be monitored or use intrusive corrosion-monitoring probes based on electrochemistry measurements.

Both corrosion coupons and electrochemistry-based corrosion monitoring techniques, however, depend upon the principle of corrosivity measurements of the carried media. These types of measurements may not reflect the real changes occurring to the actual pipe or vessel. In many cases, data obtained by such indirect measurement techniques are not fully reliable and may provide misleading information to operators. In the operation of a large network of oil and gas facilities, this practice creates an undesirable risk.

FOS trial

The Saudi Aramco Master Gas System, completed in the early 1980s, harnesses for domestic and world markets immense quantities of associated natural gas in Saudi Arabia's oil fields. Designed to process up to 9.9 million cu m/day (3.5 bcfd) of gas, the system furnishes fuel and feedstock for plants at the Saudi industrial cities of Yanbu' and Jubail: mainly oil refineries, petrochemical and fertilizer plants, plus a steel plant, and a rolling mill.

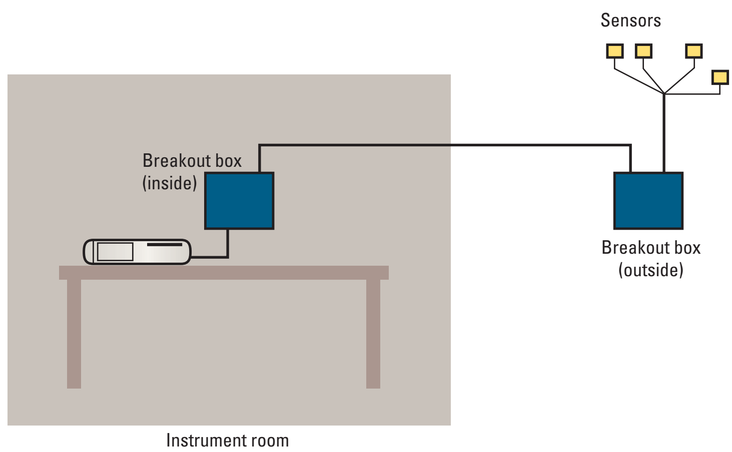
Collection of the gas begins in the kingdom's eastern oil fields, where it is separated from crude oil in one of 34 gas-oil separation plants (GOSPs) and piped to strategically located gas plants. At those plants, the gas is treated to remove sulfur compounds and carbon dioxide.

The main reason for installing the FOS system on a reducer in one of the system's gas processing plants in the Eastern Province was to identify issues related to plant operation that may not be typically encountered in laboratory testing. The 20-in. x 12-in. reducer (Fig. 1) in the de-ethanizer section of a light crude stabilization plant was selected because of a history of high corrosion rates of up to 3 mm/year (118 mpy) caused by the sour gas (C_1 = 15%; C_2 = 35%; C_3+ = 33%; CO_2 = 7%; H_2S = 10%) environment, a nominal operating pressure of 2.76 MPa (400 psig), and a typical throughput of 1.5 million cu m/day (53 MMscfd).

Because the FOS system is nonintrusive and can be installed at relatively

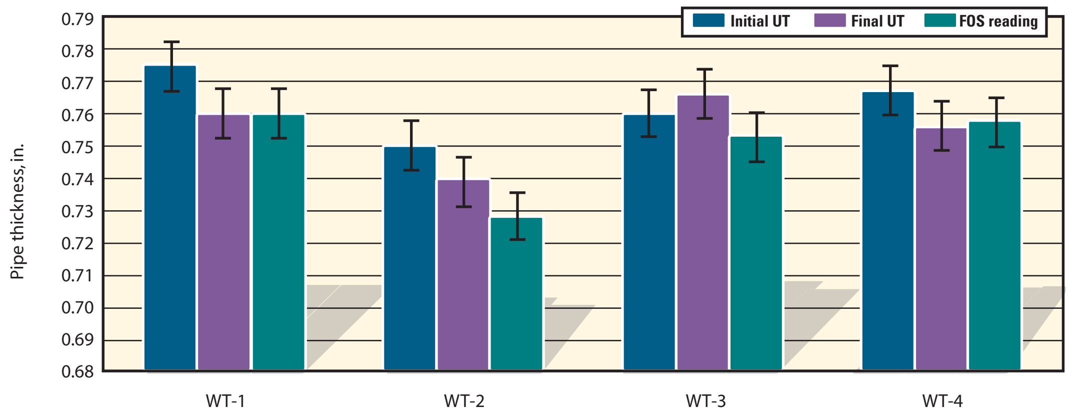
FOS installation layout

Fig. 2



Initial UT, final UT, FOS readings*

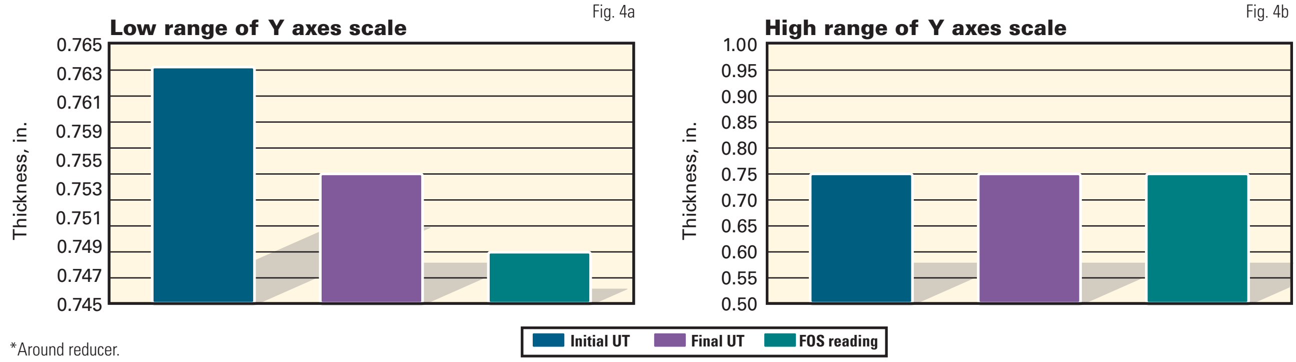
Fig. 3



*After 5 months monitoring.

AVERAGE WT AROUND REDUCER FROM OF ALL UT, FOS*

Fig. 4



*Around reducer.

high temperatures, no shutdown is required to install the sensors. Eight sensors were installed on the reducer, which is located in the inlet line of an economizer. The FOS system is designed to monitor WT losses as well as pressure and temperature changes.

Measuring pressure and temperature changes is essential because the analysis engine in the FOS system database software separates all strains caused by changes in process parameters from the strain caused by wall thinning. The WT losses of the reducer were benchmarked by monthly readings that used UT scans.

Installation

At the time of installation, because the minimum period of monitoring the wall thinning of the reducer to observe a significant loss was unknown, it was decided to set the monitoring period at 90 days. Data collected during that initial period, however, showed wall-loss values that could not be verified due to the limited sensitivity of the UT technology. The monitoring interval was subsequently extended to 6 months.

FOX-TEK, to conduct proper installation, performed a complete site survey and preparation. The survey included the following:

1. Collect data relevant to the parameter of interest, including the history of ultrasonic measurements, temperature, pressure, material grade, and pipe dimensions.

2. Ensure the presence of needed infrastructure before installation of the FOS system, including instrument room, conduit-protected optical trunk, breakout boxes, area accessibility, and surface preparation.

This preparation involved removing any insulation or protective covers from the site of interest before installation and sand blasting the locations of the intended sensors placement.

FOS MOUNTING CONFIGURATION

Table 1

Sensor no.	Type	Original location
WT-1	WT	12 o'clock position
WT-2	WT	9 o'clock position
WT-3	WT	6 o'clock position
WT-4	WT	3 o'clock position
T-1	Thermal strain	Above WT-2 (9 o'clock)
T-2	Thermal strain	Above WT-4 (3 o'clock)
Reference (pair)	Wall loss/temp	Above the reducer (12 o'clock)

The system requires placement of the FT 3405 sensor monitor inside an instrument room where AC power and a computer network are available. For an optimal set up, the FT 3405 monitor is directly connected to the network via an ethernet port so that data downloading and analysis can be carried out from any computer on the network.

The fiber-optic sensors mounted on the pipe to be monitored are connected to fiber-optic leads that run inside conduit. The conduit starts about 30 cm from the sensors and runs to the first breakout box, preferably within 10-20 m of the sensor area.

The second conduit runs from the first breakout box to the second breakout box, which is close to the FT 3405 scanner inside the instrument room. The second conduit has no minimum length and can be run several hundred meters from the first breakout box.

Fig. 2 shows a simplified schematic drawing of a typical fiber-optic system installation layout.

The first four coil sensors, configured to monitor WT, were mounted on the surface of the reducer at its mid-point at clock positions of 3, 6, 9, and 12. Two FOS temperature sensors were installed immediately above the 3 and 9 o'clock sensors to measure the local pipe thermal strain for compensation of the WT sensor readings (Table 1).

In addition to the four WT and two temperature sensors, another coil sensor was mounted on the 12-in. pipe just above the reducer to provide pressure change readings and to act as a reference sensor for WT readings. The location was selected on the basis that the 12-in. pipe has minimal wall loss.

If corrosion takes place at the reference sensor location, however, the analysis based upon the reference reading will not give the desired precision because the compensation for pressure changes will not be accurate. Therefore, to achieve high precision WT readings with FOS, reference sensor must be installed on a pipe section that is expected not to experience corrosion or the actual corrosion rate should be taken in consideration during model development and data analysis.

The fiber-optic sensor leads were guided through conduit to the first explosionproof breakout box. The sensor leads were fusion spliced to the ends of a 12-conductor fiber-optic trunk cable that had been installed earlier in a conduit run from an instrumentation room several hundred meters away.

An FT 3405 Sensor Scanner was installed in the instrumentation room and the trunk cable was connected to the front panel connectors with fusion-spliced E2000 connectors. The FT 3405 was programmed to scan each of the eight channels 10 times, once hourly, and store the data in a nonvolatile memory aboard the scanner.

The data were periodically downloaded (weekly for the purpose of this trial) to a laptop computer. The collected data were then entered in the FOX-TEK DMAT (database management and analysis tool) database software for analysis to obtain wall loss and changes in temperature and pressure.

An analytical model was developed that embodied the relationship between the surface strains at various locations on the reducer. Information from the model was entered into the database software, where changes in the sensor strains are converted into WT values. The software includes calculations that directly compensate the sensor strains for changes in pressure and temperature using values obtained from the reference sensors. The database also archived all of the raw data to facilitate tracking of historical trends and to preserve the information for further data imports.

Data compilation

A UT scan was carried out during installation of the FOS on the reducer. Table 2 shows initial readings from the UT scan. To achieve accurate results with similar components, selecting a suitable UT instrument is crucial.

The instrument should be designed by the manufacturer for the thickness gauge measurement of corroded pipes and vessels, with a good capability for eliminating interference or distortion produced by corrosion products or corroded surfaces in general.

The FOS measures displacement produced by changes of process parameters and WT of the component upon which the sensor is mounted. The scanner stores the displacement readings of each sensor.

Over the 6-month monitoring interval, the gathered FOS data were processed weekly with the database model specifically developed for this reducer. The database built within the DMAT software is another critical part of the technology. It uses the sensor strain data collected by the scanner and converts them into meaningful measurements of WT values, which become meaningful only after compensation for the pressure and temperature changes of the process after adjustment with reference sensors.

A comparison of initial and final UT readings to the FOS measurements, as determined by the DMAT software after 5 months of continuous monitoring, appears in Table 2 and Fig. 3. These results show that the fiber-optic sensors indicate a wall loss at each location.

A comparison of the FOS and final UT readings shows agreement of the wall reduction at three out of four locations. The UT measurement at sensor location WT-3 shows a WT increase; however, the change is within the acceptable accuracy for field measurements. It is important to note the overlap of the 1% error bars, which indicates the small values of WT losses during the 5-month period of monitoring.

It is believed that longer monitoring will produce more obvious data, especially when the difference in the thickness becomes higher than the UT instrument error. The precision of the FOS measurements will be clear following a longer period of monitoring.

In an attempt to generalize the wall loss across the circumference of the reducer, Figs. 4a and 4b are plotted to show the average wall losses measured by FOS and UT. The two different y-axes scales demonstrate the small amount of wall losses during the 6 months of monitoring.

It is important to note that averaging the values of different sensors is not the purpose of this technology because it is designed to monitor critical areas. Therefore, in real implementation, this

INITIAL, FINAL READINGS

Table 2

Sensor	Clock position	Initial UT	Final UT	FOS reading
		in.		
WT-1	12	0.775	0.760	0.760
WT-2	3	0.750	0.739	0.728
WT-3	6	0.760	0.766	0.753
WT-4	9	0.767	0.756	0.758

LNG Observer kicks off 2007

With the Jan. 1, 2007, issue of Oil & Gas Journal, more than 60,000 subscribers will also receive the first-quarter 2007 installment of OGJ's ***LNG Observer***, a quarterly magazine produced with the widely respected GTI, Des Plaines, Ill. This publication aims at anyone interested or involved in the natural gas and LNG business.

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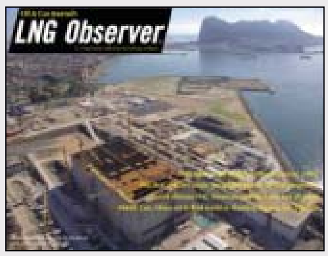

average will not be used because it may give misleading values to actual wall losses.

