EUB Alberta Energy and Utilities Board

Calgary Office 640 – 5 Avenue SW Calgary, Alberta Canada T2P 3G4 Tel 403 297-8311 Fax 403 297-7336

Writer's direct line: (403) 297-3505
Writer's fax: (403) 297-7031
Email: Gary.Perkins@gov.ab.ca

March 21, 2005

Paramount Energy Operating Corp.
500, 630 – 4th Avenue SW
Calgary, Alberta T2P 0J9

Attention: Susan L. Riddell Rose

Dear Ms. Riddell Rose:

RE: PROCEEDING NO. 1347905
BITUMEN CONSERVATION REQUIREMENTS
ATHABASCA, WABISKAW-MCMURRAY
PHASE 3 FINAL HEARING

Please find enclosed information requests made by the Board staff to Paramount Energy Operating Corp. with respect to its submission filed in the Phase 3 proceedings.

Yours truly,

Original signed by

Gary D. Perkins
Board Counsel

Cc: List of Participating Parties
List of Counsel

Board Staff Information Requests for Paramount Energy Operating Corp. (Paramount)

1. Provide, in electronic format (ASCII TXT), the input data files for all the geological and flow simulation models included in your submission. Specifically with respect to the geological models, provide:

   a) the UWI, X, Y, and Z location coordinates, facies, PHIE, Vsh and Sw;

   b) Appendix 4 (the "Depth Conversion" spreadsheet) as an ASCII TXT file, with the actual X (easting) and Y (northing) locations for the control points in the same coordinate system as that of the block modeling and maps.

   Supplemental 1: For the geological models, provide the output files, consisting of the X, Y, and Z location coordinates, facies, PHIE, Vsh and Sw, that were selected to generate the input to the flow simulation models.

   Supplemental 2: Provide a summary table that lists all the models and briefly describes the purpose and main features of the models.

2. On page 2 of its covering letter dated February 14, 2005, Paramount states that the three dimensional pool models were calibrated by way of history match to the gas pool pressure and production decline profiles. Since it appears that the history match only involved matching data for the gas pools, does this mean that the models are not calibrated with respect to the bitumen zone?

3. Regarding the two figures shown on page 4 of Paramount's covering letter dated February 14, 2005, clarify what the x-axis is for Figure 1 and whether the title of the y-axis for Figure 2 should be the same as that for Figure 1.

4. On page 5 of its covering letter dated February 14, 2005, Paramount states that its current work supports conclusions that are not consistent with results from previous simulation efforts by other parties; and that it is Paramount's view that a detailed review of and a comparison between the different geological and flow simulation models will in all likelihood reveal why these different conclusions exist. How is this statement useful to the Board, considering the review that Paramount is referring to has not been included in Paramount's submission?

5. On page 6 of its covering letter dated February 14, 2005, Paramount states that the results of its detailed analysis covering a wide spectrum of geology and fluid configurations all reach the same conclusion that continued gas production poses no risk to bitumen recovery, and therefore Paramount requests that the Board change the production status of the interval(s) of the wells listed in Schedule A from shut-in to produce. Paramount's analysis involved 6 pools while Paramount

is requesting that the production status of intervals from approximately 50 different pools located over a large area be changed from shut-in to produce. Elaborate on the basis for concluding that the analysis of the 6 pools is applicable to all the pools that Paramount is requesting be allowed to produce.

6. With respect to the geostatistical modeling:

   a) Explain the appropriateness of using geostatistics as the geological modeling tool and why other forms of geological modeling such as Inverse Power of Distance or Nearest Neighbour were not used.

   b) In its submission (for example, page 19 of the Corner McMurray C Pool) Paramount states that ten cores were logged in the Corner-Hangingstone area. Comment on whether this is a sufficient number of cores to accurately represent the area that was modeled.

   c) Indicate if any wells from outside the pool areas were used in the geostatistical models.

      Supplemental: If not, explain why interpolation from data outside the pools was not used.

   d) Confirm that the statistics presented in Appendix 8 for PHIE in section 5.1.1 table for "Basic Statistics for PHIE", Vsh in section 5.2.1 table for "Basic Statistics for Vsh", Sw in section 5.3.1 table for "Basic Statistics for Sw" are vertical only as the analysis is assumed to be similar to that done for facies.

   e) Submit variograms with labels for the two x-axes and variogram model nugget and range in addition to the variogram regression nugget, range and sill.

      Supplemental: Confirm that the grey curve is the variogram regression and the blue curve is the variogram model.

   f) Tabulate the horizontal nugget and sill values for the variogram models and indicate if these values were extrapolated from other areas in the Athabasca Wabiskaw-McMurray Deposit that have increased data density and lower inter-well distances.

