

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

Re: **THE APPLICATION OF BP**) **Area Injection Order No. 23**
EXPLORATION (ALASKA) INC.)
allowing underground injection of) Northstar Field
fluids for enhanced oil recovery in) Northstar Oil Pool
Northstar Oil Pool, Northstar Field,)
Beaufort Sea, Alaska)

October 9, 2001

IT APPEARING THAT:

1. By letter and application dated June 25, 2001, BP Exploration (Alaska) Inc. (“BPXA”) requested an order authorizing the injection of fluids for enhanced oil recovery in the Northstar Oil Pool (“NOP”) encompassing acreage within the Northstar Unit, Beaufort Sea, Alaska.
2. Notice of opportunity for public hearing was published in the Anchorage Daily News on July 5, 2001.
3. The Commission did not receive a protest.
4. By letter and application dated August 13, 2001, BPXA submitted a new public version of pre-filed testimony and exhibits to be entered into the public record for the August 16, 2001 public hearing.
5. A hearing concerning BPXA’s request was convened in conformance with 20 AAC 25.540 at the Commission’s offices, 333 West 7th Avenue, Suite 100, Anchorage, Alaska 99501 on August 16, 2001. Concurrently, the Commission heard testimony concerning proposed pool rules for the NOP.

FINDINGS:

1. Commission regulation 20 AAC 25.402 provides authority to issue an order governing underground injection of fluids on an area basis for all wells within the same field, facility site, reservoir, project, or similar area.
2. BPXA is the operator of the Northstar Unit. BPXA and Murphy Exploration, Inc. are working interest owners in the Northstar Unit. The State of Alaska and the US Federal Government are the landowners.
3. The proposed injection interval is the NOP, which consists of the accumulation of hydrocarbons that is common to, and correlates with, the interval between 12,418 feet and 13,044 feet measured depth (“MD”) in the Seal A-01 well. This accumulation occurs in the Sag River, Shublik and Ivishak Formations.

4. The average oil saturation of the Ivishak is 42% at the volumetric reservoir centroid, and the maximum oil column is estimated to range from 270 to 300 feet.
5. The NOP oil-water contact (“OWC”) is 11,100 feet true vertical depth subsea (“TVDss”), based on core, RFT, MDT and well test data.
6. Original in place oil and gas volumes contained in the Ivishak Formation were estimated, by the Operator, using geologic and engineering data and reservoir modeling. The NOP contains approximately 247 million stock tank barrels (“MMSTB”) original oil in place (“OOIP”), 487 BCF original gas in place (“OGIP”) including an estimated 7 BCF gas cap inferred from reservoir data.
7. The Sag River Formation in the NOP contains approximately 37.7 million barrels OOIP and 52.1 BCF OGIP based on log and core analysis in addition to analog comparison to similar accumulations on the North Slope. There are currently no production tests in the Sag River Formation within the NOP.
8. At this time, there is insufficient information regarding Shublik Formation reserves.
9. The Operator studied miscible gas injection, waterflood with miscible gas injection, gas cycling, and primary depletion to evaluate recovery mechanisms. All of the cases used the same number of wells and locations. Injection was controlled to maintain reservoir pressure near the original conditions for the miscible gas and waterflood cases, with pressure declining in the gas cycling and primary depletion cases. The table below summarizes recovery of oil and natural gas liquids (“NGL”) based on simulation evaluation.

	Oil MMSTB	NGL MMSTB	Total Liquid MMSTB	Recovery Factor % OOIP (Oil)
Miscible Gas Injection	159.3	16.9	176.2	64.5
Waterflood	128.3	6.6	134.9	52.0
Gas Cycling	123.6	12.1	135.7	50.0
Primary Depletion	89.1	5.1	94.2	36.1

10. The Operator selected miscible gas injection as the enhanced oil recovery method because the model studies indicated miscible gas injection would recover 12% and 14%, respectively, more oil than either gas cycling or waterflood. Water alternating with gas (“WAG”) model runs indicated no increased additional recovery over miscible gas injection.
11. Miscible injectant will be made by blending make up gas from Prudhoe Bay Unit (“PBU”) with Northstar produced gas. The present development plan anticipates NGL will be left in the produced gas during the miscible injection phase of the project that is expected by the Operator to last the first four years of field life.
12. The project will inject up to 60% hydrocarbon pore volume of miscible enriched

natural gas and NGL into the oil column. The miscible gas injection phase will be followed by lean chase gas injection for the remainder of the oil production phase of field life.