System benefits

The FOS system is a new approach to monitoring WT loss. The FOS system has several benefits over existing monitoring techniques as follows:

1. Nonintrusive.
2. Sensors have long operational life and are permanently bonded.
3. System continuously monitors process parameters and WT.
4. No interruption to the process was reported or needed during sensor installation or system operation.
5. Once installed, the system requires no operator attendance for routine monitoring.
6. Sensors have no moving parts and

Nelson-Farrar Cost Indexes

Refinery construction (1946 Basis)
(Explained on p.145 of the Dec. 30, 1985, issue)

	1962	1980	2003	2004	2005	Sept. 2005	Aug. 2006	Sept. 2006
Pumps, compressors, etc.	222.5	777.3	1,540.2	1,581.5	1685.5	1,701.1	1,758.6	1,777.5
Electrical machinery	189.5	394.7	522.0	516.9	513.6	513.7	524.6	530.5
Internal-comb. engines	183.4	512.6	911.7	919.4	931.1	931.0	965.7	965.7
Instruments	214.8	587.3	1,076.8	1,087.6	1,108.0	1,111.7	1,178.1	1,199.4
Heat exchangers	183.6	618.7	732.7	863.8	1,072.3	1,079.2	1,179.4	1,179.4
Misc. equip. average	198.8	578.1	956.7	993.8	1,062.1	1,067.3	1,121.3	1,130.5
Materials component	205.9	629.2	933.8	1,112.7	1,179.8	1,179.1	1,301.9	1,321.4
Labor component	258.8	951.9	,228.1	2,314.2	2,411.6	2,450.1	2,482.1	2,497.2
Refinery (Inflation) Index	237.6	822.8	1,710.4	1,833.6	1,918.8	1,941.7	2,010.0	2,026.9

Refinery operating (1956 Basis)
(Explained on p.145 of the Dec. 30, 1985, issue)

	1962	1980	2003	2004	2005	Sept. 2005	Aug. 2006	Sept. 2006
Fuel cost	100.9	810.5	934.8	971.9	1,360.2	1,637.1	1,652.4	1,491.5
Labor cost	93.9	200.5	200.8	191.8	201.9	231.9	192.6	206.8
Wages	123.9	439.9	971.8	984.0	1,007.4	1,056.7	977.7	1,046.1
Productivity	131.8	226.3	485.4	513.3	501.1	455.7	507.8	505.8
Invest., maint., etc.	121.7	324.8	643.0	686.7	716.0	724.5	744.5	750.7
Chemical costs	96.7	229.2	237.7	268.2	310.5	319.7	380.5	371.5
Operating indexes								
Refinery	103.7	312.7	464.7	486.7	542.1	583.0	583.7	576.6
*Process units**	103.6	457.5	612.5	638.1	787.2	896.1	896.7	846.8

**Add separate index(es) for chemicals, if any are used. See current Quarterly Costimating, first issue, months of January, April, July, and October.*

These indexes are published in the first issue of each month. They are compiled by Gary Farrar, Journal Contributing Editor.

Indexes of selected individual items of equipment and materials are also published on the Costimating page in the first issue of the months of January, April, July, and October.

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no cleaning is required.

7. Sensor is made of glass fiber (no metals) and carries no electrical current. The sensor carries only light; therefore it is safe for plant equipment and personnel.

8. There is no interference with other wireless or plant instruments.

Results obtained out of this work show that the fiber-optic system can monitor high rates of WT losses. The precision of the measurement will be determined in future work. Following is a list of the main findings of this work:

1. The research program produced the desired results in developing the nonintrusive fiber-optic sensor system for monitoring pressurized pipes and vessels in terms of a high rate of wall thinning and changes in temperature and pressure.

2. The FOS technology proved to be, through laboratory and field testing, a good monitoring technique for WT losses of components of the pressurized system. Therefore, this technology is a suitable choice whenever UT scans and other inspection or monitoring techniques become impractical in terms of frequency of inspection required, cost, and reliability of other techniques.

3. The FOS system is not standalone equipment that can be purchased and used without developing some expertise at undertaking site surveys for installation, development of a database for each site, and data analysis. Therefore, it requires a certain level of initial involvement with the manufacturer and technical support in most cases.

4. This FOS technology is recommended to be further explored in terms of field and laboratory trials for other applications such as leak detection, and refinery overhead line corrosion monitoring. ✦

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How refinery fuel indexes have varied

Gary Farrar
Contributing Editor

Indexes for refinery fuels

Year, quarter	PADD 1	PADD 2	PADD 3	PADD 4	PADD 5	Natural gas
	Residual fuels					
2003						
1st	1,395.4	1,144.2	1,054.8	908.3	1,384.4	4,622.1
2nd	966.3	1,364.0	864.0	1,011.7	1,155.0	4,531.6
3rd	1,025.7	1,577.9	993.9	879.3	1,293.1	4,129.6
4th	1,024.1	1,525.0	950.6	806.9	1,258.1	3,889.7
Year	**1,102.9**	**1,402.8**	**965.8**	**901.6**	**1,272.6**	**4,293.3**
2004						
1st	1,075.9	1,122.6	929.8	871.0	1,246.4	4,834.7
2nd	1,129.1	1,248.2	1,042.0	918.6	1,359.2	4,765.3
3rd	1,104.8	1,226.6	1,001.9	904.1	1,479.7	5,095.7
4th	1,212.8	1,405.2	961.8	1,121.4	1,625.6	6,592.2
Year	**1,130.7**	**1,250.7**	**983.9**	**953.8**	**1,427.7**	**5,322.0**
2005						
1st	1,228.0	1,185.4	1,005.1	933.1	1,534.2	5,333.6
2nd	1,403.0	1,570.1	1,385.0	1,200.0	1,921.1	5,986.1
3rd	1,766.7	1,772.2	1,622.3	1,324.1	2,123.3	6,554.3
4th	1,760.7	2,013.6	1,901.2	1,638.6	2,187.5	10,168.3
Year	**1,539.6**	**1,635.3**	**1,478.4**	**1,274.0**	**1,941.5**	**7,010.6**

Refinery fuels costs have endured an unsteady course since 2003. As shown in the accompanying table, most of the PADD residual fuels' increases in cost occurred in 2004 and 2005 for all five PADDs. PADD 4 experienced the least variance while PADD 3 incurred the highest variance in price over the period.

The cost for natural gas for refinery usage decreased a fair amount through 2003, and then increased during 2004 and dramatically in 2005. These conclusions are based on costs of an average refinery fuel consisting of 1 bbl each of PADDs 1-5 and an average US cost of $4.40/MMscf of natural gas (a 1 bbl equivalent on a btu content basis). Raw residual fuel oil and natural gas prices come from publications published by the US Department of Labor. Biggest variations occurred in PADDs 2, 3, and 5. PADD 4 increased during the period in yearly average to 1,274.0 from 901.6.

PADD 1's 3-year averages started with 1,102.9, increased to 1,130.7, and then reached 1,539.6. All indexes shown are based on 1956 = 100, the basis of the Nelson-Farrar Operating Index for an average US refinery. ✦

Itemized refining cost indexes

The cost indexes may be used to convert prices at any date to prices at other dates by ratios to the cost indexes of the same date. Item indexes are published each quarter (first week issue of January, April, July, and October). In addition the Nelson Construction and Operating Cost Indexes are published in the first issue of each month of Oil and Gas Journal.

Operating cost (based on 1956 = 100.0):	1954	1972	2003	2004	2005	Aug. 2006	*References	Index for earlier year in Costimating and Questions on Technology issues
Power, industrial electrical	98.5	131.2	721.3	727.9	771.3	896.0	Code 0543	No. 13, May 19, 1958
Fuel, refinery price	85.5	152.0	900.9	944.5	1,288.9	1,572.5	OGJ	No. 4, Mar. 17, 1958
Gulf cargoes	85.0	130.4	1,402.8	1,250.7	1,635.4	2,050.9	OGJ	No. 4, Mar. 17, 1958
NY barges	82.6	169.6	1,102.9	1,130.7	1,539.6	1,957.0	OGJ	No. 4, Mar. 17, 1958
Chicago low sulfur	—	—	965.8	983.9	1,478.4	1,882.0	OGJ	July 7, 1975
Western US	84.3	168.1	1,272.6	1,427.7	1,941.5	2,506.4	OGJ	No. 4, Mar. 17, 1958
Central US	60.2	128.1	901.6	953.8	1,274.0	1,737.9	OGJ	No. 4, Mar. 17, 1958
Natural gas at wellhead	83.5	190.3	4,293.3	5,322.0	7,010.6	6,040.8	Code 531-10-1	No. 4, Mar. 17, 1958
Inorganic chemicals	96.0	123.1	488.3	504.9	562.9	691.2	Code 613	Oct. 5, 1964
Acid, hydrofluoric	95.5	144.4	414.9	414.9	414.9	414.9	Code 613-0222	Apr. 3, 1963
Acid, sulfuric	100.0	140.7	383.9	397.4	397.4	397.4	Code 613-0281	No. 94, May 15, 1961
Platinum	92.9	121.1	664.8	762.1	819.3	1,434.7	Code 1022-02-73	July 5, 1965, p. 117
Sodium carbonate	90.9	119.4	315.5	310.3	357.3	455.3	Code 613-01-03	No. 58, Oct. 12, 1959
Sodium hydroxide	95.5	136.2	529.6	529.6	529.6	624.1	Code 613-01-04	No. 94, May 15, 1961
Sodium phosphate	97.4	107.0	733.7	733.7	733.7	733.7	Code 613-0267	No. 58, Oct. 12, 1959
Organic chemicals	100.0	87.4	496.9	587.9	666.5	804.6	Code 614	Oct. 5, 1964
Furfural	94.5	137.5	717.1	848.1	961.9	1,160.8	Chemical Marketing Reporter	No. 58, Oct. 12, 1959
MEK, tank-car lots	82.6	87.5	402.1	408.3	625.0	625.0	Reporter	
Phenol	90.4	47.1	333.5	339.1	411.3	361.3	Code 614-0241	No. 58, Oct. 12, 1959

Itemized refining cost indexes

Operating cost (based on 1956 = 100.0):	1954	1972	2003	2004	2005	Aug. 2006	*References	Index for earlier year in Costimating and Questions on Technology issues
Operating labor cost (1956 = 100)								
Wages & benefits	88.7	210.0	971.8	984.0	1,007.0	977.7	Employ & Earn	No. 41, Feb. 16, 1969
Productivity	97.2	197.0	485.4	513.3	501.1	507.8	Employ & Earn	No. 41, Feb. 16, 1969
Construction labor cost (1946 = 100)								
Skilled const.	174.6	499.9	2,002.5	2,077.2	2,170.8	2,227.8	Eng. News Record	No. 55, Nov. 3, 1949
Common labor	192.1	630.6	2,646.9	2,747.1	2,863.5	2,954.5	Eng. News Record	No. 55, Nov. 3, 1949
Refinery cost	183.3	545.9	2,228.1	2,314.2	2,411.6	2,482.1	OGJ	May 15, 1967
Equipment or materials (1946 = 100):								
Bubble tray	161.4	324.4	1,168.2	1,329.6	1,409.4	1,514.7	Computed	July 8, 1962, p. 113
Building materials (nonmetallic)	143.6	212.4	799.4	825.9	886.4	984.8	Code 13	No. 61, Dec. 15, 1949
Brick—building	144.7	252.5	1,190.0	1,215.8	1,301.7	1,415.0	Code 1342	No. 20, Mar. 3, 1949
Brick—fireclay	193.1	322.8	1,308.2	1,358.6	1,441.1	1,547.4	Code 135	May 30, 1955
Castings, iron	188.1	274.9	1,138.0	1,192.5	1,290.0	1,357.5	Code 1015	Apr. 1, 1963
Clay products (structural, etc.)	159.1	342.0	829.3	843.9	893.8	956.0	Code 134	No. 20, Mar. 3, 1949
Concrete ingredients	141.1	218.4	879.7	908.3	985.5	1,106.3	Code 132	No. 22, March 17, 1949
Concrete products	138.5	199.6	727.6	761.9	841.3	934.7	Code 133	Oct. 2, 1967, p. 112
Electrical machinery	159.9	216.3	522.0	516.9	513.6	524.6	Code 117	May 2, 1955
Motors and generators	157.7	211.0	782.9	796.8	839.2	900.5	Code 1173	May 2, 1955
Switchgear	171.2	271.0	1,022.9	1,045.9	1,090.0	1,146.1	Code 1175	May 2, 1955
Transformers	161.9	149.3	471.2	486.0	537.1	652.4	Code 1174	No. 31, May 19, 1949
Engines (combustion)	150.5	233.3	911.7	919.4	931.1	965.7	Code 1194	No. 36, June 23, 1949
Exchangers (composite)	171.7	274.3	732.7	863.8	1,072.3	1,179.4	Manufacturer	Mar. 16, 1964
Copper base	190.7	266.7	714.2	816.2	992.1	1,081.8	Manufacturer	Mar. 16, 1964
Carbon steel	156.8	281.9	727.6	866.1	1,080.2	1,189.4	Manufacturer	Mar. 16, 1964
Stainless steel (304)	—	—	759.9	914.3	1,119.3	1,193.3	Manufacturer	July 1, 1991
Fractionating towers	151.0	278.5	968.5	1,065.1	1,157.2	1,219.3	Computed	June 8, 1963, p. 133
Hand tools	173.8	346.5	1,609.9	1,651.7	1,722.1	1,796.4	Code 1042	June 27, 1955
Instruments (composite)	154.6	328.4	1,076.8	1,087.6	1,108.0	1,178.1	Computed	No. 34, June 9, 1949
Insulation (composite)	198.5	272.4	2,208.7	2,230.4	2,228.6	2,240.2	Manufacturer	July 4, 1988, p. 193
Lumber (composite):	197.8	353.4	1,208.8	1,417.9	1,359.6	1,260.3	Code 81	No. 7, Dec. 2, 1948
Southern pine	181.2	303.9	831.4	1,040.7	998.6	888.2	Code 81102	No. 7, Dec. 2, 1948
Redwood, all heart	238.0	310.6	1,743.8	2,145.1	2,057.9	1,830.7	Code 811-0332	July 5, 1965, p. 117
Machinery								
General purpose	159.9	278.5	1,076.1	1,106.7	1,163.6	1,225.5	Code 114	Feb. 17, 1949
Construction	165.9	324.4	1,361.6	1,407.3	1,499.2	1,557.7	Code 112	Apr. 1, 1968, p. 184
Oil field	161.9	269.1	1,295.5	1,333.0	1,454.8	1,616.1	Code 1191	Oct. 10, 1955
Paints—prepared	159.0	231.8	883.0	907.4	975.3	1,051.4	Code 621	May 16, 1955
Pipe								
Gray iron pressure	195.0	346.9	1,980.1	2,301.2	2,580.2	2,738.9	Code 1015-0239	Jan. 3, 1983
Standard carbon	182.7	319.9	1,298.3	1,900.0	2,217.3	2,339.1	Code 1017-0611	Jan. 3, 1983
Pumps, compressors, etc.	166.5	337.5	1,540.2	1,581.5	1,685.5	1,758.6	Code 1141	No. 29, May 5, 1949
Steel-mill products	187.1	330.6	969.9	1,300.6	1,409.1	1,616.7	Code 1017	Jan. 3, 1983
Alloy bars	198.7	349.4	842.1	1,050.1	1,146.8	1,641.8	Code 1017-0831	Apr. 1, 1963
Cold-rolled sheets	187.0	365.5	1,095.1	1,278.4	1,462.5	1,764.5	Code 1017-0711	Jan. 3, 1983
Alloy sheets	177.0	225.9	547.1	665.0	760.3	917.6	Code 1017-0733	Jan. 3, 1983
Stainless strip	169.0	221.2	566.0	710.0	811.6	980.0	Code 1017-0755	Jan. 3, 1983
Structural carbon, plates	193.4	386.7	1,025.1	1,493.7	1,654.5	1,823.4	Code 1017-0400	Jan. 3, 1983
Welded carbon tubing	180.0	265.5	1,315.5	1,925.0	2,246.8	2,370.1	Code 1017-0622	Jan. 3, 1983
Tanks and pressure vessels	147.3	246.4	789.7	868.7	974.4	1,023.0	Code 1072	No. 5, Nov. 18, 1949
Tube stills	123.0	125.3	410.0	503.5	540.5	603.6	Computed	Oct. 1, 1962
Valves and fittings	197.0	350.9	1,608.7	1,660.6	1,738.2	1,866.3	Code 1149	No. 46, Sept. 1, 1940
Nelson-Farrar Refinery (Inflation Index)								
(1946)	179.8	438.5	1,710.4	1,833.6	1,918.8	2,010.0	OGJ	May 15, 1969
Nelson-Farrar Refinery Operation								
(1956)	88.7	118.5	464.7	486.7	542.1	583.7	OGJ	No. 2, Mar. 3, 1958
Nelson-Farrar Refinery Process								
(1956)	88.4	147.0	612.5	638.1	787.2	896.7	OGJ	No. 2, Mar. 3, 1958

*Code refers to the index number of the Bureau of Statistics, US Department of Labor, "Wholesale Prices" Itemized Cost Indexes, Oil & Gas Journal.