      Supplemental: If these values were extrapolated provide the details of that.

   g) The horizontal variogram ranges appear to be generally the same for all four pools with minor changes in azimuth among the Corner McMurray C (and Hangingstone McMurray KKK), Corner McMurray G, and Hangingstone McMurray X pools. Considering the location of the four

pools, explain the reasonableness of the similarities in the majority of the variables and indicate the method of determining the azimuths.

h) Variograms and summaries were displayed with data separation by facies categories. Why was this done?

Supplemental 1: Was there cokriging of PHIE, Sw or Vsh with relation to facies?

Supplemental 2: If not, explain why not.

Supplemental 3: Explain whether the interpretation of facies could implicitly migrate interpretive bias into the variogram exercise.

Supplemental 4: Submit general data (all facies) variograms for each variable (facies, PHIE, Sw, Vsh) for all the models.

Supplemental 5: Indicate if general data variogram models were extrapolated to individual facies models.

i) Explain the methodology in applying a standard spherical variogram model and/or regression to experimental variograms with only 2 datapoints.

Supplemental: Explain why facies were not amalgamated for the A1 zone to give a better variogram result. (For example, Corner McMurray C Pool, Appendix 8, Figures 12, 13, 14, 15, 48, 49, 50, 51, 55, 74, 75, 76, 81, 112, 113, 114, 119).

j) Explain large differences between experimental variogram results, variogram regressions and variogram models. (For example, Corner McMurray C Pool, Appendix 8, Figures 18, 19, 20, 22, 52, 56, 77, 78, 83, 115, 116).

k) With reference to Appendix 8 of the submission, explain the statement in section 5.3.3 (for example, page 72 in Appendix 8 of the Corner McMurray C Pool) that Sw horizontal variogram ranges are assumed to be similar to facies variogram ranges, when the subsequent tables show that the values are quite different from the corresponding tables in section 4.2.

Supplemental: Explain why the Sw variogram ranges are different while the PHIE and Vsh variogram ranges are generally the same.

l) A hand contoured map was created from seismic data and then scanned into geostatistical software to act as a structural bounding surface for the model (section 3.1, pages 6 or 7 of the Corner Murray C and G pools, and

the Hangingstone McMurray X Pool submissions). Explain why a cokriging exercise was not completed to create the surface from combined downhole sonic geophysical log calibration, wells depths, and seismic velocities.

m) Provide greater detail than what is provided in section 3.2 of Appendix 8 of the submission as to why a constraining Paleozoic surface was used instead of geostatistical modeling of a limestone facies and subsequent restriction of the reservoir simulation.

n) The information shown on the maps provided in the submission has well data density usually at distances between 700 and 1600 meters. The variogram summary indicates most variogram horizontal ranges (with the exception of Sw) are 500 to 1000 meters. Normal geostatistical procedures (for example, Armstrong and Champigny, CIM Bulletin Vol. 82, No. 923, pp. 128-133, March 1989) have block or grid size as no smaller than one quarter the data spacing. Explain the choice of 50x50x0.5 meter grid size in all models, which means the grid size is less than 1/10 of variogram range and less than 1/6 of data spacing.

o) Explain if a new procedure would be required or if there would be procedure limitations in reservoir simulation if a geostatistical model was created with 200x200x0.2 meter block size.

p) Section 5.6 of the submission (for example, page 36 in the Corner McMurray C Pool submission) and Appendix 8, section 4.2, state that the well spacing for data was greater than the acceptable range for variogram analysis. Explain the resulting reliability of the geostatistical model when variations are only known in a vertical direction and the horizontal directions are assumed by operator experience with outcrop.

Supplemental: Indicate the distance and direction to the nearest outcrop that was used for analogy.

q) Data statistics matching (for example, Corner McMurray C Pool, Appendix 8, Figures 31-43, 60-72, 88-100) was presented as rationalization for the geostatistical results. Indicate if any “jack-knifing” geostatistics were completed.

Supplemental: If yes, provide the results.

r) Explain why the water zone as calculated from Sw>75% was filtered out of the block model (Appendix 8, page 66).

Supplemental: Explain the effect on reservoir simulation of not filtering out Sw.

s) Paramount states in its submission (for example, page 71 of Appendix 8, Hangingstone McMurray X Pool) that horizontal permeability was calculated based on the correlation provided in the petrophysical analysis for the Hangingstone McMurray X Pool [4]. Provide reference 4, as it does not appear in the submission.

t) In its submission (for example, page 74 of Appendix 8 for the Hangingstone McMurray X Pool) Paramount provides an equation for calculating the vertical permeability. It states that a "w" value of 0.1 was used in the final calculation of kv, and that this value was chosen based on the geological knowledge of the area. Explain how the geological knowledge of the area allowed Paramount to determine a "w" value of 0.1.

u) Clarify the variables involved in Table 31 in section 5.3.4 of Appendix 8 (for example, on page 77 of the Corner McMurray C Pool submission).

