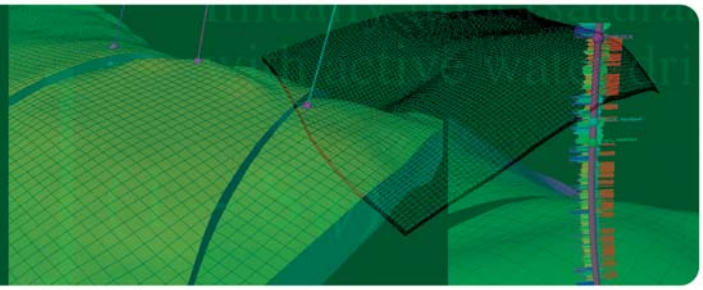
RESERVOIR SOLUTIONS



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Industry score: Reserves training 3, Formal testing 0

SPE joins SPEE, AAPG for training, education; Proposal for testing is nixed by industry groups

The oil and gas industry has endorsed association-administered education and training for reserves evaluators while rejecting an initiative for a training-and-testing process leading to certification. The Society of Petroleum Engineers, the largest industry association, recently decided to assist the American Association of Petroleum Geologists and Society of Petroleum Evaluation Engineers in developing an education program to facilitate understanding of established definitions, guidelines and specifications for reserves and resources.

Although the SPE board of directors failed to vote on the agenda item at the annual meeting in October, a new SPE committee on education, chaired by **Mike Black**, decided to pool its efforts with the other two associations to develop a cosponsored program. When the certification initiative was introduced last year, SPE withheld formal support but asked that SPE members be on the investigating subcommittees.

Certification by testing never achieved at-large support. Some geologists and engineers said that by virtue of their education, experience and, in some cases, state licensing that they did not need what they saw as more requirements. The initial proposal called for voluntary, not mandatory certification.

Ron Harrell, chairman at Ryder Scott, proposed training and testing in March 2004 immediately after major reserves writedowns. "If our industry wants to set the standards rather than government, then surely industry-prescribed certification is a step in that direction and a better long-term solution than mandated third-party reserves reviews," Harrell said.

The political mood, already heightened because of

Please see Certification on next page

Inside Reservoir Solutions newsletter

Ryder Scott and company employees donated almost $60,000 to the American Red Cross for Hurricane Katrina disaster relief. Individual donations from employees totaled $24,437. Ryder Scott matched that and donated another $10,000.

"We only have 110 employees, so those dollar totals reflect an exceptional generosity toward those in need," said CEO **Don Roesle**. Other Houston businesses and individuals aided Katrina victims as the city was dubbed the "City of Hope." About 150,000 evacuees sought shelter in Houston and 11,000 evacuees in the Astrodome received food, shelter and medical aid. To date, the Red Cross has raised almost $1 billion for Katrina aid.

On Sept. 2, Red Cross shelters at the Astrodome housed about 11,000 Hurricane Katrina survivors.

Certification—Cont. from Page 1

the Enron scandal and the passage of the Sarbanes Oxley Act, intensified as Harrell predicted. In May, 2004, U.S. Representative John Dingell, a member of the House Committee on Energy and Commerce, recommended that the SEC and Financial Accounting Standards Board adopt a requirement for third-party reserves audits, but no action was taken. The committee has jurisdiction over accounting standards set by the FASB.

In July 2004 at a hearing of the U.S. House Committee on Financial Services, witnesses called for mandated certification of those who estimate petroleum reserves for public filings. The committee did not follow up on the recommendations.

Major companies did not write down reserves in 2005, but some observers said that high, sustained oil and gas prices masked reserves reporting problems.

Harrell continues to work with SPE, SPEE and AAPG in trying to create a modular training and education approach. "The modules will incorporate extensive, in-depth sample problems and exercises," he said. "Training is the more important component of the training-testing process, because in the final analysis, if the evaluator has mastered the material, then validation by exam is merely an exercise."

