

**CENTER FOR
STRATEGIC AND INTERNATIONAL STUDIES**

THIRD ANNUAL U.S.-SAUDI ENERGY DIALOGUE

**“THE ROLE FOR TECHNOLOGY
IN MEETING FUTURE ENERGY CHALLENGES”**

**MONDAY, MAY 1, 2006
1:00 – 5:00 P.M.**

**RONALD REAGAN INTERNATIONAL TRADE CENTER
WASHINGTON, D.C.**

2:30 P.M. – QUESTION AND ANSWER SESSION

3:00 P.M. – PANEL II: “THE ROLE OF UPSTREAM TECHNOLOGY”

SPEAKERS:

**MR. STEPHEN CASSIANI, PRESIDENT,
EXXONMOBILE UPSREAM RESEARCH COMPANY**

**DR. MOHAMMED Y. AL-QAHTANI, MANAGER,
PRODUCTION AND FACILITIES DEPARTMENT, SAUDI ARAMCO**

DR. MUHAMMAD M. SAAGAF, CHIEF GEOPHYSICIST, SAUDI ARAMCO

**DR. KEVIN KIMBER, MANAGER, HEAVY OIL FOCUS AREA,
CHEVRON ENERGY TECHNOLOGY COMPANY**

MODERATOR:

**DR. TOM HAMILTON, CO-OWNER AND FOUNDER,
MEDORA INVESTMENTS**

*Transcript by:
Federal News Service
Washington, D.C.*

GUY CARUSO: We have a considerable number of questions as you can imagine, and let me start with one for Mr. Jum'ah. This is from Reuters. "How much oil is the Kingdom currently producing? Is it true that you can't find buyers for all of your supply?"

MR. JUM'AH: Well, of course when you hear the minister speak, he speaks Kingdom; I speak Saudi Aramco. But I think roughly we are – you are somewhere between 9.5, 9 to 9.5 of oil production. But mind you, we have a policy in Saudi Arabia, a government policy that says we will keep between 1.5 to 2 million barrels of extra capacity over and above the call on us. So it's not as though we are not being able to sell additional oil. Yes, our customers, we are satisfying all of the demands from our customers, but we are also keeping a cushion so that the world doesn't see any hiccups.

MR. CARUSO: Thank you.

"Mr. Tillerson, can you comment on Congress' attempt to take away industry tax incentives granted in last year's energy bill? And how about the LIFO inventory tax; do you consider that a 'windfall profits tax'" – in quotes.

MR. TILLERSON: Well, with respect to the incentives that were contained in the energy bill of 2005, I think I have commented before and I think it's been made clear those have had little impact on our activities in terms of projects or programs or drilling opportunities we would undertake. We have never taken a view of a need for any particular incentives or programs to stimulate our activities.

Now, I would want to put that now in a broader industry context though. The industry in this country in the United States is unique compared to the industry in other parts of the world because a significant part of this industry is comprised of independence, small companies, some of which are literally mom-and-pop oil companies, ranging all of the way up to the larger independents that are better known to you.

And across that wide array of participants, some of these programs may in fact be meaningful to their activities and cause them to undertake additional work that does bring additional supply into the U.S. marketplace, domestic supply. These are in small marginal fields that we are no longer involved in. So for us it has little impact, but I would not want to suggest that it would not have impact for other players in the industry.

With regard to the examination of a change to LIFO accounting, I find that extraordinary on the heels of all of the scrutiny around good accounting practices for corporate America, the passage of Sarbanes-Oxley to now, someone suggests, that we will just willy-nilly change the accounting rules because we don't like the current situation on oil prices.

I think that is a very dangerous and a very poorly thought out step to take. LIFO accounting is a standard accounting practice that cuts across all industries. It is not unique to the oil industry. It was not created with the oil industry in mind. And targeting a specific industry and more particularly any specific companies you can only conclude is nothing more but a backdoor windfall profit stacks.

MR. CARUSO: Thank you.

“Mr. Jum’ah, you touched on the issue of the critical roles of skilled personnel in your company, the period of the ’80s and ’90s in which considerable downsizing occurred in the industry. And now there is the expansion program. Given the current level of the top managers’ ages and experience, where do you find the skill labor needed to meet your new requirements?”

MR. JUM’AH: It is indeed a challenge because first our capital program is unprecedented. Capital program in the last five-year plan and the current five-year plan are the biggest in our history. But it’s a challenge, but it’s a manageable challenge. We do have – we have always had our training programs, training and development programs even during the low years, you know, in the 1986 and beyond. We were still sending hundreds of students going to study basically in the United States. And those are now really giving us the support that we need.

It is tight. The programs we have are unprecedented. Frankly, we never planned for this level of activity. But we do tap the market for expatriates and our programs that have been going on for many, many years are giving us a lot of help in this area. Difficult? It is very difficult, but it is very manageable.

MR. CARUSO: “Mr. Tillerson, what is the greatest political/geopolitical threat to increasing technical production?” I would assume it means generally production. “What would help technological advancements for production the most?”

MR. TILLERSON: Well, I think in the short term – and I suspect where everyone’s attention is focused as what can be done in the near term. And I’ll use near term to say over the next five years because that is near term in our business. It is really gaining the access to new resource opportunities to which we can bring the technology to bear. There are, as you heard in my remarks and in Mr. Jum’ah’s remarks, there have been enormous advances in technology capability in the upstream, both from the standpoint of what we are able to do in terms of accessing resources physically but also in the manner in which we can now develop and produce those in ways that are we think environmentally sound with a high degree of reliability.

So the biggest challenge for us from a geopolitical standpoint is simply getting granted access to apply this technology to new resource opportunities. And that is true of countries the world over. Some countries are more willing and open to allowing the industry to access their resources than others, but that is what is needed in the near term to develop additional supply.

MR. CARUSO: Thank you.

“Mr. Jum’ah, Saudi Arabia’s stated oil – improved oil reserves were about 270 barrels in 1980. The published number is a similar number now in 2006. Since then of course Saudi Arabia has produced many billions of barrels. Why have Saudi’s stated reserves not changed?”

MR. JUM’AH: Technology is one of the reasons. I think our team is here and I think they will address this issue but in the last 10 years or even 15 years, we have been adding to our reserves at least the amount of crude that we have produced in the previous year. And that is because technology is giving us – is giving us this help, our brainpower is giving us this help. Our fields are prolific. You know, if you count on a column of 70 feet and then you find you have 100 feet, you are adding. If you count on a certain area where the oil and water meet and then you find that it’s further, that is more.

And of course additional information – every time you produce from a certain well, you have more information about the state of your fields. And really, our reserve philosophy, our production philosophy is of prudent, long term – really gives us a lot of information that would probably for many years to come would make our reserves either staying the same or even increasing.

MR. CARUSO: Thank you.

“Mr. Tillerson, ExxonMobil announced a large increase in capital spending for this fiscal year in order to grow production. Is that directly related to the oil price increases? Do you think they will stay this high? And what price range is ExxonMobil looking at when you decide to invest in new projects?”

MR. TILLERSON: Well, let me answer that question in reverse because maybe it will help. In terms of where prices are going I don’t know. In terms of why they are where they are today, I don’t understand. And in terms of how we view the future, we have to take a view that this is a commodity business. The price does fluctuate from highs to lows. I know people, again, think in terms of shorter time frames than perhaps this business operates, but I would only remind everyone again that in 1998 the price of crude oil dropped to below \$10 a barrel, and here we are now only eight years later, which is not a very long time in our industry, and we are now all the way at a – on almost on order of magnitude above that.

The future period of time over which our project investment decisions have to perform are generally 30 to 40 years. On the front end of that process, which involves a lot of geo-science and engineering work before you decide to make an investment decision. And then you have multiple years of three to four to five years of engineering and construction activity before you get the first barrel of production says that if I start with a new resource opportunity today, I might see the first barrel in about eight years, and then I start the 30- to 40-year time clock on the revenue stream.

So the way we make investment decisions is completely irrelevant to today's prices because today's prices – interesting to our revenues which are funding all of that future stuff. But when I'm deciding, well, what is the right investment to make, somebody has to tell me what is the price of oil going to be 10, 15, 20 years from now when I'm kind of at the peak of that producing and revenue stream? Well, there is nobody that can tell me that.

And so we have to take a view that the investments we make are sound from a technical standpoint, they are sound from a cost-management standpoint, and they are capable of performing over a wide range of prices, which means when you're at the bottom of the cycle, you want to make sure you can keep the doors to the shop open. So they have to be very robust, and it means you're at the top of the cycle we do extraordinary well, and that is the period of time we are in now.

The increase in our capital spending, now having given you that perspective, has been unaffected by this recent price run up. We have had for some time a very large inventory of resource opportunities that we have been working on since the merger of Exxon and Mobil, which we are now into the sixth year. And that work is beginning to produce this large inventory of investments that we're making. You mentioned those timelines to you again.

So we are hitting kind of the peak of that activity that we always expected we would find as a result of our merger between Exxon and Mobil. And so the increase that you're seeing is largely activity-driven. And that is reflected in the projects we have started up and the projects that we have talked about will be starting up in the coming years.

