

STATE OF ALASKA
ALASKA OIL AND GAS CONSERVATION COMMISSION
333 West 7th Avenue, Suite 100
Anchorage, Alaska 99501

Re: THE APPLICATION OF BP) Enhanced Recovery Injection Order
EXPLORATION (ALASKA) INC.) No. 1
for an order authorizing a pilot)
waterflood project designed to test) Prudhoe Bay Field
the potential for enhanced oil) Schrader Bluff Formation
recovery in the Schrader Bluff) Well V-105i
Formation, Prudhoe Bay Field,)
North Slope, Alaska) October 16, 2003

IT APPEARING THAT:

1. By letter and application dated August 22, 2003, BP Exploration (Alaska) Inc. ("BPXA") in its capacity as Unit Operator of the Prudhoe Bay Unit ("PBU") requested an order from the Alaska Oil and Gas Conservation Commission ("Commission") authorizing the injection of water for enhanced oil recovery into Well V-105i.
2. Notice of a public hearing was published in the Anchorage Daily News on September 4, 2003.
3. No comments or request for public hearing were received.
4. The Commission determined it has sufficient information as a basis for ruling, and a public hearing was not needed.

FINDINGS:

1. Operator:
BPXA is operator of the Orion Undefined Oil Pool in the Prudhoe Bay Field, North Slope, Alaska.
2. Project Location
The surface location of the injection well is located in Township 11N, Range 11E UM with the surface location in Section 11, and the bottomhole location and proposed water injection interval in Section 2.
3. Operators/Surface Owners Notification:
BPXA provided operators and surface owners within one-quarter mile of the proposed area with a copy of the application for injection. The only affected operator is BPXA. The State of Alaska, Department of Natural Resources is the only affected surface

owner.

4. Description of Operation:

The Orion waterflood pilot project (“OWPP”) includes a single injector, Well V-105i, and Wells V-201 and V-202 (which is a trilateral well), producing from the Upper Cretaceous Schrader Bluff Formation. Well V-105i is currently injecting into the Lower Cretaceous Kuparuk formation. The Schrader Bluff formation has been perforated in this well and is isolated behind pipe. By pulling a gas lift “dummy” and replacing it with an injection valve, commingled injection of the Kuparuk and Schrader Bluff may occur. The purpose of the injection test is to:

- determine the injectivity into the Schrader Bluff formation;
- determine the operability of commingled injection into two pools;
- confirm that geological barriers will contain the injection fluid when injected at injection pressures above fracture gradient.

Data gathering will include:

- injection profile and temperature logs in well V-105i including monthly injection logs to determine volume flow split between the Kuparuk and Schrader Bluff formations;
- injectivity and step rate tests in well V-105i;
- static pressures in Wells V-105i, V-201, and V-202;
- production and injection rates/pressure;
- pressure buildup in well V-202.

5. Geologic Information:

- a. Injection will occur within V-105i within the Schrader Bluff Formation. A pool has not been defined for the Schrader Bluff formation within the pilot waterflood area. An application to establish the Orion Oil Pool is planned for submittal by December 31, 2003.
- b. Schrader Bluff Formation O-Sands are divided into seven separate reservoir intervals that are named, from deepest to shallowest, O_{Bf}, O_{Be}, O_{bd}, O_{Bc}, O_{Bb}, O_{Ba}, and O_A. Each of these intervals coarsens upward from non-reservoir, laminated muddy siltstone at the base to reservoir-quality sandstone at the top.
- c. The injection interval is 4,347’ true vertical depth sub-sea (“tvdss”) to 4,605’ tvdss, and includes the O_A, O_{Ba}, O_{Bb}, O_{Bc}, and O_{Bd} Sand intervals. The O_{be} and O_{Bf} units are not perforated and will not be receiving injection water.
- d. The O_A interval is abruptly truncated and capped by 62’ of silt and mudstone that will serve as upper confinement to the injection fluids.
- e. The V-105i will provide downdip pressure support within a fault block common to wells V-201 and V-202.

6. Well Logs:

The logs of V-105i are on file with the Commission.

