

March 30, 2016

7600-4520-59240-09

Ms. Kelsey Whiting-Hewlett C.E.T.
Pengrowth Energy Corporation
Suite 2100, 222 – 3rd Avenue S.W.
Calgary, AB T2P 0B4

Dear Ms. Whiting-Hewlett:

**RE: PRESSURE MAINTENANCE WATERFLOOD SPECIAL PROJECT – AMENDMENT #4
OTHER THAN NORMAL SPACING ORDER – AMENDMENT #4
RIGEL FIELD - CECIL “G” POOL**

The Commission has reviewed the email request of January 12, 2016, to continue injection into the subject pool through the well Pengrowth HZ Rigel B13-14-88-18 (WA 13533), during a period of suspended pool production.

Rigel field Cecil “G” pool production commenced in December 1996. A pressure maintenance scheme using waterflood was approved in March 1998 (Order # 98-09-003). Pool production has been suspended since July 2015.

Continued injection will raise the cumulative pool VRR, seeking an average reservoir pressure increase to approximately 9,300 kPa, with the objective of increasing ultimate oil recovery upon resumption of production. This amendment permits operation of the previously approved injection well Pengrowth HZ Rigel B13-14-88-18, until July 31, 2016. At that time the Commission requests that reservoir pressure tests be taken at the injector and two additional pool wells. This information will measure the effectiveness of pressure distribution and provide a basis for forward planning.

This amended approval includes a maximum wellhead injection pressure, an ultimate pool pressure limit, restriction of injection for the purpose of oil recovery, reporting of injection water source, and a revised submission date for the annual progress report.

The following Orders are attached;

- 1) Order 98-09-003 Amendment #4 designating Pressure Maintenance Waterflood within the Rigel field – Cecil “G” pool, as a Special Project under section 75 of the *Oil and Gas Activities Act*, and
- 2) Order 98-09-003 Amendment #4 - OTN approving Other Than Normal Spacing under section 65.1 of the *Petroleum and Natural Gas Act* for the subject area and formation.

Please note that, as per section 75 of the *Drilling and Production Regulation*, a record of the volume of water injected must be included on a Monthly Injection or Disposal Statement (BC-S18). This statement must be submitted to the Commission no later than the 25th day of the month in which activity occurred.

Should you have any questions, please contact Petra Kriescher-Trudgeon at (250) 419-4415 or the undersigned at (250) 419-4430.

Sincerely,



Ron Stefik, EngL
Supervisor, Reservoir Engineering
Oil and Gas Commission

Attachments

IN THE MATTER of an application from Pengrowth Energy Corporation to the Commission dated January 12th, 2016 for the production of oil using pressure maintenance (water injection).

ORDER 98-09-003 Amendment #4

- 1 Under section 75(1)(a) of the *Oil and Gas Activities Act*, the Rigel field – Cecil “G” pool is designated as a Special Project for the recovery of oil utilizing pressure maintenance waterflood within the following area;
DLS Twp 88 Rge 18 W6M Section 10, W/2 Sec 14, E/2 & SW/4 Sec 15,
SE/4 Sec 22, W/2 & NE/4 Sec 23, and Sec 26
- 2 Under section 75(2) of the *Oil and Gas Activities Act*, I specify the following:
 - a) The oil production allowable for a month shall be based on the previous month’s voidage replacement.
 - b) All associated produced gas must be conserved.
 - c) Water may be injected into the wells B13-14-88-18 W6M (WA# 13533), 11-23-88-18 (WA# 10584) and 07-10-88-18 (WA# 12738).
 - d) Not exceed an injection pressure, measured at the wellheads on the wells listed in (c), of 15,200 kPaa or the pressure required to fracture the formation, whichever is lesser.
 - e) Not exceed an average pool pressure of 11,270 kPaa measured at MPP.
 - f) Once the cumulative voidage replacement ratio (VRR) exceeds 0.8, conduct annual reservoir pressure tests on the subject pool, with a shut-in period of sufficient length to provide data for calculation of the reservoir pressure, and submit a report of each test within 60 days of the end of the test.
 - g) Inject only through tubing with a packer set as near as is practical above the injection interval.
 - h) Cease injection and notify the Commission immediately if hydraulic isolation is lost in an injection wellbore or the formation.
 - i) Submit the annual packer isolation test report to the Commission within 30 days of the completion of the test.
 - j) Include the injection hours and the maximum injection pressure value on the monthly BC-S18 form.
 - k) Cease by 12:00 PM midnight on July 31, 2016.
 - l) The permit holder must submit a Progress Report to the Commission for each 12 month period the project is in operation. The Progress Report must be filed by March 31st the following year and must contain the information specified in Pressure Maintenance Progress Report Requirements, attached to this Order.



Ron Stefik, Eng.L.
Supervisor, Reservoir Engineering
Oil and Gas Commission

DATED AT the City of Victoria, in the Province of British Columbia, this 30th day of March 2016.

Advisory Guidance for Order 98-09-003 Amendment #4

- I. A production packer must be set above the injection interval and the space between the tubing and casing filled with corrosion and frost inhibiting fluids, as per section 16(2) of the Drilling and Production Regulation.
- II. Annual packer isolation tests are required to be submitted, as per section 16(3) of the Drilling and Production Regulation.
- III. Injected fluids must be metered and the injection pressure measured at the wellhead, as per section 74 of the Drilling and Production Regulation.
- IV. A monthly injection statement must be submitted to the Commission not later than the 25th day of the month following the reported month, as per section 75 of the Drilling and Production Regulation.
- V. Seismic events must be reported and disposal operations suspended as per section 21.1 of the Drilling and Production Regulation.