So our production volumes are up in the first quarter 5 percent. That is why we expect our production volumes will continue to grow in the near term.

MR. CARUSO: “Mr. Jum’ah, you have talked about the impressive developments in technology within your own company and your plans for the future. How much investment in dollar terms do you think is needed to foster the technology you have talked in the longer term?”

MR. JUM’AH: (Chuckles.) I don't think there is anyone, either myself or anyone, would say how much in the future. But I think we will spend what it takes and we will spend what – at the end of the day we are a commercial organization that wants to see a return on any investment. We cannot fully follow a technology today that basically doesn't improve our bottom line. So it would be very hard for me to decide on what – how much of investment looking into the future. I think what it takes – we evaluate every technology, and then we will decide if it really would give us dividend short term or even long term – we will look at it.

MR. CARUSO: Thank you.

“Mr. Tillerson, can you give us any new information on your Russian projects? You mentioned Sakhalin in your remarks.”

MR. TILLERSON: Well, the Sakhalin-1 project did start up its first production this past few months. It will be increasing to the first plateau, which is \$250,000 barrels a day by the end of year. We have major – the final major phases of the work activity, the construction, are really getting underway here in the next month with the breakup of the ice up there and our ability to move new modules into the location. And that will complete phase one.

The Sakhalin resource itself is a multiphase development. There are at least two and probably three more phases of development yet to come. The next phase, which we’re concentrating on, is to develop the natural gas resources from Sakhalin.

We are already selling some gas domestically to the Russian Far East because they have dire needs for energy in the Far East of Russia. And we are evaluating and in discussions with potential markets for the gas, a major gas sale that could be to China or to Japan. And those discussions are ongoing. There are subsequent oil phases after the current one that will likely maintain our oil plateau at this 250,000-barrel-a-day level for a number of years to come.

With respect to other opportunities in Russia, we continue to monitor the way the Russian government is evolving the whole framework for foreign investor participation there. We continue to evaluate a number of resource areas. As all of you I’m sure know, Russia is a resource-rich country. And at this stage it’s just trying to find the right opportunity under the right terms and conditions and under the right legal framework that you have some confidence isn’t going to change so that you can pursue another opportunity.

MR. CARUSO: Thank you.

This is really for both of our speakers, and it has to do with Iraq, acknowledging the vacuum that Iraq has been in technologically for the last 20 years and difficulties of bring to bear the latest technology given the leadership that existed.

“Is there – can you share with us what Aramco and ExxonMobil are doing or would envision doing once the Iraqi situation had stabilized to make it possible?”

MR. TILLERSON: Obviously we are very interested in the future of Iraq, all of us, in the industry as well as I think all of us that live in major consuming countries. At this time, other than doing some joint studies with the national oil companies of Iraq outside of the country just to build some relationships, get a little better understanding of some of the challenges that they are phased with. There is no other activity inside the country – waiting on the security situation to improve, and waiting on the government,

the newly formed government of Iraq to define how they want to allow foreign investors to participate. So that is the extent of what we can do at this time.

MR. JUM'AH: I think I share the comments by Mr. Tillerson. We would like to see Iraq a major producer. We would like to see Iraq coming into the market as soon as possible. What would we be doing at that time I really don't know. But of course Iraqi experts will be benefiting of course from technical sessions, by technical organizations. If they were to attend later – and I think that we can – we can share with them within those organizations a lot of information that would probably exchange with them that would help them even improve their situation. But other than that, all we need is as peaceful Iraq. And we want Iraq as soon as possible to come into the market. We need every barrel that can come to the market now.

MR. CARUSO: Thank you very much. That concludes the time we have allocated for this session. So I would like to once again thank Abdallah Jum'ah and Rex Tillerson. And please join me in a round of applause for them.

(Applause.)

MR. : We are going to take a 10-minute break while we set up for the technical presentations. Restrooms and phones, should you need either one, are out and to your right. But if you could be back here by 10 after three, we would greatly appreciate it. Thank you.

(Audio break.)

MR. : Okay, we're going to go ahead and start the technical portion of the program. And I was just informed outside that on a volumetric basis, this is more expensive than a gallon of gasoline.

Our moderator for the technical portion is Dr. Tom Hamilton. Tom started his career in the 1970s with Exxon, so I see a pattern emerging here. He was also a colleague, actually my boss, at Pennzoil. You see another pattern emerging that no good deeds goes unpunished.

In the '70s, he had a variety of management positions with Exxon. In the '80s, he served as executive VP for exploration for Aminoil, and later headed the exploration activity at Sohio. With Sohio's merger into BP, Tom became director of BP Exploration and the chief executive officer for their international EMP activity. Subsequent to that he served as executive vice president at Pennzoil and COO and president of the company's EMP activity, and later as chairman and CEO of EEX Corporation.

Tom earned his master's and doctoral degrees from the University of North Dakota, and he currently serves on the boards of FMC Technologies, Todco, which is the offshore drilling company, and Western Gas Resources. He is a past chairman of the

board of trustees for the American Geologic Institute and a past recipient of the institute's distinguished service award.

Ladies and gentlemen, Tom Hamilton.

(Applause.)

TOM HAMILTON: Thank you, Frank. Good afternoon, distinguished guests, ladies and gentlemen. It's a pleasure to be here today. And I want to welcome you to this second panel of the afternoon.

Let me give you quickly a roadmap of where we are going. There are, as you know from your itinerary three presentations. I will introduce each of the speakers before their presentations. Following the presentation I'll come up with a few summary comments and then we will have a question and answer session. Now, we will take questions from the floor. And I would encourage you of course, unless I see a microphone out here, to speak up, but also to give us questions and limit the amount of commentary. So with those ground rules, we will – let's begin the session.

Our first speaker today, Mr. Stephen Cassiani I have known I guess 35 years back when I had hair. Mr. Cassiani is president of ExxonMobil Upstream Research Company located in Houston, Texas, which is responsible for the development and delivery of enhanced technology to ExxonMobil's upstream operating companies. Prior to his current position, Mr. Cassiani served as executive vice president of ExxonMobile's Worldwide Exploration Company. Mr. Cassiani is a member of the Society of Exploration of Geophysicists, the American Association of Petroleum Geologists, and the Society of Petroleum Engineers. He serves on the board of directors at the greater Houston Chapter of the American Red Cross.

Steve? Ladies and gentlemen – (off mike).

(Applause.)

STEPHEN CASSIANI: Thank you, Tom. Distinguished guests, ladies and gentlemen, good afternoon. I too would like to thank CSIS for hosting this timely event on an important topic. And I'm pleased to be on the panel with distinguished colleagues from Saudi Aramco and Chevron. As Rex Tillerson said earlier, the global energy system faces tremendous challenges. I appreciate the opportunity to share some thoughts on how the upstream oil and gas industry is helping meet those challenges through the development and application of advanced technology.

When I am finished today, I hope you are left with three key messages: first, that the upstream oil and gas industry is a highly technical business with a long history of innovation and accomplishment. From Drake's first well to today's complex multibillion-dollar developments, the industry has aggressively developed and deployed new technology with a remarkably consistent record of achievement.

Second, I think it's clear that future opportunities will require substantial advances in technology, and with history as a guide, we will meet those challenges. For example, many new discoveries will come from hotter, higher-pressure portions of producing basins, or from areas that are currently under-explored for any number of reasons, including water depth, ice cover, and structural complexity.

Third it is clear that a significant research and development effort will be required to meet these challenges, with a focus on next-generation and breakthrough technologies. ExxonMobil for its part has maintained a continuous commitment to proprietary research since the 1920s. We continue to believe that advanced technologies, particularly of a next generation and breakthrough nature will be a significant driver of our continued business success.

I would like to start by focusing on several key technology areas, providing a perspective on the past, present and potential future directions in these important areas. Now given the limited time I'll be selective in the technologies that I discuss.

Wallace Pratt, the first geologist to work for one of ExxonMobil's predecessor companies, the Humble Oil & Refining Company, had it right over 50 years ago when he said where oil is first found is in the minds of men. Today many minds of both men and women are expanding exploration opportunities by developing new innovative exploration concepts and technologies.

Let me illustrate by example with the U.S. Gulf basin. Significant oil production began in the coastal onshore regions of Texas and Louisiana in the 1930s. In the 1940s, geologists developed models that showed hydrocarbon systems extending into the offshore, shallow water shelf. New drilling and production technology was developed that validated these models with discoveries, thus beginning the march offshore.

In the '70s through the '90s, deeper-water hydrocarbon play concepts were pursued. Further improvements in technology driven by these new play concepts led to the discovery and development of several significant fields. Today in the Gulf the industry has drilled in 10,000 feet of water and is producing in 7,500 feet of water.

From the 1990s through today, exploration has continued to move towards deeper more challenging prospects with the trend moving back toward shore. This trend will likely continue in the future towards even deeper, higher pressure, and higher temperature reservoirs both on the shelf and coastal areas on shore as the concept of new geological concepts and advances in technologies continue to expand exploration opportunities.

