SUPPLEMENTARY STATEMENTS ON THE RISKS OF CONCURRENT DEVELOPMENT OF OIL AND GAS NEXT TO NEW MEXICO POTASH MINES

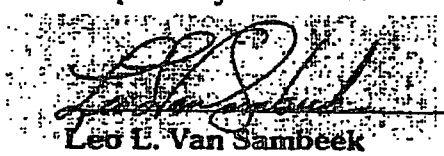
Topical Report RSI-1873

by

Leo L. Van Sambeek, Ph.D., P.E.
RESPEC
Rapid City, South Dakota

February 2006

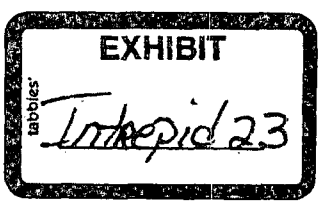
Respectfully Submitted



Leo L. Van Sambeek

February 20, 2006
Date

RESPEC
CONSULTING & SERVICES



Report of Dr. Leo L. Van Sambeek

I, Dr. Leo L. Van Sambeek, Manager of Mine & Field Services for RESPEC and a registered professional engineer in the states of New Mexico, Kansas, and South Dakota, was asked to respond to Yates Petroleum Corporation's Reply to Opposition to its Motion to Partially Lift the Stay.

My qualifications in this matter were described in my earlier report, *Technical Opinion on the Risks of Concurrent Development of Oil and Gas Next to New Mexico Potash Mines*, dated November 2005. I have reviewed the Yates reply and present the following comments.

1.0 MINE SAFETY AND HEALTH ADMINISTRATION REPORT AND HEARING

Yates Petroleum Corporation claims the safety arguments advanced by PANM and IMC are contradicted by a scientific report that the potash industry submitted to the Mine Safety and Health Administration (MSHA). Yates absolutely mischaracterizes the potash industry's report and the MSHA hearings; never—not even once—are oil or gas wells or oil- or gas-well drilling mentioned in the report. The context of the potash industry report and the MSHA hearing was to address methane that entered the mines solely from potash mining activities from either the potash-ore rock or the rock layers immediately above or below the potash ore zone.

2.0 WIPP NO MIGRATION APPLICATION

Similarly, Yates claims the Waste Isolation Pilot Plant (WIPP) no-migration application and its technical discussion support their contention that oil and gas wells can not leak through the salt rocks and into a potash mine. Such use of the WIPP no-migration application is total misrepresentation. The WIPP no-migration application primarily addresses the situation for transport of liquid hazardous waste from the WIPP underground facility across the WIPP land-withdrawal boundaries. These boundaries form a 4-mile-square area (2 miles from WIPP to the boundary in any direction). The WIPP situation (liquid waste migration from a nonpressurized facility through 2 miles of salt) is markedly different from gas migration into a mine from a pressurized oil or gas well that penetrates a pillar in a potash mine. The technical arguments for tightness of the repository are much different from those for a gas well. In fact, the WIPP situation is an example of the desirability of a buffer zone between oil and gas wells and underground mined openings; the mandated separation between the WIPP underground

openings and any oil- or gas-well drilling is essentially 2 miles. To the extent gas emissions from the WIPP are considered in the no-migration application, it is only in the context of gaseous waste emissions through the shafts–not leakage through salt.

3.0 VAN SAMBEEK ASSERTATIONS OF HAZARDS

Yates suggests that the Van Sambeek report is merely a "speculative assertion of harm" or descriptions of "dissimilar catastrophes" or "references to irrelevant mining and gas-storage incidents." My rationale for selecting the case histories I described was clear (see itemized list on Page 3). Simply stated, my rationale was to show the reality of the required components or possible contributing factors of a catastrophe:

1. Methane has been involved in mine explosions.
2. Miners in nongassy mines may be inexperienced to methane entering their mine.
3. Gas can migrate long distances through rock, even with low driving pressures.
4. Gas can migrate through shear stress-damaged salt rocks.
5. Common oil-field practice hydrofracing can be unpredictable.

I describe one or more incidents for each of these five points to demonstrate the reality of each point. The case histories are part of the engineering record and my personal experience, and each case history contributes to my belief that a catastrophe could occur if adequate barriers are not maintained between underground mines and oil and gas wells.

It is wonderful that, at least according to Yates, no case history exists for a gas explosion in a New Mexico potash mine because of gas leak from a well; I say wonderful, because, if true, that means no one has been hurt or killed nor has damage been done to a potash mine. However, I say it again, case histories exist for the essential elements that could combine for such a disaster in New Mexico if diligent and proper attention is not given to sufficiently isolating oil and gas wells from underground potash mines. I repeat myself because my concern is not just "speculative assertion of harm," it is standard professional engineering practice. Such "dissimilar catastrophes" are often the very elements formerly believed to be impossible to happen. The cited case histories can hardly be considered irrelevant when they all relate in one way or another to salt rocks, mining, and gas production or storage. The facts that for the Belle Isle explosion the methane came from the rock instead of a gas well, or that the explosion at Cane Creek was in Utah instead of New Mexico, or that the Hutchinson explosions followed gas migration through 7 miles of dolomite do not make the case histories irrelevant.

