OIL AND GAS DOCKET NO. 03-0242323

THE APPLICATION OF SQUARE MILE ENERGY, LLC. TO PERMANENTLY CLASSIFY ITS APPELT ET AL UNIT, WELL NO. 1, IN THE GILBERT WELLS (9490) FIELD AS A GAS WELL, JEFFERSON COUNTY, TEXAS

Heard by: Margaret Allen, Technical Hearings Examiner
Reviewed by: James M. Doherty, Legal Examiner

Procedural history

Application received: March 23, 2005
Hearing held: April 19, 2005
Proposal for decision issued: July 28, 2005

Appearances

	Representing
James N. Bostic	Square Mile Energy, LLC.
Kerry Bonner	

EXAMINER'S REPORT AND PROPOSAL FOR DECISION

STATEMENT OF THE CASE

Square Mile Energy, LLC. ("Square Mile") is seeking to have its Appelt et at Unit, Well No. 1, ("Appelt No. 1") in the Gilbert Wells (9490) Field, permanently classified as a gas well. The applicant is also seeking to have this well's overproduction canceled.

DISCUSSION OF THE EVIDENCE

Background

The Gilbert Wells (9490) Field was discovered in 1991, and the only active well is Square Miles' Appelt No. 1. The previous well in this field produced only 61 MMCF and 364 barrels of condensate during 1991 and 1992. The reservoir is located on a three-way closure between two faults, and the 160 acre unit around the Appelt No. 1 covers most of field. The log of this well indicates 20 feet of sandstone pay that has 30% porosity.

The subject well was perforated from 9921' to 9932' and from 9936' to 9946', measured depth (true vertical depths 9412'-9437'). It was tested January 11-13, 2005, at a maximum daily rate of 2687 MCF, with a gas/liquid hydrocarbon ratio of 26,870 cubic feet per barrel. The initial bottomhole

pressure in the Appelt No. 1 was 4082 psi, which is essentially virgin pressure at the pressure gradient of 0.44 psi/foot. The bottomhole temperature was 206° F.

During its first month of production, production from the Appelt No. 1 was reported to be 1397 barrels of oil or condensate and 43,255 cubic feet of gas, for a gas/oil ratio of 30,963 cubic feet per barrel. As the subject well produces less than 100,000 cubic feet per barrel, it would be classified as an oil well, absent any other information. As part of its effort to classify the well as a gas well, the operator performed a distillation test on the produced hydrocarbons and reported the results on Form G-5.

The results of this test did not meet several of the criteria established by the Commission for classification as a gas well. For gas classification, the initial boiling point of the sample should be less than 120°F., while the sample from the subject well had an initial boiling point of 139° F. A sample from a gas well should also be less than 520° F. at 80% recovery, while temperature of this sample was considerably higher at 657° F. To be a gas well, the liquid hydrocarbons produced should be clear or white and have a gravity over 50° API, yet the liquid sample from the Appelt No. 1 was brown and had a gravity of only 37° F. The Commission classified the Appelt No. 1 as an oil well on February 28, 2005.

Classification criteria for gas wells and oil wells

Statewide Rule 79 has the following definitions of oil wells and gas wells:

(11) Gas well--Any well:

(A) which produces natural gas not associated or blended with crude petroleum oil at the time of production;

(B) which produces more than 100,000 cubic feet of natural gas to each barrel of crude petroleum oil from the same producing horizon; or

(C) which produces natural gas from a formation or producing horizon productive of gas only encountered in a wellbore through which crude petroleum oil also is produced through the inside of another string of casing or tubing. A well which produces hydrocarbon liquids, a part of which is formed by a condensation [sic] from a gas phase and a part of which is crude petroleum oil, shall be classified as a gas well unless there is produced one barrel or more of crude petroleum oil per 100,000 cubic feet of natural gas; and that the term "crude petroleum oil" shall not be construed to mean any liquid hydrocarbon mixture or portion thereof which is not in the liquid phase in the reservoir, removed from the reservoir in such liquid phase, and obtained at the surface as such.

(18) Oil well--Any well which produces one barrel or more crude petroleum oil to each 100,000 cubic feet of natural gas.

There is no statewide rule with a specific definition of "crude petroleum oil", apart from the explanation of what shall not be construed as "crude petroleum oil." According to the Texas Natural Resources Code § 86.002(1) " 'Oil' means crude petroleum oil." If a well produces less than one barrel of oil per 100,000 cubic feet of gas the Commission classifies it as a gas well. If the well produces more than one barrel of oil per 100,000 cubic feet of gas the Commission classifies it as an oil well and the gas produced from it is considered casinghead gas under Rule 79:

(3) Casinghead gas--Any gas or vapor, or both, indigenous to an oil stratum and produced from such stratum with oil.