Reference: The top of the table indicates this table provides correlation coefficients between Vsh and PHIE, but the title of the table indicates a correlation between Sw and PHIE by Facies.

v) Specifically with respect to the Corner McMurray C Pool:

i. Explain why the figure "Vertical Facies Proportion Curve, A1 zone" (section 5.5 page 35) shows a very simple trend for 11 wells, and explain why there are only 3 layers when two other pools in the study show 6 and 8 layers.

ii. Explain the statement that the well spacing is "about 1600 meters" (section 5.6 page 36) while the map shows that some inter-well distances are as low as 800 meters.

Supplemental: Explain how an inter-well distance of 800 meters would affect the assumption that horizontal ranges need to be extrapolated from outcrop.

iii. Section 5.6 and section 5.7 on page 38 shows Figure 20 and a reference to "Hangingstone McMurray X Pool study: 3D Reservoir Modeling" which is identical to that in the submission for the Hangingstone McMurray X Pool. Confirm that these references are in error and the Corner McMurray C Pool, Appendix 8 should be referenced instead, and also provide the correct diagram for Figure 20.

iv. Explain why Appendix 8, table 3 (page 6) and the location map Appendix 8, Figure 2 (page 7) do not match for well locations as

the table is missing wells 03-34, 03-03, and 08-05 and the map is missing wells 03-36, 07-26, and 10-08.

Supplemental: Confirm which wells were used as data in the variogram analysis and geostatistical modeling.

v. Explain how 11wells can generate only two facies distributions on a variogram analysis.

w) Specifically with respect to the Hangingstone McMurray KKK Pool:

i. On page 28 of its submission Paramount states that the KKK Pool is a one-well pool. In order to get an appropriate variation in geology, it was necessary to look beyond the data from the 12-28 well. To achieve a realistic geology, the C pool (understood to be the Corner McMurray C Pool) data was merged into this model. Considering the limited amount of data available for the KKK Pool, why did Paramount model this pool?

ii. Paramount's geostatistical modeling of the KKK Pool included both an A1 zone and a McMurray zone. The SSG's January 26, 2004 submission to the Interim Hearing indicates the only stratigraphic interval in the KKK Pool is McMurray channel. Why was an A1 zone included in the Paramount's geostatistical model for the KKK Pool?

iii. Explain the absence of a "hand contoured structure" map for the KKK Pool similar to those provided for the other pools.

Supplemental: If a structure map was not used, explain how the base of the McMurray was constrained in the geostatistical model.

7. With respect to Paramount's flow simulation modeling:

a) Paramount states in its submission (for example, page 53 of the Corner McMurray C Pool) that to assess the impact of gas pool depletion on SAGD, a two-dimensional cross-section model was used. Explain how a two-dimensional model can properly predict the impact of gas pool depletion on SAGD in a heterogeneous reservoir.

b) Reference: With respect to the well-specific simulation grids of the geological model:

i. For the Corner McMurray C Pool, eleven well-specific downscaled grids were selected at the 11 well locations within the pool but only one (3-34) was used for the 2-D SAGD simulation;

ii. For the Corner McMurray G Pool, ten well-specific downscaled grids were selected at the 10 well locations within the pool but only three (4-15, 6-27 and 10-23) were used for the 2-D SAGD simulations; and

iii. For the Hangingstone McMurray X Pool six well-specific downscaled grids were selected at the 6 well locations within the pool but only one (11-19) was used for the 2-D SAGD simulation.

Question: What was the basis for selecting the particular well-specific downscaled grids for the 2-D SAGD simulations?

Supplemental 1: How do the selected well-specific downscaled grids properly represent the reservoir heterogeneity of these pools?

Supplemental 2: For the Hangingstone McMurray KKK Pool, one well-specific (12-28) downscaled grid was used for the 2-D SAGD simulation. How does this well-specific grid properly represent the reservoir heterogeneity in this pool?

c) Regarding the Corner McMurray C Pool:

i. With respect to the Geological Sensitivity Forecasts (section 7.1), on page 63 the statement is made that bitumen recovery and the cumulative SOR responses are nearly identical for the three operating configurations tested (gas pool operating pressures of 1200, 600, and 200 kPa) and have been corrected to represent performance only to the point when steam directly encounters the gas zone. Why was this done?

