

**STATE OF ALASKA**  
**ALASKA OIL AND GAS CONSERVATION COMMISSION**  
**333 West 7<sup>th</sup> Avenue, Suite 100**  
**Anchorage, Alaska 99501**

Re **THE APPLICATION OF UNION** ) **Storage Injection Order No. 6**  
**OIL COMPANY OF CALIFORNIA** )  
("Unocal") for an order authorizing ) **Swanson River Field**  
the underground storage of ) **Tyonek Undefined Gas Pool**  
hydrocarbons in the Tyonek 77-3 )  
Sand, Swanson River Field, Cook Inlet )  
Area, Alaska. ) **October 31, 2005**

**IT APPEARING THAT:**

1. By application dated August 24, 2005, Union Oil Company of California ("Unocal") as operator of the Swanson River Field, requested an area storage injection order from the Alaska Oil and Gas Conservation Commission ("Commission") authorizing the underground storage of natural gas in the Tyonek 77-3 Sand within the Swanson River Field.
2. Notice of opportunity for public hearing was published in the Anchorage Daily News on September 6, 2005 in accordance with 20 AAC 25.252(i) and 20 AAC 25.540.
3. Unocal submitted additional information on September 7, 2005 and September 22, 2005.
4. A revised notice of opportunity for public hearing was published in the Anchorage Daily News on September 7, 2005 in accordance with 20 AAC 25.540.
5. The Commission received no protests to or written comments on Unocal's application.
6. The Commission held a public hearing October 13, 2005 at the Commission's offices at 333 West 7th Avenue, Suite 100, Anchorage, Alaska 99501.

**FINDINGS:**

1. Operator:  
Unocal is the operator of the Swanson River Field. There are no other operators within a one-quarter mile radius of the boundaries of the proposed storage area.
2. Injection Strata:  
Unocal proposes to inject gas into the Tyonek 77-3 sand within the Swanson River Field. The Tyonek 77-3 sand accumulation occurs at depths of 7972 to 8001 feet measured depth within Well SCU 42A-05.

3. Proposed Storage Area:

The hydrocarbon-bearing interval of the Tyonek 77-3 sand is located within Sections 4 and 5, Township 7 N, Range 9 W, SM.

4. Operators/Surface Owners Notification:

Unocal has provided an affidavit showing that the Operators and Surface Owners within one-quarter mile radius of the proposed storage well have been notified.

5. Description of Operation:

Unocal proposes injection of hydrocarbon gas into the Tyonek 77-3 sand for gas storage purposes. Produced natural gas from the Swanson River Field and from other fields in the Cook Inlet area will be injected and stored in the proposed storage interval during periods of high supply and redelivered during periods of high demand. The estimated maximum amount of gas to be injected is 42 MMSCFD. Existing compression will be used for gas injection and production operations and has a capacity of 4400 psi corresponding to a 0.676 psi/ft gradient. The average wellhead injection pressure is projected to be 3500 psi. Original reservoir pressure in the 77-3 sand in SCU 42A-05 is estimated at 4774 psi and equates to an original pressure gradient of 0.61 psi/ft. Unocal's original application identified Tyonek 77-3 sand producer SCU 42A-05, as the single proposed gas storage injector for the project. Unocal has also requested permission to be able to recompleat other wells within the approved storage area such as SCU-42-05B for storage service.

6. Pool Information:

Information provided by Unocal indicates that the requested affected area for this order contains 100% of the net sand mapped to date in the Tyonek 77-3 Sandstone. The Tyonek 77-3 Sandstone is interpreted as a meandering stream deposit with river channel sandstones laterally equivalent to predominately fine grained floodplain mudstone and coals. Lateral facies changes from sandstone to mudstones in the eastern portion of the affected area form a stratigraphic trap element in those areas. An updip sealing fault provides the trapping element along the southern portion of the affected area. A fault seal along the northern boundary of the reservoir and uniform dip to west provide structural trap elements along the northern and western portions of the area. The dependence of this trap configuration on a potentially dynamic up-dip fault seal will require an engineering based justification for injection pressures exceeding the original conditions within the proposed storage reservoir.

Core data from the Tyonek 77-3 Sandstone indicate average net reservoir porosity of 28% and permeability ranging to several hundred millidarcies. Gross thicknesses for the 77-3 Sandstone range from 25 to approximately 40 feet based on well control. Average water saturation is estimated at 50%. The sandstone is bounded above and below by confining zones consisting of fine grained fluvial overbank deposits of mudstones and coals exceeding fifty feet in true stratigraphic thickness.