13. Initial NOP drilling development plans comprise 22 wells. This well count includes five miscible gas injectors, sixteen oil producers, and one Class I disposal well. The injectors will be located in the thickest oil column in the central portion of the reservoir to maximize miscible sweep. Two of the injectors will be pre-produced to help load the production facility at startup.
14. Wells will be perforated with sufficient standoff from the OWC to maintain water production below the 30,000 barrels of water per day ("BWPD") facility limit. Vertical barriers to water coning in the NOP will be evaluated with reservoir pressure data obtained after field startup.
15. The Operator reports initial reservoir pressure measured in 1984 was 5305 pounds per square inch ("psi") at 11,100 feet TVDss. Current reservoir pressure (circa August 2001) at the same datum is estimated to be 5180 psi. The pressure decrease, as interpreted by the Operator, is attributed to regional communication with the Prudhoe Oil Pool through an aquifer common to both the Northstar and Prudhoe Bay Unit reservoirs.
16. Based on initial reservoir simulation results, the Operator's reservoir management strategy during miscible injection is for 100% voidage replacement and to maintain reservoir pressure within +/- 50 psi of the current pressure level, 5180 psi at 11,100 feet TVDss.
17. The Operator's objective, with respect to the reservoir management strategy, is to maximize ultimate recovery consistent with sound engineering practice. The injection project is being implemented concurrent with field startup in order to deliver maximum benefit. During the first year of the project, injection may exceed voidage replacement to ensure miscibility and compensate for pressure decline.
18. The Operator has indicated reservoir pressure in the Northstar reservoir will need to be managed in order to: ensure miscibility; minimize oil loss due to shrinkage from producing below the bubble point pressure; minimize oil loss due to pushing oil into the aquifer by over pressuring the reservoir; and achieve some aquifer influx to sweep the periphery and structurally low areas. Reservoir pressure may decline at about 6-10 psi/year assuming continued pressure depletion through the Ivishak aquifer. The Operator anticipates average reservoir pressure will not be increased appreciably above its current level to prevent hydrocarbon displacement into the Ivishak aquifer. Injection wells will be located in the thick oil column areas of the reservoir to minimize oil pushed into the aquifer beneath injectors due to local pressure gradients.
19. The gas injection plant and a gas injection well will be commissioned prior to the initial startup of oil production using Prudhoe Bay Unit make up gas. This will reduce the amount of flared gas that is associated with the start up of new production facilities.

20. Conductor casing requirements in 20 AAC 25.030(c)(2) have been waived for the Northstar development per the memo entitled "Dispensation for 20 AAC 25.030(c)(2)" dated March 1, 2000.
21. All casing strings will be run and cemented in accordance with 20 ACC 25.030 and 30 CFR 250.404. Injection wells will have a cement evaluation log run to confirm isolation of the injection fluids to the approved injection intervals (Sag River and Ivishak Formations) as required per 20 AAC 25.030(d)(7). Such logs will also satisfy the requirements of 30 CFR 250.404(a)(5).
 - Surface hole sections for all wells will be drilled to a depth of approximately 3160 feet TVDss (150 feet TVD below the SV6 geologic marker).
 - Gas injection well intermediate hole sections are planned to be drilled to top set casing at the Sag River Formation at approximately 10,645 feet TVDss.
 - Production wells will have two intermediate hole sections. The first will be drilled to top set the Miluveach Formation at approximately 9264 feet TVDss; the second drilled to top set the Sag River Formation at approximately 10,645 feet TVDss.
 - Both production and injection hole sections will be drilled through the Sag River, Shublik, and Ivishak Formations to a TD in the Ivishak or the adjacent Kavik Formation.
22. Tubing and packers will be run in all wells. Injection well design will place the packer within 200 feet of the targeted injection zones, the Sag River and Ivishak Formations, in accordance with 20 AAC 25.412(b). Packer placement may result in a packer to perforation distance greater than 200 feet, to retain the option of perforating the Sag River Formation in the future.
23. All Northstar wells are located offshore. With the exception of the Class I disposal well, all wells are capable of unassisted flow of hydrocarbons to the surface and will be equipped with a fail-safe automatic surface safety valve ("SSV") and a fail-safe automatic surface-controlled subsurface safety valve ("SSSV"). The SSSV's in both the producers and injectors will be wire line retrievable. The SSSV's are intended to comply with the requirements of both 20 AAC 25.265 and 30 CFR 250.801 and 250.806.
24. In the process of permitting the Class I disposal well on Northstar Island, the EPA determined no USDW's (freshwater strata) were present in the Northstar area.
25. The expected maximum injection pressure for the gas injection wells is 5300 psi. This injection pressure is insufficient to initiate or propagate fractures through the confining strata, and, therefore, will not allow injection or Formation fluid to migrate out of intended injection zones.