For example, I did not describe the Cane Creek explosion as caused by oil or gas drilling (as might be construed from Yates' motion on Page 19). Rather, I cited the Cane Creek explosion as

solid evidence that despite methane gas monitoring and despite the actual detection of methane gas, an explosion still occurred because, in my opinion, the workers did not have sufficient experience dealing with methane gas to recognize the developing problem. Simply stated, the methane caught the miners off guard. I connect the Cane Creek incident to New Mexico potash mining because the New Mexico mines are nongassy; the underground work force could easily also be caught off guard and be slow to respond to a gas leak from a well, if such a leak into the mine were to occur.

Considering the case histories I describe as irrelevant or just a speculative assertion of harm requires disregard for the health and safety of the potash miners. Health and safety regulations are enacted in response to concerns both because of past incidents (avoiding repetition) and because of an expectation that an incident could occur (avoiding the occasion).

Similarly, it is wrong to disregard the experience of the Wyoming trona mining industry because trona is not potash and the mining is not in New Mexico. The basic mechanics involved in the interaction of mine-induced subsidence (rock movement) and well casings is the same for both trona and potash–the differences will be primarily in the timing and magnitude. Longwall mining of trona will potentially damage well casings sooner and to a larger degree than room-and-pillar mining of potash; on the other hand, room-and-pillar potash mining can cause earlier and more severe damage than similar room-and-pillar trona mining. For either mineral resource and with whatever type of mining, the key factor is understanding the rock movements induced by the mining and the consequences of the rock movement on cemented well casings. Subsidence from either potash mining or trona mining can create sufficient rock movement to shear or otherwise damage oil- and gas-well casings. It does not matter whether trona mining or potash mining causes the movement or whether the mining is in Wyoming or in New Mexico–the engineering principles are the same and concerns for protecting the health and safety of the miners must be paramount.

4.0 NO REACTION TO VAN SAMBEEK'S COMMENTS THAT HAZLETT AND TEUFEL ARE WRONG

In my report, I make strong statements that Hazlett and Teufel's numerical modeling results and subsequent conclusions are technically wrong. For example, on Page 4, I say, "Conclusion 2 is based on calculated stresses that, in my opinion, are wrong because of an inadequate numerical model and a misinterpretation of the type of damage an oil and gas well casing can suffer from extensional and shear strains." I say further, "Hazlett and Teufel all but ignore the effects of shear stress-induced damage in potash pillars..." Considering that the Hazlett and Teufel report is so prominent in Yates' original motion, it is noteworthy that Yates' motion totally ignores my critique.

5.0 PHYSICS OF GAS FLOW

Yates repeats the Hazlett and Teufel proposition that "Moreover, the laws of physics dictate that there is not sufficient pressure to cause oil or gas to enter a potash mine ..." The premise that the laws of physics obviate the need for concern is wrong. If there is sufficient pressure to cause gas to rise in a well, then there is also sufficient pressure to cause gas to flow through a breach in the casing. Once the gas exits the casing, the potash pillar is the only barrier between the gas in the well and the mine atmosphere--and the mine atmosphere is always at a lower pressure than the gas well. Numerous laboratory tests show that gas will flow through salt that has dilated (has been damaged) and too small pillars are classic examples of where salt will dilate. The only effective barrier is a sufficiently large volume of potash ore that the core of the "pillar" surrounding a well remains relatively undisturbed and the potash ore retains the "impermeability" of the unmined salt formation. A 60-foot-diameter pillar, as recommended by Hazlett and Teufel, can not meet that criterion.

At Pages 20 to 21, Yates again invokes the physics of gas flow and the gas- and oil-well pressure relationships to say that methane does not present a hazard to mining operations. The science they cite and the potash industry's statements concerning the impermeability of the Salado Formation actually relate to preventing gas from the Delaware Formation passing through the lower Salado Formation to reach the McNutt potash ore zone or from overlying formation down through the upper Salado Formation to the ore zone. Yates assumes that what is true for the entire formation is also true for a part of the formation (the pillars in the McNutt ore zone), despite the order of magnitude change in scale. The geological barriers provided by the upper and lower Salado Formation are hundreds of feet thick, not tens of feet as proposed for the protective pillar. Similarly, the rock stresses in the vast majority of the Salado are favorable to preserving the impermeability of the rock, while the stresses in pillars in the mine are conducive to salt-rock damage and increased permeability.

Above the Salado Formation are more brittle rocks that are not typically considered impermeable. These brittle rock layers could act in a similar manner to the dolomite layers above the Hutchinson Salt that were involved in natural gas traveling more than 7 miles to the city of Hutchinson. Given this case history, a similar migration of gas through the brittle rock above the Salado Formation and into the mine shafts must now be considered if gas well(s) are located where they can be damaged by the subsidence from a potash mine.

6.0 CLOSING COMMENT

Many of the statements made by Yates in their motions strike me as being cavalier toward the health and safety of the public (i.e., the underground miners). Yates' attitude seems to be, let us drill our wells ahead of mining, but the subsequent risks involved in mining safely are your problem. Their contention that leaving a 60-foot-diameter pillar around a well provides an adequate (impermeable) barrier is presumptive of an understanding of scientific salt-rock mechanical behavior that simply does not currently exist. Sound engineering practice demands a cautious approach rather than a cavalier approach to the development of both the potash and hydrocarbon resources.

All the risks I have discussed are applicable to the 19 APDs in the Yates motions. I have reviewed the maps showing the locations of the existing potash mine workings and the 19 APDs, and I have discussed with Intrepid Potash its definition of the ore body and its plans for future potash mining. The ore body extends continuously from existing mine workings to the vicinity of each of the 19 APDs. Drilling of any of the proposed 19 wells will affect future potash mine development in either the 10th ore zone (sylvite) or the 4th ore zone (langbenite).