STATE OF ALASKA
Department of Natural Resources
Division of Oil and Gas Conservation

Alaska Oil and Gas Conservation Committee
3001 Porcupine Drive
Anchorage, Alaska 99501

Re: The request of Atlantic Richfield Company and BP Alaska Inc. to present testimony to determine new pool rules and amend existing rules for the Prudhoe Oil Pool.	))))))	Conservation Order No. 145 Prudhoe Bay Field Prudhoe Oil Pool June 1, 1977

IT APPEARING THAT:

1. The referenced companies applied by letter received March 30, 1977, for a hearing to adopt new or amend existing pool rules.

2. Notice of public hearing was published in the Anchorage Daily News on April 2, 1977.

3. A public hearing was held in the Ramada Inn, Anchorage, Alaska on May 5 and 6, 1977.

4. The hearing record was continued until the close of business on May 16, 1977. Additional data was received.

FINDINGS:

1. Rules pertaining to the Prudhoe Oil Pool have been included in Conservation Order Nos. 98-B, 130, and 137.

2. Administrative approvals 98-B.3, 98-B.6, 98-B.7, and 98-B.8 written pursuant to Conservation Order No. 98-B, Rule 8 are currently in effect.

3. Waivers pertaining to blowout prevention practices written pursuant to Conservation Order No. 137, Rule 2 are currently in effect.

4. The applicants propose to raise and lower the vertical pool limits of the Prudhoe Oil Pool to include the "Put River Sandstone" and Ivishak Shale respectively.

5. No drill stem tests or production tests have been conducted in the "Put River Sandstone" or the Ivishak Shale.

6. No analysis of fluid from the "Put River Sandstone" or the Ivishak Shale are presently available to the Committee.

7. The areal extent of the Prudhoe Oil Pool as defined on March 12, 1971, in Conservation Order No. 98-B, is considerably larger than the area now proven to be productive by the drilling of additional wells since that time.

8. Most producing wells in the Prudhoe Oil Pool are deviated holes to minimize the number of drilling pads.

9. The applicants propose to eliminate reference to acreage spacing requirements but request that at least 2000 feet be maintained between the pay opened in the well bore in all wells in the Prudhoe Oil Pool.

10. The applicants propose that a distance of 1000 feet be maintained between the pay opened in any well and the boundary of the Prudhoe Oil Pool.

11. Data from the early production performance is needed for the proper regulation and operation of the reservoir.

12. Performance must be accurately observed and quickly analyzed for a timely assessment of reservoir behavior.

13. Performance during the first two years will be used to design the water flooding projects and will be vital in formulating and implementing future operating plans.

14. A reservoir surveillance program can provide for monitoring both reservoir and production data.

15. Monthly production tests will monitor changes in well productivity, gas-oil and oil-water ratios, and provide basic data for reservoir performance studies.

16. The reservoir is complex with many discontinuous interbedded shales.

17. The reservoir is underlain by a heavy oil or tar zone of varying thickness.

18. Some areas of the reservoir contain many faults.

19. The reservoir pressure data will provide information on well flow efficiency, reservoir permeability, reservoir discontinuities, and the need for a pressure maintenance program.

20. The use of specialized transient pressure testing techniques such as pulse testing, vertical permeability tests, and interference tests may prove useful.

21. Specific wells may be selected which are located outside the main area of the Sadlerochit oil column to monitor the pressure in the gas cap, the aquifer, the Eileen area, and the Sag River gas cap.

22. The applicants have agreed to a common datum plane of 8800 feet subsea for all pressure surveys.

23. Changes in the gas-oil fluid contact movement in the reservoir with response to production would provide information on shale continuity, effective vertical permeability, displacement efficiency of oil by gas and define areas of poor natural recovery.

24. Preliminary studies indicate that early run open hole or cased hole neutron logs may provide a suitable base log for monitoring the movement of the gas-oil contact by comparison with a later cased hole neutron log run in the same well.