There is no specific Commission definition of condensate, the common term for hydrocarbon liquids produced by gas wells, though Rule 79(11)(C) does distinguish between hydrocarbon liquids formed "by a condensation from a gas phase" and those which are "crude petroleum oil."

If a well fails the requirements on Form G-5 to be considered a gas well, an operator may present evidence from a PVT (pressure, volume, temperature) test conducted on the produced hydrocarbons. If the PVT test shows that the hydrocarbons in a reservoir at that time comprise more than 100,000 cubic feet of gas per barrel of hydrocarbon liquid, the Commission may administratively classify the well as a gas well for a certain period of time. If, due to pressure depletion, the reservoir later contains less than 100,000 cubic feet of gas per barrel of liquid, the Commission will administratively reclassify the well as an oil well.

An operator has the option of requesting a hearing to seek classification of a well as a permanent gas well (that is, regardless of the producing gas/oil ratio and regardless of the gas/oil ratio in the reservoir). These requests were rare prior to 2003 and were usually a prelude to gas cycling. Gas cycling is a type of secondary recovery which can recover more condensate from a gas reservoir. This type of project is rare, in part because most gas/condensate reservoirs are small and because of the higher price of gas.

PVT results from the Appelt No. 1

A sample of hydrocarbon liquid and gas was collected from the separator at the surface of the Appelt No. 1 on March 4, 2005. The expected proportions of the fluid as it had existed in the reservoir were obtained by mathematically recombining the gas and liquid proportions as they were found at the separator temperature and pressure. Mathematical equations were used to simulate the changes the recombined sample would undergo as the reservoir depleted (and the pressure declined).

The results of the constant composition expansion (pressure depletion while maintaining the same chemical composition) performed

by Fesco Ltd, were presented at the hearing. This analysis showed the reservoir fluid would be a single phase gas only when the pressure was above the retrograde dew point pressure[1] which was measured to be 7305 psi (far higher than discovery pressure of 4085 psi). Below that pressure, increasing amounts of liquid condense from the gas in the reservoir. According to Fesco's report, the hydrocarbons in the reservoir at the time (and pressure) the Appelt No. 1 was completed, comprised about 60,000 cubic feet of gas per barrel of liquid hydrocarbons. The maximum proportion of liquid hydrocarbons in the reservoir, 4.92% or 39,000 cubic feet per barrel, will occur when the reservoir pressure is depleted to 1000 psi.

According to established engineering criteria, a "retrograde gas reservoir" contains no liquid hydrocarbons, only single-phase gas at the time of discovery (i.e. the reservoir pressure must be above the retrograde dew point). Retrograde gas reservoirs may have a gas/oil ratio as low as 3300 cubic feet per barrel (McCain, 1973, The Properties of Petroleum Fluids). Retrograde gases contain less than 12.5 Mole % heptanes+ (hydrocarbon molecules with seven or more carbon atoms); more than 70 Mole % methane and stock-tank liquid gravities between 40° and 60° API. The well stream from this reservoir contains over 90 Mole % methane and less than 3 Mole % heptanes+, though the liquid gravity is less than 40° API.

The discovery pressure in the Appelt No. 1 is so much lower than the retrograde dew point pressure, that the PVT test of March 4 shows the Gilbert Woods (9490) Field is not a retrograde condensate reservoir regardless of the hydrocarbon composition. After the hearing, the operator offered to conduct another PVT analysis, this time using physical apparatus rather than mathematical equations to determine fluid composition at different pressures.

Fesco obtained the sample for this PVT analysis at the wellhead separator on May 9, 2005. The retrograde dew point of this sample was observed to be 9364 psi. This dew point pressure is more than double the discovery pressure, again indicating this field is not a retrograde gas reservoir, but a two-phase reservoir with a gas cap and separate oil rim. This test did show that, at the discovery pressure, the well met the conditions to be classified as a gas well as the reservoir contained 123,000 cubic feet of gas per barrel of hydrocarbon liquid. This test indicates the maximum proportion of liquid hydrocarbons in the reservoir, 3.08% or 66,000 cubic feet of gas per barrel of liquid, will occur when the reservoir pressure is depleted to 1809 psi.

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[1] The Retrograde Dew Point Pressure is the pressure below which liquid condenses out of a gas. Typical, as opposed to retrograde, pressure reduction causes a gas to expand, not condense to a liquid. The presence of a retrograde dew point in a reservoir is a function of reservoir temperature, pressure and chemical composition of the hydrocarbon gas.