SCU 42A-05, completed in June 2004, is the only well that has produced from the Tyonek 77-3 Sand. Peak production rate was 6.2 MMSCFD. Initial reservoir pressure within the sand was 4774 psi. Original gas in place is estimated to have been

3.18 BSCF using material balance analysis of historical production and reservoir pressure measurements. A volumetric estimate of about 2.8 BSCF compares well with the material balance results. As of July 1, 2005, recovery was 1.8 bcf corresponding to a recovery of 57.5% of the original gas in place and an average reservoir pressure of about 1900 psi. Material balance analysis supports the contention that the interval proposed for gas storage covers a limited area and is pressure isolated from other strata.

7. Well Logs:

The logs of existing wells in the area are on file with the Commission.

8. Mechanical Integrity and Well Design of Injection Wells:

Injector wells will be permitted and completed in accordance with 20 AAC 25.030. Cement bond logs will be run on all injection wells to demonstrate isolation of injected fluids to the Tyonek 77-3 Sandstone. The operator will demonstrate mechanical integrity of the injection wells according to the provisions of 20 AAC 25.252(d) before initiating gas injection and storage.

9. Type of Fluid / Source:

Only dry natural gas from the Swanson River Field and other Cook Inlet area fields will be injected and stored. The gas specific gravity is between 0.56 and 0.58.

10. Fluid Compatibility with Formation:

Since the composition of the injected gas is very similar to the native gas, there will be no compatibility problems.

11. Injection Rates and Pressures, Fracture Information:

Injection rates will vary dependent upon gas supply/demand and the reservoir pressure during storage. The maximum expected injection rate is 42 MMSCFD. Estimated average and maximum surface injection pressures are 3500 psi and 4400 psi, respectively.

No direct fracture gradient measurements in the Tyonek 77-3 Sand have been made. Fracture gradient is estimated at 0.81 psi/ft based upon data gathered during cementing operations in a zone just below the Tyonek 77-3 Sand. In other tests of shallower formations, the observed fracture gradients ranged from 0.75 to 1.1 psi/ft. The original Tyonek 77-3 reservoir pressure gradient was 0.61 psi/ft. At planned maximum rates and pressures, the gradient will be less than 0.674 psi/ft at the injector, well below the fracture gradient of stratigraphically adjacent mudstone confining zones. No information has been submitted characterizing the pressure integrity of the updip fault seal along the southern portion of the affected area.

Unocal sought the flexibility to inject at pressures up to 10% above the original reservoir pressure. Unocal presented no direct evidence of the competency of the fault seals if the reservoir were pressured to above the original reservoir pressure.

12. Underground Sources of Drinking Water:

The proposed gas injection will occur at depths greater than 7800 feet TVD and will be adequately confined at the approved injection pressures. As per 40 CFR 147.102(b), the aquifers greater than 1700 feet below the surface in the Swanson River Field are exempted in accordance with 40 CFR 144.7(b) and 40 CFR 146.4.

**13. Mechanical Condition of Adjacent Wells:**

Unocal supplied a report on the mechanical condition of each well that has penetrated the Tyonek 77-3 accumulation within the proposed storage area. Cementing records suggest full cement placement within all wells and there are no known mechanical integrity issues. With the exception of two wells, SCU 323-04 and SCU 41-05, cement evaluation logs verified good cement. No bond log was run on SCU 323-04. While the bond log on SCU 41-05 indicated insufficient isolation of the 77-3 Sand, cementing records indicate successful cementing operations with full cement placement. Reservoir material balance results support the contention that the interval proposed for gas storage covers a limited area and is isolated from other strata.

**14. Additional Safety Precautions/Risk Reduction:**

Unocal performed a risk analysis on the proposed gas storage operations. Compression will be supplied by the existing central Swanson River compressor facilities, which have been used for gas re-injection into the Hemlock oil zone. The maximum operating pressure of the compressor is 5000 psi. Emergency response plans are in place for the Swanson River Field that cover these operations.

A potential storage well 42B-05 is currently completed within the Hemlock formation. Unocal indicated that the production casing has good cement well above the Tyonek 77-3 Sandstone. The current completion will be abandoned, current tubing will be pulled, a new 5 1/2" liner will be cemented from below the storage zone to surface, and a new 2 7/8" tubing string with premium threads will be run. The pressure ratings of casing and cement are well above the maximum allowable injection pressure. The tree is rated at ANSI 5000#. Surface safety valve ("SSV") and an additional check valve will ensure that surface injection pressures cannot exceed 4400 psi. The injection well will be remotely monitored. Tubing and annular pressures of all wells within the storage area are monitored daily.

