EPA Comments (Draft August 23, 2011)

Pavillion Bradenhead Testing Procedure - Submitted by EnCana July 8th 2011 (document dated June 2, 2011)

EPA's view of the above-referenced procedure is that it adequately addresses only one type of problematic well condition: a well with sufficiently high bradenhead annulus pressure to cause on-going fracturing near its surface casing shoe. The procedure fails to convincingly describe how it will generate information to identify whether wellbores may now be serving as conduits for vertical fluid movement behind production casing, and the procedure does not address possible leaks in production casing that may serve as contaminant point sources.

EPA continues to believe that a wellbore integrity investigation should be designed to test for the following two types of well integrity failures:

1. Identify, by pressure testing, any gas well production casing leaks, and
2. Identify, by CBL interpretation, the potential for fluid migration pathways along the wellbore behind gas well production casing.

For the first type of integrity failure (production casing leaks), EPA suggests the pressure test should include the following standards: the applied test pressure should be no less than 300 psi, the test duration should be at least 15 minutes, and the failure criteria should be if a pressure change of more than 5% of the applied pressure occurs. Failed tests should be repeatable.

For the second type of integrity failure (a transmissive pathway along the wellbore behind production casing), EPA suggests the test should include the following standards: a transmissive channel is assumed possible if the identified top of ***well-bonded*** cement is below the surface casing shoe. ***Well-bonded*** cement means it displays at least an 80% bond index based on the CBL amplitude curve calculated using API guidance and spanning at least 18 feet in 4-1/2 inch production casing.

- The proposed method, as described in the procedures in sections 1.0 through 4.2 appears to evaluate only if the well is in a condition where the bradenhead annulus is exposed to a pressure that exceeds or exhibits a significant fraction of the fracture pressure at the surface casing shoe depth.

    - EPA interprets Encana's procedure and rationale as follows:

        - EnCana's procedure identifies frac gradients in the Wind River Formation, ranging from 0.85 to 1.15 psi/ft, and Fort Union Formation, ranging from 0.45 to 0.90 psi/ft and uses a conservative frac gradient estimate of 0.65psi/ft to represent the critical frac gradient in the bradenhead space at depths of surface casings, which would all be located within the Wind River Formation.
        - EnCana's procedure subtracts an assumed mud weight of 0.47psi/ft from the conservative frac gradient 0.65psi/ft identified above to arrive at a differential of 0.18psi/ft as representing the critical pressure differential between fracturing and mud weight, at the surface csg shoe.
        - This critical pressure thus represents a condition in the bradenhead space at the surface casing shoe depth above which fracturing of the formation would occur if the frac gradient at the casing shoe is 0.65 psi/ft.
    - EPA shares a concern that a well found in this condition (i.e. fracturing at the surface casing shoe) needs to be remediated.
- EPA's concerns as identified above are not going to be addressed using solely this procedure because this procedure does not identify potentially transmissive pathways behind production casing or production casing leaks.
    - EPA submitted suggestions to consider for well integrity testing to WOGCC on June 9th, 2011, that included ensuring that a CBL would be available for interpretation on every unplugged well in the field and would test for production csg leaks in all wells having an identified cement gap below the surface csg in every unplugged well.
    - EPA acknowledges that conducting its suggested procedure entails removal of production tubing, if present.
    - Conducting bradenhead monitoring should also include liquid and gas sampling and analysis from the bradenhead space where any positive pressure is observed.
        - Gas analysis should include gas composition (C1-C8? – check with lab folks), C-isotopes, H-isotopes in order to identify thermogenic or biogenic origin
        - Liquid analysis should include: major GW ion chemistry, Sr-isotopes?, BTEX, glycolic compounds, non-halogenated alcohols, naphthalene, DRO, GRO, TPH, phenols in order to identify water chemistry and presence of foreign chemicals
        - EPA agrees with the notion of conducting bradenhead pressure monitoring as indicated in Encana's June 2 procedure at steps 5.5, 6.3, and 7.3 but encourages a uniform frequency of, and procedure for, pressure monitoring independent of the pressure observed.

- Also on June 9th, 2011, EPA requested the method for evaluating well records to determine if well integrity testing is necessary be written up for the record.

- Once these results are compiled, remedial options to consider for a given well found to have either type of integrity problem could include, but not be limited to:
  - Squeeze cementing
  - Tremie pipe cementing (use of small diameter pipe to convey cement)
  - Casing patch
  - Cemented liner
  - Additional logging
  - Additional pressure testing
  - Pipe replacement
  - On-going bradenhead space monitoring
  - Plugging and abandonment