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“The Impact of Upstream Technological Advances on Future Oil Supply”

Your Excellencies, distinguished guests, ladies and gentlemen, over the last century, the petroleum industry has been remarkably successful in finding oil reserves, producing them, and delivering them to market. Our success has powered tremendous global economic growth and an unprecedented rise in living standards around the world. But we cannot afford to be complacent, nor can we attempt to overcome tomorrow’s challenges by using yesterday’s solutions.

Therefore, advanced technology will be critical if we are to satisfy ever-increasing global demand for petroleum, and today I would like to outline five “technology targets” and issue a series of challenges which will help us meet our long-term responsibilities as energy providers.

Target One: Finding New Oil Fields

Our first technology target is finding new oil fields in order to increase the world’s conventional oil resource base. Current estimates of total oil in place range between six and eight trillion barrels, but historically the industry has been rather conservative with projections of oil in place and proven reserves. As technology has advanced and our understanding of petroleum geology and reservoir behavior has increased, both numbers have grown steadily over time, whether at the level of individual fields or in terms

of global reserves. [*Total proven remaining reserves in 1960: approx. 670 billion barrels; 2005: approx. 1.2 trillion barrels*]

Therefore, I would like to challenge our explorationists to find enough new resources for us to add one trillion barrels to world reserves over the next 25 years.

Ambitious? Yes. But I am confident in our ability to attain that target, because of the tremendous advances we are seeing in a wide range of exploration technologies, including the massive computing power that supports a wide range of upstream applications. For example, the computing capacity at Saudi Aramco's Exploration and Petroleum Engineering Center has reached 34 teraflop, or trillion floating point operations per second—exceeding the processing power of 30,000 desktop computers. That represents a 300-fold increase in computing capacity since 1999, and is indicative of the exponential rate of development that characterizes upstream technology as a whole, and which is keeping the industry ahead of the curve in the crucial search for new oil and gas reserves.

Target Two: Increasing Recovery

Our second technology target is to leave the minimum amount of oil in the ground, and maximize ultimate recovery from our known fields. Those reservoirs hold proven reserves of more than 1.2 trillion barrels, with a reserves growth potential estimated to be around 700 billion barrels.

Although recovery rates in individual oil fields vary widely, overall they continue to rise through the application of new technologies and better

reservoir management techniques. And so, I would again like to raise the stakes for our upstreamers by challenging them to increase incremental recovery rates for existing fields by 20 percent in the next quarter century, thereby adding another trillion barrels of oil to the world's reserve base.

Of course, the industry is already improving technologies in areas like drilling and completion, production operations, and reservoir engineering, including enhanced oil recovery techniques. The future of such technology is promising, with major opportunities in the areas of digital oil fields; lightweight materials, including the use of nanotechnology; and the development and deployment of new tools to better monitor and manage the performance of our reservoirs.

Target Three: Reducing Exploration and Producing Costs

The third technology target involves reducing exploration and production costs, and making previously uneconomic prospects viable and attractive for investment. This is a vital objective, as the industry's search for additional reserves and production shifts to more challenging areas.

Offshore, it is now possible to economically develop fields located thousands of feet below the surface of the sea. Wells are now being routinely drilled in 5,000 feet of water, and in 2003 our friends at Chevron drilled a well in 10,000 feet of water in the Gulf of Mexico [*Note: Well drilled in the Toledo prospect*]. There have been additional technological developments in offshore production, storage and offloading activities, enabling the economic development of deep and ultra-deep sea oil deposits.

Equally challenging are oil activities in the Arctic and other regions characterized by extreme cold and harsh conditions, like Canada's Hibernian field and Russia's Sakhalin development. The industry has made major gains in technologies designed for cold climates, and as these continue to improve, the cost of developing these oil deposits will also be reduced and the reliability of these production streams will improve.

Older fields also pose unique problems—and ample opportunities. A wide range of enhanced oil recovery techniques are helping to recover more oil from such fields, usually as water floods start to approach their economic limit. EOR technologies can prolong production and increase recovery rates, and since today's healthy price environment makes the use of these higher cost applications more attractive, the prospects for additional advancements in the future are excellent.

Target Four: Unconventional Oil

Our next technology target involves non-conventional heavy oil resources. Unlike conventional reserves, non-conventional resources are mostly known, so it is technological advancements in production that are vital in turning these resources into supplies. Considering the nature of these non-conventional resources and the types of production challenges they entail, it is useful to divide them into two groups: the first consisting of extra heavy oil, tar sands and bitumen; and the second made up of oil shales.