ENVIRONMENTAL MITIGATION—1

Monitoring, analysis show rapid Gulf of Mexico seafloor recovery

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Hard-live bottom areas affected by the 2001 construction of Gulfstream Natural Gas System LLC's 36-in., 419-mile offshore pipeline between Mobile Bay, Ala. and Tampa Bay, Fla. have largely recovered, in the face of permitting expectations that this process would take roughly 100 years.

The term "hard-live bottom" refers to seafloor that is both hard (as opposed to such other possibilities as sandy, silty, etc.) and life-sustaining. Community structure does not appear to be significantly different between reference and affected areas. Visible disturbance also appears to be minimal as compared to predicted effects.

Background

Hard-live bottom makes up the most significant and sensitive marine benthic resource in the federal waters portion of the Gulfstream pipeline (Fig. 1). Gulfstream conducted numerous pre-construction field investigations of the biological distribution and physical characteristics of hard-live bottom near the pipeline route and reduced potential damage through not only its siting efforts but also use of technologies such as the submarine plow and the deployment of buoys on construction barge anchor cables.

US Army Corps of Engineers and Minerals Management Service permits and Federal Energy Regulatory Commission certificate requirements obligated Gulfstream to measure and mitigate effects of the construction of the marine pipeline and to monitor the recovery of affected areas.

Before construction, Gulfstream prepared a federal mitigation plan that established the monitoring and mitigation protocols to be implemented to satisfy permit conditions. This plan required Gulfstream to conduct monitoring activities to determine the extent and severity of project construction effects on hard-live bottom areas within the trench corridor and associated spoil mounds and anchor strike-cable sweep locations.

Part 1 of this article, presented here, details the methodology of Gulfstream's monitoring activities. Subsequent parts will discuss the results of its monitoring program and examine the use of pipeline habitat replacement structures by fish and epifauna.

Gulfstream established and monitored random 25-m transects perpendicular to the trench corridor and spoil mounds, within identified anchor strike and cable sweep locations in hard-live bottom areas, and also in unaffected hard-live bottom reference habitats.

Design stratification

The federal mitigation plan considered depth to be a key variable in hard-live bottom recovery due to the specifications of pipeline siting and biological community characteristics. In waters less than 200-ft deep, Gulfstream lowered the pipeline into an excavated trench with the expectation that the trench spoil would naturally backfill over time. During construction, hard substrate in some areas prevented excavation of a trench with a postlay plow. Pipeline anchors stabilized these portions of the pipeline. Plans did not require the pipeline to be trenched beyond the 200-ft contour.

The hard-live bottom habitat at all water depths along the route generally consists of low-relief algal sponge communities of algae, sponges, bryozoans, ascideans, and ahermatypic hard corals, with octocorals dominant in shallower depths.

To assess potential depth-related effects on hard-live bottom recovery, Gulfstream stratified the monitoring design into three depth zones; Depth

Based on paper presented at International Pipeline Conference (ASME), Calgary, Sept. 25-29, 2006.

Zone 1 (40-70 ft), Depth Zone 2 (70-100 ft), and Depth Zone 3 (100-200 ft). Gulfstream did not visit depths beyond the 200-ft contour during the 2005 assessment due to above-average hurricane activity.

GULFSTREAM NATURAL GAS SYSTEM, GULF OF MEXICO SEGMENT

Fig. 1

Monitoring equipment

The scope of the 2005 field survey required use of monitoring vessels, depth profilers, differential global positioning systems (DGPS), navigational software, remotely operated vehicles (ROV) with video cameras, and underwater digital still camera systems.

- *Monitoring vessels*. The Tracy Gayle (30-ft vessel for shallow water surveys) and Miss Casey (62-ft vessel for deepwater surveys) performed survey operations during the 2005 monitoring effort. Both vessels used the following survey equipment, as well as a boom arm extension to which a hydrophone was fixed to receive transmissions from the underwater trackpoint system.
- *Depth profiler (single beam)*. A single-frequency (340 kilo-hz) Odom Hydrotrac depth sounder provided depth profiles.
- *DGPS*. An Ashtech BR2G DGPS receiver established positioning of the monitoring vessel using US Coast Guard differentially corrected signals transmitted from Egmont Key, Fla. (Radio Beacon ID 812). The Tracy Gayle also used the Furuno GPS system.
- *Navigational software*. A Hypack integrated navigation system (INS) performed survey pre-plotting, positioning tasks, and provided a display allowing the survey vessel helmsman to navigate the survey transects and ROV positioning.
- *ROV*. A Phantom S2 remotely operated vehicle collected all video data unless otherwise specified. The ROV uses a high-resolution video camera to quantify sampling stations (e.g., transects, boundary delineations) and document general site conditions. Hypack navigational software, coupled with the ROV Trackpoint system, allowed for real-time positioning information.
- *Digital still camera*. An Olympus Camedia C-5060 wide-angle digital camera with 5.1 megapixel capacity collected transect and photostation photographs. An Olympus PT-020 underwater housing with a retractable rod affixed to the bottom of the housing held the camera.

The retractable rod allowed divers to accurately maintain a fixed distance from the seafloor during photograph collection and subsequently maintain a fixed scale in each transect photograph for analysis.

The camera flash and two diver lights mounted on the camera housing provided lighting for the transect photographs.

Transect establishment

Gulfstream established a total of 136 transects within the stratified depth zones in compliance with the federal mitigation plan (Table 1). All transects contained hard-live bottom habitat. Survey divers collected photograph transect data in Depth Zone 1. Either survey divers or ROV collected transect data in Depth Zones 2 and 3.

The analysis used randomly selected 25-m transect lengths within both affected and unaffected hard-live bottom areas to facilitate comparison. Gulfstream established the random transects perpendicular to the pipeline to assess trenched pipeline corridor, reference habitat, and anchor strike areas.

Transect coordinates provided to the field survey crews and entered into the vessel's navigation system before deployment allowed the survey vessel to navigate to the appropriate locations, where either survey divers or ROV were deployed.

Survey divers navigated to each Depth Zone 1 transect coordinate end point and established a transect end point marker. After establishing the transect end points, survey divers

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measured each transect with a weighted tape measure to verify the transect length.

In Depth Zones 2 and 3, survey divers used one end point coordinate and a defined azimuth for each transect. After navigating to the end point, survey divers extended a weighted tape measurer 25 m along the defined azimuth direction and established the second transect end point. The digital still camera then collected photographs along the transect length.

Collecting sequential, overlapping photographs that contained a clear view of the tape measure within each frame ensured complete transect coverage and photograph position references. An ROV first navigated to one transect end point coordinate utilizing the Hypack Integrated Navigation System to ensure accurate positioning. Once at the end point, the ROV navigated down the length of each transect, collecting video 2 ft above the seafloor. The ROV's two-point laser system ensured consistent height above the substrate.

Reference habitat transects represent delineated hard-live bottom areas close to the pipeline corridor but not affected by project construction activities. These transects serve as a reference for statistical comparison to affected hard-live bottom areas. Comparisons between the two allowed assessment of the effect of pipeline construction.

Delineating of hard-live bottom areas relatively close to the pipeline route took place before pipeline construction, during the permitting phase of the project. The survey team entered hard-live bottom polygons, the pipeline corridor route, and depth-zone demarcations into a GIS. Unaffected hard-live bottom polygons outside the pipeline corridor served as potential reference habitat transect locations. GIS then randomly selected 10 transect coordinates per depth zone.

Routing the pipeline to avoid large areas of hard-live bottom minimized potential effects on these areas within the trenched pipeline corridor. Further precautions included use of construction methods determined to significantly reduce hard-live bottom damage during pipeline lowering.

Plans called for the pipeline to be placed in an excavated trench 3 ft below the natural seafloor elevation in water less than 200-ft deep. This approach would provide pipeline stability under severe storm conditions based on storm models. Predictions foresaw trenching impacts 75-ft wide, based on a 25-ft wide trench corridor, with associated spoil mounds spreading 25 ft to either side of the trench. The anticipation that the trench would backfill through natural sediment transport made backfilling in federal waters unnecessary. Plans did not require trenching the pipeline corridor in water more than 200-ft deep.

TRANSECTS MONITORED

Table 1

Depth zone	Area type	Number of random transects, 25 m
1: 40-70 ft	Trench corridor	10
	Trench spoil mound	10
	Reference habitat	10
	Anchor strike	17
2: 70-100 ft	Trench corridor	10
	Trench spoil mound	13
	Reference habitat	10
	Anchor strike	16
3: 100-200 ft	Trench corridor	10
	Trench spoil mound	10
	Reference habitat	10
	Anchor strike	10
	Total	**136**

Gulfstream divided the assessment of hard-live bottom affected by pipeline trenching between the trench corridor and the associated trench spoil mounds. Spoil containing rock would serve as hard substrate for epifaunal-epifloral colonization. Independently collecting and analyzing transects within each category determined the amount of damage and recovery attributed to each feature.

Preconstruction studies indicated that some hard-live bottom would be affected during construction as a result of mooring the lay barge and plow barge. Vessel anchors can affect hard-live bottom when anchors are placed, set, and lifted from the seafloor. Anchor cables can also affect benthic habitats when the barges are winched forward with anchors in place.

A portion of the heavy anchor cable rests and sweeps along the seafloor in an arc as the barge is pulled ahead. Gulfstream minimized potential damage from anchor handling by attempting to place the anchors in areas where hard-live bottom did not occur and by using midline buoys on anchor cables to minimize the size of cable sweeps.

The federal mitigation plan required postconstruction monitoring at up to 25 anchor strike and cable sweep locations documented to have occurred in hard-live bottom areas.

Data recorded by the anchor-handling vessel's onboard computer identified potential anchor strike and cable sweep locations based on construction-collected coordinates. Identifying each anchor drop and lift location with a unique number produced a pair of coordinates for each anchor drop-lift event and associated cable sweep.

Overlaying these coordinate pairs on the affected hard-live bottom polygons in GIS generated a list of potential anchor strike or cable sweep locations. Postconstruction side-scan sonar records, examined for evidence of seafloor disturbance from anchors or anchor cables, also identified anchor strike and cable sweep locations. A random-selection process then determined locations to be visited for monitoring.

Divers or the ROV deployed at each random transect location searched for evidence of seafloor disturbance attributable to anchors and anchor cables. Evidence of damage would prompt measurement of the affected area's areal extent and establishment of transects within the affected area.

If no disturbance was identified at or near the given location, the divers or ROV searched the periphery of the area in order to survey all potentially affected areas. Failure to find evidence of damage after all of these steps had been taken would prompt the assumption that the area had recovered naturally over time.

Acknowledgments

Erik Danielson of ENSR provided GIS support for the monitoring and reporting processes during the Gulfstream project. We also acknowledge Tracy Gayle Charters of Holmes Beach, Fla., for its vessel and diving support during the survey period and Walt Jaap, formerly of the Florida Fish and Wildlife Research Institute, for his support with field operations and review of this work. ✦

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Correction

The article "Multiproduct software sets optimal pump use," by Liang Yongtu, (OGJ, Dec. 4, 2006, p. 53) incorrectly identified the operator of the Luwan pipeline as China National Petroleum Co (CNPC). Luwan is operated by China Petrochemical Corp. (Sinopec).

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New seal for pumps in light hydrocarbon service

Here's the QBQ LZ contacting-face mechanical seal, featuring Precision Face Topography and its patented wavy face seal design. The unit promises high-reliability sealing with low emissions and is suited for pumps in light hydrocarbon service at low vapor pressure margins.

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Source: **Flowserve Corp.**, 5215 N. O'Connor Blvd., Suite 2300, Irving, TX 75039.

New flowmeter handles custody transfer

The new AutoFLOW ultrasonic liquid flow measurement system is an in-line multipath transit time flowmeter used mainly for custody transfer of products.

It features a patented transducer technology and a rugged, compact design to maximize instrument accuracy, operator safety, and cost-effective facility operations, the firm says. The system's combination of performance and safety features are suited for onshore and offshore installations.

AutoFLOW's ultrasonic technology and patented, intrinsically safe transducer design eliminate the possibility of sparks, the company notes. The system's spool offers ATEX Zone 0 intrinsically safe certification that allows it to be used in the world's most hazardous environments. The flowmeter also interfaces seamlessly with existing Class 1 Division 1 installations.

The AutoFLOW features four-path transit time technology that delivers the highest attainable accuracy on virtually all liquid petroleum products, the firm points out.

Source: **Thermo Electron Corp.**, 81 Wyman St., Waltham, MA 02454.