7. Mechanical Integrity and Well Design of Injection Wells:

Well V-105i was permitted, drilled and completed in accordance with Commission state-wide regulations. A cement bond log was run on well V-105i that demonstrates good cement integrity between the Kuparuk and Schrader Bluff formations and above the Schrader Bluff formation.

8. Type of Fluid / Source/water analysis:

Fluids requested for injection include:

- produced water from Prudhoe Bay Unit;
- tracer survey fluid to monitor reservoir performance;
- non-hazardous filtered water collected from well house cellars, well pads and PBU reserve pits.

The initial target rate will be 3,000 barrels water per day ("BWPD"). BP requested a maximum injection rate of 30,000 BWPD. The OWPP produces from the same formation as the Polaris Oil Pool ("POP"), a Schrader Bluff Formation pool directly east of the pilot area, and the produced water planned for injection is processed at the same facility (Gathering Center 2). Compatibility of injected fluids with the formation has not been a problem in the POP, and hence, no problems are anticipated at Orion. Water samples will be obtained from well V-201 during the pilot project.

9. Injection Pressures, Fracture Propagation

As part of this pilot project BPXA plans to acquire information at pressures above fracture gradient. Confirmation of vertical confinement is an objective of the pilot project. BPXA requested a maximum surface injection pressure of 2800 pounds per square inch ("psi") with an average surface operating pressure of 2200 psi. The injection rate will be controlled by flow restriction at the downhole injection mandrel, and hence pressure will be restricted adjacent to the perforations in the Schrader Bluff formation.

BPXA had previously supplied fracture propagation information in the application for Area Injection Order for the POP. Step rate tests indicate fractures initiate at about 1000 psi surface injection pressure while injecting at 1½ to 2 barrels per minute. A stress test performed in well S-213 indicates a fracture gradient of 0.66 psi/ft for the basal mudstone of the OBa interval. This is a typical silty mudstone within the Polaris Oil Pool. Minimum stress values for the sandstones show an average fracture gradient of 0.61 psi/ft, indicating a stress contrast of approximately 255 psi between reservoir sandstone and confining mudstone. This agrees with the stress contrast of 300 psi estimated using a dipole sonic log from well W-200 (or a fracture gradient in the mudstones of approximately 0.67). On the basis of this test information, the Commission ordered (Area Injection Order 25, dated 2/4/03) that POP normal injection pressure be limited to 0.67 psi/ft to ensure injection stays within the intended injection interval.

Subsequently, BPXA performed step rate water injection tests in two Polaris wells, W-212i and S-215i. The Schrader Bluff Formation reservoir in these wells should be comparable to that of the OWPP. Injection rates of up to 10000 BWPD and injection gradients of 0.75-0.8 psi/ft were achieved. Temperature surveys showed the water to be confined to the intended intervals, with no fluid movement behind pipe. This pressure exceeded that obtained with the stress test described above. The step rate information suggests that a less conservative injection pressure limitation may be appropriate.

10. Freshwater exemption:

Aquifer Exemption Order #1, dated July 11, 1986 exempts all portions of aquifers beneath the Western Operating Area of the Prudhoe Bay Unit, including the area designated for the Orion waterflood pilot project.

11. Expected Increase in Hydrocarbon Recovery

BPXA expects that the incremental increases due to waterflooding would be 10-20% OOIP. Further information on recovery benefits will be provided with the application for pool rules.

12. Mechanical Condition of Adjacent Wells:

There are no wells within ¼ mile of injection for the test.

CONCLUSIONS:

1. The application requirements of 20 AAC 25.402 have been met.
2. Water injection is anticipated to significantly increase recovery.
3. An injection test will provide information needed for development planning.