Supplemental: Why weren't the sensitivities continued to determine the effect of the different gas pool pressures on SAGD after the steam had encountered the gas zone?

ii. With respect to Appendix 1, provide a larger scale or more readeable version of the three log cross-sections.

d) Regarding the Corner McMurray G Pool, with respect to Appendix 1, provide a larger scale or more readable version of the five log cross-sections.

e) Regarding the Hangingstone McMurray X Pool:

i. With respect to the History Match (section 6.3), on page 46. Paramount states that calculated pressure response and to a limited extent water production were the primary history match criteria.

However, Figure 28 does not show any field pressure data. Are the data missing?

Supplemental: If yes, provide a revised plot that includes the field pressure data and also provide the predicted and actual water production.

ii. With respect to the Top Sand Reservoir Sensitivity (section 7.2) starting on page 70:

a. Why are the bitumen production rates shown on Figures 56 and 57 so low for what is understood to be a 500 m SAGD well pair in a uniform clean sand reservoir?

b. Why are the initial bitumen production rate and bitumen recovery after 4 years for the high pressure case lower than those for the low pressure case?

8. Regarding the Hardy Wabiskaw-McMurray A Pool:

a) On page 2 it is stated that where there is a regional Wabiskaw D shale, the Wabiskaw C is isolated from the underlying McMurray. What information does Paramount have to support the hypothesis that the Wabiskaw D shale is an effective hydraulic seal that separates the Wabiskaw gas from the underlying McMurray gas?

b) On Figure 4 (page 7) the Hardy pool has been divided into different pool pressure trend quadrants. Why are 3 pools (E8504, E7525, E7430) in two different quadrants?

c) On page 26 Paramount it is stated that one of the criteria for interpreting communication between wells was that well pairs should have similar pressures; hence a 200 kPa difference was allowed. Larger differences were considered to reflect discontinuity. What is the basis for the 200 kPa pressure difference criterion?

d) On page 27 it is stated that an approximate difference of 4 meters in gas/oil contacts was used to decide on continuity or disconnects within or between pools. Explain how this criterion was determined.

Supplemental: It is also stated that if there is communication between pools, the contacts would equalize. Simulations could be used to show that the contacts would equalize over geologic time if there is communication. Explain how contacts in bitumen would be expected to equalize.

e) With respect to Figure 27 (page 43) explain what is meant by "PET Upper Bright Spots" and "PET Middle Bright Spots"?

Supplemental: Pools E8612, E7518, E6431, and E6419 are interpreted to be continuous but there are breaks in the bright spots within these pools. Why are there breaks in the bright spots in these pools?

f) With respect to Figure 30 (page 49) provide a larger scale map or a more readable version of the map.

g) On table 8 (page 63) Paramount has classified four pools as non-linear (dual tank) pools. Is Paramount able to identify the additional gas source for these pools?

h) With respect to Appendix A:

i. Provide revised net pay maps that include contour values for the bold contour lines and the Township and Range.

ii. The PetRob CONTINUOUS BITUMEN MAP (<60 api and >40 ohmm) shows bitumen pay in the north and north-east areas of the map. However, the Petrel Robertson's Interpretation of Bitumen in Place map (Figure 30 on page 49) indicates there is no bitumen in this area. Explain this apparent discrepancy.

iii. The stick diagram location map shows the Epic pool outlines in green. Are these pools a composite of all Wabiskaw-McMurray gas zones?

iv. The well ID's on the stick diagrams have been overprinted and are not readable. Clarify the well ID's for each stick diagram.

i) With respect to Appendix B:

i. Regarding Figure 2 (page B-3) what criteria were used to determine which cored wells would be used to determine the permeability from core data?

ii. Regarding Figure 4 (page B-4) provide a more readable map that also includes the Township and Range.

iii. Clarify the formula on page B-8 used to dimensionalize the pressure data. Should the denominator be $P_{max} - P_{min}$ rather than $P_{min} - P_{min}$?

j) With respect to Appendix C:

i. Paramount indicates the Wabiskaw D shale is present in Pool E6625 but the RGS indicates the shale has been eroded. On what basis does Paramount interpret the Wabiskaw D shale to be present?

ii. In Pool E7418, well 2-18 appears to be within the 10 m continuous bitumen contour of the PetRob CONTINUOUS BITUMEN MAP. Clarify how it was determined that the underlying bitumen is less than 10 m.

iii. Are there water interfaces in any of the wells in pools E8406 and E8504?

k) With respect to Appendix D:

i. Provide a more readable version of the map shown on page D-2.

ii. With respect to the development of an automatic pool grouping algorithm by GRC Ltd., on page D-4 it is stated that the maximum allowable pressure deviation between wells was 150 kPa and the range of interaction was 3200 m (i.e. the width of two sections). What is the basis for these criteria?