AAPG nixed a proposal for testing and certification after receiving "adverse commentary" from the association's corporate advisory committee at a joint meeting in June, said **Pete Rose**, president of AAPG.

Dan Olds, president of SPEE and a vice president at Ryder Scott, said, "The formal testing and certification aspects of the program have caused a disproportionate amount of concern and consternation from many people for many reasons and have threatened to derail the whole project. Testing and recognition of achievement is being de-emphasized at this time."

One challenge will be for SPEE and SPE to pool their collective published resources to form a body of knowledge on the engineering side. SPE has its reserves and resources definitions and reserves auditing standards. SPEE has its recommended evaluation practices and guidelines for the application of reserves definitions.

"SPEE will continue to take a lead in developing training materials. We welcome SPE's cooperation and look forward to working with the society. After all, probably 90 percent of our members are also SPE members," said Olds.

SPE solicits comments on reserves definitions

The SPE Oil and Gas Reserves Committee recently mapped resources and reserves definitions used by eight agencies to SPE definitions. SPE is soliciting comments by members by Dec. 15 and offers a draft of the mapping document at www.spe.org.

The society has mapped definitions used by the U.S. Securities

Please see SPE on next page

Publisher's Statement

Reservoir Solutions newsletter is published quarterly by Ryder Scott Company LP. Established in 1937, the reservoir evaluation consulting firm performs hundreds of studies a year. Ryder Scott multidisciplinary studies incorporate geophysics, petrophysics, geology, petroleum engineering, reservoir simulation and economics. With 110 employees, including 66 engineers and geoscientists, Ryder Scott has the capability to complete the largest, most complex reservoir-evaluation projects in a timely manner.

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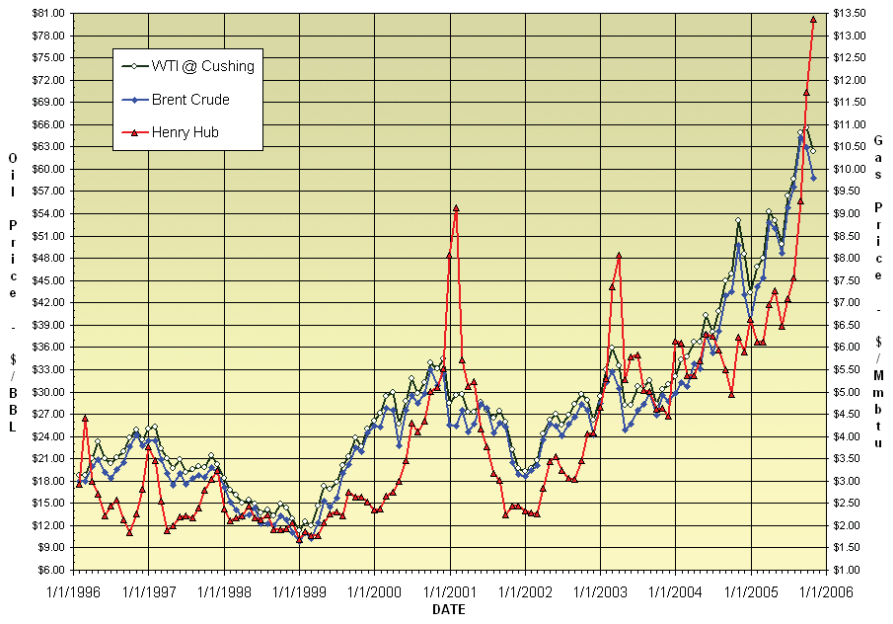
Price history of benchmark oil and Henry Hub gas



The historical price chart shows published, monthly-average, cash market prices for WTI crude at Cushing (NYMEX), Brent crude and Henry Hub gas.

SPE—Cont. from Page 2

and Exchange Commission, U.K. Statement of Recommended Practices, Canadian Security Administrators, Russian Ministry of Natural Resources, China Petroleum Reserves Office, Norwegian Petroleum Directorate, U.S. Geological Survey and United Nations Framework Classification.