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API IMPORTS OF CRUDE AND PRODUCTS

	Districts 1-4 12-15 2006	Districts 1-4 [1]12-8 2006	District 5 12-15 2006	District 5 [1]12-8 2006	Total US 12-15 2006	Total US [1]12-8 2006	Total US 12-16 2005
	1,000 b/d						
Total motor gasoline	375	267	8	18	383	285	343
Mo. gas. blending comp.	527	656	8	7	535	663	496
Distillate[2]	356	393	15	19	371	412	369
Residual	212	242	44	42	256	284	399
Jet fuel-kerosine	104	152	106	110	210	262	77
LPG	332	315	0	0	332	315	345
Unfinished oils	528	521	76	79	604	600	430
Other	337	564	16	8	353	572	746
Total products	**2,771**	**3,110**	**273**	**283**	**3,044**	**3,393**	**3,205**
Canadian crude	1,616	1,682	165	303	1,781	1,985	1,578
Other foreign	6,346	7,621	715	809	7,061	8,430	8,300
Total crude	**7,962**	**9,303**	**880**	**1,112**	**8,842**	**10,415**	**9,878**
Total imports	**10,733**	**12,413**	**1,153**	**1,395**	**11,886**	**13,808**	**13,083**

[1]Revised. [2]Includes No. 4 fuel oil.
Source: American Petroleum Institute.
Data available in OGJ Online Research Center.

Additional analysis of market trends is available through **OGJ Online**, *Oil & Gas Journal's* electronic information source, at http://www.ogjonline.com.

OIL&GAS JOURNAL online research center.

OGJ CRACK SPREAD

	*12-15-06	*12-16-05	Change	Change, %
	$/bbl			
SPOT PRICES				
Product value	70.80	70.48	0.32	0.5
Brent crude	62.40	58.77	3.63	6.2
Crack spread	8.40	11.71	–3.32	–28.3
FUTURES MARKET PRICES				
One month				
Product value	70.63	71.07	–0.44	–0.6
Light sweet crude	61.91	60.31	1.60	2.7
Crack spread	8.72	10.76	–2.04	–19.0
Six month				
Product value	77.89	75.08	2.81	3.7
Light sweet crude	65.41	62.90	2.51	4.0
Crack spread	12.48	12.19	0.29	2.4

*Average for week ending
Source: Oil & Gas Journal.
Data available in OGJ Online Research Center.

API CRUDE AND PRODUCT STOCKS

	Crude oil	Motor gasoline Total	Motor gasoline Blending comp.[2]	Jet fuel Kerosine	Fuel oils Distillate	Fuel oils Residual	Unfinished oils
	1,000 bbl						
PAD I	14,418	50,801	23,190	9,911	63,841	18,772	8,342
PAD II	69,156	51,896	16,389	7,284	25,010	2,201	12,385
PAD III	171,014	63,734	26,716	13,159	33,281	17,071	42,528
PAD IV	14,374	6,082	2,079	475	2,541	430	3,663
PAD V	[1]52,511	27,308	20,950	7,530	10,539	5,880	20,729
Dec. 15, 2006	**[1]321,473**	**199,821**	**89,324**	**38,359**	**135,212**	**44,354**	**87,647**
Dec. 8, 2006[3]	**325,799**	**200,121**	**88,882**	**39,021**	**136,630**	**43,764**	**88,888**
Dec. 16, 2005	**324,623**	**203,646**	**68,116**	**43,553**	**129,855**	**38,347**	**90,606**

[1]Includes 8.745 million bbl of Alaskan crude in transit by water. [2]Included in total motor gasoline. [3]Revised.
Source: American Petroleum Institute.
Data available in OGJ Online Research Center.

API REFINERY REPORT—DEC. 15, 2006

District	Refinery operations: Total refinery input	Crude runs	Input to crude stills	Operable capacity	Percent operated	Refinery output: Total motor gasoline	Jet fuel, kerosine	Fuel oils Distillate	Fuel oils Residual
	1,000 b/d					1,000 b/d			
East Coast	3,346	1,420	1,438	1,618	88.9	1,764	95	493	95
App. Dist. 1	100	95	95	95	100.0	9	0	27	1
Dist. 1 total	**3,446**	**1,515**	**1,533**	**1,713**	**89.5**	**1,773**	**95**	**520**	**96**
Ind., Ill., Ky.	2,143	2,131	2,133	2,355	90.6	1,314	124	536	53
Minn., Wis., Dak.	394	390	394	442	89.1	304	36	124	11
Okla., Kan., Mo.	874	701	712	786	90.6	515	42	285	6
Dist. 2 total	**3,411**	**3,222**	**3,239**	**3,583**	**90.4**	**2,133**	**202**	**945**	**70**
Inland Texas	973	581	620	647	95.8	446	46	164	8
Texas Gulf Coast	3,949	3,420	3,432	4,031	85.1	1,247	321	793	142
La. Gulf Coast	3,459	3,231	3,247	3,264	99.5	1,282	337	848	162
N. La. and Ark.	219	190	195	215	90.7	83	10	48	5
New Mexico	156	85	90	113	79.7	101	2	33	0
Dist. 3 total	**8,756**	**7,507**	**7,584**	**8,270**	**91.7**	**3,159**	**716**	**1,886**	**317**
Dist. 4 total	**686**	**544**	**548**	**596**	**92.0**	**313**	**22**	**161**	**17**
Dist. 5 total	**2,738**	**2,626**	**2,736**	**3,173**	**86.2**	**1,740**	**403**	**615**	**125**
Dec. 15, 2006	**19,037**	**15,414**	**15,640**	**17,335**	**90.2**	**9,118**	**1,438**	**4,127**	**625**
Dec. 8, 2006*	**18,657**	**15,231**	**15,578**	**17,335**	**89.9**	**9,084**	**1,491**	**4,147**	**583**
Dec. 16, 2005	**16,820**	**14,905**	**15,365**	**17,115**	**89.8**	**8,662**	**1,475**	**4,043**	**595**

*Revised.
Source: American Petroleum Institute.
Data available in OGJ Online Research Center.

OGJ gasoline prices

	Price ex tax 12-13-06	Pump price* 12-13-06	Pump price 12-14-05
	¢/gal		
(Approx. prices for self-service unleaded gasoline)			
Atlanta	180.6	220.3	215.8
Baltimore	178.8	220.7	214.4
Boston	179.1	221.0	207.4
Buffalo	184.3	244.4	212.0
Miami	192.7	243.0	217.4
Newark	181.5	214.4	217.3
New York	174.9	235.0	220.8
Norfolk	177.4	215.0	220.1
Philadelphia	187.3	238.0	222.5
Pittsburgh	176.2	226.9	219.5
Wash., DC	192.2	230.6	222.5
PAD I avg	182.3	228.1	217.3
Chicago	223.6	274.5	231.0
Cleveland	177.3	223.7	208.9
Des Moines	177.5	217.9	207.5
Detroit	180.5	229.7	210.2
Indianapolis	182.6	227.6	211.5
Kansas City	180.7	216.7	210.1
Louisville	184.8	221.7	208.5
Memphis	173.8	213.6	216.6
Milwaukee	186.4	237.7	218.7
Minn.-St. Paul	182.4	222.8	216.4
Oklahoma City	174.1	209.5	206.1
Omaha	177.5	223.9	213.4
St. Louis	181.7	217.7	217.0
Tulsa	173.2	208.6	205.7
Wichita	176.3	219.7	206.8
PAD II avg	182.1	224.3	212.6
Albuquerque	187.9	224.3	211.0
Birmingham	187.2	225.9	210.2
Dallas-Fort Worth	180.1	218.5	209.6
Houston	174.9	213.3	207.6
Little Rock	182.5	222.7	210.4
New Orleans	181.7	220.1	252.1
San Antonio	178.6	217.0	214.5
PAD III avg	181.9	220.3	216.5
Cheyenne	185.3	217.7	209.6
Denver	172.3	212.7	219.6
Salt Lake City	184.9	227.8	214.8
PAD IV avg.	180.8	219.4	214.7
Los Angeles	186.3	244.8	227.2
Phoenix	187.3	224.7	225.2
Portland	199.6	242.9	222.3
San Diego	191.3	249.8	231.3
San Francisco	209.3	267.8	234.3
Seattle	211.2	263.6	225.3
PAD V avg.	197.5	248.9	227.6
Week's avg.	**184.2**	**227.8**	**216.7**
Nov. avg.	**180.1**	**223.7**	**229.9**
Oct. avg.	**183.8**	**228.0**	**263.9**
2006 to date	**213.3**	**256.9**	—
2005 to date	**181.9**	**223.9**	—

*Includes state and federal motor fuel taxes and state sales tax. Local governments may impose additional taxes.
Source: Oil & Gas Journal.
Data available in OGJ Online Research Center.

Refined product prices

	12-8-06 ¢/gal		12-8-06 ¢/gal
Spot market product prices			
		Heating oil	
Motor gasoline		No. 2	
(Conventional-regular)		New York Harbor	169.74
New York Harbor	161.70	Gulf Coast	167.74
Gulf Coast	157.20	Gas oil	
Los Angeles	171.45	ARA	173.45
Amsterdam-Rotterdam-		Singapore	167.86
Antwerp (ARA)	153.96		
Singapore	158.33	Residual fuel oil	
Motor gasoline		New York Harbor	95.76
(Reformulated-regular)		Gulf Coast	104.76
New York Harbor	160.45	Los Angeles	126.27
Gulf Coast	155.95	ARA	95.55
Los Angeles	179.45	Singapore	103.47

Source: DOE Weekly Petroleum Status Report.
Data available in OGJ Online Research Center.

Baker Hughes rig count

	12-15-06	12-16-05
Alabama	5	6
Alaska	9	10
Arkansas	35	16
California	33	31
Land	30	27
Offshore	3	4
Colorado	90	80
Florida	0	2
Illinois	0	0
Indiana	0	0
Kansas	13	7
Kentucky	8	6
Louisiana	187	167
N. Land	60	50
S. Inland waters	21	20
S. Land	40	35
Offshore	66	62
Maryland	0	0
Michigan	2	1
Mississippi	17	6
Montana	20	23
Nebraska	0	0
New Mexico	91	95
New York	10	6
North Dakota	35	24
Ohio	10	9
Oklahoma	177	153
Pennsylvania	19	17
South Dakota	1	1
Texas	781	652
Offshore	10	6
Inland waters	4	1
Dist. 1	18	20
Dist. 2	23	29
Dist. 3	61	54
Dist. 4	96	66
Dist. 5	144	111
Dist. 6	124	109
Dist. 7B	36	23
Dist. 7C	48	35
Dist. 8	97	73
Dist. 8A	27	27
Dist. 9	37	32
Dist. 10	56	66
Utah	45	29
West Virginia	32	25
Wyoming	87	93
Others—HI-1; ID-1; NV-1; TN-3; VA-2; WA-1	9	4
Total US	**1,716**	**1,463**
Total Canada	**497**	**649**
Grand total	**2,213**	**2,112**
Oil rigs	278	237
Gas rigs	1,433	1,222
Total offshore	81	74
Total cum. avg. YTD	**1,646**	**1,379**

Rotary rigs from spudding in to total depth.
Definitions, see OGJ Sept. 18, 2006, p. 42.

Source: Baker Hughes Inc.
Data available in OGJ Online Research Center.

Smith rig count

Proposed depth, ft	12-15-06 Rig count	12-15-06 Percent footage*	12-16-05 Rig count	12-16-05 Percent footage*
0-2,500	46	—	22	—
2,501-5,000	112	49.1	92	42.3
5,001-7,500	219	18.2	184	22.8
7,501-10,000	424	3.3	318	4.4
10,001-12,500	412	2.6	341	2.3
12,501-15,000	256	0.3	309	—
15,001-17,500	121	0.8	97	—
17,501-20,000	80	—	57	—
20,001-over	34	—	26	—
Total	**1,704**	**7.1**	**1,446**	**7.1**
INLAND	32		33	
LAND	1,613		1,361	
OFFSHORE	59		52	

*Rigs employed under footage contracts.
Definitions, see OGJ, Sept. 18, 2006, p. 42.

Source: Smith International Inc.
Data available in OGJ Online Research Center.

OGJ production report

	[1]12-15-06	[2]12-16-05
	1,000 b/d	
(Crude oil and lease condensate)		
Alabama	20	21
Alaska	807	845
California	705	693
Colorado	59	60
Florida	7	7
Illinois	30	28
Kansas	96	92
Louisiana	1,402	1,067
Michigan	15	14
Mississippi	53	49
Montana	93	97
New Mexico	165	162
North Dakota	104	104
Oklahoma	174	166
Texas	1,390	1,281
Utah	44	48
Wyoming	142	140
All others	66	74
Total	**5,372**	**4,948**

[1]OGJ estimate. [2]Revised.

Source: Oil & Gas Journal.
Data available in OGJ Online Research Center.

US crude prices

$/bbl*	12-15-06
Alaska-North Slope 27°	49.52
South Louisiana Sweet	59.25
California-Kern River 13°	61.65
Lost Hills 30°	59.40
Wyoming Sweet	60.43
East Texas Sweet	60.66
West Texas Sour 34°	51.25
West Texas Intermediate	60.00
Oklahoma Sweet	60.00
Texas Upper Gulf Coast	56.75
Michigan Sour	53.00
Kansas Common	59.00
North Dakota Sweet	50.00

*Current major refiner's posted prices except North Slope lags 2 months. 40° gravity crude unless differing gravity is shown.

Source: Oil & Gas Journal.
Data available in OGJ Online Research Center.

World crude prices

$/bbl[1]	12-8-06
United Kingdom-Brent 38°	64.37
Russia-Urals 32°	59.79
Saudi Light 34°	57.95
Dubai Fateh 32°	60.21
Algeria Saharan 44°	64.51
Nigeria-Bonny Light 37°	65.52
Indonesia-Minas 34°	62.26
Venezuela-Tia Juana Light 31°	58.13
Mexico-Isthmus 33°	58.02
OPEC basket	60.94
Total OPEC[2]	59.41
Total non-OPEC[2]	57.36
Total world[2]	58.21
US imports[3]	55.55

[1]Estimated contract prices. [2]Average price (FOB) weighted by estimated export volume. [3]Average price (FOB) weighted by estimated import volume.

Source: DOE Weekly Petroleum Status Report.
Data available in OGJ Online Research Center.

