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

| | | |
|---|---|---|
| **Re: THE APPLICATION OF Marathon Oil Company for disposal of Class II oil field wastes by underground injection in the Sterling Formation in the Kenai Unit Well 12-17, Section 17, T4N, R11W, S.M.** | ) | **Disposal Injection Order No. 34** |
| | ) | **Docket No. DIO-08-10** |
| | ) | **Sterling Formation** |
| | ) | **Kenai Unit Well 12-17** |
| | ) | |
| | ) | **November 20, 2008** |
| | ) | |
| | ) | |
| | ) | |

**IT APPEARING THAT:**

1. By correspondence received by the Alaska Oil and Gas Conservation Commission (Commission) August 22, 2008, Marathon Oil Company (Marathon) requested that the Commission issue an order authorizing underground disposal of Class II oil field waste fluids into the Sterling Formation through the Kenai Unit (KU) 12-17 wellbore.

2. Notice of opportunity for a public hearing was published in the ANCHORAGE DAILY NEWS on September 2, 2008, on the State of Alaska Online Notices on September 2, 2008, and on the Commission's Web site on September 2, 2008, in accordance with 20 AAC 25.540. The scheduled hearing date was October 7, 2008.

3. The Commission requested additional information regarding the construction of KU 12-17 on September 9, 2008. Marathon provided the requested information on September 23, 2008.

4. Marathon was requested to provide further information about the evaluation of the KU 12-17 well construction on September 23, 2008. Marathon provided the requested information on October 1, 2008

5. As part of the evaluation of the technical content of Marathon's application, the Commission requested an expanded area of review around the proposed disposal injection well. Marathon responded with additional information on November 4, 2008.

6. The Commission did not receive any comments, protests or requests for a public hearing.

7. The public hearing was vacated on September 29, 2008.

8. The information submitted by Marathon and public well history records are the basis for this order.

**FINDINGS:**

1. Location of Adjacent Wells (20 AAC 25.252(c)(1))

   KU 12-17 is an existing well directionally drilled in June-July 2008 to a total depth of 5786 feet true vertical depth (TVD). The bottom hole location for KU 12-17 is in Section 17, Township 4N, Range 11W, Seward Meridian (2823 feet from north line, 163 feet from east line). The surface location is on the Marathon-operated 41-18 drill site within the Kenai Gas Field in Section 18, Township 4N, Range 11W (848 feet from north line, 742 feet from east line). The plat included with Marathon's application shows the location of all wells within a ¼-mile radius of KU 12-17.

2. Notification of Operators/Surface Owners (20 AAC 25.252(c)(2) and 20 AAC 25.252(c)(3))

   Marathon is the only operator within a ¼-mile radius of the proposed disposal well. Surface owners within a ¼-mile radius of KU 12-17 are Salamatof Native Corporation and Cook Inlet Regional Corporation. All surface owners were notified by letter regarding the proposed injection using KU 12-17 according to the "Affidavit of Notice to Surface Owners and Operators" provided by Marathon.

3. Geological Information on Disposal and Confining Zones (20 AAC 25.252(c)(4))

   The Sterling Formation consists of thick, sandy, meandering stream bar deposits alternating with coals and shales. Sterling B1 and B2 are the intended injection zone, from 4002 feet to 4147 feet TVD. Porosity and permeability in the disposal interval range up to 28 percent and 1000 millidarcies, respectively. The disposal injection zone is within the aquifer exemption area defined by EPA in 40 CFR 147.102(b)(1)(iii). Marathon states that Sterling B2 (4052 feet to 4147 feet TVD) in KU 12-17 will be perforated for primary waste disposal injection. Approximately 50 feet of shale and coal immediately overlaying Sterling B1 is identified by Marathon as providing upper confinement for injected fluids. Interpreted cross sections indicate the upper confining layer is laterally continuous across the Kenai Gas Field. Lower confinement is provided by a laterally continuous shale and coal sequence. Structure maps provided by Marathon indicate there are no transmissive faults in the drillsite 41-18 vicinity at the depths that correlate to the injection zone and confining layers.

4. Evaluation of Confining Zones (20 AAC 25.252(c)(9))

   Fracture modeling specific to KU 12-17 disposal injection was not performed. Instead, Marathon indicates that the recent fracture model updates for waste disposal wells KU 11-17 and 24-07RD (which, also located on the 41-18 drill site, dispose into the Sterling Formation) appropriately characterize fracturing for planned injection into KU 12-17. The model

updates evaluated a range of factors to determine the sensitivity of those factors to fracture dimensions. Historical performance data (*i.e.*, rate, pressure, and fluid composition data) for the KU 11-17 and 24-07RD disposal injection wells were also used in the model updates to estimate fracture geometry for an injected volume of up to 2 million barrels. Marathon reports that similar rock and fluid properties allow these well fracture model updates to predict fracture behavior for KU 12-17. A copy of the KU fracture model update is in the Commission's files.