4. 20 AAC 25.450 allows the Commission to approve pilot projects for enhanced recovery with less stringent requirements for well construction, operation, monitoring, and reporting, if the project will not result in an increased risk of fluid movement into freshwater sources.
5. All aquifers in the proposed area are exempt.
6. Dual injection within well V-105i is appropriate so long as mechanical isolation of the pools within the wellbore is assured and water injection is allocated between the pools.
7. Sufficient information has been provided to authorize V-105i to inject water into the Schrader Bluff Formation for the purposes of pressure maintenance and enhanced oil recovery and data gathering.
8. Injection pressures will be above the fracture gradient of the formation. As part of the test, increasing injection pressure in staged periods, and injection logging will be utilized to verify the injection does not propagate fractures through the confining interval.
9. Reservoir and well surveillance, coupled with regularly scheduled mechanical integrity tests will demonstrate appropriate performance of the enhanced oil recovery project or disclose possible abnormalities.
10. The Commission shall be apprised of the progress of the pilot test.

NOW, THEREFORE, IT IS ORDERED that:

The underground injection of fluids for enhanced oil recovery is authorized, subject to the following rules and the statewide requirements under 20 AAC 25 (to the extent not superseded by these rules).

Rule 1 Authorized Injection Strata for Enhanced Recovery

Authorized fluids may be injected for purposes of pressure maintenance and enhanced oil recovery into strata that are common to, and correlate with the O-Sand interval between 4,347' tvdss to 4,605' tvdss, in Prudhoe Bay Unit well V-105i.

Rule 2 Fluid Injection Well

The underground injection of fluids for enhanced oil recovery is authorized in Well V-105i in Section 2, Township 11N, R11E.

Rule 3 Authorized Fluids for Enhanced Recovery

Fluids authorized for injection include:

- a. produced water from Prudhoe Bay Unit production facilities for the purposes of pressure maintenance and enhanced recovery;
- b. tracer survey fluid to monitor reservoir performance;
- c. non-hazardous filtered water collected from well house cellars and well pads.

Rule 4 Reporting of Test Information

Validation is required that water injection is confined to the intended injection interval. Information gathered from the test, including daily injection pressures and rates, and results of injection surveys, must be provided monthly to the Commission.

Rule 5 Commingled Water Injection

- a. Well V-105i may proceed with commingled water injection into both the Kuparuk Formation (Borealis Oil Pool) and the Schrader Bluff Formation.
- b. Monthly injection log surveys must be conducted during the first three months, and quarterly thereafter, for determining the allocation of water injection. These results must be supplied to the Commission.

Rule 6 Notification of Improper Class II Injection

Injection of fluids other than those listed in Rule 2 without prior authorization is considered improper Class II injection. Upon discovery of such an event, the operator must immediately notify the Commission, provide details of the operation, and propose actions to prevent recurrence. Additionally, notification requirements of any other State or Federal agency remain the operator's responsibility.

Rule 7 Other conditions

- a. It is a condition of this authorization that the operator complies with all applicable Commission regulations.
- b. The Commission may suspend, revoke, or modify this authorization if injected fluids fail to be confined within the designated injection strata.

Rule 8 Administrative Actions

Unless notice and public hearing is otherwise required, the Commission may administratively waive the requirements of any rule stated above or administratively amend any rule as long as the change does not promote waste or jeopardize correlative rights, is based on sound engineering and geoscience principles, and will not result in an increased risk of fluid movement into freshwater.

Rule 9 Expiration Date

This Order shall expire July 1, 2004.

DONE at Anchorage, Alaska and dated October 16, 2003.

Sarah Palin, Chair
Alaska Oil and Gas Conservation Commission

Daniel T. Seamount, Jr., Commissioner
Alaska Oil and Gas Conservation Commission

Randy Ruedrich, Commissioner
Alaska Oil and Gas Conservation Commission

AS 31.05.080 provides that within 20 days after receipt of written notice of the entry of an order, a person affected by it must file with the Commission an application for rehearing. A request for rehearing must be received by 4:30 PM on the 23rd day following the date of the order, or next working day if a holiday or weekend, to be timely filed. The Commission shall grant or refuse the application in whole or in part within 10 days. The Commission can refuse an application by not acting on it within the 10-day period. An affected person has 30 days from the date the Commission refuses the application or mails (or otherwise distributes) an order upon rehearing, both being the final order of the Commission, to appeal the decision to Superior Court. Where a request for rehearing is denied by non-action of the Commission, the 30-day period for appeal to Superior Court runs from the date on which the request is deemed denied (i.e., 10th day after the application for rehearing was filed).