In offshore Angola, a similar progression is playing out, although a few decades behind the Gulf Basin. In my company we started piecing together the Angola offshore regional geology story in the mid-1980s. It was some 10 years later before the first wildcat was drilled. I suspect you are likely well aware of the Angolan exploration

success story. We are now moving into deeper parts of the basin analogous to the Gulf basin progression.

I am confident that new concepts and technology will continue to expand exploration opportunities around the world provided that the host countries provide the necessary access supported by stable, consistent policies.

Much of the industry's success in exploration and subsequent resource development has been driven by continued advances in imaging the subsurface, one of the industry's great technology revolutions. In 1921, the so-called Arbuckle experiment in Oklahoma proved that sound waves could be used to see below the earth's surface. After the first oil discovery based on seismic data in 1924, the use of seismic imaging expanded rapidly.

With the advent of digital computers and recording devices in the '60s, we moved from analog to digital seismic acquisition in processing. Ingenuity and rapid computing advances enabled the transition from two-dimensional to three-dimensional seismic beginning in the '60s with the first true 3-D survey shot by ExxonMobil over the Friendswood field just outside of Houston. The invention of 3-D seismic by ExxonMobil in the '60s and its subsequent application as one of the most important breakthroughs in our industry.

Today new methods for volume interpretation and direct hydrocarbon indicators are enabling quantitative assessment of the presence of hydrocarbons. We also routinely apply repeated 4-D seismic and utilize advance visualization capabilities to enable accurate tracking of fluid movements over time during reservoir depletion, focused on increasing the ultimate reservoir recovery.

At ExxonMobil we have recently taken pioneering steps in delivering new imaging technology based on advanced electromagnetics. This technology appears to be in the same position 3-D seismic was 20 or more years ago. Over the next decade I expect to see electromagnetics mature analogously to 3-D seismic. Given this impressive history of technical advances, what does the future hold? The challenges we're going to face will require next-generation imaging, imaging technology with significant advances in several areas. We will need tools and procedures to acquire seismic data with substantially higher resolution in all three dimensions and time.

I also expect to see advanced processing techniques that use all of the data measured at the surface. The earth is a solid and generates pressure waves and shear waves in response to seismic sources. In many cases we only record or use the pressure wave data. Next-generation seismic processing will use all returning energy to develop more accurate images.

Finally, we will likely be combining data from multiple imaging sources including seismic and electromagnetics in dynamic interactive environments. Perhaps in no other area has innovation and the impact of new technology been more dramatically

evident than in extending drilling capabilities. Turn-of-the-century drillers use steam power and fish tail bits on cable tools, originally invented for drilling water wells to unlock shallow reservoirs in Pennsylvania. In the 20s and 30s, the industry transitioned to rotary drill rigs to reach deeper reservoirs, one of our earliest breakthroughs. A series of rapid innovations followed that enabled successively deeper vertical wells including new drilling bits and fluids along with well-controlled devices.

Concurrent with drilling deeper, the industry began experimenting with different types of horizontal wells to increase production and certain formations. The capability to drill and complete increasingly complex wells both on shore and off shore had continued to grow through the present – driven by opportunity, ingenuity, and resources. Multilateral technology has provided yet another option for tapping reservoirs with increasingly designer wells.

Over the last decade, the most significant drilling technology trend has been in the application of extended-reach wells. The chart shows the vertical depth versus horizontal reach for a representative set of wells. As you heard from Rex, ExxonMobil's wells at Sakhalin-1 off the east coast of Russia have reached nearly 35,000 feet, over 10 kilometers from the drill rig, an industry record for their vertical depth.

Given the significant progress over the last several decades, one might expect to see innovation and technology in this area slowing. In fact, it appears to be accelerating. ExxonMobil believes that the key to the future is to continue driving towards the physics-based limits of drilling complexity and speed. To this end we maintain a significant drilling research effort. One recent advance, our fast-drill process has achieved a greater than two-fold increase in drilling penetration rates, leading to consistent and repeatable improvements in drilling time of as much as 35 percent over the entire well.

As the industry continues to push drilling to new frontiers, I expect to see steadily increasing capabilities to drill deeper, longer, reach, more complex wells, to construct increasingly sophisticated and reliable multilaterals, and to reach higher pressure, higher temperature reservoirs than are accessible today.

An early oil operator's concept of reservoir management was to drill as many wells as quickly as possible. Technology for optimizing reservoir recovery began with the birth of reservoir engineering in the 1920s coincident with the formation of a number of research laboratories including ExxonMobil's humble production research division, which opened in 1929.

Rapid development of techniques for measuring fluid, core, and formation properties, and the equations and concepts for describing flow within the reservoir were followed by the development of analog reservoir simulators. These began as sandboxes, constructed with transparent glass sides, evolved into electrical analog circuits, and were then quickly converted from analog to digital, and ExxonMobil development with the growth of computing in the 1960s.

Widespread development and field testing of enhanced and improved oil recovery methods followed, including techniques for water flooding, gas injection, chemical flooding, and thermal recovery of heavy oils. In the later half of the 20th century, worldwide reservoir recovery factors continued to grow, playing a major factor in increasing reserve estimates.

The figure shows historical production rate, versus cumulative production for an ExxonMobil operated field. The example illustrates how recovery can be increased by the systematic application of reservoir management, reservoir simulation, and improved oil recovery technologies.

In 1982, after the initiation of in-fill drilling and immiscible carbon dioxide flood, it was thought that the field would achieve a total recovery of 28 percent. The field development plan was re-evaluated and improved in 1990, 1995, and again in 2003 to incorporate additional in-field drilling, surveillance of flood performance, new carbon-eight sequence stratigraphy concepts and 3-D seismic. After each improvement, the expected recovery increased and is now 40 percent.

Human ingenuity has continued to drive advances in reservoir management technology, enabled in large part by continuing advances in computing. Today we have an integrated geologic modeling and reservoir simulation capability with models having millions of sales.

ExxonMobil has developed a process for developing in parallel fit-for-purpose geologic and reservoir simulation models that more accurately match historical production and predict field performance. The process leverages off our propriety next-generation reservoir simulator that Rex outlined, which was industry's first next generation simulator and rests on a 50-year foundation of simulated development.

Modern electronics have also enabled companies to gather staggering amounts of data transmitted around the world in real time and visualize it on multiple display platforms. This data and the communications explosion has put in place the building blocks for the next wave of technologies for optimizing reservoir recovery, real-time management and optimization.

Many companies are pursuing this area under the name such as smart well, smart fields, i-Fields, e-Fields among others. Future challenges will include acquiring and managing real-time data from down haul sensors systematically collecting and automating what is now people-based reservoir management experience, collecting and mining data from around the world using expert systems, and increasingly integrating into the entire decisionmaking process rigorous mathematical optimization.

Given today's global, highly competitive natural gas business, it's easy to forget that for much of the last century, gas was often considered either a troublesome byproduct of oil production or a highly regulated low-value commodity. Modern methods for commercializing gas began with the development of pipeline networks

following World War II, such as the transcontinental gas pipeline from the U.S. Gulf Coast to the Northeast states.

Over the next 50 years, a series of enormous gas fields were discovered, many in remote areas. However, the development of gas commercialization technology was slowed because of a lack of customers and a surplus of accessible resources. Where commercially viable, new technologies were sporadically deployed, including early applications of LNG technology. One example was ExxonMobil's Marsa El Brega Plant in Libya, which began delivering LNG to Spain in 1969.

As natural gas demand increased, driven by domestic use and chemical electric power and other industries, pipeline networks continued to expand. Gas marketing and transmission companies built storage capacity and major transnational pipelines began to be built.

Continuing demand growth has set this stage for a revolution in natural gas transportation. New LNGs that take advantage of incredible economies of scale are playing a crucial role. From 2000, to 2008, LNG liquefaction trains will more than double in capacity to nearly 8 million tons per annum. And LNG ships will carry up to 80 percent more LNG per load, developments brought first to (Cutter's Massive ?) North field by ExxonMobil.

Together, these technologies are enabling LNG to compete with pipeline gas in major markets around the world. Much of the world's remaining gas will be even more challenging to develop, process, and transport. Commercializing challenge gas resources will require numerous technology advances and breakthroughs, including improved methods for pipeline construction and testing, methods to cost-effectively develop smaller, more remote resources, the improved LNG liquefaction, and regasification technologies for offshore environments, and methods to convert gas to high-valued liquids and chemicals.

The key lesson to be learned from our progress in commercializing gas is that when the right combination of access to resource, commercial opportunity, and fiscal regulatory environments are present, the industry will rapidly respond to develop the enabling technologies.

The industry has long been focused on and has made significant improvements in protecting the environments in which operate. Many improvements were driven by enhanced design standards, structured management systems for operations integrity, and improved scientific understanding influencing governmental regulations.

Improvements in environmental performance were also facilitated by numerous technology advances. For example, offshore, subsea well control, and low-toxicity biodegradable drilling fluids have reduced the potential environmental impact of drilling and production. On land, extended reach drilling and advanced completion technologies have enabled many well heads to be grouped together on common paths, significantly

reducing the operational footprint. The example shown is our Collake (ph) operations in Canada. Sensitivity to Marine life has led to increased joint industry research to better understand and mitigate the impacts of our operations.