Marathon predicts a fracture height of 200 feet, growing into the Sterling B1, and a half-length of 4,000 feet as the most likely case based on the fracture model updates and nearby waste injection performance in the Sterling Formation. The modeling predictions indicate neither the upper nor lower confining layers would be penetrated because of the planned injection operations in KU 12-17. Additional evidence that the confining layers would be effective barriers includes the historic injection in the Sterling Formation within the KU 11-17,14-4, 24-07, and 24-07RD wells.

5. Standard Laboratory Water Analysis of the Formation (20 AAC 25.252(c)(10)); Aquifer Exemption (20 AAC 25.252(c)(11))

By regulation [40 CFR 147.102(b)(1)(iii)], EPA has exempted those portions of aquifers below 1300 feet TVD in the Kenai Gas Field. As additional confirmation, Marathon provided the water analysis for a Sterling Formation water sample taken from KU 14-6 indicating total dissolved solids greater than 10,000 mg/l.

6. Well Logs (20 AAC 25.252(c)(5))

Log data from KU 12-17 are on file with the Commission.

7. Demonstration of Mechanical Integrity and Disposal Zone Isolation (20 AAC 25.252(c)(6))

KU 12-17 was drilled to be a Class II waste disposal injector. The well was completed in July 2008, and operations were suspended without perforating, pending approval of the disposal injection order. The well was directionally drilled south to a depth of 5786 feet TVD; constructed with 20-inch conductor casing set at 189 feet TVD, 10-3/4-inch surface casing set at 1492 feet TVD, and 7-5/8-inch production casing set at 5786 feet TVD; and plugged back to 5682 feet TVD. The injection completion will consist of 4.5-inch injection tubing run to 3896 feet TVD and a permanent packer installed at 3865 feet TVD, thereby establishing the Sterling Formation as the intended zone for underground injection control (UIC) Class II disposal.

The surface casing is cemented from shoe depth to the surface. The production casing is constructed with sufficient cement to cover from total depth to 2517 feet TVD.

Cement bond log was run in KU 12-17 to evaluate the cement placement and bond integrity of the casing string isolating the planned injection zone. Marathon evaluated the 7-5/8-inch casing interval with a cement bond log from 5680 feet to 2373 feet TVD. An estimated cement top of 2586 feet TVD with good to excellent cement bond is interpreted from the log

data. Cement bond appears to be excellent throughout, above and below the proposed Sterling B1 and B2 injection zone. The interpreted top of the cement is approximately 360 feet above the top of the upper confining zone.

A mechanical integrity test will be performed before injection commences and at intervals required by the Commission. Marathon will continuously monitor wellhead pressures using a supervisory-controlled automated data acquisition system supplemented with daily visual inspections and pressure recordings. Additionally, Marathon indicates that annual due diligence reviews will be performed for all active slurry injection on the 41-18 drill site that will include pressure trend data and fracture modeling updates.

8. Disposal Fluid Type, Composition, Source, Volume, and Compatibility with Disposal Zone (20 AAC 25.252(c)(7))

KU 12-17 will be the third active waste disposal well on the KU 41-18 drill site injecting into the Sterling Formation; there are another three active waste disposal wells within the Kenai Gas Field (2 Kenai Gas Field waste disposal wells are plugged and abandoned). Marathon intends to use KU 12-17 to dispose of drilling, production, completion, and workover wastes originating from exploration and development well activities on the Kenai Peninsula in a manner and to an extent that is similar to the use of the other KU 41-18 drill site waste disposal wells. Marathon projects the injection volume into KU 12-17 could exceed 1,000,000 barrels of Class II wastes over the expected life of the field. Marathon expects the injection rate to average 1000 barrels per day (with a maximum injection rate of 7200 barrels per day), with rates of up to 5 barrels per minute. The expected performance is less than the injection performance used in fracture modeling for this project.

No compatibility concerns relating to the injected fluids and in-situ formation fluids have been identified by Marathon while injecting more than 6.5 million barrels of Class II wastes into the KU disposal wells.

9. Estimated Injection Pressures (20 AAC 25.252(c)(8))

Marathon estimates that the average surface injection pressure will be 1600 psig. The maximum surface injection pressure is limited by the 3000 psig working pressure of the injection pump, which is equipped with a 2400 psig pressure safety relief valve.