SPE compared them to its 1997 SPE/World Petroleum Council (WPC) reserves definitions and 2000 SPE/WPC/AAPG resources definitions. The hope is for international financial, regulatory and reporting bodies and the industry to adopt a common set of classifications. Mapping various definitions will enable SPE to understand and resolve differences.

Ryder Scott reserves conference set for May 5 at end of OTC week

Ryder Scott will offer a free one-day conference on various petroleum reserves topics, Friday, May 5 at the Doubletree Hotel in downtown Houston. Those attending the Offshore Technology Conference at Reliant Center in Houston, which concludes Thursday, May 4, can participate in the second annual Ryder Scott reserves conference by extending their stays an extra day.

How to register

Those wanting to attend the reserves conference should submit applications via e-mail with the subject heading, "Reserves Conference," to **Mike Wysatta**, business development manager, at mike_wysatta@ryderscott.com.

An applicant should include the following:

- His or her name, company title and affiliation, address, phone, fax and e-mail
- Primary job duties and number of years of experience as a decision-maker on reserves estimating and reporting
- Suggested topics

Ryder Scott will send confirming invitations via return e-mail as applications are considered and processed. The invitee should confirm receipt and acceptance of the invitation via an e-mail reply to finalize the reservation.

Capacity is limited, so qualified candidates are encouraged to apply early. Applications will be considered in the order that they are received and will be processed as early as possible so advanced travel arrangements can be made.

Conference curriculum

The reserves conference is targeted to senior-level geologists, engineers and technical managers who make daily decisions on reserves estimates and regulatory reporting. Last May, a capacity audience at the conference heard **Richard Adkerson**, a staff member the U.S. Securities and Exchange Commission in the 1970s, give a firsthand account of how disclosures rules in petroleum reserves accounting originated. Ryder Scott plans to invite another guest speaker to the event.

Those attending the one-day conference will qualify for six to eight hours of CEUs. Breakfast, lunch and snacks will be provided. **Don Roesle**, CEO, will chair the conference.

Upcoming Events

Feb. 2—SPE MidContinent section; Tulsa, OK; Short course by John Hodgin, president at Ryder Scott. Not finalized yet. For more details, go to www.tulsaweb.com/midcont-spe.
Feb. 2-3—NAPE Expo 2006, George R. Brown Convention Center, Houston, Ryder Scott and TRC at Booth Nos. 1425, 1524.
April 10-12—AAPG annual convention, George R. Brown Convention Center, Houston, Ryder Scott Booth No. 1758.
May 5—Ryder Scott Second Annual Reserves Conference, Doubletree Hotel, Houston. For details, see article on this page.

Acuna

Gibbon

Keelan

Olds

Ryder Scott recently promoted four petroleum engineers. **Herman Acuna** is a senior vice president. **Ed Gibbon**, **Kirk Keelan** and **Dan Olds** are vice presidents.

Technical challenges in estimating reserves Part 5: Analogy, reservoir simulation, volumetrics