US natural gas storage[1]

	12-8-06	12-1-06	Change
	Bcf		
Producing region	955	1,010	–55
Consuming region east	1,853	1,946	–93
Consuming region west	430	450	–20
Total US	**3,238**	**3,406**	**–168**
	Sept. 06	Sept. 05	Change, %
Total US[2]	**3,323**	**2,932**	**13.3**

[1]Working gas. [2]At end of period.
Note: Current data not available.
Source: Energy Information Administration
Data available in OGJ Online Research Center

World oil balance

	2006 2nd qtr.	2006 1st qtr.	2005 4th qtr.	2005 3rd qtr.	2005 2nd qtr.	2005 1st qtr.
	Million b/d					
DEMAND						
OECD						
US & Territories	20.88	20.76	21.16	21.24	21.02	21.20
Canada	2.14	2.18	2.23	2.24	2.24	2.36
Mexico	2.01	2.08	2.10	2.06	2.11	2.04
Japan	4.78	5.96	5.46	5.03	4.94	6.00
South Korea	2.03	2.28	2.23	2.01	2.07	2.40
France	1.89	2.10	1.96	2.00	1.93	2.11
Italy	1.63	1.86	1.78	1.68	1.69	1.77
United Kingdom	1.83	1.85	1.84	1.82	1.79	1.84
Germany	2.55	2.56	2.63	2.75	2.55	2.54
Other OECD Europe	7.16	7.35	7.49	7.30	7.22	7.37
Australia & New Zealand	1.06	1.06	1.10	1.04	1.06	1.04
Total OECD	**47.96**	**50.04**	**49.98**	**49.17**	**48.62**	**50.67**
NON-OECD						
China	7.34	7.15	7.14	6.93	6.89	6.62
FSU	3.90	4.40	4.60	4.04	3.81	4.30
Non-OECD Europe	0.69	0.74	0.69	0.64	0.69	0.74
Other Asia	8.81	8.43	9.06	8.43	8.71	8.34
Other non-OECD	14.46	14.40	14.14	14.14	13.91	13.84
Total non-OECD	**35.20**	**35.12**	**35.63**	**34.18**	**34.01**	**33.84**
TOTAL DEMAND	**83.16**	**85.16**	**85.61**	**83.35**	**82.63**	**84.51**
SUPPLY						
OECD						
US	8.35	8.18	7.74	7.95	8.84	8.78
Canada	3.13	3.22	3.28	3.02	3.06	3.01
Mexico	3.79	3.80	3.75	3.72	3.89	3.77
North Sea	4.71	5.11	5.05	4.95	5.22	5.46
Other OECD	1.41	1.41	1.51	1.55	1.57	1.49
Total OECD	**21.39**	**21.72**	**21.33**	**21.19**	**22.58**	**22.51**
NON-OECD						
FSU	11.96	11.75	11.97	11.72	11.62	11.53
China	3.85	3.83	3.75	3.80	3.76	3.73
Other non-OECD	13.07	12.94	13.14	13.13	12.73	12.39
Total non-OECD, non-OPEC	**28.88**	**28.52**	**28.86**	**28.65**	**28.11**	**27.65**
OPEC	**33.83**	**33.90**	**34.30**	**34.55**	**34.25**	**33.99**
TOTAL SUPPLY	**84.10**	**84.14**	**84.49**	**84.39**	**84.94**	**84.15**
Stock change	**0.94**	**–1.02**	**–1.12**	**1.04**	**2.31**	**–0.36**

Source: DOE International Petroleum Monthly.
Data available in OGJ Online Research Center.

US petroleum imports from source country

	Aug. 2006	July 2006	Average YTD 2006	Average YTD 2005	Chg. vs. previous year Volume	Chg. vs. previous year %
	1,000 b/d					
Algeria	803	743	631	487	144	29.6
Kuwait	155	155	164	221	–57	–25.8
Nigeria	1,026	1,073	1,152	1,153	–1	–0.1
Saudi Arabia	1,514	1,313	1,451	1,607	–156	–9.7
Venezuela	1,438	1,467	1,453	1,617	–164	–10.1
Other OPEC	782	754	680	631	49	7.8
Total OPEC	**5,718**	**5,505**	**5,531**	**5,716**	**–185**	**–3.2**
Angola	544	695	506	440	66	15.0
Canada	2,468	2,114	2,278	2,127	151	7.1
Mexico	1,758	1,709	1,781	1,682	99	5.9
Norway	255	236	207	231	–24	–10.4
United Kingdom	262	340	290	392	–102	–26.0
Virgin Islands	377	353	314	323	–9	–2.8
Other non-OPEC	3,230	2,885	2,844	2,773	71	2.6
Total non-OPEC	**8,894**	**8,332**	**8,220**	**7,968**	**252**	**3.2**
TOTAL IMPORTS	**14,612**	**13,837**	**13,751**	**13,684**	**67**	**0.5**

Source: DOE Monthly Energy Review.
Data available in OGJ Online Research Center.

NOTE: No new data at press time.

OECD total net oil imports

	Aug. 2006	July 2006	June 2006	Aug. 2005	Chg. vs. previous year Volume	Chg. vs. previous year %
	Million b/d					
Canada	–1,037	–1,001	–968	–943	–94	10.0
US	13,334	12,441	12,801	12,552	782	6.2
Mexico	–1,665	–1,614	–1,677	–1,731	66	–3.8
France	2,012	2,055	1,746	1,937	75	3.9
Germany	2,467	2,367	2,465	2,628	–161	–6.1
Italy	1,543	1,555	1,536	1,491	52	3.5
Netherlands	966	1,114	1,152	989	–23	–2.3
Spain	1,514	1,723	1,521	1,511	3	0.2
Other importers	3,901	3,860	3,983	3,886	15	0.4
Norway	–2,609	–2,636	–2,836	–2,730	121	–4.4
United Kingdom	313	270	44	336	–23	–6.8
Total OECD Europe	**10,107**	**10,308**	**9,611**	**10,048**	**59**	**0.6**
Japan	5,102	5,122	4,443	5,100	2	—
South Korea	2,165	1,974	2,128	2,049	116	5.7
Other OECD	725	726	974	588	137	23.3
Total OECD	**28,731**	**27,956**	**27,312**	**27,663**	**1,068**	**3.9**

Source: DOE International Petroleum Monthly
Data available in OGJ Online Research Center.

OECD* total gross imports from OPEC

	Aug. 2006	July 2006	June 2006	Aug. 2005	Chg. vs. previous year Volume	Chg. vs. previous year %
	Million b/d					
Canada	375	447	435	322	53	16.5
US	5,718	5,505	5,649	5,673	45	0.8
Mexico	—	—	5	—	—	—
France	857	939	916	800	57	7.1
Germany	508	523	522	705	–197	–27.9
Italy	1,227	1,372	1,246	1,318	–91	–6.9
Netherlands	719	604	652	782	–63	–8.1
Spain	790	844	807	689	101	14.7
Other importers	1,316	1,371	1,412	1,308	8	0.6
United Kingdom	329	212	253	227	102	44.9
Total OECD Europe	**5,746**	**5,865**	**5,808**	**5,829**	**–83**	**–1.4**
Japan	4,540	4,484	4,007	4,274	266	6.2
South Korea	2,454	2,309	2,273	2,162	292	13.5
Other OECD	612	674	678	584	28	4.8
Total OECD	**19,445**	**19,284**	**18,855**	**18,844**	**601**	**3.2**

*Organization for Economic Cooperation and Development.
Source: DOE International Petroleum Monthly.
Data available in OGJ Online Research Center.

Oil stocks in OECD countries*

	Aug. 2006	July 2005	June 2006	Aug. 2005	Chg. vs. previous year Volume	Chg. vs. previous year %
	Million bbl					
France	198	192	189	193	5	2.6
Germany	279	281	281	276	3	1.1
Italy	133	131	126	136	–3	–2.2
United Kingdom	98	100	101	104	–6	–5.8
Other OECD Europe	667	672	658	643	24	3.7
Total OECD Europe	**1,375**	**1,376**	**1,355**	**1,352**	**23**	**1.7**
Canada	178	176	168	169	9	5.3
US	1,764	1,745	1,730	1,716	48	2.8
Japan	640	631	627	645	–5	–0.8
South Korea	159	158	155	151	8	5.3
Other OECD	105	112	108	94	11	11.7
Total OECD	**4,221**	**4,198**	**4,143**	**4,127**	**94**	**2.3**

*End of period.
Source: DOE International Petroleum Monthly Report.
Data available in OGJ Online Research Center.

Statistics

Editor's note: Due to a holiday in the US, API data were not available at presstime.

OGJ gasoline prices

	Price ex tax 12-20-06	Pump price* 12-20-06	Pump price 12-21-05
	¢/gal		
(Approx. prices for self-service unleaded gasoline)			
Atlanta	181.3	221.0	215.9
Baltimore	179.6	221.5	215.4
Boston	179.7	221.6	208.4
Buffalo	184.6	244.7	211.9
Miami	193.3	243.6	218.4
Newark	183.2	216.1	217.7
New York	175.5	235.6	221.5
Norfolk	178.3	215.9	220.6
Philadelphia	187.9	238.6	223.4
Pittsburgh	176.9	227.6	220.4
Wash., DC	192.7	231.1	223.4
PAD I avg.	183.0	228.9	217.9
Chicago	224.5	275.4	235.6
Cleveland	177.4	223.8	210.9
Des Moines	178.2	218.6	209.8
Detroit	180.6	229.8	212.0
Indianapolis	182.8	227.8	214.4
Kansas City	174.8	210.8	212.6
Louisville	184.9	221.8	210.1
Memphis	174.0	213.8	218.1
Milwaukee	186.5	237.8	220.2
Minn.-St. Paul	182.5	222.9	218.7
Oklahoma City	174.4	209.8	208.6
Omaha	177.5	223.9	215.1
St. Louis	181.8	217.8	218.9
Tulsa	173.4	208.6	207.8
Wichita	176.4	219.8	209.5
PAD II avg.	182.0	224.2	214.8
Albuquerque	188.3	224.7	212.3
Birmingham	187.9	226.6	211.3
Dallas-Fort Worth	180.4	218.8	210.5
Houston	175.3	213.7	208.5
Little Rock	183.3	223.5	211.4
New Orleans	182.2	220.6	254.0
San Antonio	179.2	217.6	215.4
PAD III avg.	182.4	220.8	217.6
Cheyenne	185.4	217.8	210.5
Denver	172.4	212.8	220.5
Salt Lake City	185.0	227.9	215.5
PAD IV avg.	180.9	219.5	215.5
Los Angeles	186.4	244.9	226.3
Phoenix	187.4	224.8	225.0
Portland	199.6	242.9	222.7
San Diego	191.4	249.9	231.0
San Francisco	209.4	267.9	234.0
Seattle	211.4	263.8	225.0
PAD V avg.	197.6	249.0	227.3
Week's avg.	**184.5**	**228.1**	**217.9**
Nov. avg.	**180.1**	**223.7**	**229.9**
Oct. avg.	**183.8**	**228.0**	**263.9**
2006 to date	**212.7**	**256.3**	—
2005 to date	**181.7**	**223.8**	—

*Includes state and federal motor fuel taxes and state sales tax. Local governments may impose additional taxes.
Source: Oil & Gas Journal.
Data available in OGJ Online Research Center.

Refined product prices

	12-15-06 ¢/gal		12-15-06 ¢/gal
Spot market product prices			
Motor gasoline (Conventional-regular)		Heating oil No. 2	
New York Harbor	178.37	New York Harbor	172.75
Gulf Coast	166.62	Gulf Coast	172.25
Los Angeles	174.12	Gas oil	
Amsterdam-Rotterdam-Antwerp (ARA)	157.79	ARA	175.85
Singapore	165.24	Singapore	169.69
Motor gasoline (Reformulated-regular)		Residual fuel oil	
New York Harbor	177.50	New York Harbor	97.93
Gulf Coast	165.87	Gulf Coast	100.60
Los Angeles	181.62	Los Angeles	111.19
		ARA	95.17
		Singapore	102.42

Source: DOE Weekly Petroleum Status Report.
Data available in OGJ Online Research Center.

Baker Hughes rig count

	12-22-06	12-23-05
Alabama	4	6
Alaska	8	10
Arkansas	34	15
California	33	33
Land	30	29
Offshore	3	4
Colorado	94	81
Florida	0	2
Illinois	0	0
Indiana	0	0
Kansas	13	7
Kentucky	7	6
Louisiana	192	170
N. Land	62	50
S. Inland waters	20	18
S. Land	43	36
Offshore	67	66
Maryland	0	0
Michigan	2	2
Mississippi	19	4
Montana	21	24
Nebraska	0	0
New Mexico	88	97
New York	10	5
North Dakota	37	22
Ohio	10	9
Oklahoma	180	155
Pennsylvania	18	15
South Dakota	1	1
Texas	782	663
Offshore	12	7
Inland waters	2	1
Dist. 1	17	20
Dist. 2	26	29
Dist. 3	64	55
Dist. 4	96	72
Dist. 5	139	113
Dist. 6	122	105
Dist. 7B	38	25
Dist. 7C	49	38
Dist. 8	97	77
Dist. 8A	26	26
Dist. 9	37	27
Dist. 10	57	68
Utah	45	30
West Virginia	32	25
Wyoming	84	90
Others—HI-1; ID-1; NV–1; TN-3; VA-2; WA-1	9	3
Total US	**1,723**	**1,475**
Total Canada	**450**	**532**
Grand total	**2,173**	**2,007**
Oil rigs	279	243
Gas rigs	1,438	1,230
Total offshore	84	79
Total cum. avg. YTD	**1,647**	**1,381**

Rotary rigs from spudding in to total depth.
Definitions, see OGJ Sept. 18, 2006, p. 42.

Source: Baker Hughes Inc.
Data available in OGJ Online Research Center.

Smith rig count

Proposed depth, ft	Rig count (12-22-06)	Percent footage* (12-22-06)	Rig count (12-23-05)	Percent footage* (12-23-05)
0-2,500	45	—	23	—
2,501-5,000	114	52.6	89	43.8
5,001-7,500	217	19.8	190	22.1
7,501-10,000	437	3.2	317	4.4
10,001-12,500	409	2.4	349	2.2
12,501-15,000	262	0.3	307	—
15,001-17,500	124	0.8	99	—
17,501-20,000	78	—	57	—
20,001-over	37	—	24	—
Total	**1,723**	**7.4**	**1,455**	**7.0**
INLAND	32		36	
LAND	1,634		1,367	
OFFSHORE	57		52	

*Rigs employed under footage contracts.
Definitions, see OGJ Sept. 18, 2006, p. 42.

Source: Smith International Inc.
Data available in OGJ Online Research Center.