A number of challenges lie before us. We must better understand the impact and find cost-effective ways to mitigate the production of greenhouse gasses. This is why, as mentioned by Rex, ExxonMobil is supporting Stanford University's global climate and energy project. Over the long term, ExxonMobil will provide up to \$100 million, which is dedicated to accelerating the development of commercially viable technologies that can meet global energy demand while dramatically reducing greenhouse gas emissions on a worldwide scale.

The industry must also continue to find cost-effective ways to dramatically reduce gas flaring, further reduce particulate emissions to the air, and work with customers to substantially increase energy efficiency and conservation. I expect new technologies to play an increasing role in meeting this and other challenges that are critical to protecting the environment.

Given this perspective on several key technology area, I would next like to discuss two examples where we have brought together industry leading technologies to cost-effectively develop extremely challenging offshore resources. Developments in deep water have been enabled by a succession of technology innovations. Our Kizomba A project, offshore Angola, in approximately 4,000 feet of water required the integration of leading-edge technology on a massive scale.

There are several main components of the development. The drilling center is a tension-link platform that includes a rig and 36 slots for wells. (Inaudible) – near by is a massive 250,000-barrel-a-day floating production, storage, and offloading vessel designed to process and store the produced oil until it can be offloaded onto wading tankers. On the seafloor, there are 26 well heads to re-inject water and gas that have been separated from the produced oil to maintain pressure in the reservoir.

Accurate description of the reservoir was a critical factor in optimizing the development plan, and especially important to project success given the costs associated with deep water, where the premium is on being right the first time. The development included a series of complex drilling and completion challenges. Our unique physics base, well planning, and drilling technologies were used to successfully drill some of the most complex wells ever, avoiding significant well boards stability issues.

The plan also included some of the longest deepwater completion intervals ever attempted approaching 3,000 feet, and required technology that simply did not exist. We rapidly developed a new proprietary technology that has led to over 35 consecutive successful completions without a failure, an unprecedented success rate in a challenging environment such as this.

Reservoir management challenges including operating wells to avoid compaction-induced failure and establishing operating procedures to maximize ultimate recovery. We are prying proprietary technology to avoid well failures, and utilizing advanced reservoir simulation methods to gain a thorough understanding of reservoir performance.

Kizomba A is one of the largest deepwater energy developments in West Africa and required extraordinarily complex project execution. Components were constructed on four continents and assembled in a just-in-time fashion. Despite the challenge of integrating numerous leading-edge technologies, Kizomba A set an industry record for the shortest project execution time from contract award to first oil for a project of this size. Kizomba A is the first of three world-class Angola block 15 projects that will collectively develop more than 2.5 billion barrels of oil.

With the start up of Kizomba B last year, combined daily production capacity on the block is now 550,000 barrels a day. Using the strategy of design one and build multiples, the project execution team was able to bring Kizomba B on line in an even shorter period of time and a considerably lower cost than the record setting Kizomba A project.

We have had a sustained research program on arctic technology for more than 30 years, and are pioneering arctic develop in Sakhalin-1, just off the East Coast of Russia. Exploration offshore Sakhalin began in the 1970s, but tapping its resources until recently was only a dream. Development at Sakhalin required new technologies for extremely challenging environments. Pack ice encases the island six months of the year. The average temperature in January is about 4 degrees below zero Fahrenheit. The field sits six miles off shore, and in the winter, the sea is covered with ice up to six-feet thick and is prone to huge storms. And if all of that isn't bad enough, the area is subject to earthquakes.

For phase one development, we are applying extended-reach drilling and completions of world-class complexity to reach much of the reservoir using the world's most power land drilling rig. Reservoir targets are at a vertical depth of about 7,500 feet and need to be achieved with an accuracy of plus-or-minus 50 feet. Each target is five to six miles horizontally from the drilling rig. Using our physics-based well planning and drilling technologies we have to date, drilled nine of these world-class extended reach wells with virtually no hole-related problems.

The outer reaches of the reservoir are being developed from the Orlan offshore platform designed to resist ice and huge waves, and fitted with its own extended-rich drilling rig. Complex engineering designs for the offshore platform were required to enable the area's first year-round operations. The production facilities will be connected to the Russian mainland by a buried pipeline. Pipeline design had to consider the pressure exerted from ice grounding as well as the potential for earthquake-related activity.

Sakhalin also has a number of unique environmental considerations, including more than 90 species of rare animals, fish, and plants, and as part of the project, we have implemented one of the most extensive environmental protection programs ever undertaken by the industry. Today the dream is a reality. As you heard from Rex, production at Sakhalin was initiated in October. And despite the technical and environmental challenges, we have worked with Russian and other international contractors to establish a safety record that is six-times better than the worldwide oil and gas construction industry average. And this is only the first phase of a multiphase project that will ultimately develop an estimated 5 billion barrels of oil equivalent energy – of energy.

This afternoon I have suggested a number of technical challenges that must continue to be met to deliver the energy the world needs in the coming decade. How we will meet these challenges I believe will be through innovation, which will be the key to the future as, not surprisingly, it has been in the past. Innovation of course is not generated in a vacuum. It comes from the creative minds of experienced, talented, and dedicated people.

Meeting future global challenges will require continuing efforts to attract, develop, and retain outstanding people, and a long-term relentless focus on developing next-generation and breakthrough technologies. As John Maynard Keynes once wrote, “Ideas shape the course of history.”

I stated at the outset that the industry has a long history of innovation and accomplishment, and I have tried to give you some sense of that this afternoon. Many significant challenges lie ahead, but I’m quite confident that the dedicated men and women across this global industry are up to the challenge.

I thank you for the opportunity to share my thoughts with you today.

(Applause.)

MR. HAMILTON: Thank you very much, Steve, for that talk.

Our next presentation will be from Saudi Aramco. Note in your agenda that order of the speakers has been reversed. So let me first of all introduce the speakers.

First, Dr. Muhammad M. Saggaf: Dr. Saggaf, chief geophysicist of Saudi Aramco, joined the Saudi Aramco exploration organization in 1989. He has held various assignments with the company including chief explorationist, southern area; senior geophysicist, gas fields; manager, northern-area producing, engineering; and superintendent – (inaudible) – producing operations. He has a bachelor of science in mathematics from the King Fahd University of Petroleum and Minerals in Saudi Arabia, and an M.S. and PH.D. in geophysics from MIT, and an MBA from King Fahd.

Dr. Saggaf has received several company and industry awards, including the technology achievement award in 1997, the creative contribution award in 2001, and the SEG J. Clarence Karcher Award in 2001. He is a member of the SEG, AAPG, SPE, and a former president of the Dhahran Geoscience Society. He has authored numerous technical papers, two books, has a patent in fractal deconvolution, and founded and edited the new technical journal, GeoFrontier.

The second Saudi Aramco speaker is Dr. Mohammed Y. Al-Qahtani. He is currently the manager of production and facilities development department. Dr. Al-Qahtani oversees business planning of the company's crude production slates and all related upstream facilities projects. His responsibilities also include coordination of hydrocarbon reserves reporting. He has held numerous assignments since joining the company in 1983 such as manager of seawater injection division head in reservoir management and production engineering.

Dr. Al-Qahtani holds a bachelor of science from the King Fahd University of Petroleum and minerals, and an M.S. and Ph.D. degrees all in petroleum engineering from the University of Southern California. He has published more than 20 technical papers and participated in various industry conferences and workshops.

There are two other members of the Saudi Aramco team that I would like to introduce. They are in the audience and I would like to ask each of them to stand so you can see them as I introduce them.

First is Ms. Batama H. Al-Awami (ph). Ms. Al-Awami joined Saudi Aramco in 1980 and became one of Saudi Aramco's leading experts in the area of reservoir modeling. She has extensive experience in reservoir management and production engineering, and has participated in a number of major Saudi Aramco development projects as the lead modeler, including those for Shaybah, Sophania (ph), Ghawar, and Abqaiq (?) fields.

Ms. Al-Awami holds a B.S. degree in petroleum engineering from the University of Southern California. She graduated with distinction from the technologist development program in reservoir simulation, sponsored by Saudi Aramco petroleum engineering. She has also represented the company in several international forums including women in business in London in 2003, women in engineering and technology in the UAE in 2005, and the eight international forum on reservoir simulation in Italy in 2005. Ms. Al-Awami has published several technical papers on reservoir simulation.

The other member of the Saudi Aramco delegation is Dr. Nansen G. Solari (ph). Dr. Solari holds reservoir management and strategic planning activities for the company's hydrocarbon reserves. He has held various positions with Saudi Aramco including chairman of the gas development strategy taskforce; co-leader, drawing reengineering project; and chairman best in class in well optimization. He also has spearheaded the company's efforts in maximum reservoir contact and next-generation wells.

Dr. Solari joined the company in 1992. He previously worked for Chevron from 1974 to 1992 where he served as manager of reservoir engineering in Houston before joining Saudi Aramco. He was involved in the worldwide development projects and was the principle constructor for Chevron's reservoir management schools.