26. The Kingak Formation is approximately 1,000 feet thick in the area and serves as the upper confining zone. The Kingak Formation is continuous throughout the area and conformably overlies the Sag River Formation. The Kingak Formation was deposited as marine shale and silt during the Jurassic period and is impermeable.
27. The NOP is confined below by the Kavik Formation, a marine shale sequence of Permian age, which is continuous throughout the area. The Kavik Formation rests unconformably on the carboniferous aged Lisburne Group. The Kavik Formation is essentially impermeable with a thickness of approximately 100 feet in this area.

CONCLUSIONS:

1. The application requirements of 20 AAC 25.402 have been met.
2. An Area Injection Order is appropriate for the project area in accordance with 20 AAC 25.460.
3. There are no freshwater strata in the NOP area.
4. The proposed injection operations will be conducted in permeable strata. The injection pressures will be maintained below the fracture pressures of the confining intervals.
5. Injected fluids will be confined within the appropriate receiving intervals by impermeable lithology, cement isolation of the wellbore and appropriate operating conditions.
6. Implementation of an enhanced recovery operation initially using miscible gas injected into the Sag River, Shublik and Ivishak Formations will preserve reservoir pressure energy and enhance ultimate recovery. The miscible gas injection phase will be followed by lean chase gas injection for the remainder of the oil production phase of field life.
7. The proposed NOP miscible gas /lean gas chase injection project will result in approximately 29% increased recovery (82 MMSTB) over primary production alone.
8. Reservoir surveillance, operating parameter surveillance and mechanical integrity tests will demonstrate appropriate performance of the enhanced oil recovery project or disclose possible abnormalities.
9. An Area Injection Order enabling enhanced oil recovery activity will not cause waste or jeopardize correlative rights.

NOW THEREFORE IT IS ORDERED THAT: Underground injection of enriched miscible gas and lean gas pursuant to the project described in BPXA's application and subject to the conditions, limitations, and requirements established in the rules set out below (in addition to the statewide requirements under 20 AAC 25 to the extent not superceded by these rules) apply to the affected area encompassing all of State Oil and Gas Leases ADL 312798, ADL 312799 and ADL 312808, portions of State Oil and Gas

Leases ADL 312809 and ADL 355001, and all of Federal Oil and Gas Leases OCS-Y-1645, OCS-Y-0179 and OCS-Y-0181 to the extent such leases are located within the lands described below:

STATE LEASES

Umiat Meridian

Township	Range	Sections
T14N	R13E	30 through 35: All State lands
T13N	R13E	2 through 18, 20 through 24: All State lands
T13N	R14E	17 through 20, 29 and 30: All State lands

The affected area is more particularly described as follows:

ADL 312798

Consists of Tract C30-46 (BF-46), a portion of Blocks 470 and 514 as shown on the "Leasing and Nomination Map" for the Federal/State Beaufort Sea Oil and Gas Lease Sale, dated 1/30/79, more particularly described as follows:

Those lands located easterly of the west boundary of T.13N., R.13E., and T.14N., R.13E., Umiat Meridian, Alaska, being the north-south line intersecting the north and south boundary of Block 470, within the offshore three-mile arc lines listed as State area of Block 470 "Supplemental Official O.C.S. Block Diagram" approved 10/4/79, and those lands in Block 514 easterly of the west boundary of T.13N., R.13E., Umiat Meridian, Alaska (being identical with line 1-2 of Block 514) and lying northerly of the south boundary of Sections 7 and 8, T.13N., R.13E, Umiat Meridian, Alaska (being identical with line 2-3 of Block 514) and that portion of Section 16, T.13N., R.13E., Umiat Meridian, Alaska, within the N1/2 S1/2 (being easterly of line 3-4 of Block 514), being a portion of the listed State area of Block 514 on the "Supplemental Official O.C.S. Block Diagram" approved 12/9/79.

ADL 312799

Consists of Tract C30-47 (BF-47), a portion of Blocks 471 and 515 as shown on the "Leasing and Nomination map" for the Federal/State Beaufort Sea Oil and Gas Lease Sale, dated 1/30/79, more particularly described as follows:

Those lands located in Block 471 within the offshore three-mile arc lines, listed as State area on the "Supplemental Official O.C.S. Block Diagram", approved 10/4/79, and those lands in N1/2, N1/2 S1/2 of Block 515 within the offshore three-mile arc lines being a portion of the listed State area on the "Supplemental Official O.C.S. Block Diagram " approved 10/4/79.

ADL 312808

Consists of Tract C30-56 (BF-56), a portion of Blocks 514, 515, 558, and 559 as shown on the "Leasing and Nomination Map" for the federal/state Beaufort Sea Oil and Gas Lease Sale, dated 1/30/79, more particularly described as follows:

Those lands located in the S1/2 S1/2 of Block 514, within Section 16 and 21 of T.13N., R.13E.; Umiat Meridian, Alaska, (being those lands lying easterly of line 3-4 on Block 514), a portion of the state area on the "Supplemental Official O.C.S. Block Diagram" approved 12/9/79, and those lands in S1/2 S1/2 of Block 515, being a portion of the State area on the "Supplemental Official O.C.S. Block Diagram" approved 10/4/79, and those lands within Block 558 located in Section 21, T.13N., R.13E.; Umiat Meridian, Alaska, (being the portion easterly of line 1-2 and northerly of line 2-3 block 558), listed as State area on the "Supplemental Official O.C.S. Block Diagram" approved 12/9/79, and those lands in Block 559 lying northerly of the south boundary of Sections 21, 22, 23, and 24, T.13N., R.13E.; Umiat Meridian, Alaska, (being the northerly portion of Block 559), listed as State area on the "Supplemental Official O.C.S. Block Diagram" approved 10/4/79.

ADL 312809

Consists of Tract C30-57 (BF-57), a portion of Block 516 and 560 as shown on the "Leasing and Nomination Map" for the Federal/State Beaufort Sea Oil and Gas Lease Sale, dated 1/30/79, more particularly described as follows:

Those lands located in Block 516 within the offshore three-mile arc lines, listed as State area on the "Supplemental Official O.C.S. Block Diagram" approved 10/4/79, containing 227.02 hectares, and those lands in Block 560 located within Section 24, T.13N., R.13E., Umiat Meridian, Alaska, and those lands in Block 560 located within Sections 19, 20, 29 and 30 of T13N, R14E, Umiat Meridian, Alaska, within the offshore three-mile arc lines, listed as State area on the "Supplemental Official O.C.S. Block Diagram" approved 12/9/79.

ADL 355001

That portion of Blocks 514 and 558 as shown on the "Leasing and Nomination Map" for the federal/state Beaufort Sea Oil and Gas Lease Sale, dated 1/30/79, more particularly described as follows:

Those lands in Block 514 lying located within Sections 17, 18, and 20 of T.13N., R.13E., Umiat Meridian, Alaska, and those lands located in Block 558 within Section 20, T.13N., R.13E., Umiat Meridian, Alaska.