PRESSURE MAINTENANCE PROGRESS REPORT REQUIREMENTS

Operation of a Pressure Maintenance project (waterflood or gas injection) for enhanced oil recovery, as a Special Project under section 75 of the Oil and Gas Activities Act, requires submission of Progress Reports to the Commission. The purpose of a Progress Report is to; 1) compel the project owner to review performance and identify operational opportunities, and 2) to ensure the Commission that approved operating conditions are being met and conservation is being achieved. Progress Report content, formerly stipulated by regulation, may be stated within the project approval conditions. This document provides a current common standard for Report content.

The approval holder must submit a Progress Report to the Commission for each twelve month period the project is in operation, unless an alternate reporting period has been approved. Progress Reports are due within 60 days after the anniversary of the project effective date (date that injection commenced), containing the following:

1. For each producing well, and for the project as a whole;
 - (1) The average daily oil rate, gas-oil and water-oil ratios for each month
 - (2) The monthly and cumulative volume of oil, gas and water production
2. For each injection well, and for the project as a whole;
 - (1) The average daily injection rate for each month
 - (2) The monthly and cumulative volume of fluid injected
 - (3) The monthly average wellhead injection pressure
3. The voidage replacement ratio (VRR), between fluids injected and fluids withdrawn, both monthly and cumulative, from the project, and by individual patterns where applicable. A VRR table showing the data elements used for calculation of the monthly and cumulative VRR (see Appendix A).
4. A summary of any reservoir pressure tests performed on wells in the project area and an estimate of the current formation pressure for the project including an isobaric map from which this pressure was derived.
5. The date and type of any well treatments or workovers. Indicate the date and type of the workover on the injection/production volume data of this report as indicated in items (1) and (2) above.
6. Summary Tables:
 - (1) Identifying the volume and source of the fluid injected i.e. by-product produced water (pool), water source well (well license number), surface water (water license number).
 - (2) Pre-injection treatment of fluids identified in (1)
 - (3) Injection well packer isolation tests conducted within the project area.
 - (4) Any injection well hydraulic isolation and wellbore integrity logging.
 - (5) Any surface casing vent flows detected within the project area.

Data filed must be submitted in **graph and table form**, unless the Commission has authorized in writing the submission of these data in interpretative map or other form.

A central aspect of pressure maintenance progress reporting is the Voidage Replacement Ratio (VRR) indicated in #3). An example VRR table showing the data elements and the voidage replacement calculation is shown in Appendix A.

Mature projects with consistent reporting history and demonstrated effective project management can apply for the reporting period to be amended to biennial (every 2 years), or exempted for submission of further Reports. An application would consist of a request letter to the Supervisor of Reservoir Engineering indicating the rationale for the request and supporting information showing the project's proven track record.

NOTE: For any injection well operating within a pressure maintenance project, a monthly **Injection/Disposal S18 Statement** must be submitted to the Commission not later than 25 days after the end of the month reported.

Appendix A: Voidage Replacement Table

Month	Bo	Rs	Bg	Bw	Monthly Oil (m3)	Monthly Gas (e3m3)	Monthly Water (m3)	Monthly Water Injected	Monthly GOR (m3/m3)	Reservoir Volume Produced	Reservoir Volume Injected	Monthly VRR	Cum VRR since Injection
Jan													
Feb													
Mar													
Apr													
May													
Jun													
Jul													
Aug													
Sep													
Oct													
Nov													
Dec													

It is recommended that the following values be evaluated at reservoir conditions at the average reservoir pressure at the time of the test.

Bo	Oil formation volume factor
Bw	Water formation volume factor
Bg	Gas formation volume factor
Rs	Solution gas-oil ratio

$$\text{VOIDAGE REPLACEMENT RATIO (VRR)} = \frac{\text{injected reservoir volumes}}{\text{produced reservoir volumes}}$$

$$\text{VRR} = \frac{B_w(i_w)}{B_o(q_o) + B_w(q_w) + q_o(\text{GOR} - R_s)B_g}$$

IN THE MATTER of an application from Pengrowth Energy Corporation to the Oil and Gas Commission dated January 12th, 2016 for Other Than Normal Spacing.

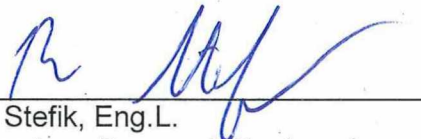
ORDER 98-09-003 Amendment #4 - OTN

1 Under Section 65.1(2) of the *Petroleum and Natural Gas Act*, Other Than Normal Spacing is approved within the Rigel field – Cecil “G” pool within the following area;

DLS Twp 88 Rge 18 W6M Section 10, W/2 Sec 14, E/2 & SW/4 Sec 15,
SE/4 Sec 22, W/2 & NE/4 Sec 23 and Sec 26.

2 Under section 65.1(3) of the *Petroleum and Natural Gas Act*, I specify the following:

- a) the target area for an oil well completed within the project area is not nearer than 100 m to the sides of the Other Than Normal Spacing area,
- b) an oil well completed outside the target area specified in paragraph (a) may be subject to an off-target production penalty,
- c) oil wells drilled within the specified project area are not subject to spacing requirements.



Ron Stefik, Eng.L.
Supervisor, Reservoir Engineering
Oil and Gas Commission

DATED AT the City of Victoria, in the Province of British Columbia, this 30th day of March 2016.