Dr. Solari holds both M.S. and Ph.D. degrees in chemical engineering from the University of Virginia. He is a member of the advisory board of petroleum engineering at the University of Houston, SPE distinguished lecturer, co-chairman of the SBE European forum, keynote speaker at the fifth, sixth, and eighth international forums and reservoir simulation, SBE's speaker's bureau member, member of the SBE Fluid Mechanics Committee, and an invited speaker at more than 90 industry gatherings. He has also authored numerous technical papers.

So with that I will ask the first of the Saudi Aramco speakers to join us. In the control room they will be using the lavalier mikes so if you need to flip a switch, now would be a good time to do it.

(Applause.)

MUHAMMAD M. SAGGAF: Thank you very much, Tom. Good afternoon, ladies and gentlemen. It feels good to be back in Washington, D.C. I was here two years ago participating in a seminar co-facilitated by CSIS, and I must say I have some of the fondest memories of that seminar and of Washington, D.C.

Today our focus is on technology and how it can pave the road for a bright future. I'm going to give one perspective on that topic, that of exploration, whereas my colleague, Dr. Mohammed Al-Qahtani, is going to give another perspective, that of development.

But perhaps before we talk about the bright future, we should also look at the bright past as well, for indeed Saudi Aramco has a very bright history. For over 70 years, Saudi Aramco has been exploring and developing the vast resources of the Kingdom of Saudi Arabia. From the 1933, with the signing of an historic agreement between Saudi Arabia and Socal, to 1938 with the discovery of the first oil field, the Dammam field, and the drilling of the discovery well, lucky well number 7, Dammam well number 7 to 2006 currently.

Saudi Aramco has accumulated immense resources and reserves, including '96 oil and gas fields, 320 reservoir accommodations, and 260 billion barrels of proven oil reserves, making it the largest in the world. That is roughly one-fourth of the world's reserves. And I'm going to go back and elaborate on this in just a little bit.

Saudi Aramco's current production capacity stands at 10.8 million barrels a day and all of this is in addition to 230 trillion standard cubic feet of gas reserves, making it the fourth-largest in the world for the gas. And when we talk about resources, I have to say that strictly speaking, this refers to the discovered oil resources of which Saudi

Aramco has over 700 billion barrels. This is the oil originally discovered, the so-called oil initially in place.

Of course not all of this oil is recoverable with current technologies, and some of it has already been produced. In fact, 106 billion barrels have already been produced. That is only about one in seven barrels of the discovered resources, by the way. Therefore the remaining 260 billion barrels of proven reserves that they mentioned represent about 36 percent of the discovered oil resources.

The goal of exploration, my mandate as a geophysicist is to increase the discovered oil resources, is to increase the total size of the pot. And I must admit this pie metaphor is quite appealing especially since they didn't have cookies during the break. So I am going to carry it forward.

Like I said, the goal of exploration is to increase the total size of the pie. The goal of development is not to increase the total size of the pie but rather to get the most out of the same pie, in other words, to increase this 36 percent into more. And that bar is going to be covered by my colleague Mohammed Al-Qahtani.

Of course to achieve these mandates, there are challenges to be overcome. Saudi Arabia has a vast exploration area, diverse geology, and the environment is quite harsh. The topography is difficult, covered with thousand-foot sand dunes that complicate data acquisition and drilling, and most of our seismic data is land data, which is usually more problematic than marine data elsewhere in the world because of the variability of the shallow areas.

Technology of course plays an important role coupled with the resource potential, the people, technology, and best practices. And I'm going to discuss some of the technologies that we developed in house in Saudi Aramco to tackle these challenges. But before I do that, since I'm going to mention seismic data a lot and because of the diversity of the audience, perhaps a brief introduction to seismic data is in order.

I think most all of us are familiar with ultrasound pictures like the one you see to your left, sonograms of the baby in its mother's womb. We developed these pictures by sending sound waves into the human body and recording their reflections in order to see the baby before it is born. The objective of seismic data is quite similar – however, not to image the baby in its mother's womb, not to image the belly of a human, but to image the belly of the earth. We would like to tell something about subsurface structures before we drill by doing and having sonograms of the earth, and we do this utilizing sound waves as well.

So let's talk about some of these technologies. These are seismic sections, pictures of the subsurface at 10,000 feet. The white and dark areas, by the way, represent different layers, different geologic formations. Processing seismic data is extremely important because it improves the clarity of these pictures.

In Saudi Aramco, we develop a new algorithm called fractal deconvolution that allows us to improve the resolution and focus of the picture. Now, remember, seismic data is all about pictures. So the more focus and resolution that you have in these pictures, the more you can image your subject and therefore you improve your success in drilling.

This algorithm is called fractal deconvolution. I'm not going to describe the methodology but I'm going to give an example. The section at the top is a seismic section processed with the conventional method. As you can see, it looks all right overall, but you see several breaks in the data because of the lack of focus and resolution.

The section at the bottom was processed with this new method, fractal deconvolution. And as you can see, these breaks in the data disappeared; we have more continuous events, and therefore we can interpret this data with much better ease. We can map the subsurface structures, identify them, and therefore improve our accuracy in drilling and enhance our success rate in looking for oil and gas.

These sections are slices of 3d seismic data – the big thing, the reservoir, in map view, at about 10,000-feet deep. One of our objectives is to be able to tell something about the quality of the reservoir before we drill just like you like to see the baby before it is born. And in particular, we would like to tell something about subsurface channels because they hold some of the best reservoir quality. These are not migration paths; these are bay zones within the reservoirs, and you would like to target them so that you can improve and enhance oil productivity.

Coherence analysis allows us to do this. However, the conventional methods for computing coherence do not lead to lucid images of these subsurface channels. Therefore we developed a new algorithm for computing coherence based on generalized Hilbert transform and implemented it in a tool that we call DETECT for detecting these subsurface channels, and that tool allows us to see these channels with much better clarity.

The section that you see to your left was produced by a commercial package, and you can see hints of these meandering channels. The map to the left, to the right, was produced by DETECT, and now because the image is so clear, is so well focused, you can identify these subsurface channels with much better ease. And therefore, once you have identified them, you can target these sweet spots of the reservoir and therefore improve the well productivity.

And not only are we interested in detecting subsurface channels, we are also interested in estimating their thickness because the thicker the channel, the bigger the pay. Therefore we developed an algorithm based on analyzing the variability of the frequency content of seismic data that allows us not only to detect the locations of the channels and map these locations, but also estimate their thickness – here color-coded – such that we can zoom in and target the thickest portions of the reservoir and therefore drill wells with much better productivity.

And the last technology that I'm going to talk about is neural networks. Biological neural networks are quite interesting. The human brain has over 50 billion small cells called neurons interconnected together via synapses and electrical signals flow between these neurons through these synapses. And actually it is through the flow of these electrical signals, and activation of the neurons that we get our capacity of learning, behavior, and perception. We get our smarts – 50 billion cells. Whenever I feel dumb, I just say, oh, I have 40 billion cells, by the way.

At any rate, artificial neural networks simulate biological ones in software, in computers with the objective of fabricating the human's ability to perform better matching, better identification, and information extraction but on a massive scale. We use neural networks to extract porosity information from seismic data. And by the way, in a nutshell, porosity is how much void space the rock has; how sponge-like the rock is. The more void space the rock has, the more it can hold hydrocarbons, and therefore the better the reservoir quality.

So we use neural networks to build large-scale porosity models like this one that form the basis for reservoir simulation models. Our contribution here is that we developed a new type of neural networks called regularized neural networks that are more accurate than the conventional ones. In fact, in this application, in the Shedgum field, we were able to obtain a 22-percent improvement in the accuracy of estimating porosity from seismic data over the conventional neural networks.

And of course this means that we are better able to estimate our reserves with more accuracy, and we are better able to predict the outcome of the wells before drilling and therefore reduce our risk in exploration and in development.

So I talked about different technologies. I talked about fractal deconvolution and how it improves the focus and resolution of the seismic data, and I talked about detecting subsurface channels using DETECT and estimating their thickness, using the frequency information, and I talked about artificial neural networks, the regularized neural networks that are more accurate than the conventional ones that allow us to estimate reservoir porosity more accurately.

And there are other – a host of other technologies we are using in our exploration activities. Unfortunately I cannot cover them here, for example, elimination of ghost multiples, fuzzy logic, and extend elastic inversion, and others. I would love to tell you about them but I admit time is tight, and I'm sure Tom is not going to allow me. He is already nodding his head. Suffice is to mention them in brief. I am not going to cover them.

All of this is part of exploration through innovation, which is one component of our overall strategy of combining our large resource base with qualified manpower, with the appropriate technologies, and with the guiding management tenets that emphasize employing the best practices in exploration and in development.

And I'm going to give you some examples of the outcome of this strategy, some examples showing the impact of technology on our oil and gas exploration, and in particular, two recent discoveries, one last year and one this year.