Liquid mobility

Square Mile submitted evidence from an engineering text (Exhibit 11) which states that retrograde condensate reservoirs typically occur at high reservoir temperatures and have no liquid phase initially. A liquid phase develops within the reservoir as pressure declines below the dew point due to retrograde condensation. According to this text, the retrograde condensate liquid which forms is trapped as an immoble liquid phase within the pore spaces of the reservoir. Laboratory experiments have shown that the oil phase is essentially immoble until it builds up a saturation in the range of 10 to 20 per cent of the pore space.

The minimum saturation necessary before hydrocarbon liquids are mobile, depends on the size of rock pore spaces and the amount of connate saltwater present. However, this text (Exhibit 11) points out that pressure is less near the wellbore than out in the reservoir and continued flow may increase the liquid saturation until there is liquid flow to the wellbore. At no time will more than 10% of the pore space around the Appelt No. 1 be occupied by hydrocarbon liquid.

Legal argument of Square Mile

Though the Appelt No. 1 is not in a retrograde gas reservoir, Square Mile believes this well should be remain classified as a gas well even when the proportion in the reservoir around the well drops below 100,000 cubic feet of gas per barrel of liquid. A letter from Square Mile, dated June 3, 2005, states in part:

> Accordingly, even if (as speculated) the anomalous condition of a measured dew point higher than the discovery reservoir pressure is indicative of a small oil rim deeper in the subject reservoir, it would not be an economically viable venture to undertake to search for same via additional drilling and thus it will never be known if one currently exists. Therefore, there is no valid conservation purpose or reason to regulate the subject well as anything but what it is, a gas well.

According to Square Mile, the liquid hydrocarbons in the reservoir are immobile and therefore the liquid produced at the surface by the Appelt No. 1 does not meet the definition of crude petroleum oil. Instead, according to Square Mile, the produced liquid is entirely a product of condensation and should therefore not be used as a basis for classifying the well as an oil well.

EXAMINERS' OPINION

The examiners believe that the Appelt No. 1 should not be permanently classified as a gas well because it produces from an associated

gas and oil reservoir not a retrograde condensate reservoir. The gas produced to date does exhibit retrograde behavior (liquid condensation at lower pressures) but this is not uncommon in gas cap wells. The Appelt No. 1 is apparently completed in the gas cap and should be classified as an associated gas well as long as it meets the standard gas well criteria. The well should be reclassified as an oil well in the future if it meets the standard oil well criteria.

The Gilbert Woods (9490) Field should be classified as an associated field, subject to Statewide Rule 49 if necessary. Because the Appelt No. 1 is the only well now in the field, proration is not necessary and the field should be balanced to cancel any overproduction at the time the Final Order is signed.

Purpose of classification

The Commission classifies wells to prevent waste and to protect correlative rights. Many fields have different special rules for gas wells and oil wells, primarily because gas flows more easily and gas wells can usually drain more acreage than oil wells. Also, casinghead gas is given higher priority when gas prorationing is in effect. Oil wells have depth-dependent yardstick allowables and the daily gas limits oil wells are allowed to produce are based on 2000 cubic feet of gas per barrel of oil. In the past, Commission rules allowed all casinghead gas from oil wells to be flared but that is no longer permitted.

Operators may be concerned about the classification of wells as gas or oil for a number of reasons. Different density rules for oil wells than for gas wells may require more wells to be drilled and different spacing rules may cause a well to be in violation of Rule 37 depending on its classification. Sometimes gas rights and oil rights are severed, causing different ownership of hydrocarbons produced from gas wells and produced from oil wells. Different ownership can occur when authority to pool leases depends on whether a well is a gas well or oil well. If more acreage can be pooled for a gas well then more owners may participate in production from a well that is classified as a gas well. If less acreage can be pooled for an oil well, an operator may have to drill additional wells or relinquish leases.

In the past, there have been differences in federal regulations and in prices for gas well gas versus casinghead gas. There may also be tax consequences from treating hydrocarbon liquids as oil rather than condensate, and from treating gas as casinghead gas rather than gas well gas. This is particularly likely if the gas well gas is considered high cost gas.

Hydrocarbon phases

When discovered, a reservoir may contain single-phase hydrocarbons at the original pressure, that is the hydrocarbons are either all gas or all liquid (oil). A discovery well may also encounter a two-phase reservoir, one that has both a gas cap and oil rim. The presence of only

one phase, whether gas or oil, or of two phases at discovery depends on the chemical composition of the hydrocarbon mixture and on the original temperature and pressure of the reservoir.