10. Mechanical Condition of Wells Penetrating the Disposal Zone Within ¼-Mile of KU 12-17 (20 AAC 25.252(c)(12))

No wells penetrate the Sterling Formation within a ¼-mile radius of KU 12-17. The fracture modeling results led the Commission to request a larger area of review—*i.e.*, a radius equivalent to the 4000-foot fracture half-length around the proposed disposal well—to evaluate the mechanical condition of wells penetrating the disposal zone. Eleven wells were identified: 8 wells within the Kenai Unit (KU 11-17, 14-8, 24-7, 24-7RD, 41-18, 41-18X, 41-19, and 44-18); and 3 wells within the Kenai Beluga Unit (KBU 13-8, 24-7X, and 33-7). Marathon indicates the cement and casing in each of the wells appear to be adequate to prevent the movement of injected fluids outside of the disposal zone.

**CONCLUSIONS:**

1. The requirements and conditions for approval of an underground disposal application in 20 AAC 25.252 are met.

2. The Sterling disposal zone is approximately 145 feet thick. Upper confinement will be provided by a 50-foot shale and coal sequence that is shown on structural cross sections derived from logging data to be laterally continuous across the field. Lower confinement of injected fluids will be provided by a shale and coal sequence that is also laterally continuous across the field. No significant faults are in the vicinity of the proposed operations. Past injection operations into Sterling B1 and B2 in active disposal injection wells located on the KU 41-18 drill site show the confining layers are effective barriers to fluid movement.

3. Kenai Gas Field aquifers below 1300 feet TVD are exempted by EPA as underground sources of drinking water for Class II injection activities. *See* 40 CFR 147.102(b)(1)(3). The total dissolved solids content of the water within Sterling B1 and B2 exceeds 10,000 mg/l.

4. Commercial gas accumulations are in the Sterling Formation in other parts of the KU. In the section of the Sterling penetrated by KU 12-17, all intervals but the deepest—*i.e.*, Sterling Pool 6—are water wet. Fracture height growth will not likely reach Sterling Pool 6.

5. For disposal operations, fluid compatibility in the Sterling B1 and B2 is not an issue. Operating experience and data from disposal injection involving similar materials and performance parameters (*i.e.*, pressures, rates, and volumes) elsewhere within the Kenai Unit Sterling Formation provide an analogy for underground disposal in KU 12-17.

6. Based on the modeled injection rates in nearby waste disposal injectors operating analogously to what is planned for KU 12-17, reasonable grounds exist to conclude that waste fluids should be contained within the proposed disposal zone by the lithologies above and below the Sterling B1 and B2, cement isolation of the wellbore, and operating conditions. Modeling predicts a zone of influence (*i.e.*, waste plume area) for injected materials equal to a fracture domain extending approximately 4,000 feet laterally from the well. The Commission concurs with Marathon's assessment that the casing, cement, and cement evaluation tool records indicate that all wells penetrating the disposal zone within an area of review described by a 4000-foot radius around KU 12-17 have sufficient mechanical integrity to prevent the migration of injected fluids outside of the proposed disposal zone.

7. Disposal injection operations in KU 12-17 will be conducted at rates and pressures below those estimated to fracture through the confining zones. Therefore, oil field wastes injected into KU 12-17 will be confined to the isolated Sterling B1 and B2.

8. Supplemental mechanical integrity demonstrations and the surveillance of injection operations—including temperature surveys, monitoring of injection performance (*i.e.*, pressures and rates), and analyses of the data for indications of anomalous events—are appropriate to ensure that waste fluids remain within the disposal interval.

**NOW, THEREFORE, IT IS ORDERED THAT** disposal injection is authorized into the Sterling Formation within Kenai Unit Well 12-17 subject to each of the following requirements:

**RULE 1: Injection Strata for Disposal**
The underground disposal of Class II well oil field waste fluids is permitted into the Sterling Formation within KU 12-17 in the interval from 4002 feet to 4147 feet TVD. The Commission may immediately suspend, revoke, or modify this authorization if injected fluids fail to be confined by the upper or lower confining zone.

**RULE 2: Fluids**
This authorization is limited to Class II oil field waste fluids generated during drilling, production or workover operations.

**RULE 3: Injection Rate and Pressure**
Disposal injection is authorized at (a) rates that do not exceed 5 barrels per minute and (b) surface pressures that do not exceed 2400 psig.

**RULE 4: Demonstration of Mechanical Integrity**
The mechanical integrity of KU 12-17 must be demonstrated before injection begins and before returning the well to service following a workover affecting mechanical integrity. A Commission-witnessed mechanical integrity test must be performed after injection is commenced for the first time in KU 12-17; that test must be scheduled when injection conditions (temperature, pressure, rate, etc.) have stabilized. Subsequent mechanical integrity tests must be performed at least once every two years after the date of the first Commission-witnessed test. The Commission must be notified at least 24 hours in advance of each such test to enable a representative to witness the test. Unless an alternate means is approved by the Commission, mechanical integrity must be demonstrated by a tubing/casing annulus pressure test that meets the following conditions: (1) pressure of either 1,500 psig or 0.25 psi/ft. multiplied by the vertical depth of the packer, whichever is greater is applied; (2) the test shows stabilizing pressure; and (3) pressure does not change more than 10 percent during a 30-minute period. The results of all mechanical integrity demonstrations and Marathon interpretation of those results shall be provided to the Commission and be readily available for Commission inspection.