The first group, which accounts for some 4.7 trillion barrels of oil in place, is already being exploited and should make an increasingly significant contribution to global supplies, notwithstanding the challenges associated

with their production. Here I would like to propose a stretch goal of utilizing technology to add between one and two trillion barrels of oil to producible global resources. Reaching that target will not be easy given the issues surrounding these non-conventional resources, including environmental concerns, the availability of sufficient water and gas for processing, operational complexity and overall production costs. But that's what technology, innovation and ingenuity are all about, and our industry boasts those attributes in abundance.

If anything, the challenges involved in the recovery of oil from oil shale are even more complex, and include the development of mining, transportation, processing and waste disposal operations which are economical and environmentally friendly. But oil shales do offer a massive target, since estimates of total in-place resources vary between 2.5 and three trillion barrels. Ultimate recoveries could vary considerably, and once again, R&D initiatives and the utilization of advanced technologies will be vital in unlocking the potential of these extensive energy reserves.

Target Five: Environment

My final technology target today underscores each of the other four, and concerns lightening the environmental footprint of our industry's activities, and of our products. Our panel today is devoted to technology and future energy supplies, and at first glance environmental issues may seem to lie outside the scope of that discussion. However, our industry's exploration and production activities are dependent upon access to acreage, and if environmental concerns prompt regulations that constrain our E&P activities, many promising upstream opportunities could be taken off the table. In

other words, advanced 3-D seismic, super-detailed reservoir modeling and MRC wells mean nothing without access to fields, which in turn is dependent upon the consent of governments and the public. As in other aspects of our business, technology development has an important role to play in environmental protection and the preservation of natural ecosystems.

Total Impact

So taken together, what do these technology targets mean? I believe we will eventually tally about a trillion barrels each from yet-to-be-discovered fields and higher recovery rates. Add those two trillion barrels to the 1.2 trillion barrels of current proven reserves and the 1.5 trillion barrels of oil that can be extracted from non-conventional oil using current technology, and we are looking at more than four and a half trillion barrels of potentially recoverable oil. That number translates into more than 140 years of supply at today's current rate of consumption. To put it another way, the world has only consumed about 18 percent of its conventional and non-conventional producible potential*, even leaving aside oil shale potential. That fact alone should discredit the argument that "peak oil" is imminent, and put our minds at ease concerning future petroleum supplies.

[**1 trillion bbls produced*
+ 1.2 trillion bbls proven reserves
+ 1 trillion bbls in new discoveries
+ 1 trillion bbls from improved recovery
+ 1.5 trillion bbls non-conventional oil
= 5.7 trillion barrels of total producible potential]

R&D Trends

Let me conclude today with a look at some emerging trends related to research and development in our industry.

At present, most national oil companies are focusing their technology development efforts on conventional reserves, the lion's share of which are managed by NOCs. Many of our IOC colleagues, on the other hand, are engaged in a broader range of technologies and more niche opportunities, in keeping with their own business interests in various plays around the globe. We must also remember that service companies and academia are playing an increasingly important and successful role in technology development.

As a result, I believe that NOCs must assume greater responsibility for technology initiatives related to conventional oil reserves, given our stewardship of such resources. These technology efforts are vital because of the vast size of conventional reserves, the pressing need to increase recovery rates while reducing costs, and the large share of energy demand that is satisfied by conventional oil. If we are to successfully meet our responsibilities as national petroleum enterprises, NOCs need to do more to ensure that technology development is well-balanced across our industry, to understand that our efforts and those of the IOCs are complementary in nature, and to recognize that innovative technologies are vital tools in securing our energy future.

Conclusion

Ladies and gentlemen, our challenge consists of leaving the least amount of oil in the ground, finding every last economic barrel yet to be discovered, and expanding our resource base through both niche opportunities and non-conventional oil. I acknowledge those tasks are challenging. But

"challenging" is not the same as "impossible," and overcoming technological hurdles is nothing new for our industry.

In 1907, the Kern Oil and Trading Company of California hired five mining and geology graduates from Stanford to solve their oil production problems. Those men were the first upstream professionals, and their technological tools were primitive. But over the last century, petroleum became the world's fuel of choice, our industry grew into one of the most sophisticated industrial sectors on the planet, and we went from using rock hammers and pocket transits to smart well completions and parallel processors. This hundred years of progress underscores the importance not only of technological change, which continues to accelerate, but also of the need for well-trained, highly skilled and highly motivated professionals who can develop, deploy, adapt and improve upon that technology.

And make no mistake: the future success of our industry—and with it our ability to meet future energy needs—will depend to a large extent on our continued ability to push the envelope of technology. Today, I have outlined five critical technology targets, and challenged our upstream professionals to locate three to four trillion barrels of additional producible potential. That's an ambitious goal, and a vital one. But working together and tapping the remarkable talent and instinct for innovation that characterize our business, I am confident that our companies can, and will, achieve that target.

Thank you.