Testimony of William M. Griffin, Jr.
"Advances in Technology: Innovations in the Domestic Energy and Mineral Sector"
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on behalf of

American Petroleum Institute
Domestic Petroleum Council
Independent Petroleum Association of America
International Association of Drilling Contractors
Natural Gas Supply Association
National Ocean Industries Association
Petroleum Equipment Suppliers Association
U.S. Oil & Gas Association

Madam Chairwoman and Members of the Subcommittee, I appreciate the opportunity to testify here today on the subject of the advances in technology within the domestic energy and mineral sector. I am Bill Griffin, Vice-President of Onshore and Offshore Divisions for El Paso Production Company. Because the issues we face are common to all of us engaged in the search for and production of energy to meet the country's needs, I am also testifying for the members of the National Ocean Industries Association, the Domestic Petroleum Council, the American Petroleum Institute, the Independent Petroleum Association of America, the U.S. Oil & Gas Association, the International Association of Drilling Contractors, the Natural Gas Supply Association, and the Petroleum Equipment Suppliers Association.

Slide 1 - Gulf of Mexico Deep Wells
Well Characteristics

Wells drilled on the Outer Continental Shelf of the Gulf of Mexico are typically considered "deep" when drilled below the depth of 15,000 feet. The technology required to drill, complete and produce this type of well is better understood when we analyze the characteristics of "deep" wells, rather than a simple categorization based on depth. Three primary characteristics of a "deep well" are those of high pressure, high temperature and high rate.

Reservoir pressures in excess of 20,000 pounds per square inch are not uncommon. The densities of fluids necessary to contain this type of pressure during the drilling and completion phases of the well are extremely high. The chemistry associated with these fluids and their reactions to pressure and temperature, along with the special alloys utilized in the pipe are examples of applied technology being utilized today.

In addition to pressure, temperatures exceeding 350ÁF are common. It is the combination of temperature with pressure that creates the hostile operating environment found when drilling, completing and producing wells at this depth.

A final key characteristic of "deep shelf wells" is the rock formation characteristics. Gulf coast reservoirs have long been known for their high permeability, or ability to produce oil and gas at very high rates with little restriction from the rock through which they flow. Unlike many of the onshore "deep" formations that generally have very low permeability and are considered "tight", the deep formations in the Gulf of Mexico retain some of the producing characteristics of the shallower reservoirs. It is the combination of permeability with high pressure that creates prolific flow rate potential. The appeal was demonstrated at El Paso's South Timbalier 204 Block where the B #6 well had sustained production rates of 118 Mmcf per day and 8160 bbls of condensate per day. The very element that makes the play so attractive, high production rates, is also the component that creates some of the most technological challenging issues we face and I shall describe today.

Slide 2 - Gulf of Mexico Deep Wells
Industry Activity Drivers

What has driven the increased interest and activity in the deep opportunities on the Gulf of Mexico Shelf? It is a combination of events or drivers that have created this situation.

It can't be forgotten that oil and gas is a non-renewable resource and by definition that creates an ever-diminishing supply as consumption continues. The deep opportunities being pursued are simply a result of the fact that the easier, less risky, lower cost opportunities are disappearing. We are driven to pursue the more difficult objectives, whether deeper below the surface or into deeper water.

Of course, supply and demand will always be the ultimate driver. As the shallow Gulf of Mexico undeveloped opportunity inventory declines with associated production rates, the supply must be replenished with deeper production.

I have mentioned risk several times. Mitigating risk is a critical component of both industry willingness and its capability to successfully make the necessary significant capital investments. The evolution of three dimensional seismic, computing capacity and accessible seismic data has been and will continue to be core to this play. The processing technology and improved seismic shooting and acquisition parameters designed specifically to analyze deep opportunities has been crucial. Much of the existing seismic inventory was shot with focus on analyzing shallow opportunities. It is only recently that we have seen the shift toward seismic focused on the deep water potential. Ultimately, as an industry we must drill a sufficient number of deep wells to calibrate the assumptions utilized to explore at this depth. This is a critical component of understanding what will work and what doesn't. It is with this information that we will continue to refine our analysis and ultimately lower the risk.

The last driver in allowing the expansion of deep activity on the "Shelf" has been the evolution in technology with regard to electronics, chemistry and metallurgy. Many of these technologies have evolved through deep drilling onshore and are being modified for application in the Gulf of

Mexico. It is my opinion that the ability to utilize electronics at these pressures and temperatures has made this type of well mechanically possible. Remember, we utilize sophisticated electronics to guide drill bits and analyze these rock formations. A good analogy would be to think of putting your television in an oven set at 350ÁF and expecting it to work trouble-free for the next four days.

Slide 3 - Gulf of Mexico Deep Wells
Technological Challenges

To better understand the application of technology to successfully operating deep wells in the Gulf of Mexico, it is first necessary to define the challenges.

This is one of the single most challenging environments with regard to predictability. It seems that almost every well is unique and this uncertainty creates a situation that mandates contingency planning which ultimately increases the cost of the well. As mentioned previously, there are a limited number of wells that have even penetrated these depths. Not only is the size of this sampling critical to managing the geological risk, it is equally important to managing the mechanical risk by providing the knowledge necessary for minimization of contingency costs and improvement of time required to both drill and complete.