FEDERAL LEASES

Lease Number	Description
OCS-Y-1645	All Federal lands
OCS-Y-0179	All Federal lands
OCS-Y-0181	All Federal lands

The affected area is more particularly described as follows:

OCS-Y-1645

That portion of Block 6510, OCS Official Protraction Diagram NR06-03, Beechey Point, approved February 01, 1996, shown as Federal 8(g) Area C on OCS Composite Block Diagram dated April 24, 1996.

OCS-Y-0179

That portion of Block 470 lying east of the line marking the western boundary of parcel "1" and between two lines bisecting Block 470, identified as parcel "1", containing approximately 94.30 hectares, and parcel "2", containing approximately 15.27 hectares, as shown on the Supplemental Official OCS Block Diagram, dated 10/4/79, based on Official Protraction Diagram NR 6-3, Beechey Point, approved April 29, 1975; and that area lying between the two lines bisecting Block 471, containing approximately 611.95 hectares, as shown on the Supplemental Official OCS Block Diagram, dated 10/4/79, based on Official Protraction Diagram NR 6-3, Beechey Point, approved April 29, 1975; and that area lying northeasterly of the line bisecting Block 515, containing approximately 189.83 hectares, as shown on the Supplemental Official OCS Block Diagram, dated 10/4/79, based on Official Protraction Diagram NR 6-3, Beechey Point, approved April 29, 1975.

OCS-Y-0181

That area lying northeasterly of the line bisecting Block 516, containing approximately 2076.98 hectares, as shown on the Supplemental Official OCS Block Diagram, dated 10/4/79, based on Official Protraction Diagram NR 6-3, Beechey Point, approved April 29, 1975; and that area lying northeasterly of the line bisecting Block 560, located in the northeast corner of Block 560, containing approximately 44.65 hectares, as shown on the Supplemental Official OCS Block Diagram, revised and dated 12/9/79 based on Official Protraction Diagram NR 6-3, Beechey Point, approved April 29, 1975.

Rule 1: Authorized Strata for Enhanced Recovery Injection

Enriched miscible gas and lean gas may be injected for the purposes of pressure maintenance and enhanced recovery into strata in the Sag River, Shublik and Ivishak

Formations that correlate with, and are common to, the interval in the Seal A-01 well between the measured depths of 12,418 and 13,044 feet MD.

Rule 2: Fluid Injection Wells

The underground injection of fluids must be through a well permitted for drilling as a service well for injection in conformance with 20 AAC 25.005, or through a well approved for conversion to a service well for injection in conformance with 20 AAC 25.280.

Rule 3: Well Packer Placement

Tubing and isolation packers must be run in all wells. Well design will place the packer within 200 feet of both targeted injection zones (Sag River and Ivishak Formations) in accordance with 20 AAC 25.412(b). As such, it is recognized that this packer placement may result in a packer to perforation distance greater than 200 feet MD, however, the future option of Sag River Formation perforations is maintained while not compromising zonal isolation given the depth and thickness of the Kingak Formation, the overlying confining interval.

Rule 4: Monitoring the Tubing-Casing Annulus Pressure Variations

The tubing-casing annulus pressure of each injection well must be checked at least weekly to confirm continued mechanical integrity of the well.

Rule 5: Demonstration of Tubing-Casing Annulus Mechanical Integrity

A schedule must be developed and coordinated with the Commission that ensures that the tubing-casing annulus for each injection well is pressure tested prior to initiating injection, following well workovers affecting mechanical integrity, and at least once every four years thereafter.

Rule 6: Well Integrity Failure

Whenever injection rates and/or operating pressure observations or pressure tests indicate pressure communication or leakage of any casing, tubing or packer, the operator must immediately shut in and secure the well, notify the Commission on the first working day following the observation, and submit a plan of corrective action on Form 10-403 for Commission approval.

Rule 7: Notification of Improper Class II Injection

The operator must notify the Commission if it learns of any improper Class II injection. Additionally, notification requirements of any other State or Federal agency remain the operator's responsibility.

Rule 8: Other Conditions

- a. It is a condition of this authorization that the operator comply 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 9: Administrative Action

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.

DONE at Anchorage, Alaska and dated October 9, 2001.

Cammy Oechsli Taylor, Chair
Alaska Oil and Gas Conservation Commission

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

Julie M. Heusser, 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 may 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).