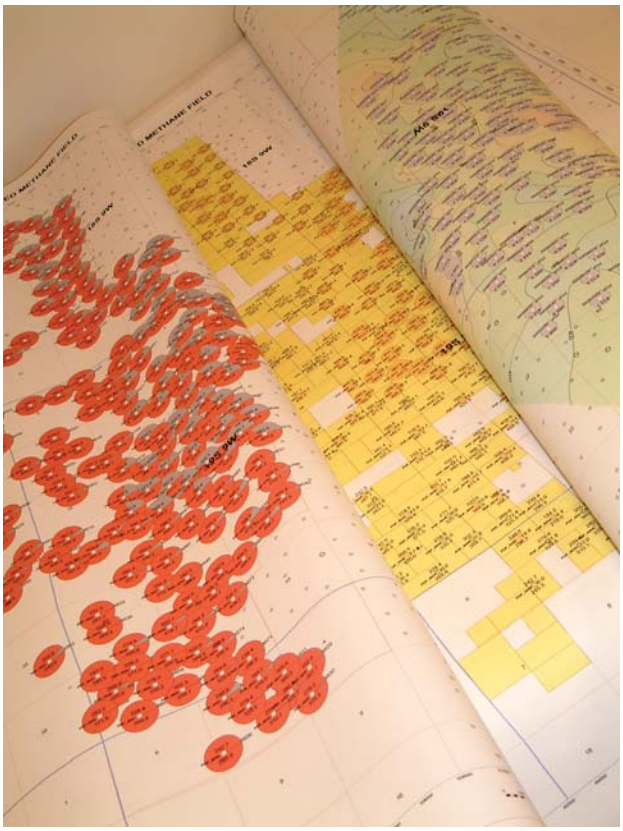
Editor's Note: This is a revised excerpt from "Oil and Gas Reserves Estimates: Recurring Mistakes and Errors," (SPE Paper No. 91069). To order a copy of the full paper, go to www.spe.org and access the e-library.

Ryder Scott personnel see a wide variety of internally produced petroleum reserves estimates and most of them are well prepared. However, the firm has noticed common technical errors in reserves estimates.

This multipart article offers guidelines to help reduce the chance of errors in geoscientific and engineering analysis. This fifth newsletter article focuses on analog-, simulation- and volumetric-based reserves estimates.

Inappropriate selection of analogs

Engineers and geologists have historically relied on the use of analogies to estimate several reservoir parameters and performance expectations. An ideal analog is a developed reservoir with well-documented physical parameters and an adequate performance history to rely on for future production and performance expectations. Such a reservoir is an excellent analog for predicting the qualities of a nearby undeveloped reservoir in the same formation assuming the same development plan and operating scenario.



However, given several potential analogs in an area, selecting the best-performing reservoir to compare to a subject reservoir is inappropriate. An evaluator should analyze several potential analogs to more fully understand the extent and impact of variations in performance before selecting a reservoir or family of reservoirs as the analog.

The suitability of a reservoir to be an analog is related to the purpose of the comparison. Estimations of gross rock properties, for example, may be reliably obtained from comparisons with nearby similar reservoirs within the same formation. However, ultimate recovery may vary considerably depending on well spacing, completion practices and other operational details that affect recovery efficiency.

Evaluators estimate reserves by analogy during the early field development stages before definitive performance and geologic data are available. Conversely, analogy is frequently used when new recovery mechanisms are introduced to a mature field, for example, a field undergoing waterflooding, well stimulation or infill drilling.

The analogy method typically involves the following three necessary stages:

- Establish proof of analogy to a mature reservoir and recovery process.
- Study performance and operations of analogous reservoir.
- Apply analogy performance with appropriate adjustments to account for deviations to target reservoir.

Challenges in proper selection and application of analogs are associated with all three stages, but typically the first and third stages are the most problematic.

Problems with establishing proof of analogy

In most cases, omitting or misinterpreting the effect of key parameters causes errors. Proof of analogy requires establishing geologic/petrophysical, reservoir engineering and operational similarities. Operational similarity is assured in a scenario where the target field is operated similarly to the analogous field.

The following bulleted summaries list parameters under geoscience, engineering and operational areas that are analyzed to make a case for the analogy method.

- Geoscience—Structural configuration, lithology and stratigraphy, principal heterogeneities, reservoir continuity, average net thickness, water saturation, permeability, porosity, areal proximity
- Engineering—Pressure and temperature, fluid properties, recovery mechanism, fluid mobilities, fluid distribution, reservoir maturity, well productivity, EOR specifications, areal proximity
- Operational—Well spacing, artificial lift methods, pattern type and spacing, injector-to-producer ratio, annual injection volumes, fluid handling capacity, stimulation design, areal proximity

For the target reservoir, all parameters have to be as favorable or more favorable than for the analog,

especially for a proved reserves classification. Not all items necessarily apply to each case. The key is to identify the main performance drivers that will influence the intended, analogous treatment and to determine if similarity can be established.

