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NEW DEVELOPMENTS IN UPSTREAM OIL AND GAS TECHNOLOGIES

HEARING

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE

ONE HUNDRED TWELFTH CONGRESS

FIRST SESSION

TO

RECEIVE TESTIMONY ON NEW DEVELOPMENTS IN UPSTREAM OIL AND GAS TECHNOLOGIES

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APPENDIXES

APPENDIX I

Responses to Additional Questions

RESPONSE OF KEVIN R. BANKS TO QUESTION FROM SENATOR BINGAMAN

Question 1. As a regulator for Alaska—do you feel that there are adequate safety and oil spill prevention and mitigation technologies available for E&P operators and drillers in the advent that a blowout or some other type of oil spill should occur on-shore in arctic areas?

Answer. Since the Exxon Valdez oil spill, oil spill response planning and equipment staging and availability have improved dramatically. As a direct result of the State's oil spill response program outlined in AS 46.04.200, the Alaska Department of Environmental Conservation, (ADEC) develops, annually reviews, and revises, as necessary, the State Oil and Hazardous Substance Contingency Plans (Unified Plan and Subarea Contingency Plans). These plans address all oil and gas related contingency planning activity in the state. The Unified plan is a coordinated and cooperative effort by government agencies and was written jointly by the Alaska Department of Environmental Conservation, the U.S. Coast Guard and the U.S. Environmental Protection Agency. The Unified Plan is then divided into 10 Subarea Contingency Plans (SCP) that concentrate on issues and provisions specific to that region or subarea.

As identified in the Unified Plan, ADEC, as the State of Alaska's lead agency for responses to oil and hazardous substance spills, has developed a network of response equipment packages positioned in at-risk areas throughout the state.

ADEC also requires that all municipalities, operators of facilities and private owners be able to respond to spills and must itemize all spill response equipment required in their respective spill response contingency plans. Through the Unified Plan and the Subarea Contingency Plans, the ADEC has a comprehensive list of spill response equipment available to be deployed throughout the state.

In the North Slope subarea specifically, BPXA, ConocoPhillips Alaska and other companies operating in the North Slope oilfields have a substantial amount of spill response equipment, as identified in their respective contingency plans. In the event of a spill in this area, the industry spill response cooperative, Alaska Clean Seas, would provide much of the required response equipment and personnel. Industry equipment would also be utilized, especially when the company is identified as the responsible party for the spill.

While appropriate response equipment is staged throughout Alaska and the North Slope, due to its vastness and sometimes extreme weather conditions, there is always the logistical challenge of getting the right piece of equipment to the right location at the right time.

RESPONSES OF KEVIN R. BANKS TO QUESTIONS FROM SENATOR MURKOWSKI

Question 1. As you are aware, there has been a strong effort to find new sources of oil to keep the Trans-Alaska Pipeline System operating at sound levels. With Prudhoe Bay, Alaska has a super-enhanced oil recovery operation because so much gas is being re-injected into that huge field.

a. Can you address how Prudhoe was originally estimated to be maybe one third its size or less, and how much greater the recovery has been as technology has advanced?

Answer. A reference to Alaska Department of Natural Resources (DNR) report from January 1982—TAPS start up was June 1977—estimated that the Prudhoe

Bay, Sadlerochit reservoir in 1980 contained 7.8 billion barrels of recoverable oil. (DNR January 1982. Historical and Projected Oil and Gas Consumption) The most recent report published by DNR says that by the end of 2009, the Prudhoe Bay Unit produced 12.6 billion barrels of oil and still had remaining reserves of 2.4 billion-a total of 15 billion (DNR 2010 Annual Report). Total production to date from all of the fields on the North Slope exceeds 16 billion barrels.

This growth of the Prudhoe Bay field over time can be attributed to two causes: technological advances in recovery methods, and the fact that as drilling progresses, additional reserves were added with discovery and development of over-and underlying horizons, and around the periphery of the field.

Question 1b. Can you describe the progress that has been made, through the use of modern technologies, in shrinking the footprint for drilling areas, roads, and other facilities?

Answer. In my written submission to the committee I provided several examples that show how the drilling technologies, including especially the use of extended reach drilling has significantly reduced the size of drill sites on the surface and the number of drill sites required to reach the oil reservoirs underground. To illustrate the point, one of the earliest drill sites built in the in the 1970's at Prudhoe Bay (DS-1), covered 65 acres of tundra. Well spacing, the distance between the well heads on the site, was 160 feet. Each early Prudhoe Bay drill site could accommodate 25-30 wells. These wells could be deviated from vertical only about a mile.