25. Open hole neutron logs have already been run on the majority of wells.

26. Cased hole neutron logs have already been run in a number of wells and will continue to be run in selected wells until this technique is confirmed.

27. Monitoring the movement of the oil-water contact should help to determine the extent of water influx from the aquifer, identify areas of peripheral water influx and allow determination of the water displacement efficiency.

28. Monitoring the oil-water contact should provide information to help define locations where water injection would be beneficial.

29. A program is now in progress to evaluate the capability of monitoring the oil-water contact with one of three different methods, such as the Thermal Decay Tools (T.D.T.) or the Neutron Lifetime Log (N.L.L.), the Carbon-Oxygen Log and the Gamma Ray Log.

30. The capability of these methods to monitor the changing oil-water contact has not been demonstrated as yet.

31. The contribution of each of the various perforated intervals in each producing well may be determined through downhole spinner flow meter surveys.

32. A reliable assessment of the rate of the production from the various lithologic subdivisions within the reservoir will assist in the determination of the effectiveness of the well completions to drain the reservoir.

33. Numerous computer reservoir simulation model studies of the Sadlerochit Formation have been made by the State and the working interest owners. In these studies the offtake rates of oil and gas and the injection rates of gas and water have been varied.

34. The Trans-Alaska Pipeline will have an initial capacity of 1.2 million barrels per day and should be ready to accept oil near mid 1977.

35. The applicants have submitted a Plan of Operations which includes proposed average annual offtake rates of 1.5 million barrels per day for oil plus condensate production and 2.7 billion cubic feet per day for gas.

36. Production facilities to support an average oil offtake of 1.2 million barrels per day will be installed by the last quarter of 1977. Additions are planned during 1978 and 1979 to support an average oil offtake rate of 1.5 million barrels per day plus condensate production, when pipeline capacity is available.

37. Gas sales in large volumes from the Prudhoe Bay Field will not be possible until a gas conditioning plant and a large gas sales pipeline are constructed.

38. The completion of a large gas sales pipeline and plant to condition gas is estimated at approximately five years from start of oil production.

39. Until a large gas sales pipeline is available, all produced gas, except that used as fuel in the field and small local gas sales, will be reinjected into the gas cap.

40. Gas will be used to supply the operating requirements of the Prudhoe Bay Field, the first four pump stations of the Trans-Alaska Pipeline and other minor local fuel needs.

41. To meet pipeline sale quality it will be necessary to remove carbon dioxide from the gas.

42. Water production will be minimal initially and will be disposed of by injection into sands of Cretaceous age.

43. When water production becomes significant, the applicants plan to file a secondary recovery application for the injection of this water into the Prudhoe Oil Pool.

44. Injection of produced water into the Prudhoe Oil Pool could begin within two years after start of oil production.

45. The applicants will proceed with design and implementation studies concurrently with injectivity tests and reservoir data gathering to shorten the implementation time for a source water injection system.

46. The Sadlerochit Formation aquifer exhibits the best reservoir qualities near the Prudhoe Bay Field area and progressively deteriorates away from the field.

CONCLUSIONS:

1. To avoid confusion it would be desirable to consolidate the outstanding Pool rules effecting the Prudhoe Oil Pool into one order. Conservation Orders Nos. 98-B, 130, and Rule 2 of Conservation Order No. 137 should be canceled and the relevant portions included in Conservation Order No. 145.

2. Administrative Approvals 98-B.3, 98-B.6, 98-B.7, and 98-B.8 should remain in effect and will be applicable until stable production from the field is attained or until the time period stipulated expires.

3. Waivers pertaining to blowout preventers written pursuant to Conservation Order No. 137, Rule 2 should remain in effect.

4. There are insufficient data to justify raising or lowering the vertical limits of the Prudhoe Oil Pool, as proposed by the applicants, to correspond with the vertical limits of the Prudhoe Bay (Permo-Triassic) Reservoir as described in the Prudhoe Bay Unit Agreement.