The importance of areal proximity is emphasized in the Society of Petroleum Engineers "Standards Pertaining to the Estimating and Auditing of Oil and Gas Reserve Information." It states, "If performance trends have not been established with respect to oil and gas production, future production rates and reserves may be established by analogy to reservoirs in the same geographic area having similar characteristics and established performance trends."

Incorrectly applying analogous performance to the target field will cause mistakes in establishing proof of analogy and include the following:

- Assuming similarity because of areal proximity and same formation without proper evaluation of all parameters.
- Field not located in same geographic area.
- No similarity in critical parameters that have been overlooked in the analysis.
- Bias toward trying to force analogy if a few key parameters match.

Problems applying analogy to target field

When an evaluator establishes an analogy but key parameters are slightly different, he may apply the analogy method by making appropriate adjustments. Inappropriate applications of analogous behavior are caused by the following:

- Not designing for operational similarity, particularly well density.
- Not making appropriate adjustments to account for operational differences, including costs.
- Not making appropriate adjustment to account for differences in quantified geoscience and engineering parameters. For example, the evaluator must calculate displacement efficiency resulting from differences in fluid properties or he must account for differences in stratification that may affect vertical sweep.

Examples

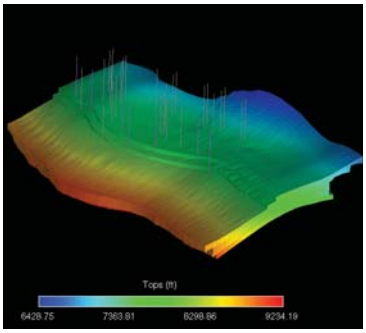
- When estimating future recovery from a planned waterflood by analogy, the evaluator must establish similarity between geoscience and engineering parameters to assure similar displacement and sweep behavior and design the target waterflood similarly to the analog for well spacing, pattern type and annual injection volumes. Operational dissimilarity frequently causes overly conservative or aggressive projections.
- Similarly, differences in mobility may not necessarily disqualify an analogy as long as the evaluator makes proper adjustments to account for the change in displacement efficiency.

Guidelines to reduce mistakes using analogies

Give preference to analogies in areal proximity to target field.

- Follow a strict process where the evaluator tabulates and compares key parameters that need to be similar.
- Accept analogy only if a good match exists or if adjustments can be quantified to account for differences. Qualitative or "instinct" adjustments need to be weighed carefully and may be cause for downgrading to a lower reserves classification.
- Review, and if necessary, design for operational similarity. This will also capture appropriate costs.

Simulation-derived estimates of proved reserves



E&P companies manage most significant oil and gas reservoirs worldwide through the use of detailed reservoir models. They are excellent tools for decisions on development, operations and reservoir management. **Dean Rietz**, manager of reservoir simulation at Ryder Scott, and former Ryder Scott petroleum engineer **Miles Palke** have documented their concerns about using even the most robust models for proved reserves estimates under given definitions.

They support using simulation of immature reservoirs to estimate recovery efficiencies and for testing the ranges of other parameters, including permeability and aquifer support. Rietz and Palke further recommend that models of mature reservoirs be used for proved reserves estimates only when reasonable history matches of the reservoir and wells have been obtained.

They do not reject reserves estimates based on reservoir simulation. However, Rietz and Palke warn

Please see Simulation on next page

Simulation—Cont. from Page 5

about the dangers of estimating reserves without a detailed review of the model to fully understand associated assumptions, limitations and applicability. Failure to review the model may cause significant overstatement of proved reserves.