The Alpine field (the Colville River Unit) is a recent example of how far the technology has advanced to reduce the industry's onshore footprint. The typical Alpine drill site is only 13 acres and supports 54 wells. Extended reach drilling means that the wells can reach four miles from vertical and intercept 50 square miles of the reservoir from a single location on the surface. Alpine is also the first oil field on the North Slope that is not supported by a year-round road. During the winter, the operator builds an ice road to the central Alpine facility and equipment is staged there for summer work. Operations during the summer months are supported by air.

Question 2. Is it fair to say that the technologies born in Alaska have grown out of necessity? In other words, has the combination of strict environmental laws and the economic considerations of not wanting to drag many new rigs and new equipment that great of a distance caused a natural inclination to make the most of seismic data, shrink footprints, reach further from one pad, and try to squeeze as much from one well as possible?

Answer. Yes, it is fair to say that these technologies have been born out of necessity. We would add that the driving forces behind technological advancements reflect regulatory insistence and industry commitment to maximize economic benefit and recovery while minimizing the development footprint. It has been necessary to engineer the development of smaller fields at reduced costs, adopting more innovations to increase recovery efficiency, both at the level of individual wells and entire fields.

The fact that the in-place oil volumes in several of the North Slope's largest fields (Prudhoe Bay, Kuparuk, and the various heavy oil reservoirs) are so enormous means that the economic return associated with increasing total recovery by even 1-2% is worth major investments in new technologies that make that additional recovery feasible. On the other hand, many of the North Slope's smaller fields face major economic challenges that were mitigated in large part by technological advances and efficiencies that originated in the giant fields nearby.

The following are examples of some of the many technologies that have been created or refined in developing the major oil fields of the North Slope:

Technology	Impact
Extended reach drilling	Dramatically fewer surface pads needed to access reservoir.
Horizontal/designer wells	Improves reservoir drainage relative to vertical wells.
Coiled tubing drilling	Reduces noise, fuel consumption, emissions, cost, surface area.
Multi-lateral drilling	Drains more of reservoir per surface well location.
Grind-and-inject	Zero surface discharge of drilling wastes.
Reservoir modeling	Models oil-in-place, drainage, injection, pressure, etc. in 3-D over time.
WAG, MWAG, MI, etc.	Enhanced oil recovery methods, beyond simple waterflooding.
Gas cap water injection	Stabilizes reservoir pressure, increasing oil recovery.
Gravity survey surveillance	Monitors movement of reservoir fluids over time.
3-D and 4-D seismic	Sharper imaging of reservoir compartments, fluid movements, etc..
BrightWater EOR treatments	Improves waterflood efficiency by blocking off thief zones.
Low-salinity water injection	Liberates oil molecules bound to clay particles in the reservoir rock.
Heavy oil extraction methods	Several different methods in development to enhance recovery, depending on reservoir temperature, oil viscosity, etc..

a. Would the other witnesses like to comment on the Alaska experience and how it's allowed operations elsewhere to advance?

Question 3. Some have suggested that the Trans-Alaska Pipeline System is perfectly capable of operating soundly until mid-century, even with no access to federally controlled oil deposits. As one of the State's leading oil experts, can you describe the throughput decline of TAPS and what it will take to maintain its operation through that point in the future?

Answer. TAPS was originally designed to move about 1.5 million barrels per day. Throughput peaked at 2.03 million barrels per day in 1988-a rate achievable with the application of drag reducing agents and other improvements. Throughput has declined in all but two years since 1988. Current throughput is about 0.6 million barrels per day. Most forecasts show continued decline into the future.

The TAPS line has already begun to be impacted by lower throughput. During the shut-down in January 2011 (leak at Pump Station No. 1), there was concern about being able to restart the line due to the temperature. TAPS will have some material operational issues as the flow rate reaches 0.3 million barrels per day. The operational issues are primarily related to the temperature of the crude as it moves through the pipeline. With less flow and without mitigating investments, the temperature may fall below 32 F. Lower temperatures may allow ice to form inside the pipeline that could damage equipment and cause possible frost heaving on buried sections of the pipeline route. Lower temperatures will also lead to more build-up of wax on the inside of the pipeline, and increase the viscosity of the crude moving in TAPS.