OGJ production report

	[1]12-22-06	[2]12-23-05
	1,000 b/d	
(Crude oil and lease condensate)		
Alabama	19	21
Alaska	800	840
California	696	691
Colorado	58	60
Florida	7	7
Illinois	30	28
Kansas	95	92
Louisiana	1,390	1,090
Michigan	15	14
Mississippi	52	49
Montana	92	97
New Mexico	164	162
North Dakota	102	104
Oklahoma	172	166
Texas	1,385	1,285
Utah	43	48
Wyoming	141	140
All others	65	73
Total	**5,326**	**4,967**

[1]OGJ estimate. [2]Revised.

Source: Oil & Gas Journal.
Data available in OGJ Online Research Center.

US crude prices

$/bbl*	12-22-06
Alaska-North Slope 27°	49.52
South Louisiana Sweet	58.00
California-Kern River 13°	50.80
Lost Hills 30°	58.20
Wyoming Sweet	59.41
East Texas Sweet	59.89
West Texas Sour 34°	50.25
West Texas Intermediate	59.00
Oklahoma Sweet	59.00
Texas Upper Gulf Coast	55.75
Michigan Sour	52.00
Kansas Common	58.00
North Dakota Sweet	48.75

*Current major refiner's posted prices except North Slope lags 2 months. 40° gravity crude unless differing gravity is shown.

Source: Oil & Gas Journal.
Data available in OGJ Online Research Center.

World crude prices

$/bbl[1]	12-15-06
United Kingdom-Brent 38°	62.34
Russia-Urals 32°	58.04
Saudi Light 34°	56.61
Dubai Fateh 32°	58.13
Algeria Saharan 44°	63.59
Nigeria-Bonny Light 37°	64.56
Indonesia-Minas 34°	61.11
Venezuela-Tia Juana Light 31°	56.88
Mexico-Isthmus 33°	56.77
OPEC basket	59.66
Total OPEC[2]	58.10
Total non-OPEC[2]	56.12
Total world[2]	56.94
US imports[3]	54.79

[1]Estimated contract prices. [2]Average price (FOB) weighted by estimated export volume. [3]Average price (FOB) weighted by estimated import volume.

Source: DOE Weekly Petroleum Status Report.
Data available in OGJ Online Research Center.

US natural gas storage[1]

	12-15-06	12-8-06	Change
	Bcf		
Producing region	941	955	–14
Consuming region east	1,801	1,853	–52
Consuming region west	425	430	–5
Total US	**3,167**	**3,238**	**–71**
	Sept. 06	**Sept. 05**	**Change, %**
Total US[2]	**3,323**	**2,932**	**13.3**

[1]Working gas. [2]At end of period.
Source: Energy Information Administration
Data available in OGJ Online Research Center.

PACE REFINING MARGINS

	Oct. 2006	Nov. 2006	Dec. 2006	Dec. 2005	Change	Change, %
	$/bbl				2006 vs. 2005	
US Gulf Coast						
West Texas Sour	10.67	12.15	9.69	12.05	–2.36	–19.6
Composite US Gulf Refinery	9.94	11.35	10.33	13.42	–3.10	–23.1
Arabian Light	10.56	12.09	10.58	13.22	–2.63	–19.9
Bonny Light	2.76	4.07	1.87	7.74	–5.87	–75.8
US PADD II						
Chicago (WTI)	9.07	10.91	7.58	7.90	–0.32	–4.1
US East Coast						
NY Harbor (Arab Med)	6.31	7.52	4.48	9.14	–4.66	–51.0
East Coast Comp-RFG	6.44	7.98	6.42	10.06	–3.65	–36.2
US West Coast						
Los Angeles (ANS)	12.78	18.45	19.56	8.60	10.96	127.5
NW Europe						
Rotterdam (Brent)	2.79	1.65	–0.57	0.65	–1.22	–187.8
Mediterranean						
Italy (Urals)	7.27	7.47	7.34	5.60	1.74	31.1
Far East						
Singapore (Dubai)	0.37	–0.43	–1.39	1.46	–2.85	–195.0

. Source: Jacobs Consultancy Inc.
Data available in OGJ Online Research Center.

US NATURAL GAS BALANCE
DEMAND/SUPPLY SCOREBOARD

	Sept. 2006	Aug. 2006	Sept. 2005	Sept. 2006-2005 change	Total YTD 2006	Total YTD 2005	YTD 2006-2005 change
	bcf						
DEMAND							
Consumption	1,466	1,760	1,422	44	16,190	16,589	–399
Addition to storage	394	302	358	36	2,420	2,356	64
Exports	50	55	44	6	707	811	–104
Canada	14	17	16	–2	210	300	–90
Mexico	32	32	22	10	449	462	–13
LNG	4	6	6	–2	48	49	–1
Total demand	**1,910**	**2,117**	**1,824**	**86**	**19,317**	**19,756**	**–439**
SUPPLY							
Production (dry gas)	1,497	1,542	1,354	143	13,916	13,804	112
Supplemental gas	6	5	5	1	52	51	1
Storage withdrawal	37	113	86	–49	1,729	2,117	–388
Imports	319	357	346	–27	3,113	3,207	–94
Canada	279	305	293	–14	2,661	2,743	–82
Mexico	0	0	1	–1	3	2	1
LNG	40	52	52	–12	449	462	–13
Total supply	**1,859**	**2,018**	**1,791**	**68**	**18,810**	**19,179**	**–369**

NATURAL GAS IN UNDERGROUND STORAGE

	Sept. 2006	Aug. 2006	July 2006	Sept. 2005	Change
	bcf				
Base gas	4,215	4,213	4,214	4,205	10
Working gas	3,323	2,969	2,779	2,932	391
Total gas	**7,538**	**7,182**	**6,993**	**7,137**	**401**

Source: DOE Monthly Energy Review.
Data available in OGJ Online Research Center.

WORLDWIDE NGL PRODUCTION

	Sept. 2006	Aug. 2006	9 month average – Production – 2006	2005	Change vs. previous year Volume	%
	1,000 b/d					
Brazil	91	91	86	77	9	11.1
Canada	630	642	674	672	2	0.3
Mexico	427	445	438	430	9	2.0
United States	1,781	1,726	1,727	1,777	–49	–2.8
Venezuela	200	200	200	200	—	—
Other Western Hemisphere	166	181	172	155	16	10.6
Western Hemisphere	**3,294**	**3,284**	**3,298**	**3,311**	**–14**	**–0.4**
Norway	235	295	281	266	15	5.8
United Kingdom	145	119	150	170	–21	–12.3
Other Western Europe	19	19	20	22	–3	–12.2
Western Europe	**399**	**433**	**450**	**459**	**–8**	**–1.8**
Russia	390	420	396	474	–79	–16.6
Other FSU	160	160	160	160	—	—
Other Eastern Europe	16	17	17	18	–1	–4.1
Eastern Europe	**566**	**597**	**573**	**652**	**–80**	**–12.2**
Algeria	320	315	304	295	9	3.2
Egypt	65	65	65	65	—	—
Libya	60	60	60	60	—	—
Other Africa	192	194	190	169	21	12.5
Africa	**637**	**634**	**620**	**589**	**31**	**5.2**
Saudi Arabia	1,490	1,490	1,477	1,460	17	1.1
United Arab Emirates	400	400	400	400	—	—
Other Middle East	670	670	670	571	99	17.3
Middle East	**2,560**	**2,560**	**2,547**	**2,431**	**115**	**4.7**
Australia	84	91	82	82	—	–0.5
China	180	180	180	180	—	—
India	42	35	42	44	–2	–5.3
Other Asia-Pacific	220	220	220	218	1	0.7
Asia-Pacific	**525**	**526**	**523**	**525**	**–1**	**–0.2**
TOTAL WORLD	**7,982**	**8,034**	**8,010**	**7,967**	**43**	**0.5**

Totals may not add due to rounding.
Source: Oil & Gas Journal.
Data available in OGJ Online Research Center.

OXYGENATES

	Oct. 2006	Sept. 2006	Change	YTD 2006	YTD 2005	Change
	1,000 bbl					
Fuel ethanol						
Production	10,308	9,992	316	94,302	76,017	18,285
Stocks	9,814	9,727	87	9,814	5,591	4,223
MTBE						
Production	1,575	2,479	–904	27,713	39,501	–48,304
Stocks	1,197	1,665	–468	1,197	3,204	–2,007

Source: DOE Petroleum Supply Monthly.
Data available in OGJ Online Research Center.

US HEATING DEGREE DAYS

	Nov. 2006	Nov. 2005	Normal	2006 % change from normal	Total degree days July 1 through Nov. 30 2006	2005	Normal	% change from normal
New England	584	676	727	–19.7	1,250	1,175	1,384	–9.7
Middle Atlantic	525	585	667	–21.3	1,021	948	1,193	–14.4
East North Central	668	681	757	–11.8	1,347	1,145	1,337	0.7
West North Central	742	726	840	–11.7	1,453	1,238	1,447	0.4
South Atlantic	326	303	339	–3.8	543	451	528	2.8
East South Central	448	405	449	–0.2	741	619	695	6.6
West South Central	249	228	293	–15.0	356	334	385	–7.5
Mountain	583	571	676	–13.8	1,119	976	1,219	–8.2
Pacific	342	325	396	–13.6	579	554	690	–16.1
US average*	**469**	**470**	**539**	**–13.0**	**872**	**770**	**922**	**–5.4**

*Excludes Alaska and Hawaii.
Source: DOE Monthly Energy Review.
Data available in OGJ Online Research Center.

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Lease bluster raises question about 'new cop'

"When the new Democratic Congress takes office in January, there will be a new cop on the beat to force every big oil company that is currently lining its pockets with taxpayer dollars [to] come back to the negotiating table."

That's from Rep. Ed Markey (D-Mass.), responding to a US Department of the Interior announcement that five oil and gas companies have agreed to pay royalties not required by leases they hold to deepwater acreage in the Gulf of Mexico (OGJ Online, Dec. 15, 2006).

The Editor's Perspective

by Bob Tippee, Editor

"The Bush administration's Interior Department and the big oil and gas companies that have cheated taxpayers out of billions in revenues for drilling on public lands have run out of time," Markey said. "Their too little, too late efforts to recoup only a small percentage of the billions of dollars of oil and gas royalties that the American people are rightfully owed is pitiful."

What's pitiful is Markey's distortion of the issue.

On Dec. 14, Interior announced that BP PLC, ConocoPhillips, Marathon Oil Corp., Shell Oil Co., and Walter Oil & Gas Corp. had agreed to pay full royalties starting Oct. 1 on production from deepwater leases issued in 1998-99.

Unlike those issued in other years providing limited relief for deepwater production, the 1998-99 leases lack price thresholds that cancel the incentive when oil and gas prices are high.

The widespread assumption in Washington is that omission of the thresholds reflects bureaucratic oversight. So some companies have chosen to renegotiate their deepwater leases and forgo relief they acknowledge they don't need with commodity prices at current levels.

The companies haven't cheated taxpayers out of anything. According to the leases in question—contracts with the US government—the American people are in fact not owed the "billions of dollars" Markey claims.

What's more, the mistake, if that's what it was, happened when Markey's party ran the Executive Branch.

Renegotiation of the leases, on most of which production hasn't even begun, is a benign act by the leaseholders. Discrediting them for it is politically opportunistic and raises a disturbing question: Does January's new cop understand law?

(Online Dec. 15, 2006; author's e-mail: bobt@ogjonline.com)

Market Journal

by Sam Fletcher, Senior Writer

Little reaction seen to second OPEC reduction

Despite knee-jerk purchases that hiked the January contract for benchmark US crudes to $63.43/bbl by Dec. 15, the highest closing in weeks on the New York market, there was little immediate reaction after the Organization of the Petroleum Exporting Countries agreed Dec. 14 to trim production by 500,000 b/d to 25.8 million b/d, effective Feb. 1, "in order to balance supply and demand."

In October, OPEC ministers voted to reduce crude output by 1.2 million b/d to 26.3 million b/d effective Nov. 1. Although many industry observers said OPEC had curtailed only 800,000 b/d at most, OPEC officials claimed at the December meeting their earlier agreement "succeeded in stabilizing the market and bringing it into balance, although prices remain volatile."

OPEC's latest promised reduction "basically comes out to nothing," said Olivier Jakob at Petromatrix GMBH, Zug, Switzerland. "It is only illustrative of the disagreement within OPEC of the need for any further cuts, buying some more time and letting the market dictate through prices what should be the next step for OPEC," Jakob said. "If there is a strong price crash then OPEC would cut (but this would be expected anyway); if there is a price increase it will continue to not respect the previous agreement (this is also somehow expected). OPEC could not comply [with the earlier proposed production cut] below $60/bbl, so we should not expect them to comply better above $60/bbl."

Moreover, he said, "We are somehow back to having Saudi Arabia as the swing balancing producer. While the rest of OPEC will continue with the cheating, this creates a framework where it takes a longer period of time to significantly tighten the crude oil supply and demand."

Dollar declines

The "additional problem" for OPEC since its October meeting is the dollar index has dropped 4%, "which in terms of OPEC revenues is equivalent to an additional production cut," said Jakob. While crude prices were higher in mid-December than mid-October, the weakness of the US dollar offset those price gains and reduced OPEC's revenue. "OPEC would need a stronger dollar to encourage less cheating and better enforce their output cut decisions," Jakob said. Meanwhile, the US dollar fell to a four-session low against the euro on Dec. 19.

Analysts in the Houston office of Raymond James & Associates Inc. said, "The decision to curtail production for the second time comes on the back of high crude stockpiles in the US and Organization for Economic Cooperation and Development nations, concerns of slowing global growth in 2007, and the pullback in the greenback that has eroded the purchasing power of OPEC members. Going forward, the market will remain skeptical as to the magnitude of the announced cut that will actually be taken off the market come February."

Nevertheless, Raymond James analysts said: "The cartel seems determined to continue its quest to defend $60/bbl as a price floor for crude oil. On a further note, the cartel has approved the induction of its newest member, Angola. The second-largest producer in Africa will join the cartel in 2007, adding strength to OPEC's muscle." Because it has not yet returned to its prewar production level, Iraq is not subject to OPEC production quotas.

Meanwhile, Raymond James said, "Unrest in Nigeria continues to take a toll on oil production. Armed guerrillas attacked a Royal Dutch Shell oil complex in Nigeria and abducted three employees. The incident has forced Shell to shut in 12,000 b/d in production." Civil unrest and violence in the oil-rich Niger River delta have shut in 600,000-800,000 b/d of crude production, industry sources report.