5. The areal extent of the Prudhoe Oil Pool should be identical to the initial participating area of the Prudhoe Bay Unit which is described as the Prudhoe Bay (Permo-Triassic) Reservoir in the Unit Agreement.

6. A rule eliminating acreage spacing in the Prudhoe Oil Pool should facilitate present and future additional recovery operations and enable the unit operators to develop the productive capacity to meet the planned throughput of the Trans-Alaska Pipeline.

7. A distance of 2000 feet between the pay opened in the well bore in all wells in the Prudhoe Oil Pool should maintain an adequate drainage area, not unnecessarily restrict bottomhole target locations and protect correlative rights and prevent waste.

8. A distance of 1000 feet between the pay opened in any well and the boundary of the Prudhoe Oil Pool will protect correlative rights.

9. To gather the data necessary for proper regulation and operation of the reservoir, a rigorous surveillance program of reservoir performance should be accurately observed and assessed especially during the first two years of operation. The surveillance program should also provide guidelines for a long term key well surveillance program.

10. A surveillance program should include monitoring the reservoir pressures, gas-oil and oil-water contact movements, production tests, gas-oil and water-oil ratios, and productivity profiles of individual wells.

11. A gas-oil contact movement monitoring program, based on a comparison of open hole neutron base logs to be later compared with neutron logs run in the same wells should be attempted.

12. The data obtained during the first two years could lead to a key well program of periodic surveys that may adequately monitor the gas-oil contact movements.

13. Monitoring the movement of the oil-water contact is desirable to evaluate the water influx in the reservoir and the applicability of water injection systems. Three methods are potentially applicable as means of monitoring the movement of the oil-water contact. These methods are the Thermal Decay Tools or the Neutron Lifetime Log, the Carbon-Oxygen Log and the Gamma Ray Log. The program to evaluate the relative capability of these

logs should be continued and should any method be demonstrated capable of adequately monitoring the changing water saturations in the reservoir, a key well program should be set up.

14. Downhole spinner flow meter surveys to determine well productivity profiles should help determine the effectiveness of completions and provide information on reservoir drainage.

    To provide the necessary productivity profile data a base line survey should be run on each well with later follow up surveys on each well.

15. The injection of produced water into the sands of Cretaceous age will not contaminate fresh water sources or endanger other natural resources.

16. Studies of the aquifer have indicated that it probably will not offer much pressure support.

17. Reservoir studies have shown that both produced water injection and source water injection into the Prudhoe Oil Pool should increase oil recovery.

18. Reservoir studies have shown that large scale source water injection will probably be necessary to maximize oil recovery.

19. The planned reinjection of gas into the Sadlerochit gas cap prior to large gas sales will help to maintain reservoir pressure and will not adversely affect ultimate recovery.

20. The Plan of Operations proposed by the applicants which include average annual offtake rates of 1.5 million barrels per day for oil plus condensate production and 2.7 billion cubic feet per day for gas are consistent with sound conservation practices based on currently available data.

21. After field and local fuel requirements and the removal of carbon dioxide and liquids from the produced gas, it is estimated that a gas production rate of 2.7 billion standard cubic feet per day will yield 2.0 billion standard cubic feet per day of pipeline quality gas.

22. Production history will be needed to locate water injection wells and to refine reservoir model studies.

23. The offtake rates approved by the Committee at this time must be established without the benefit of production history. Therefore, these offtake rates may be changed as production data and additional reservoir data are obtained and analyzed.

NOW, THEREFORE, IT IS ORDERED THAT the rules hereinafter set forth apply to the following described area referred to in this order as the affected area:

UMIAT MERIDIAN			
T. 10N.,	R. 12E.,	Sections	1, 2, 3, 4, 10, 11, 12
T. 10N.,	R. 13E.,		1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 24
T. 10N.,	R. 14E.,		1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 36
T. 10N.,	R. 15E.,		all
T. 10N.,	R. 16E.,		5, 6, 7, 8, 17, 18, 19, 20, 29, 30, 31
T. 11N.,	R. 11E.,		1, 2, 3, 4, 9, 10, 11, 12, 13, 14, 15, 24, 25
T. 11N.,	R. 12E.,		all
T. 11N.,	R. 13E.,		all
T. 11N.,	R. 14E.,		all
T. 11N.,	R. 15E.,		all
T. 11N.,	R. 16E.,		30, 31, 32
T. 12N.,	R. 11E.,		15, 16, 17, 18, 19, 20, 21, 22, 25, 26, 27, 28, 29, 30, 32, 33, 34, 35, 36
T. 12N.,	R. 12E.,		23, 24, 25, 26, 27, 28, 33, 34, 35, 36
T. 12N.,	R. 13E.,		19, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36
T. 12N.,	R. 14E.,		25, 26, 27, 28, 29, 31, 32, 33, 34, 35, 36
T. 12N.,	R. 15E.,		27, 28, 29, 30, 31, 32, 33, 34

Rule 1 Pool Definition

The Prudhoe Oil Pool is defined as the accumulations of oil that are common to and which correlate with the accumulations found in the Atlantic Richfield - Humble Prudhoe Bay State No. 1 well between the depths of 8,110 and 8,680 feet.

Rule 2 Well Spacing

In the affected area, no pay shall be opened in a well closer than 2000 feet to any pay opened in another well in the Prudhoe Oil Pool or be nearer than 1000 feet to the boundary of the affected area.

Rule 3 Casing and Cementing Requirements

(a) Casing and cementing programs shall provide adequate protection of all fresh waters and productive formations and protection from any pressure that may be encountered, including external freezeback within the permafrost.

(b) For proper anchorage and to prevent an uncontrolled flow, a conductor casing shall be set at least 75 feet below the surface and sufficient cement shall be used to fill the annulus behind the pipe to the surface.

(c) For proper anchorage, to prevent uncontrolled flow and to protect the well from the effects of permafrost thaw, a string of surface casing shall be set at least 500 feet below the base of the permafrost section but not below 2,700 feet unless a greater depth is approved by the Committee upon showing that no potentially productive pay exists above the proposed casing setting depth, and sufficient cement shall be used to fill the annulus behind the pipe to the surface.

The surface casing shall have minimum post-yield strain properties of 0.9% in tension and 1.26% in compression.

(d) If the surface casing does not meet the strain requirements in (c) above, the integrity of the well shall be protected from the effects of permafrost thaw by running an inner string of casing also set at least 500 feet below the base of the permafrost section and properly cemented except that the two casing strings shall not be bonded together within the permafrost section. This inner string of casing shall not be utilized as production casing.

(e) Other means for maintaining the integrity of the well from the effects of permafrost thaw may be approved by the Committee upon application.

(f) Production casing shall be landed through the completion zone and cement shall cover and extend to at least 500 feet above each hydrocarbon-bearing formation which is potentially productive. In the alternative, the casing string may be set and adequately cemented at

at an intermediate point and a liner landed through the completion zone. If such a liner is run, the casing and liner shall overlap by at least 100 feet and the annular space behind the liner shall be filled with cement to at least 100 feet above the casing shoe, or the top of the liner shall be squeezed with sufficient cement to provide at least 100 feet of cement between the liner and casing. Cement must cover and extend at least 500 feet above each hydrocarbon-bearing formation which is potentially productive.

(g) Casing and liner, after being cemented, shall be satisfactorily tested to not less than 50% of minimum internal yield pressure or 1,500 pounds per square inch, whichever is less.

(h) No well shall be produced through the annulus between the tubing and the casing unless a cement sheath extends from the top of the pay to the shoe of the next shallower casing string.

Rule 4 Blowout Prevention Equipment and Practice

(a) The use of blowout prevention equipment shall be in accordance with good established practice and all equipment shall be in good operating condition at all times.

All blowout prevention equipment shall be adequately protected to ensure reliable operation under the existing weather conditions. All blowout prevention equipment shall be checked for satisfactory operation during each trip.