In Duaiban, for example, we use the tools that I have mentioned in an integrated manner, coupling several of them together to tackle this non-conventional stratigraphic – (inaudible) – and locate Duaiban-1 in Central Saudi Arabia which was the discovery well for the Duaiban oil field. That was 2005 last year. And we also use these tools to locate Karan-6, which we finished drilling only two weeks ago off shore in the Arabian Gulf. The well was quite successful and it was the discovery well for the Karan gas field.

This field has a substantial upside potential. As it's currently mapped, closure extends over 30 kilometers in length, over 20 miles in link, over 400 square kilometers in area. That is roughly the size of Washington, D.C., between the Beltway, by the way. The well was tested in restricted fraction, and it flowed 40 million standard cubic feet of gas per day. It is estimated to be able to flow over 80 million standard cubic feet of gas per day at – (inaudible). By the way, that is roughly about four times the productivity of our average gas producers.

So these were two examples of technology on our oil and gas exploration. And in particular Karan was an example from the non-associated gas program. This chart shows the growth of non-associated gas reserves since 1987. By the way, non-associated gas is gas that exists as gas in the reservoir, not associated with oil, not dissolved in oil.

We started this program in 1994 once the need for additional gas volumes was identified to fuel our emerging domestic power and petrochemical industries. At the time, associated gas was not adequate to meet our big domestic demands, especially at times of low oil production.

Before starting this program, you see, before 1994, we were adding small volumes every year. However, once the need was identified, the focus was given, and the program was started in earnest, we were very successful in accomplishing our objective. In fact, we more than doubled the reserve's base that existed at the onset of this program in 1994 from 45 to 102 standard cubic feet of non-associated gas reserves.

Of course we made the appropriate investment. As you can see, at the onset of this program in 1994, we ramped up our exploratory gas well drilling and roughly doubled the number of rig years for exploration gas drilling. This chart shows both oil and gas rigs. However, the emphasis during that period was on the gas because of the already large reserves base of oil that we have. So most of these were gas rigs.

What is going to be our level of activities of the next five years and beyond? I'm going to tell you about it but I'm going to tell you about it a little bit later in my presentation and keep it as a teaser for now. I have to make the presentation exciting after all.

Let us look at our area. As you can see, much of our exploratory oil drilling has been mostly concentrated in a rather small portion of Saudi Arabia. Likewise, seismic data coverage both 2D and 3D has also been mostly limited to that area, although we have reconnaissance exploration outside it. That area is the northeastern area of Saudi Arabia. However, the resource within (Shell ?) is not limited to that area. In fact, we have exploration plans in vast areas of Saudi Arabia and in particular in four more areas: in the Red Sea, Northwest, North Riyadh and Rub' Al-Khali.

Each of these areas is larger than the northeastern area. In fact, in total, these areas are more than seven times the size of the northeastern area. To put it in perspective, they are larger than the size of California and Texas combined. We have had already reconnaissance exploration in these areas which were successful, but now we have a focused exploration program for oil and gas in all five areas, and we feel we are very well positioned to aggressively pursue oil and gas exploration in all five areas.

But let me be more specific. I posed earlier the question of our level of activities during the next five years and beyond. We are going to maintain our commitment to gas exploration, even increase it a little bit over the next five years. However, we are now focusing on the oil and we are going to massively increase our level of activities in oil exploration.

This chart shows both oil and gas exploration, but most of the increase is in oil exploration. In fact, we are going to more than quadruple the level of investment, the level of activity in oil exploration during the next five years and beyond. This is broadly similar to what we did at the onset of the non-associated gas program, except we are now doing it for the oil.

So in conclusion, in short, in brief, I would like to say that coupling our large resource potential with the appropriate technologies, and with qualified manpower and guiding management tenets has allowed us to be very successful in the gas program. And now we are focusing on oil and we are coupling the same technology, same people, same management tenets with the oil resource potential. That, in Saudi Arabia, as you know, is substantially more immense than the gas potential.

And we have learned to aggressively pursue oil exploration in all five areas in Saudi Arabia. And we are confident that we will be successful in increasing the size of the discovered oil resources. In fact, we forecast that by 2025, our discovered oil resources will have increased from the current 716 billion barrels to 900 billion barrels and beyond. And that my mandate as a geophysicist as increasing the total size of the pie will have been fulfilled.

And ladies and gentlemen, this indeed is a bright future. Thank you very much.

(Applause.)

And now my colleague, Mohammed Al-Qahtani, is going to tell us about the other mandate, not increasing the total size of the pie, but getting the most out of the same pie. So without further ado, Mohammed.

MOHAMMED Y. AL-QAHTANI: Thank you, Muhammad.

Building on now what Dr. Saggaf has just discussed, my goal over the next 10 to 15 minutes will be to share with you, reflect on the role of technology to develop our fields and get most of the pie. And perhaps a good way, a good start would be to share with you our expansion program in the crude program here.

As you can see, here is the crude program over the next five years, going from 2004 all the way to 2010. And what you see here is the maximum sustainable production capacity for the company going from 10 million barrels per day in 2004 all the way to 12 million barrels per day by the end of 2009. And you can see that there is – this is the component from the company, Saudi Aramco, but there is additional half-a-million which brings it to 12.5 million barrels per day by the end of 2009.

What you see here is that we have been maintaining a strategy of keeping 1.5 to 2 million barrels of spare production capacity that is available to meet any disruptions in markets and to keep up with the demands at any given point in time. These are some of the increments that we will be bringing on as we increase our production. We will be developing new fields and expanding on some of the existing fields.

Just an example in Abu Sa'fah – (inaudible) – in 2004, with the level, with a total of 800,000 barrels per day, but most importantly is the Haradh Increment-3, which we put on stream just three months ago with 300,000 barrels per day and came really five months ahead of schedule. This increment will be the focus of some technology applications, and I will discuss it in details during my presentation.

By the end of next year we will have another increment in the AFK complex of 500,000 barrels per day, bringing the total MSC to 11 million barrels per day by the end of 2007. Later on in 2008, we will have another expansion program in Shaybah and – (inaudible) – totaling 350,000 barrels per day. But most importantly will come 2009 where we will have a mega increment in the Harez (ph) field, which is a giant field, and this is considered the biggest increment in the oil industry with 1.2 million barrels per day by mid-2009, allowing us to go to 12 million by the end of 2009.

I will share with you next our strategy for meeting these – ensuring that we will meet these aggressive development programs. The strategy here entails four essential pillars. The first one is a large reserve base, which we have discussed a few minutes ago with my colleague Muhammad Saggaf, and the second one is the use of appropriate technologies as I will discuss later on. And the third one is the qualified and well-trained human resources that will ensure the appropriate application of these technologies. And the fourth one and the most important one is really what we call the management tenet,

which are the body of knowledge, and mechanism, and processes that govern our fields and allow us to implement the best practices in field development.

The strength of the company is in its ability to optimally optimize and coordinate all of these four elements. For the purpose of this presentation I will focus on the role of technology and its impact on our operations and management tenets. Here are some examples of high-impact technologies that I will discuss during the presentation. The first one is advanced and smart wells. The second one is reservoir diagnostics and modeling. And the third one is in the i-Field concept. I will go over each one in detail for some examples and demonstrate the impact in our operations. And there is a whole and a wide range of technologies that are available to us but due to time constraint I will not focus on them and I will focus on these three technologies only.

And the first one is really in the area of maximum reservoir contact wells and geo-steerings. These are a new game changer for the industry. Indeed, we have been able to enjoy a tremendous gain in oil rate and benefit in ultimate recovery from application of the smart – from maximum reservoir contact just like the well you see here. These are horizontal wells that cross the reservoir in multiple branches and contact the reservoirs with over seven to eight miles of reservoir contact, thus increasing the production rate and allowing us to have higher recovery and lower development costs.

Now, one key technology that allows us to implement these technologies and maximum reservoir contact and allowing us to place the entire length of the horizontal section within a window of roughly 10 to 100 feet from 5,000 feet all the way to 15,000 feet is the use of geo-steering technology. And the geo-steering technology is a process where by we control the drilling bits thousands of feet in the formation from our offices, geo-steering centers in our headquarters, using satellite connection, communicating all the way to the drilling bit.

And what we do with it is we try to geo-steer the well, basically steering it to cut across a window just like the height of this screen above me about 10 feet all the way to 30 feet in some areas. And we stay with it for miles across the reservoir branching out with several branches. Geo-steering and geo-navigation has really become really an essential and very important, and a standard way of doing our horizontal drilling in the company.

To illustrate the benefits of such technology, MRCs, and geo-steering, let me focus on one example from the Abqaiq field. This is a well, Abqaiq 474 is MRC and it was drilled using the geo-steering technology. What you see below here is a cross section across the Abqaiq reservoir in the most mature area of the Abqaiq reservoir. The cross section is about seven miles. And what you see here is at the top of this reservoir, we have an oil zone and that is only 30 feet of an interval of hydrocarbon sitting above the water zone below it. Our goal is to place these maximum reservoir contact wells at the top of this 30-foot interval, indeed at the top of only 10-foot interval out of the 30 feet.