More than 99% of TAPS throughput comes from fields on State or Native lands or from State waters. Production from Federal lands and the OCS today amounts to less than two thousand barrels per day.

With the exception of development of the heavy oil resources known to exist around the Prudhoe Bay, Kuparuk, and Milne Point fields, and potential resource plays (like the Bakken in North Dakota) that may exist on the North Slope on State controlled lands, the natural field declines cannot be replaced without access to production from Federal lands and the OCS. There are no known conventional resources on State or Native lands that are likely sufficient to replace the decline in the existing production rates.

Conoco-Phillips and Anadarko want to expand the Alpine field by developing a new drill site (CD-5). New production would come from State, Native, and Federal lands (~60 miles west of TAPS). This development is on hold awaiting permits from the Corps of Engineers to allow construction of a bridge over the Colville River. The permit was first requested in 2005. Development in the National Petroleum Reserve Alaska (NPRA) can only proceed once the Alpine bridge over the Colville River is complete. Thankfully, the Administration has proposed having lease sales in the NPRA annually. We hope that these sales will be accompanied by a willingness of federal agencies to allow permits for development (e.g., CD-5 project) and that lands with high resource potential (e.g., north of Teshekpuk Lake) can be made available for leasing with appropriate environmental safeguards.

There are current plans to develop an oil and gas field on State lands at Point Thomson (Miles east of TAPS). Development at Point Thomson has also been delayed due to Corps of Engineers permitting issues. Development of resources at Point Thomson would extend the feeder lines for TAPS about 30 miles east of the Badami field. This would lessen development costs and could lead to development in this relatively unexplored area. It is also at the boundary to ANWR and the 1002 area.

Question 4. Can you talk about the new technologies we're hearing about in terms of allowing for development of an area where the law doesn't currently allow for conventional access? In other words, are there applications for this technology that would provide an opportunity to extract resources from the 1002 area subsurface without having any permanent or significant impacts on the surface area?

Answer. Although it remains unclear how far, if at all, the Sourdough or Pt. Thomson reservoirs discovered on State leases near the Canning River delta might extend beneath the 1002 area, there is the potential that extended reach drilling could at least partially develop these reservoirs. Without more detailed subsurface data on these and other prospects along ANWR's western border and along the coastline adjacent to state submerged waters, it will not be possible to accurately evaluate how much of these reservoirs would benefit from extended reach drilling techniques. Three-dimensional seismic acquisition and near-vertical exploration and delineation drilling would have to occur inside the 1002 area. These activities can be conducted in the winter with zero or minimal permanent surface impact. Allowing these activities would help answer the question of whether how much oil extended-reach production wells drilled from outside ANWR would be economically viable.

Responses of Thomas Davis to Questions From Senator Bingaman

Question 1. Are there recent advances that will help reduce the footprint of seismic activities in environmentally sensitive areas, both in terms of active seismic data acquisition and passive?

Answer. Yes, major advances have occurred with the advent of wireless seismic technology and increased sensitivity and numbers of seismic sensors. Wireless recording systems now leave only human footprints in terms of placement of recording systems. The weight and power consumption of these wireless recorders is such that a person can carry several devices and plant them in environmentally sensitive areas provided they are accessible to humans. There has been recent experimentation with dropping these devices from helicopters as well, but retrieval remains an issue. These devices can record up to a month without being serviced. They contain GPS receivers and the clocks in the devices are synchronized and are highly accurate. The devices can be placed in active recording mode to record generated sources from hydraulic vibrators, weigh drops, or dynamite, for example. They can also be placed in continuous recording mode when the intention is to record passively the natural seismicity or induced seismicity, for example, from drilling or completion operations.

Question 2. Have there been any recent advances in downhole seismic instrumentation that allows an operator to see further into the formation from the wellbore to areas that may not have been adequately imaged using conventional 2-or 3-Dimensional seismic data?

a) Or to areas that cannot be accessed at the surface due to environmental sensitivities?

b) In other words, is there a borehole version of conventional seismic?

Answer. Yes, major advances have occurred in downhole seismic recording technology as well. We have developed capabilities to record with borehole arrays of receivers spanning different intervals and within different wells. The closer we can