**CONCLUSIONS:**

1. Subject to the limitation of Rule 4(a) of this order, the project as described and proposed satisfies the requirements of 20 AAC 25.252.
2. Mechanical integrity of all storage injection wells must be demonstrated according to the requirements of 20 AAC 25.252(d) prior to initiating gas injection and storage operations.
3. The proposed injection of natural gas into the Tyonek 77-3 Sand for the purpose of storage will not propagate fractures through the confining zones or cause movement

of hydrocarbons into sources of freshwater.

4. The proposed injection of natural gas into the Tyonek 77-3 Sand for the purpose of storage will not cause waste, jeopardize correlative rights, endanger freshwater, or impair ultimate recovery.
5. The proposed injection operations will be conducted in permeable strata, which can reasonably be expected to accept injected fluids at pressures less than the fracture pressure of the confining strata.
6. Data as to whether the reservoir compartment will maintain pressure integrity if the average reservoir pressure exceeds the original reservoir pressure are insufficient to justify allowing injection to increase reservoir pressure above the original pressure.
7. Surveillance of operating parameters on the storage and offset wells will aid in preventing stored gas from moving out of the formation where it is intended to be stored.

**NOW, THEREFORE, IT IS ORDERED** that the following rules, in addition to statewide requirements under 20 AAC 25, apply to the underground storage of hydrocarbons by injection operations in the Tyonek 77-3 Sand accumulation in the affected area described below:

**Seward Meridian Township 7N, Range 9W**

Sec 4: W1/2 SE1/4 NE1/4;  
SW1/4 NE1/4;  
S1/2 NW1/4;  
NE1/4 SW1/4;  
N1/2 NW1/4 SW1/4;  
SE1/4 NW1/4 SW1/4;  
NE1/4 SE1/4 SW1/4  
NW1/4 NE1/4 SE1/4;  
NW1/4 SE1/4;  
N1/2 SW1/4 SE1/4;

Sec 5: SE1/4 NE1/4;  
E1/2 SW1/4 NE1/4;  
N1/2 NE1/4 SE1/4;  
NE1/4 NW1/4 SE1/4

### **RULE 1: STORAGE INJECTION**

The Commission approves the injection for storage of natural gas into the 77-3 Sandstone of the Tyonek Formation, common to and correlating with the interval of 7972 to 8001 feet measured depth within Well SCU 42A-05. The Operator shall report disposition of production and injection as required by 20 AAC 25.228, 20 AAC 25.230, and 20 AAC 25.235.

### **RULE 2: DEMONSTRATION OF MECHANICAL INTEGRITY**

A Commission-witnessed mechanical integrity test must be performed after injection is commenced for the first time in the well, to be scheduled when injection conditions (temperature, pressure, rate, etc.) have stabilized. Results of mechanical integrity tests must be readily available for Commission inspection.

### **RULE 3: WELL INTEGRITY FAILURE AND CONFINEMENT**

In addition to complying with 20 AAC 25.252(e), the operator shall immediately shut in the well if continued operation would be unsafe or would threaten contamination of freshwater, or if so directed by the Commission. The operator shall submit to the Commission a monthly report of daily tubing and casing annuli pressures and injection rates, for all wells within the affected area.

### **RULE 4: MAXIMUM INJECTION PRESSURE**

- (a) Injection operations may not increase the average reservoir pressure beyond original conditions of 4774 psi.
- (b) To allow for friction losses through injector perforations, the injection pressure at the formation sandface may reach a maximum allowable gradient of 0.676 psi/ft TVDss, so long as the limit in item (a) of this rule is not exceeded.

### **RULE 5: ANNUAL PERFORMANCE REPORT**

An annual report evaluating the performance of the storage injection operation must be provided to the Commission no later than 60 days after the beginning of each calendar year. The report shall include material balance calculations of the gas production and injection volumes to provide assurance of continued reservoir confinement of the gas storage volumes.

### **RULE 6: EXPIRATION OF APPROVAL**

As provided in 20 AAC 25.252(j), if storage operations are not begun within 24 months after the date of this Order, this injection approval shall expire unless an application for extension has been approved by the Commission.

**RULE 7: ADMINISTRATIVE ACTIONS**

Unless notice and public hearing are otherwise required, the Commission may administratively waive or amend any rule stated above 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 fluid movement outside of the authorized injection zone.

**DONE at Anchorage, Alaska** and dated October 31, 2005.

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John K. Norman, Chairman  
Alaska Oil and Gas Conservation Commission

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Cathy P. Foerster, 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 23<sup>rd</sup> 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 nonaction 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., 10<sup>th</sup> day after the application for rehearing was filed).