The result is that we have been able to achieve seven kilometers, roughly around four-and-half mile of reservoir contact, thus allowing us to produce the well at 7,000 barrels per day. If you take it and compare it to a nearby conventional vertical well, you will have an increase of seven-fold compared to that vertical one, indeed an increase that is allowing us to effectively deplete the Abqaiq reservoir in the most important, in the most optimal manner.

Geo-steering have increased our efficiency drilling, our horizontal wells just like this by 50 percent over the last three years alone. And we have been able to achieve substantial gain in oil rate.

Now let me reflect on the impact of such technology, MRC and geo-steering on the Abqaiq field, which is the most mature field within the Kingdom. What you are looking at here is the Abqaiq Arab D reservoir, which is the principle reservoir in Abqaiq area. The field was discovered and put on production in 1948 and currently is producing around 400,000 barrels per day with water cut of less than 40 percent, indeed an impressive performance. So far we have been able to produce around 55 percent of oil initially in place.

And let me discuss now the recovery from the Abqaiq field and application and how it is going to impact our future recoverable resource from the Abqaiq field. What you see here is an actual data of water cut and we have been able to achieve 55, as I mentioned, percent, with 40 percent water cut.

Now, we are projecting using water flooding along to reach in the neighborhood of 70-percent recovery. If you want to compare it and it would be appropriate here to mention that both of the reserves, the recovery factor for the Abqaiq field is only 65 percent, which underscore our conservative approach towards reserve. You can see the performance here is stellar and with time we will be able to produce an excess of 70 percent of the reserves from the Abqaiq field, indeed, without the help of advanced oil recovery. And if we put the help, and put the technology from in-house oil recovery, and other technologies, we will be able – and we are projecting somewhere in the neighborhood of 80 percent from the Abqaiq field.

Our point here is that the performance of the Abqaiq field and other fields are not coincidental. In fact, they are a reflection of our management approach and our management tenets and how we are developing our fields, and putting in place the right technology where applicable.

And let me now discuss the second application of technology, which is the area of reservoir simulation and model. One of the most important tools for a reservoir manager is to be able to simulate the performance of the reservoir and be able to forecast its performance over the next 10, 50 years, and how different scenarios of development scenarios can impact the production from that field, and how we can optimize it to achieve the maximum recovery and reduce the development cost.

Simulation is, as I said, one of the most important tools. Basically you divide the reservoir into cells, into blocks, grid blocks. And the higher the number of the cells, the better and the more accurate the simulation and the results will be, just like if you take the digital camera approach, higher the pixels, the better the resolution and the better the overall quality of the reservoir. Well, we have developed in our company, inside Aramco, in order to meet the simulation requirements for our giant reservoirs and our giant fields. We have developed the simulator called POWERS based on parallel simulation technique.

POWERS capability have grown over the last few years tremendously allowing us to achieve very high resolution and the latest being in the Shaybah field by the end of last year achieving 17 million cell model. This of course allows us to have much better accurate prediction and much better capability in terms of reservoir management and employing the best tools for that reservoir.

Currently we are working to – in the next generation, working in the next generation of the POWERS called POWERS 2. POWERS 2 will allow us to have an order of magnitude of higher resolution. We are projecting somewhere around 100 million-plus cell models by the end of 2008. The point here is that POWERS' superior technology have allowed us to have much better accuracy and prediction and will help us always in implementing the best technology where applicable.

Now let me go over the next application of technology, which is the i-Field concept. This is a game changer for the industry. We have taken a great leap in implementing this for the first time in the industry with the latest increment that we had in Haradh increment three just three months ago – developed with the i-Field concept.

But before I start, let me offer an explanation of the i-Field concept. Basically it's an integration of the all of the information we gather from the well, contact in the reservoir, all the way to the surface, all of the way to our desktops with the simulation with the 3D – with the 3D simulation and seismic. All of that is put together in order to have a much better and real time reservoir management approach to our fields. It was applied in the Haradh field.

Basically in the i-Field concept, you have all of the wells equipped with down haul sensors and control that measure the pressure, temperature, the rate of oil, water, and gas – all of this information transmitted to the surface via satellite to our desktops. And one other important component in the i-Field is that we are able to control, to monitor – (inaudible) – and control the reservoir or the wells in the real time. So we have also the capability of controlling these – (inaudible) – from our offices in real time.

This of course have taken a very important leap forward in implementing such technology in the Haradh Increment-3, which will be the focus of my presentation next and the next few slides. Haradh Increment-3 is marking a new age in the field development not only for Saudi Aramco but indeed for the rest of the industry. And I

will discuss the Haradh Increment-3 to some extent. But before that, let me offer you a brief historical perspective of the Haradh area.

Haradh is located in the southern part of the super-giant Ghawar field. This is – Ghawar is the largest oil reservoir in the world. It spans somewhere around 175 miles long and 17 miles in its widest area. It is roughly the distance between here and Philadelphia. The Ghawar was discovered – the first discovery in Ghawar was in 1948 in the northern area, in Ain Dar, followed by another discovery in the Haradh area in 1949. Ironically at that time, the two discoveries – it wasn't immediately obvious that we are dealing with a super-giant structure, but later on became the well known super giant Ghawar field.

The field was put on production in 1951 with the peripheral water injection starting in '65. Now allow me to focus on the Haradh area to the south, and what you're looking at here is the Haradh field spanning around 50 miles by 17 miles with an oil initially in place of around 38 billion stock tank barrels with a proved reserve around 19 billion stock tank barrels. We have produced 2 billion thus having a remaining reserves around 17 billion stock tank barrels.

For the purpose of development, the Haradh field was divided into equally spaced in size increments, and the first increment was in the second quarter of 1996 with 300,000 barrels per day. At the time, vertical wells were the only available option, and the field was developed with vertical wells. In 2003, second quarter 2003, the second increment came on stream with 300,000 barrels per day with a new approach, which is exclusively done with the horizontal drilling.

At the time horizontal wells were considered a game changer. But later on in Increment-3, which we have just put on stream three months ago. The field was brought on stream with 300,000 barrels per day and was developed exclusively with the next generation wells, MRCs, and smart completions and with the concept of i-Field.

Let me now offer some statistics on the benefits of maximum reservoir contact wells and the smart completions, and you see here the performance of the different increments over the last 10 years. And one increment – on in '96, Increment-2 in 2003 developed with horizontal wells and Increment-3 in 2006 with MRC and smart wells. The average well rate in Increment-3 is around 10,000 barrels per day using this type of technology. That represents a two-and-a-half-fold increase in production rate over a similar well developed using horizontal technology in 2003, and also represent a five-fold increase compared to a vertical well developed in Increment-1.

This is a demonstration of the technology capacity to continuously deliver better and smarter solutions for the oil industry. And next I will offer some examples of the benefits of the added smart completions to the MRC wells. Here is an MRC well in the Haradh area, an artistic view of an MRC well, a horizontal section here with three laterals. The smart completion is demonstrated here in the form of controls known as – (inaudible) – where we can control and regulated the flow from each lateral at any given

moment in time. The intervention is done in real time and we are optimizing the flow from each lateral in order to avoid water production and maximize the sustainability of the design rate for the well to achieve a longer plateau and maximum recovery.

This well is an actual well that was drilled in Haradh Increment-2 in order to plan for the rest of the wells in Haradh Increment-3. So far, after implementation of such technology, the well has been in production for six months without any water production, achieving our target rate from this well, and indeed providing us with the new opportunity for future application of such technology.

The next one, the next example here is in the area of real-time reservoir management. And what you are seeing here is an actual performance of the Haradh Increment-3 during the injection period that we implemented in the field just before the start up of the increment. This is a pressure map. And what you are looking at here is an animation of that pressure propagation as we inject water into the flanks produced from the center of the field.

This is just like weatherman tracking an event, if you will, animation. In real reservoir management, we use this information in order to optimize our injection strategy, production strategy, and real time, and intervene to implement the best and optimum strategy and real time.

Now that we have seen the performance of Haradh Increment-3 during this period, let's take at its performance for the next 50 years and see how the implementation of technologies like MRCs and smart completions and the concept of i-Field are going to help us to achieve the best sweep efficiency from the Haradh field. What you are looking is, again, a sophisticated simulation modeling techniques. Reservoir simulations allows us to see into the future 50 years of performance. As you can see here, the red is representing the oil and the blue is representing the water.

As we inject water from the flanks towards the center – we produce the oil from the center – you see a very uniformed, uncontrolled flood front that allows us to have excellent sweep efficiency and displacement, thus maximizing our sustainable rate, reducing our development costs, and ultimately improving our recovery from this field with the minimum water production that we can get.

Now we believe that Haradh Increment-3 is setting a new standard for global excellence for upcoming increments. Indeed, a new age of smart completion is upon us. Now this brings me to my last example before I conclude, which is a digest of over 60 years of Ghawar field performance. And I would represent it next with the performance of the Ghawar field within the last 10 years.