**RULE 5: Well Integrity Failure and Confinement**
Whenever any pressure communication, leakage or lack of injection zone isolation is indicated by the injection rate, an operating pressure observation, a test, a survey, a log, or any other evidence, the operator shall notify the Commission by the next business day and submit a plan of corrective action on Form 10-403 for Commission approval. The operator shall immediately shut in the well if continued operation would be unsafe or threaten contamination of freshwater, or if so directed by the Commission. A monthly report of daily tubing and casing annuli pressures and injection rates must be provided to the Commission for KU 12-17 indicating any well integrity failure or lack of injection zone isolation.

**RULE 6: Surveillance**

The operator shall run a baseline temperature log and perform a baseline step-rate test prior to initial injection. A subsequent temperature log must be run one month after injection begins to delineate the receiving zone of the injected fluids. Surface pressures and rates must be monitored continuously during injection for any indications of anomalous conditions. Results of daily wellhead pressure observations in KU 12-17 must be documented and available to the Commission upon request. The conduct of subsequent temperature surveys or other surveillance logging (*e.g.*, water flow; acoustic) will be based on the results of the initial and follow-up temperature surveys and injection performance monitoring data.

A report evaluating the performance of the disposal operation must be submitted to the Commission by July 1 of each year. The report shall include data sufficient to characterize the disposal operation, including, among other information, the following: injection and annuli pressures (daily average, maximum and minimum); fluid volumes injected (disposal and clean fluid sweeps); injection rates; an assessment of fracture geometry; a description of any anomalous injection results; and a calculated zone of influence for the injection fluids.

Wellhead pressures shall be monitored daily and maintained for KU 41-18 drill site wells penetrating the disposal zone within an area of review described by a 4000-foot radius around KU 12-17. Pressure records shall be made available for inspection upon Commission request. The annual surveillance report shall include for these KU 41-18 drill site wells a summary wellhead pressure plot and an assessment of their mechanical integrity.

**RULE 7: Notification of Improper Class II Injection**

The operator must immediately notify the Commission if it learns of any improper Class II injection. Complying with the notification requirements of any other local, state or federal agency remains the operator's responsibility.

**RULE 8: Administrative Action**

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.

**RULE 9: Compliance**

Operations must be conducted in accordance with the requirements of this order, AS 31.05, and (unless specifically superseded by Commission order) 20 AAC 25. Noncompliance may result in the suspension, revocation, or modification of this authorization.

**ENTERED** at Anchorage, Alaska, and dated November 20, 2008.

ALASKA OIL AND GAS CONSERVATION COMMISSION

John K. Norman, Commissioner

Cathy P. Foerster, Commissioner

**RECONSIDERATION AND APPEAL NOTICE**

As provided in AS 31.05.080(a), within **20** days after written notice of the entry of this order or decision, or such further time as the Commission grants for good cause shown, a person affected by it may file with the Commission an application for reconsideration of the matter determined by it. If the notice was mailed, then the period of time shall be **23** days. An application for reconsideration must set out the respect in which the order or decision is believed to be erroneous.

The Commission shall grant or refuse the application for reconsideration in whole or in part within 10 days after it is filed. Failure to act on it within 10-days is a denial of reconsideration. If the Commission denies reconsideration, upon denial, this order or decision and the denial of reconsideration are **FINAL** and may be appealed to superior court. The appeal **MUST** be filed within **33** days after the date on which the Commission mails, **OR 30** days if the Commission otherwise distributes, the order or decision denying reconsideration, **UNLESS** the denial is by inaction, in which case the appeal **MUST** be filed within **40** days after the date on which the application for reconsideration was filed.

If the Commission grants an application for reconsideration, this order or decision does not become final. Rather, the order or decision on reconsideration will be the **FINAL** order or decision of the Commission, and it may be appealed to superior court. That appeal **MUST** be filed within **33** days after the date on which the Commission mails, **OR 30** days if the Commission otherwise distributes, the order or decision on reconsideration. As provided in AS 31.05.080(b), "[t]he questions reviewed on appeal are limited to the questions presented to the Commission by the application for reconsideration."

In computing a period of time above, the date of the event or default after which the designated period begins to run is not included in the period; the last day of the period is included, unless it falls on a weekend or state holiday, in which event the period runs until 5:00 p.m. on the next day that does not fall on a weekend or state holiday.