A few specific issues revolve around the fact that in the Gulf Coast, it is a general, although not absolute, rule that as you drill deeper, the pressures increase faster than the compressive strength of the rock. In simple terms, the strength of the rock approaches the pressure of the contained oil and gas. It is this relationship that allows a driller to restrain the well from flowing by utilizing the hydrostatic pressure from drilling fluids to exceed that of the formation pressure while drilling the well. If the hydrostatic pressure exceeds the strength of the rock, the rock will fracture, the hydrostatic pressure will be lost and well control and/or stuck drill pipe will result. Remedial actions are significant and costly and can be as severe as re-drilling the well.

Deep drilling on land has been common for years and activity has created an equipment infrastructure to support this activity. Offshore, the evolution was toward expanding capabilities in ever increasing water depths. The sudden shift back to shallow water has resulted in a void of shallow water rigs capable of drilling deep. We have recently dealt with trying to contract a rig to operate in less than 10 feet of water, but with a lifting capacity of more the 1.5 million pounds for the depth of the well. There is an extremely small inventory of rigs capable of drilling to depth in this shallow water environment.

Pipe supply and prices have become a critical short-term issue for the industry. The deep wells on the Shelf require very large pipe and often exotic alloys. This type of pipe is generally not available in supplier's inventory and must be milled. The overall backlog in manufacturing pipe has created delays as long as six months to receive some of the special pipe required for the "Deep Shelf".

Slide 4 - Gulf of Mexico Deep Wells
Implemented Solutions

It is difficult to pinpoint any technological innovations specifically to the Deep Shelf. The industry in general has continued to evolve toward deeper, hotter, higher pressure environments.

These three variables are driving technology expansion for the exploration industry as a whole. These are a few of the new technology items that are having a major impact on offshore drilling.

Probably one of the most exciting new technology tools is that of "expandable casing". This is small diameter pipe that is run into the well and once it is on bottom, it is then expanded. This allows you to utilize smaller casing shallow in the well, but still have the capability to run an additional protective string of pipe should you encounter a situation of converging rock strength and pore pressure. The protective string of pipe will allow you to isolate the problem section and still have a large enough hole to continue drilling. The application of this technology in the Gulf of Mexico has been particularly important because of the pressure and rock strength unpredictability that I mentioned previously.

Increasingly complex computer modeling capabilities are also being utilized for the entire design spectrum of the well, from the geological predictions to drilling hydraulics to full life-of-well pipe stress modeling.

Improved understanding of metallurgy and pipe connection technology has expanded not only the capability to drill and complete these wells, making them capable of production, but they are providing durability for increased well life.

Much of the technology being utilized isn't always new, but simply new applications of existing technology. Examples of this would be changes in standard drilling fluids to provide stability at depth, improved reliability of drilling motors in heavy, high solids content fluids, upgraded rig equipment such as drill pipe and pumps, new drill bit designs and even cementing techniques utilized in certain older onshore basins. Because very thick heavy-walled pipe is necessary to contain these pressures, it has been necessary to redesign tools, such as sub-surface safety valves and packers to maintain functionality while constrained in a much reduced internal pipe diameter.

One additional item of significance that is not necessarily new technology, but perhaps a slightly different approach for the shallow water Gulf of Mexico is shared learning and investment risk between multiple companies. Because technology is viewed as a competitive advantage that requires significant capital investment and broad geological and mechanical risk spectrums, companies still follow all confidentiality requirements while partnering with other companies for greater efficiencies. This team approach mindset began with the deep water projects. This approach is being applied to the deep shelf and exists not only between the service providers but between various operators. Necessity has once again proven to be the mother of invention.

Slide 5 - Gulf of Mexico Deep Wells
Go-forward Challenges

The evolution and utilization of technology is always first dependent on the vision that there will be a product market. The single most critical element of establishing an application for this technology has been achieved with the definitive establishment that commercial oil and gas reservoirs exist deeper beneath the shallow Gulf of Mexico infrastructure. It is very reasonable to assume that this particular basin could be productive well below 30,000 feet. It is with this confidence that the industry will continue to evolve with deep drilling and production technology. The market drivers for continued expansion of technology have been demonstrated by the reduction in shallow opportunities, increased product prices, implementation of expense reduction items such as royalty relief, expanded risk mitigation with the evolution of 3-D seismic acquisition and processing and most importantly, increased demonstrations of achievability through continued increases in deep drilling activity.

Specific technological focus items for the future include:

- Continued development of directional drilling equipment to improve run time and capabilities for high pressure / high temperature environments.
- Improved synthetic drilling fluids with capability to withstand the high solids content and temperatures, yet meet environmental discharge criteria.
- Improved formation evaluation capabilities for measurement and logging while drilling, as well as wireline tools and surface equipment.
- Better predictability for gas and fluid composition determination.

In conclusion, the single biggest impact will come in the form of sustained industry activity. It is only through this demand that we will develop the necessary technology and it is though this learning that we will learn to apply our predictive tools to mitigate risk and better assure economic incentive to further expand.