Failure to incorporate early-life performance data into volumetric estimates

Early-life production and pressure-decline trends may not be sufficiently definitive to provide the sole basis for reserves estimation but should be continuously reviewed to fine tune a volumetric-, analogy- or simulation-derived reserves estimate. Quite frequently, this early-life data, including initial rate and pressure data and any available trends, has not been used to calibrate static estimates until well past the half life of a reserves estimate.

Disregarding early performance data and potential warning signs may lead to significant positive or negative reserves revisions. Common errors include the following:

- Not revising reserves expectations for undeveloped locations based on performance data of producing wells.
- Not anticipating the impact of unexpected increase in water or gas production.
- Not accounting for effects of pressure depletion on behind-pipe and infill locations over time.

Updating undeveloped locations based on performance data

Reserves estimated for undeveloped locations at the beginning of field development are typically based on drainage area and recovery factor assignments frequently in combination with analogies from nearby fields. As performance data becomes available, the evaluator needs to review and revise (calibrate) volumetric calculations and recovery-factor estimates.

Deviations from the initial estimates may require adjustments to recovery factors, rate projections and numbers and locations of future development wells. Some of the largest errors often occur if existing wells are adjusted for lower productivity but ultimate reserves are maintained by extending field life.

This situation creates two critical problems. Lower initial rates may indicate lower productivity, thinner pay, interference effects and smaller drainage areas. Therefore per-well reserves and in-place volumes may be overestimated.

Secondly, capital allocations may be underestimated as more wells may be necessary to achieve the previously estimated volumes and therefore the resulting net present value will be overstated.

Early or unexpected water production, increases in GOR

An unexpected increase in water production in down-dip wells or gas-oil ratios in updip wells may affect reserves booked in wells throughout the field. Problems with unexpected changes in water or gas production typically result from uncertain drive mechanisms.

For example, consider the following:

- Undeveloped locations may have been booked up dip of an existing location based on an expected strong water drive, but existing wells are experiencing increased gas-oil ratios indicating a secondary gas cap or a smaller-than-anticipated reservoir.
- Conversely, undeveloped reserves may have been set up on strike with existing wells that water out prematurely because of expectations of a depletion or weak aquifer drive. Under such circumstances, not only do the affected wells need to be re-evaluated but any undeveloped or behind-pipe reserves need to be reviewed as well.

Effect of depletion on behind-pipe and infill locations

Evaluators establish behind-pipe reserves and infill wells at certain points in time under existing pressure and depletion (or sweep) conditions. Often, oil and gas companies keep those reserves and wells "on the books" for several years or longer depending on the allocation of capital spending and timing of other projects.

Over time, the reserves engineer should re-evaluate volumes assigned to behind-pipe and infill wells as existing wells may have drained some or essentially all of these volumes, even in low-permeability reservoirs. A recommended approach to avoid carrying reserves that may have already been drained is to compare produced volumes with the expected ultimate recovery for the entire reservoir. This approach allows timely adjustments to the remaining volumes for behind-pipe or infill wells.

The reserves evaluator should reasonably expect that the remaining volumes will be drained by the proposed behind-pipe completion or undeveloped locations.

Other common problems with performance adjustments

- Recovery factors based on optimistic but unconfirmed drive mechanisms
- Assumed well drainage areas or reservoir areas, such as updip locations or seismic amplitudes
- Setting up offset locations without compelling evidence of reservoir continuity

Events that should trigger review of all reserves

- New wells with unexpected changes in reservoir thickness, fluid contacts, pressures or productivity
- Early or unexpected water production or unanticipated increases in gas-oil ratio
- Significant deviations from expected production or pressure-decline trends
- Reserves for undeveloped and behind-pipe locations that have not been reviewed in several years.

Guidelines to reduce frequency of mistakes

- Always review the potential field-wide implications of new data.
- Do not assume that, by chance, only poor locations are drilled and good ones are yet to come.
- Exercise caution placing undeveloped locations where drive mechanisms or efficiencies are uncertain.