The January crude contract fell to $62.21/bbl Dec. 18 as traders focused on forecasts of warmer-than-normal weather over most of the US, but it expired at $63.15/bbl Dec. 19 in expectation that US crude inventories would fall for the fourth consecutive week. The Energy Information Administration reported Dec. 20 a 6.3 million bbl plunge in commercial US crude stocks to 329.1 million bbl in the week ended Dec. 15. Gasoline inventories jumped by 1 million bbl to 200.9 million bbl in the same period. Distillate fuel stocks rose by 1.2 million bbl to 133.1 million bbl.

"Over the past 2 months, the US oil data have shown a consistent pattern of rapid tightening with the total inventory overhang having eroded dramatically and with the fall tilted toward gasoline stocks, which now exhibits a deficit of 6.2 million bbl relative to their 5-year average," said analysts at Barclay's Capital, the investment banking division of Barclays Bank PLC, London.

(Online Dec. 22, 2006; author's e-mail: samf@ogjonline.com)

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2007 Calendar of Events

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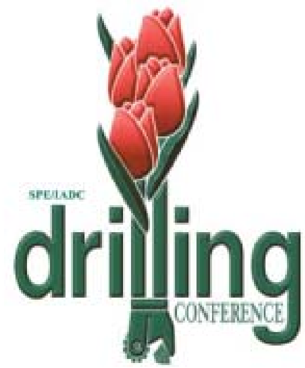

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7	8	9	10	11	12	13
14	15 Petrotech India Conference & Exhibition, New Delhi, Jan. 15-19	16 Offshore Asia Conference & Exhibition, Kuala Lumpur, Jan. 16-18	17	18	19	20
21	22 Power-Gen Middle East, Manama, Bahrain, Jan. 22-24; API Exploration & Production Winter Standards Meeting, Scottsdale, Ariz., Jan. 22-26	23 Deepwater Operations Conference & Exhibition, Galveston, Tex., Jan. 23-25	24	25	26	27
28	29 SPE Hydraulic Fracturing Technology Conference, College Station, Tex., Jan. 29-31	30	31			

January 2007

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Week of Feb. 1–3
- NAPE Expo, Houston, Feb. 1-2

Week of Feb. 4–10
- IPAA Small Cap Conference, Boca Raton, Fla., Feb. 5-8
- IADC Health, Safety, Environment & Training Conference & Exhibition, Houston, Feb. 6-7
- Russia Offshore Oil & Gas Conference, Moscow, Feb. 7-8

Week of Feb. 11–17
- Multiphase Pumping & Technologies Conference & Exhibition, Abu Dhabi, Feb. 11-13
- International Petrochemicals & Gas Technology Conference & Exhibition, London, Feb. 12-13
- International Downstream Technology & Catalyst Conference & Exhibition, London, Feb. 14-15
- Pipeline Pigging & Integrity Management Conference, Houston, Feb. 12-15
- IP Week, London, Feb. 12-15
- CERA Week, Houston, Feb. 12-16

Week of Feb. 18–24
- SPE/IADC Drilling Conference & Exhibition, Amsterdam, Feb. 20-22
- AustralAsian Oil Gas Conference & Exhibition, Perth, Feb. 21-23
- Geo-Resources in the Middle East & North Africa Conference & Exhibition, Cairo, Feb. 24-28...
- PLCA Annual Meeting, Aventura, Fla., Feb. 21-25...

Week of Feb. 25–28
- ...PLCA Annual Meeting continues
- Subsea Tieback Forum & Exhibition, Galveston, Tex. Feb. 27-Mar.1...
- ...Geo-Resources in the Middle East & North Africa Conference & Exhibition continues
- Laurance Reid Gas Conditioning Conference, Norman, Okla., Feb. 25-28
- SPE Reservoir Simulation Symposium, Houston, Feb. 26-28
- SPE Symposium on Oilfield Chemistry, Houston, Feb. 28-Mar. 2...

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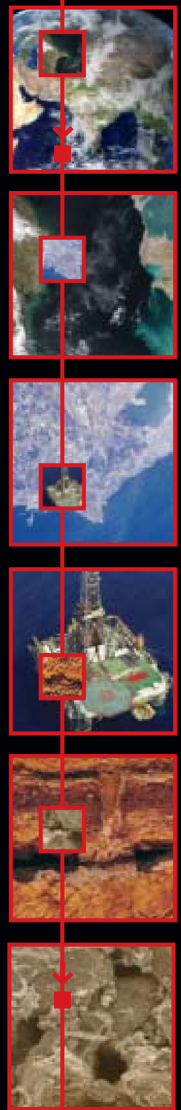

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...Subsea Tieback Forum & Exhibition continues

...SPE Symposium on Oilfield Chemistry continues

CERI Natural Gas Conference, Calgary, Mar. 5-8

Purvin & Gertz International LPG Seminar, Houston, Mar. 5-8

International Pump Users Symposium, Houston, Mar. 5-8

Gas Arabia International Conference, Abu Dhabi, Mar. 5-7

SPE E&P Environmental & Safety Conference, Galveston, Tex., Mar. 5-7

Power-Gen Renewable Energy Conference, Las Vegas, Mar. 6-8

Fuels & Lubes Asia Conference, Bangkok, Mar. 7-9

GPA Annual Convention, San Antonio, Mar. 11-14

China Offshore Expo, Tianjin, Mar. 15-17

MEOS-Middle East Oil & Gas Show & Conference, Bahrain, Mar. 11-14

NACE Annual Conference & Exposition, Nashville, Mar. 11-15

NPRA Security Conference, The Woodlands, Tex., Mar. 12-14

NPRA Annual Meeting, San Antonio, Mar. 18-20

SPE/ICoTA Coiled Tubing & Well Intervention Conference & Exhibition, The Woodlands, Tex., Mar. 20-21

Georgian International Oil, Gas, Energy & Infrastructure Conference & Showcase, Tbilisi, Mar. 22-23

ARTC Refining & Petrochemical Annual Meeting, Bangkok, Mar. 20-22

Offshore West Africa Conference & Exhibition, Abuja, Mar. 20-22

Turkish Oil & Gas Exhibition & Conference, Ankara, Mar. 27-29

SPE Production & Operations Symposium, Oklahoma City, Mar. 31-Apr. 3...

Offshore Mediterranean Conference, Ravenna, Italy, Mar. 28-30

NPRA International Petrochemical Conference, San Antonio, Mar. 25-27

IADC/SPE Managed Pressure Drilling & Underbalanced Operations Conference, Galveston, Tex., Mar. 28-29

March 2007

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Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1 ...SPE Production & Operations Symposium continues SPE Hydrocarbon Economics & Evaluation Symposium, Dallas, Apr. 1-3 AAPG Annual Convention & Exhibition, Long Beach, Apr. 1-4	2	3 IADC Environmental Conference & Exhibition, Amsterdam, Apr. 3-4 China International Oil & Gas Conference, Beijing, Apr. 3-4	4	5	6	7
8	9	10	11 ISA Calgary Show & Conference, Calgary, Apr. 11-12 SPE Digital Energy Conference & Exhibition, Houston, Apr. 11-12 ENTELEC Conference & Expo, Houston, Apr. 11-13 Kazakhstan Petroleum Technology Conference, Atyrau, Apr. 11-13	12 Molecular Structure of Heavy Oils & Coal Liquefaction Products Conference, Lyon, France, Apr. 12-13	13	14
15 Middle East Petroleum & Gas Conference, Dubai, Apr. 15-17 SPE Latin American & Caribbean Petroleum Engineering Conference, Buenos Aires, Apr. 15-18	16 Russia & CIS Refining & Petrochemicals Equipment Conference & Exhibition, Moscow, Apr. 16-17 API Spring Refining & Equipment Standards Meeting, Seattle, Apr. 16-18 SPE Rocky Mountain Oil & Gas Technology Symposium, Denver, Apr. 16-18 Pipeline Technology, Hannover, Apr. 16-20	17 International Forum, Moscow, Apr. 17-19 IADC Drilling HSE Middle East Conference & Exhibition, Bahrain, Apr. 17-18 API Pipeline Conference, Albuquerque, Apr. 17-18 API/NPRA Spring Operating Practices Symposium, Seattle, Apr. 17	18 Russia & CIS Bottom of the Barrel Technology Conference & Exhibition, Moscow, Apr. 18-19	19	20	21
22	23 IPAA OGIS East Conference, New York, Apr. 23-25	24 LNG 15 Conference & Exhibition, Barcelona, Apr. 24-27	25	26 SPE Research & Development Conference, San Antonio, Apr. 26-27	27	28
29	30 OTC-Offshore Technology Conference, Houston, Apr. 30-May. 3...					

April 2007

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	...OTC-Offshore Technology Conference continues		NPRA National Safety Conference, The Woodlands, Tex., May 2-3			
6	7	8	9	10	11	12
13	14	15	16	17	18	19
	Oil & Gas Pipelines in the Middle East Conference, Abu Dhabi, May 14-15 AchemAsia Exhibition & Conference, Beijing, May 14-18	Asia Bottom of the Barrel Technology Conference & Exhibition, Kuala Lumpur, May 15-16 International School of Hydrocarbon Measurement, Norman, Okla., May 15-17 Intergas-International Oil & Gas Conference & Exhibition, Cairo, May 15-17 Uzbekistan International Oil & Gas Exhibition & Conference, Tashkent, May 15-17		Asia Petrochemicals & Gas Technology Conference & Exhibition, Kuala Lumpur, May 17-18 IADC Drilling Onshore America Conference & Exhibition, Houston, May 17		
20	21	22	23	24	25	26
IOGCC Midyear Meeting, Billings, Mont., May 20-23	ERTC Asset Maximization Computing & Reliability Conference, Rome, May 21-23	NPRA Reliability & Maintenance Conference & Exhibition, Houston, May 22-25	Africa Oil & Gas Trade & Finance Conference & Exhibition, Nairobi, May 23-25			
27	28	29	30	31		
		Russia Power Conference & Exhibition, Moscow, May 29-31	CIS Oil & Gas Summit, Paris, May 30-Jun. 1... SPE European Formation Damage Conference, Scheveningen, The Netherlands, May 30-June 1...			

May 2007

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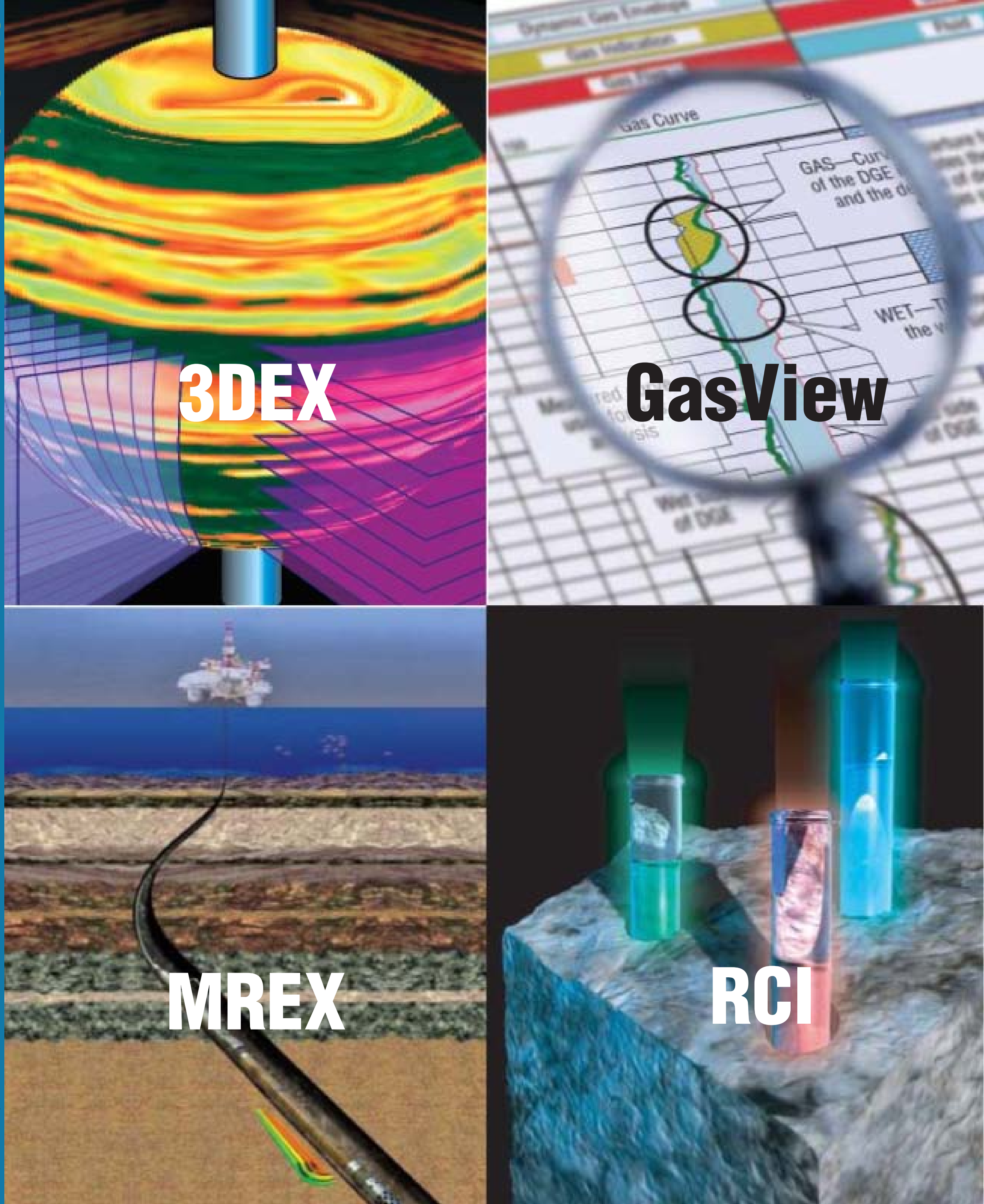

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Week of June 1–2
- ...CIS Oil & Gas Summit continues
- ...SPE European Formation Damage Conference continues

Week of June 3–9
- SPWLA Annual Symposium, Austin, June 3-6
- Caspian Oil & Gas Exhibition & Conference, Baku, June 5-8
- SPEE Annual Meeting, Vail, Colo., June 9-12...