(b) Before drilling below the conductor string, each well shall have installed at least one remotely controlled annular type blowout preventer and flow diverter system. The annular preventer installed on the conductor casing shall be utilized to permit the diversion of hydrocarbons and other fluids. This low pressure, high capacity diverter system shall be installed to provide at least the equivalent of a 6-inch line with at least two lines venting in different directions to insure downwind diversion and shall be designed to avoid freeze-up. These lines shall be equipped with full-opening butterfly type valves or other valves approved by the Committee. A schematic diagram, list of equipment, and operational procedure for the diverter system shall be submitted with the application Permit to Drill or Deepen (Form 10-401) for approval. The above requirements may be waived for subsequent wells drilled from a multiple drill site.

(c) Before drilling below the surface casing all wells shall have three remotely controlled blowout preventers, including one equipped with pipe rams, one with blind rams and one annular type. The blowout preventers and associated equipment shall have 3000 psi working pressure and 6000 psi test pressure.

(d) Before drilling into the Prudhoe Oil Pool, the blowout preventers and associated equipment required in (c) above shall have 5000 psi working pressure rating and 10,000 psi test pressure rating.

(e) The associated equipment shall include a drilling spool with minimum three-inch side outlets (if not on the blowout preventer body), a minimum three-inch choke manifold, or equivalent, and a fill-up line. The drilling string will contain full-opening valves above and immediately below the kelly during all circulating operations with the kelly. Two emergency valves with rotary subs for all connections in use will be conveniently located on the drilling floor. One valve will be an inside blowout preventer of the spring-loaded type. The second valve will be of the manually-operated ball type, or any other type which will perform the same function.

(f) All ram-type blowout preventers, kelly valves, emergency valves and choke manifolds shall be tested to required working pressure when installed or changed and at least once each week therafter. Annular preventers shall be tested to 50% recommended working pressure when installed and once each week thereafter. Test results shall be recorded on written daily records kept at the well.

Rule 5 Automatic Shut-in Equipment

Upon completion, each well shall be equipped with a suitable safety valve installed below the base of the permafrost which will automatically shut in the well if an uncontrolled flow occurs.

Rule 6 Pressure Surveys

(a) Prior to initial sustained well production, a static bottomhole pressure survey shall be taken on each well.

(b) Between 90 and 100 days after commencement of sustained pool production, the applicants shall perform an initial key well bottomhole transient pressure survey on one specific well on each producing pad or drill site. Another survey of the same type shall be conducted each 90 days thereafter.

(c) Within the first six months following the initial sustained well production, the applicants shall conduct a transient pressure survey on each well.

(d) A semi-annual transient pressure survey shall be conducted on one well in each governmental section from which oil is being produced. This is in addition to the pressure surveys conducted in (b) and (c) above.

(e) A long-term key well pressure survey will be formulated and implemented in approximately two years from the start of production based upon evaluation of data submitted under (a), (b), (c), and (d) above.

(f) Data from the above mentioned surveys shall be filed with the Committee by the fifteenth day of the month following the month in which each survey is taken. Form No. 10-412, Reservoir Pressure Report, shall be utilized for all surveys with attachments for complete additional data. Data submitted shall include but is not limited to rate, pressure, time, depths, temperature, and other well conditions necessary for

complete analysis for each survey being conducted. The pool pressure datum plane shall be 8800 feet subsea. Bottomhole transient pressures obtained by a 24 hour buildup or multiple flow rate test will be acceptable.

(g) Results and data from any special reservoir pressure monitoring techniques, tests or surveys shall also be submitted as prescribed in (f) above.

(h) By administrative order the Committee shall specify additional pressure surveys if the survey program designated in this rule is found to be inadequate.

Rule 7 Gas-Oil Ratio Tests

Between 90 and 120 days after substantial production starts and each six months thereafter a gas-oil ratio test shall be taken on each producing well. The test shall be of at least 12 hours duration and shall be made at the producing rate at which the operator ordinarily produces the well. The test results shall be reported on gas-oil ratio test form P-9 within fifteen days after completion of the survey. The Committee shall be notified at least five days prior to each test.