Editor's Note: The Part 6 article in March will conclude this series and focus on the impact of partial waterdrive and overpressured reservoirs on gas material balance. Also examined will be undrilled fault blocks and economics projection programs.

Ryder Scott posts 15th freeware program on Web site

Volumetrics tool for coalbed methane posted at Ryder Scott Web site at www.ryderscott.com

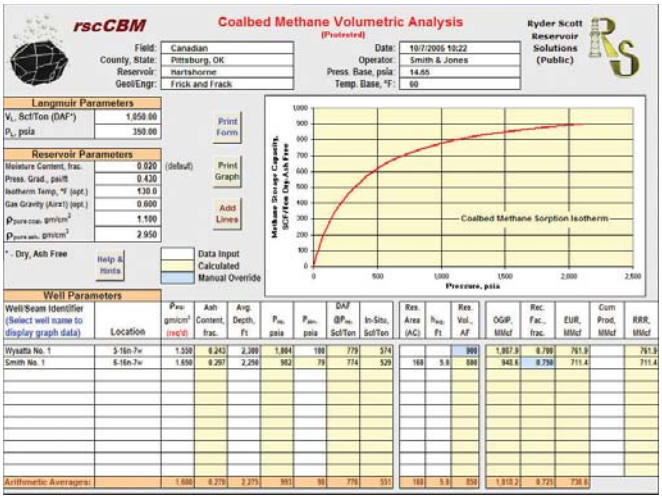
Ryder Scott posted its newest *Reservoir Solutions* freeware program, *rsc*CBM, on its Web site at www.ryderscott.com in October. The versatile coalbed methane volumetrics analysis tool incorporates standard Langmuir parameters obtained from laboratory analysis of coalbed core samples.

rscCBM has a feature-rich set of calculation procedures to provide the user with useful, reliable results. The program graphically represents results from each zone, seam or well and provides a print option for hard copies.

Data validation and enhanced navigation are used extensively. The user may optionally override calculated results and such changes will be evident on screen by a change in background color. A user typically enters manual calculations rather than Langmuir-based ones when lab data is not available.

The templates in *rsc*CBM are large by design and use "frozen panes" to facilitate data entry and visualization of graphical results. This can create difficulties for users with low-resolution graphics displays, said developer James Latham, vice president and petroleum engineer.

To compensate for this, he set up the program so it automatically detects a user's display settings to set or eliminate the frozen panes. A user's manual is included in an Excel file accessible from the engineering menu.



rscCBM incorporates standard Langmuir parameters obtained from laboratory analysis of coalbed core samples. The templates are large by design and use "frozen panes" to facilitate data entry and visualization of graphical results.

Ryder Scott offers 10 Reservoir Solutions programs and five SOS programs on its Web site. They are used by thousands in the industry the world over.

Editor's Note: Ryder Scott does not guarantee or warrant the accuracy or reliability of this software and disclaims its fitness for any particular purpose.

Three engineers, geologist join RS

Fry

Ryder Scott now has 66 technical professionals with the recent staff additions of three engineers and a geologist.

Keven Fry, petroleum engineer, recently joined Ryder Scott after working as a contract engineer starting in 2003. Before that, he worked at Global Resource Services, Gaffney Cline & Assocs. and Petroconsultants-Mai Ltd. starting in 1998. From 1994 to 1998, he worked at Union Texas Petroleum Corp. as a senior petroleum engineer. Fry provided economic evaluations for mergers, acquisitions, farm-ins, enhanced recovery projects and rank wildcat exploration projects worldwide. This included evaluations of potential acquisitions of Kazakhstan acreage and for a joint venture in Indonesia.

He was a reservoir engineer in the Nilam field group at Huffco/Vico from 1986 to 1994. Fry supervised national engineers, selected drilling locations for infill and development wells and determined requirements for well tests, workovers and production priorities. He improved reservoir evaluation through log analysis and well performance appraisal methods.