What you see here is an oil rate that is sustained – on average 5 million barrels per day over the last 10 years. Associated with this oil rate is a water production that is represented here in water cut. This water cut is representing how optimized the development is. And you can see it is going high and then reduced. Through our

commitment to unique reservoir management tenets in developing and producing our fields and application of – (inaudible) – technology just like what Dr. Saggaf and I have demonstrated today, we have been able to control the water cut and the water production for the consecutive six year, indeed a performance that is considered an outstanding performance by industry norms.

Just to put it in perspective, the average water cut for the world is around 80 percent. For this giant field that has been in production for the last 60 years, it is only 33 percent, is under control, and steadily producing oil rate at 5 million barrels per day.

Now, the question now is where do we go from here. The examples we have discussed in many ways encapsulates the future of E&P across the industry. These technologies have given us a preview of what lies ahead – real-time capture of information, better water management, and smarter and proactive reservoir management techniques. All of that will result in lower development and operating costs, and will increase the recoveries. Indeed we are looking into from somewhere from 5-, 10-, to 15-percent increases in recoveries just by using such technologies, which will translate into billions of barrels for us as a company.

Now this brings me to the concluding thoughts, and I would like to conclude by saying that indeed we are seeing a bright future for exploration and producing. We are entering a new era and new age in E&P and we are so optimistic about it. Technology provides a significant upside potential as we have explained here for increasing reserves as a result of improved recoveries. And finally, technology, people, and tenets are the three key enablers for sustainable supplies for many years to come.

With that I conclude my presentation, and I would be happy to answer any question later on with my colleagues. Thank you very much.

(Applause.)

MR. HAMILTON: Thank you. Thank you.

The last presentation of the day is by Dr. Kevin Kimber. Dr. Kimber is the heavy-oil focus area manager for Chevron, responsible for coordinating heavy-oil technology development and commercialization for Chevron's worldwide heavy-oil business targeting upstream production and downstream heavy-oil upgrading. Dr. Kimber has led this effort since 2002 and has 24 years of experience in the petroleum industry in various positions in various parts of the world. His responsibilities have spanned development of heavy-oil recovery processes and technology, establishment of the heat-management practices, reservoir management, and facility development. He has authored numerous papers, publications, and patents.

Dr. Kimber was raised in Canada and graduated from the University of Saskatchewan with a B.E. in chemical engineering, and from the University of Alberta with a Ph.D. in petroleum engineering.

Ladies and gentlemen, Dr. Kevin Kimber.

(Applause.)

KEVIN KIMBER: Thank you and good afternoon.

It is my pleasure to have the opportunity to discuss the role of steamflooding technology in increasing heavy-oil production and reserves. Several of our previous speakers have well set up this talk. We have heard earlier about the role, increasing role that heavy oil and extra-heavy oil will play in our supplies. We have also heard about how technology is expected to significantly impact resources. I think our earlier speaker referred to it as getting more out of the bar.

I am going to give you some examples of how technology already has done that, fulfilled that role, and a couple of examples of the potential that that might hold. Chevron participates in nearly all of the heavy-oil basins around the world onshore and offshore using a number of different technologies ranging from primary, pressure support, mining extraction, and thermal, or steamflooding, which I'm going to focus on.

Our oldest and one of our largest steamflood operations is in California in the San Joaquin Valley. The world's largest steamflood is located in Duri, Indonesia. The potential for a steamflood in the PNZ is being piloted today. Chevron is collaborating with Saudi Arabia and Kuwait in this effort.

And finally, to support our heavy-oil operations around the world, we have our international heavy-oil center located in Bakersfield. You might ask, why steamflood? How does steam help? Well heavy oil is very viscous. That means it's tarry; it's molasses-like; it is very difficult to flow through the reservoir rocks. By injecting steam in the ground, we heat the heavy oil and make it much thinner, less viscous, and it makes it much easier to flow to the producing wells. The result is much higher recovery rates, much higher reserves. In fact, we can achieve between two and 10 times compared to conventional techniques.

Conventional techniques might recover 5 to 15 percent of typical heavy-oil resources. Using steamflooding technology, that can be increased to 50 to 80 percent. In the lower-right corner, there is a couple of cores. Core is cut from the reservoir and brought to the surface. On the left is the before picture and on the right is the after picture. You see to the left a rock that is saturated or filled with heavy oil. Using steam, almost all of that oil is removed. This example is from a Duri field in Indonesia.

This is an example of using technology already to improve reserves. The Kern River field was discovered in the late-1800s. It hit peak production fairly quickly, 40,000 barrels a day, and then declined to only a few thousand barrel a day. In the early '60s, steamflooding technologies were developed, and that allowed us to increase production from that few thousand barrels a day to 140,000 barrels a day, dramatic improvement in

recovery rates, dramatic impact on the reserves in that reservoir. In fact, the recovery is anticipated to approach 80 percent in the Kern River field.

Now, that technology is then taken and applied and adapted to the Duri field in Indonesia. Again, the historical picture looks very similar. This field was discovered in 1941. Production peaked at about 50,000 barrels of oil per day and declined to a few thousand, similar to Kern River. Steamflood pilot was conducted and the technology is adapted to this field – consequence, we were allowed to – we were able to develop the field and raise production to 300,000 barrels a day, again, dramatic increase in production, dramatic increase in reserves. That is what we are looking for from technology; that is what we found as an industry from all sorts of technologies, and that is what we are looking for in the future.

Today we are producing over 200,000 barrels a day. We are injecting a million barrels of steam per day in this field. We have produced about 2 billion barrels of oil so far, and we have used 6,000 wells to do it.

We are excited about the opportunity to extend our long-standing relationship and partnership with Saudi Arabia, and develop a new technology for the PNZ heavy-oil carbonate. There is huge potential to dramatically increase heavy-oil production. We have got plans to make that happen over the next 30 years. We have started with some individual well tests, cyclic steam tests.

We are currently in the midst of a steamflood pilot where we are injecting steam. The challenges in a heavy-oil carbonate are significant. This isn't just apply the old technology; this is develop a new technology to some extent or extend and existing technology. The challenges include injectivity, ability to put steam in the ground. The challenges include the water treating, the very challenging waters associated with this field, and the need to recycle and reuse that water for steam generation. And the challenges are in the geochemistry of this complex reservoir.

If we are successful at this pilot stage, we will expand that into a much larger pilot in order to understand how to fully develop this field and optimize that field's development. The ambition is a profile very similar to Kern River, very similar to Duri, Indonesia – be able to dramatically extend the recovery rates and dramatically improve the reserves.

Don't let me paint a picture where it's easy; there is an awful lot to it. Many, many things have to change and one of them is going to be many more wells. EOR and certainly steamflooding requires more well blowers. The level of drilling will need to be increased by four to five times. The amount of money that need to be invested will be significantly higher. EOR is going to be more expensive. The capital required will be significant, nearly double.

The rig counts will go up dramatically associated with drilling and associated with well work. And most significantly, the number of people needed to maintain the

steamflood operation and operate a steamflood operation will be significantly higher. Not only are the numbers greater, but the skills that those people have will be very different. This is now a steamflood operation – very different.

Technology drives performance. We have been hearing about that all afternoon. Technology – it certainly drives performance in a steamflood. There are many aspects of it. I have highlighted a few here. It starts with steam generation. Then it moves to steam distribution, the ability to move steam from the generation sites to all of those wells that require it – the ability to control where that steam goes in each of those individual wells – our reservoir surveillance, reservoir characterization. You have heard numerous times this afternoon about reservoir surveillance and the importance it plays in getting more out of our resources.

Example: The Kern River field, we have 600 wells whose sole purpose is to gather data. We don't inject anything in them; we don't produce anything from them. They gather data. That is essential to reservoir management, heat management. It is required to get to that 80-percent recovery. Those are the things that we have learned; those are the technologies that have been developed. Advance thermal simulation – you heard just a moment ago the important role that thermal – that simulation plays – equal in steamflooding. It is important to be able to predict our performance.

And all of the technology in the world won't do us much good if we don't have effective means of sharing and adapting and training and giving all of the people involved the skills, the ability for this to be successful.

What is going to be required to turn that PNZ opportunity into a Duri or into a Kern River or significant production and reserves can be added? It is going to take the deployment of advanced technologies, processes, and practices from those regions. It is going to take the extension of that technology into this carbonate. There is no large commercial success in carbonate – heavy-oil carbonate steamflooding today. It is going to phased steamflood pilots to achieve that.

Efficient operations, effective heat management practices are what differentiates between a 50-percent recovery and an 80-percent recovery. And so focus on the best practices and the technologies around those will be critical. And ultimately I think the most important and maybe the most challenging is development in the transfer and building of critical organizational capability, getting that large number of people trained, skilled, and efficient and effective use of these types of technologies.

Now I hope I very quickly illustrated how technology can have a very dramatic effect on production rates and reserves. I hope I have very quickly shown how future potential is also very significant. And this is a single example of how technologies are having impact for all of us. I look forward to working more on the PNZ project with Saudi Arabia and Kuwait, and I would be interested in answering any questions you may have. Thank you.

(Applause.)

MR. HAMILTON: Good work. All right, ladies and gentlemen, I had a short summary, but in view of the time and in order to leave a few questions, let me –

(End of available audio.)