Rule 8 Gas Venting or Flaring

The venting or flaring of gas is prohibited except as may be authorized by the Committee in cases of emergency or operational necessity.

Rule 9 Gas-Oil Contact Monitoring

Open hole and cased hole neutron logs shall be run in selected wells to confirm gas-oil contact movement unless this technique is proved unworkable or an alternative approach is recommended and accepted by the Committee.

The wells selected for this neutron log survey together with a summary of the survey analyses shall be submitted to the Committee by January 1, 1978, and each six months thereafter. The Committee may also specify additional wells to be surveyed should they decide the survey program being followed is inadequate.

The cased hole neutron logs run shall be filed with the Committee by the fifteenth day of the month following the month in which the logs were run.

Other methods of monitoring the gas-oil contact movement may be approved if they show to be more effective.

A long term key well gas-oil contact movement monitoring program may be formulated and implemented in approximately two years from start of production if a workable technique is found.

Rule 10 Oil-Water Contact Monitoring

(a) A report on the evaluation program to determine the oil-water contact monitoring capability of the Thermal Decay Tools or the Neutron Lifetime Log, the Carbon-Oxygen Log and the Gamma Ray Log shall be submitted to the Committee by January 1, 1978.

(b) If the capability of monitoring the change in oil-water contact movement can be demonstrated by one or more of these methods, a key well program shall be set up by the applicants subject to the approval of the Committee.

Rule 11 Productivity Profiles

(a) A spinner flow meter survey shall be run in each well during the first six months the well is on production.

(b) A follow up survey shall be performed on a rotating basis so that a new production profile is obtained on each well periodically. Nonscheduled surveys shall be run in wells which experience an abrupt change in water cut, gas-oil ratio, or productivity.

(c) The complete spinner survey data and results shall be recorded and filed with the Committee by the 15th day of the month following the month in which each survey is taken.

(d) By administrative order the Committee shall specify additional surveys should they determine the surveys submitted under (a), (b) and (c) above are inadequate.

Rule 12 Changing the Affected Area

By administrative approval the Committee may adjust the description of the affected area to conform to future changes in the initial participating area.

Rule 13 Orders Cancelled

Conservation Orders Nos. 98-B, 130, and Rule 2 of Conservation Order No. 137 are hereby cancelled. Portions of Conservation Orders Nos. 98-B and 137 are made part of this order and the hearing records of these orders are also made part of the hearing record of this order.

Rule 14 Approvals Redesignated

Administrative Approvals made pursuant to CO 98-B, Rule 8 and the waivers made pursuant to Conservation Order No. 137, Rule 2 remain in effect and will now be authorized by this order.

Rule 15 Pool Off-Take Rates

The maximum annual average oil offtake rate is 1.5 million barrels per day plus condensate production. The maximum annual average gas offtake rate is 2.7 billion standard cubic feet per day, which contemplates an annual average gas pipeline delivery sales rate of 2.0 billion standard cubic feet per day of pipeline quality gas when treating and transportation facilities are available. Daily offtake rates in excess of these amounts are permitted only as required to sustain these annual average rates. The annual average offtake rates as specified shall not be exceeded without the prior written approval of the Committee.

Annual average offtake rates mean the daily average rate calculated by dividing the total volume produced in a calendar year by the number of days in the year. However, in the first calendar year that large gas offtake rates are initiated, following the completion of a large gas sales pipeline, the annual average offtake rate for gas shall be determined by dividing the total volume of gas produced in that calendar year by the number of days remaining in the year following initial delivery to the large gas sales pipeline.

DONE at Anchorage, Alaska, and dated June 1, 1977.

Thomas R. Marshall, Jr., Executive Secretary
Alaska Oil and Gas Conservation Committee

Concurrence:

Hoyle H. Hamilton, Chairman
Alaska Oil and Gas Conservation Committee

Lonnie C. Smith, Member
Alaska Oil and Gas Conservation Committee