Fry was a senior engineer and supervisor at Amoco Production Co. from 1979 to 1986. He worked in exploration and on black oil reservoir modeling projects in Africa and the Middle East. Fry also re-engineered declining fields by re-evaluating logs, selecting workovers, optimizing surface facilities and designing a field-wide electrical submersible pump system. Early in his career at Amoco, he evaluated acreage in Jordan and designed and supervised well tests in Oman and the U.A.E. Fry began his career at Phillips Petroleum Co. where he worked five years. He was a junior engineer in 1975 and later he became a staff reservoir engineer. He has a BS degree in mechanical engineering from Kansas State University.

Nelson

Eric Nelson, petroleum engineer, joined Ryder Scott from ExxonMobil Corp., where he handled integrated reservoir studies, reservoir model construction and simulation, horizontal well modeling and economic evaluations for more than three years.

Nelson served as the main reservoir simulation engineer for Cerro Negro, a heavy oil

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Nelson—Cont. from Page 7

development in the Orinico belt of Venezuela. He created multiple models of the development to evaluate various project proposals and to form the basis for approval of major project expansions, including surface facilities sizing to accommodate projected production increases.

Nelson also conducted reservoir surveillance and identified workovers for clean-out/stimulation for Exxon's mature oil-producing assets in Fullerton/Seminole area of west Texas, gaining experience in log analysis. He has a BS degree in chemical engineering from the University of Tulsa. Nelson is a member of the Society of Petroleum Engineers.

Dabral

Ashish Dabral, petroleum engineer, joined the reservoir simulation department. He specializes in well testing, reservoir simulation, geostatistical modeling, unconventional gas modeling and upscaling.

Before that, he worked at EOG Resources Inc. and CMG Petroleum Consulting Ltd. over the prior two years. Dabral evaluated tight gas, gas condensate, shale gas and coalbed gas reservoirs using reservoir characterization and simulation, PVT analysis and history matching and reservoir simulation for properties in the U.S. and Canada.

He began his career at Oil and Natural Gas Corporation Ltd. where he worked for three years. He designed and interpreted well tests, prepared long-term gas profiles, conducted conventional reservoir analysis based on performance, designed gas lifts, performed decline curve analysis and material balance studies and conducted economic analysis.

Dabral has BS and MS degrees in petroleum engineering from the Indian School of Mines and Stanford University, respectively. He is a member of SPE.

Tremblay

Matthew L. Tremblay, geologist, joined Ryder Scott from ExxonMobil Exploration Co. , where he worked for more than seven years as a geoscientist identifying exploration and production-uplift opportunities. His various major projects included the evaluation of offshore opportunities in Qatar and Kazakhstan, which involved 2D seismic-based interpretation, structure mapping and depth conversion and assessment. Tremblay also created two mega-regional geologic cross sections in the Middle and North Caspian basins to illustrate their tectonic evolution and those of the hydrocarbon systems and plays. He also developed a resource assessment and opportunity ranking for oil and gas fields in Kazakhstan and central Asia and gas fields in West Siberian basin in Russia.

Tremblay also was lead geologist for the development of the Borregos-Zuni and Deep Kelsey fields in the Vicksburg trend of south Texas. He identified infill and near-field wildcat drilling opportunities in the deep, overpressured sections by integrating 3D seismic with well logs and production data. He also created a detailed sequence stratigraphic framework for a multi-reservoir field to examine production and development.

He also worked as an exploration geologist at Pikes Peak Mining Co. in 1997 and as a wellsite and mudlogging geologist for Rellstab Services Inc. that same year. Tremblay has a BA degree in earth sciences from the University of California and an MS degree in geology from the University of Idaho. He is a member of the American Association of Petroleum Geologists.

Editor's Note: Detailed biographies of the professional petroleum engineers and geologists at Ryder Scott are posted at the Web site at www.ryderscott.com.

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