Week of June 10–16
- ...SPEE Annual Meeting continues
- Asian Petrochemicals & Gas Technology Conference & Exhibition, Kuala Lumpur, June 11-12
- ERTC Refining Management & Strategy Conference, Vienna, June 11-13
- ILTA Operating Conference & Trade Show, Houston, June 11-13
- IPAA Midyear Meeting, Henderson, Nev., June 11-13
- EAGE/SPE Europec Conference & Exhibition, London, June 11-14
- GO-EXPO Gas & Oil Exposition, Calgary, June 12-14
- Asian Downstream Technology & Catalyst Conference & Exhibition, Kuala Lumpur, June 13-14
- IADC World Drilling Conference, Paris, June 13-14
- Asian Oil, Gas & Petrochemical Engineering Exhibition, Kuala Lumpur, June 13-15

Week of June 17–23
- Newfoundland Ocean Industries Assn. Annual Conference, St. John's, June 18-22
- Offshore Newfoundland Petroleum Show, St. John's, June 19-20
- Brasil Offshore Trade Show & Conference, Macae, June 19-22

Week of June 24–30
- API Exploration & Production Standards Conference on Oilfield Equipment & Materials, San Francisco, June 25-29
- CERA East Meets West Executive Conference, Istanbul, June 26-28
- Power-Gen Europe, Madrid, June 26-28
- Renewable Energy Europe Conference, Madrid, June 26-28
- Russian Petroleum Congress, Moscow, June 26-28
- Moscow International Oil & Gas Conference & Exhibition, Moscow, June 26-29

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International Offshore & Polar Engineering (ISOPE) Conference & Exhibition, Lisbon, July 1-6

Oil Sands & Heavy Oil Technologies Conference & Exhibition, Calgary, July 18-20

West China International Oil & Gas Conference, Urumqi, Xinjiang, July 26-28

July 2007

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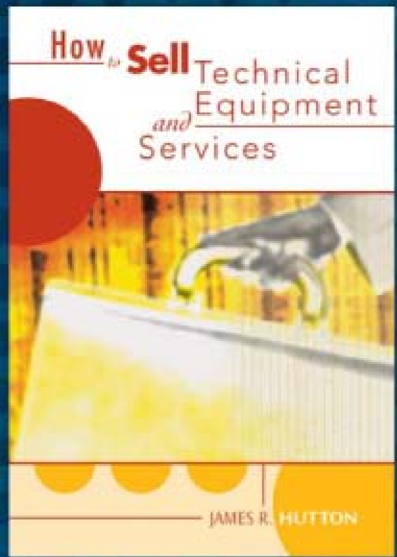

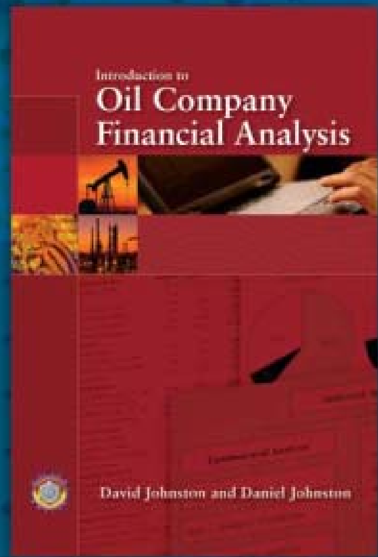

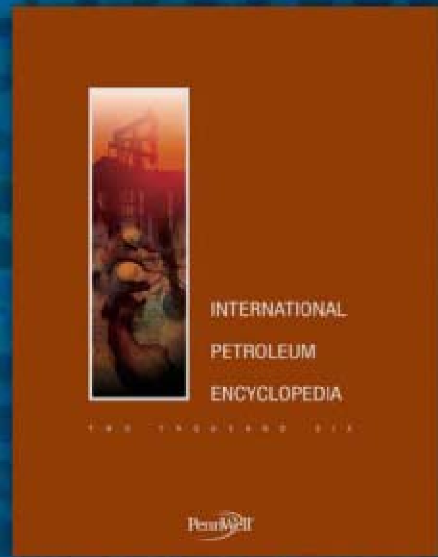

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August 2007

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1 Coal-Gen, Milwaukee, Aug. 1-3	2	3	4
5	6	7	8	9	10	11
12	13 Rocky Mountain Natural Gas Strategy Conference & Investment Forum, Denver, Aug. 13-15	14	15	16	17	18
19	20	21	22	23 NAPE Summer Expo, Houston, Aug. 23-24	24	25
26	27	28 IADC Well Control of the Americas Conference & Exhibition, Galveston, Tex., Aug. 28-29	29	30	31	

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23	24	25	26	27	28	29
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SPE/EAGE Reservoir Characterization & Simulation Conference, Muscat, Sept. 3-5

Power-Gen Asia Conference & Exhibition, Bangkok, Sept. 4-6

Offshore Europe Oil & Gas Conference & Exhibition, Aberdeen, Sept. 4-7

SPE Asia Pacific Health Safety Security Environment Conference, Bangkok, Sept. 10-12

Turbomachinery Symposium, Houston, Sept. 10-13

Oil Sands Trade Show & Conference, Fort McMurray, Alta., Sept. 11-12

Brasil Subsea, Rio de Janeiro, Sept. 18-20

Russia & CIS Petrochemicals & Gas Technology Conference & Exhibition, Moscow, Sept. 17-18

Russia & CIS Refining Technology Conference & Exhibition, Moscow, Sept. 19-20

IOGCC Annual Meeting, New Orleans, Sept. 23-25

Engineering & Construction Contracting Association Conference, Colorado Springs, Sept. 27-28

SEG Annual Meeting, San Antonio, Sept. 23-28

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October 2007

Oct. 1–6	IPLOCA Annual Convention, Sydney, Oct. 1-5 ISA EXPO, Houston, Oct. 2-4 Rio Pipeline Conference & Exposition, Rio de Janeiro, Oct. 2-4
Oct. 7–13	IPAA OGIS West Conference, San Francisco, Oct. 7-9 IADC Drilling HSE Europe Conference & Exhibition, Copenhagen, Oct. 9-10 European Autumn Gas Conference, Düsseldorf, Oct. 9-10 NPRA Q&A & Technology Forum, Austin, Oct. 9-12 DOT-Deep Offshore Technology International Conference & Exhibition, Stavanger, Oct. 10-12
Oct. 14–20	ERTC Petrochemical Conference, Brussels, Oct. 15-17
Oct. 21–27	SPE/IADC Middle East Drilling & Technology Conference, Cairo, Oct. 22-24 IPAA Annual Meeting, New Orleans, Oct. 22-24 Kuwait International Oil & Gas Exhibition, Kuwait City, Oct. 22-25 Louisiana Gulf Coast Oil Exposition (LAGCOE), Lafayette, Oct. 23-25 Pipeline Simulation Interest Group Annual Meeting, Calgary, Oct. 24-26
Oct. 28–31	GSA Annual Meeting, Denver, Oct. 28-31 Asia Pacific Oil & Gas Conference & Exhibition, Jakarta, Oct. 30-Nov. 1... Indonesia Oil & Gas Technology Exhibition, Jakarta, Oct. 31-Nov. 3...

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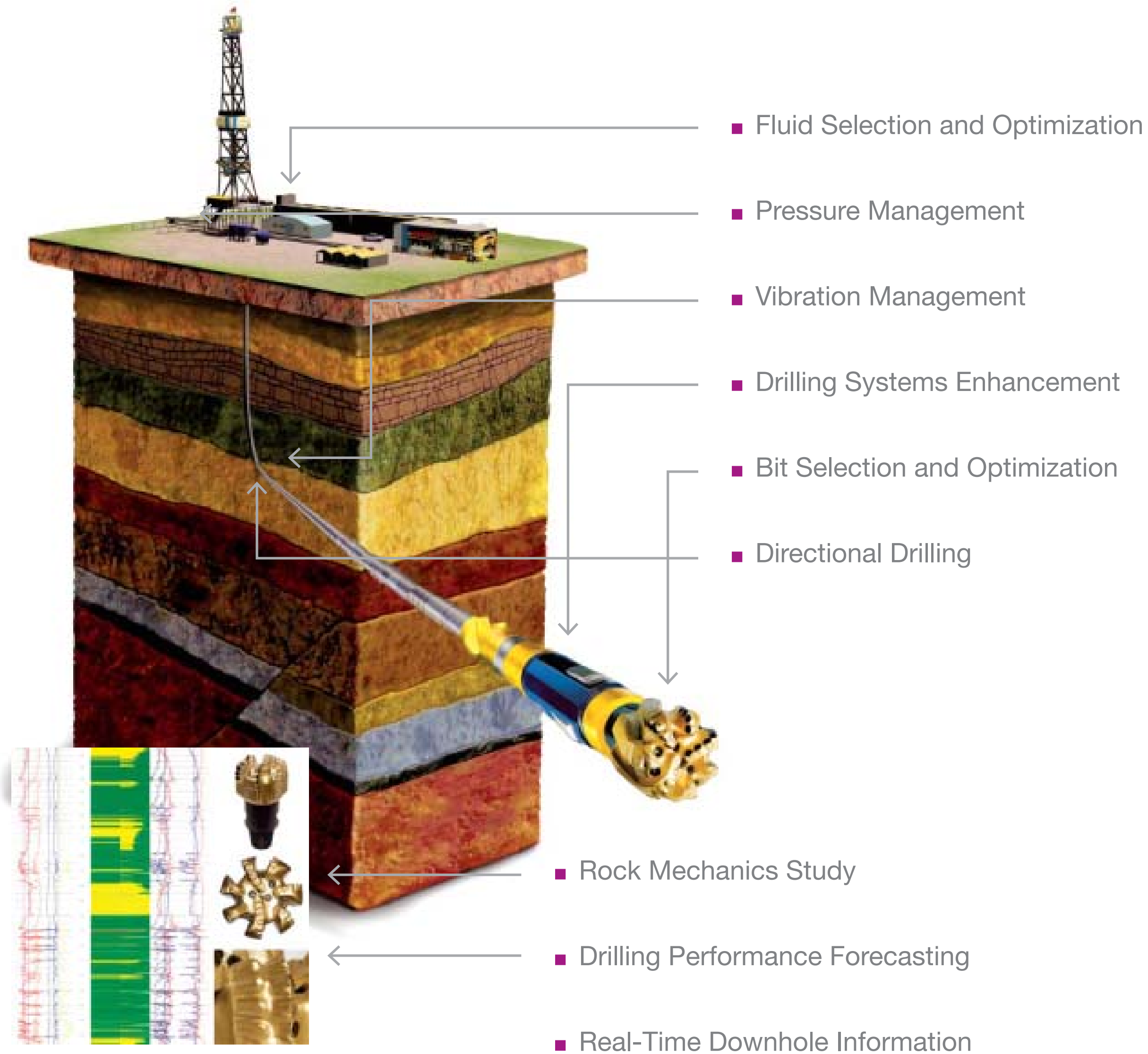

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November 2007

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
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		...Asia Pacific Oil & Gas Conference & Exhibition continues				
			...Indonesia Oil & Gas Technology Exhibition continues			
				IADC Annual Meeting, Galveston, Tex., Nov. 1-2		
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AAPG International Conference & Exhibition, San Juan, Puerto Rico, Nov. 4-7						
11	12	13	14	15	16	17
SPE Annual Technical Conference & Exhibition, Anaheim, Calif., Nov. 11-14						
World Energy Congress, Rome, Nov. 11-15						
	API Fall Refining & Equipment Standards Meeting, San Antonio, Nov. 12-14					
		API/NPRA Fall Operating Practices Symposium, San Antonio, Nov. 13	IADC International Well Control Conference & Exhibition, Singapore, Nov. 14-15			
18	19	20	21	22	23	24
Australian SEG International Geophysical Conference & Exhibition, Perth, Nov. 18-22						
	ERTC Annual Meeting, Barcelona, Nov. 19-21					
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Middle East Nondestructive Testing Conference & Exhibition, Bahrain, Dec. 2-5

International Petroleum Technology Conference, Dubai, Dec. 4-6

Oil & Gas Maintenance & Technology Conference & Exhibition, Manama, Dec. 9-13

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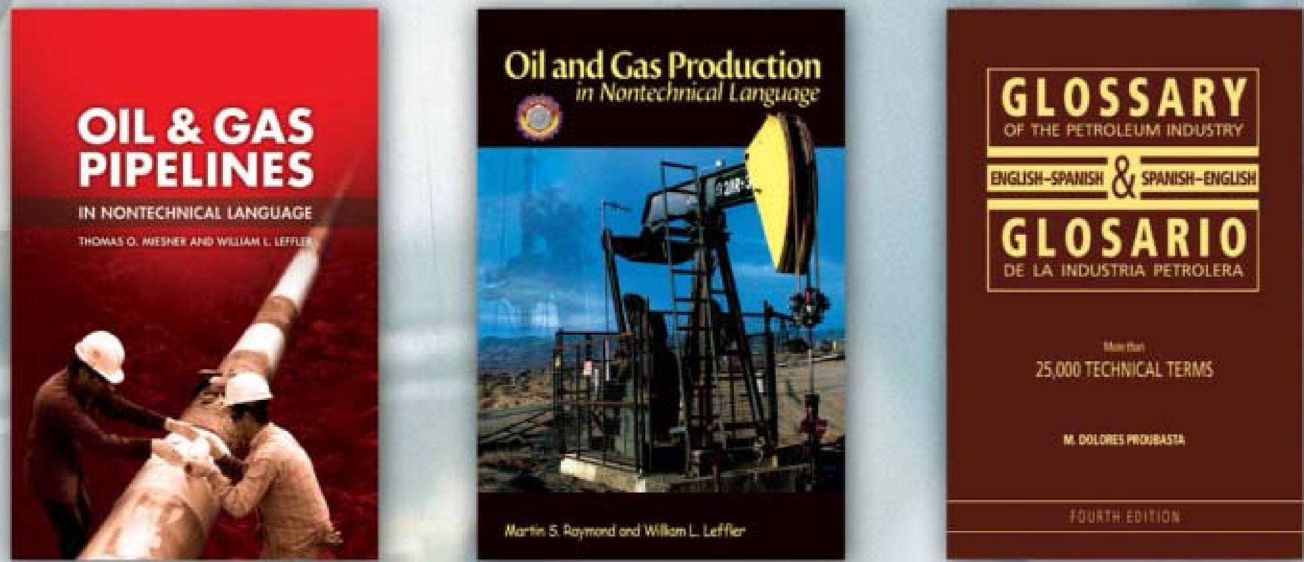

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