Some single phase reservoirs remain in that phase throughout their producing lives. A dry gas reservoir, for example, contains only gaseous hydrocarbons (and only gas wells) as the reservoir pressure is depleted. An undersaturated oil reservoir, especially one with a water-drive, may contain only oil even after all the wells are depleted. In some reservoirs, however, the temperature and particular mixture of hydrocarbons are such that some of the hydrocarbons change phase in the reservoir as the pressure is depleted. Over the life of such reservoirs, the Commission may reclassify wells, either from gas wells to oil wells, or oil wells to gas wells.

A reservoir which contains single phase gas (and no liquid) at discovery, a portion of which converts to liquid as the pressure decreases, is called a retrograde gas or a gas-condensate reservoir. However, even at discovery, the hydrocarbons produced at the surface from these reservoirs are a mixture of gas and liquid. The dramatic drop in pressure and temperature between the reservoir and the wellhead causes some of the gas produced to convert to liquid at the surface (known as flashing from gas to condensate).

Retrograde gas reservoirs

In the 1930's, operators were allowed to release or flare casinghead gas produced from oil wells. Some operators in the Aqua Dulce Field area were producing gas, then condensing it on the surface and selling only the distillate or condensate. When the amount of condensate produced was more than one barrel per 100,000 cubic feet of gas, operators considered these wells as oil wells and the rest of the gas was released or flared. In 1938, the Commission held several hearings on the proper classification of wells "where natural gas is found at comparatively great depths and high pressures." General Order No. 20-550, dated January 18, 1939, entitled "Condensate Wells Classified" is included as Attachment A.

According to General Order No. 20-550, "numerous wells...produce a high gravity, highly volatile liquid which is usually termed 'condensate' or 'distillate,' which liquid cannot be properly classified as crude petroleum oil...." Such liquids are described as "in the gas phase in the reservoir and...formed by the decrease in pressure and temperature which occurs after such gas leaves the reservoir;" and the Commission noted that such hydrocarbon liquids "are usually water-white in color...." The Commission recognized that "if the pressure in a high pressure gas phase reservoir is allowed or permitted to drop, a liquid will condense...and wet the sand grains in the reservoir, and a large portion of the liquid formed in this manner will not be recoverable...." To prevent the obvious waste of gas from flaring in such reservoirs and to encourage additional liquid recovery by gas-cycling, the Commission ordered that wells "which produce hydrocarbon liquids which are condensate products from a gas phase are hereby classified as gas wells...."

If wells produce a mixture of condensate from a gas phase and crude oil, General Order No. 20-550 classifies them as gas wells unless they produce more than one barrel of crude oil per 100,000 cubic feet of gas. Crude petroleum oil "shall not be construed to mean any liquid hydrocarbon mixture or portion thereof which is not in the liquid phase in the reservoir[,] removed from the reservoir in such liquid phase, and obtained at the surface as such."

General Order No. 20-550 was an order of statewide effect. It separately recognized a type of well known as a condensate well. Part of General Order No. 20-550 is recapitulated in Statewide Rule 79(11). It can plausibly be argued that when the Commission recompiled general rules and regulations of statewide application in 1964, it intended Rule 79 to also include a definition of a condensate well.

The language in General Order No. 20-550 applies to retrograde condensate reservoirs and only wells completed in such reservoirs should be eligible to be permanently classified as gas wells. General Order No. 20-550 does not specify how wells are to be treated if they produce condensate (liquid hydrocarbons formed as the pressure depletes) which is liquid in a reservoir, removed from the reservoir in a liquid phase, and produced at the surface as a liquid. According to some operators, if a reservoir is a retrograde condensate reservoir, even if all the surface production is liquid that formed in the reservoir, the well cannot be classified as oil.

Commission practice has been to administratively reclassify gas wells as oil wells when the ratio of liquid in a reservoir is greater than one barrel per 100,000 cubic feet of gas even if the reservoir was initially single phase gas. This treatment is in line with the Commission procedure for oil wells that produce increasing amounts of gas. In most originally single-phase oil reservoirs, increasing amounts of gas are liberated in the reservoir as the pressure is depleted. When more than 100,000 cubic feet of gas are produced per barrel, such an oil well is administratively reclassified as a gas well.

The examiners recommend that wells in retrograde condensate reservoirs (containing only single-phase gas at discovery) be eligible for permanent gas classification. Such reservoirs do not contain oil at discovery. However, if at any time, liquids condense in such a reservoir in sufficient proportions that they are mobile and the gas/oil ratio is less than 100,000 cubic feet per barrel, a well should be reclassified as an oil well. In that case, there is more than one barrel per 100,000 cubic feet that is liquid in the reservoir, removed from the reservoir as liquid and produced at the surface as liquid.

Mobility (Relative Permeability)

When a reservoir contains both oil and gas, the correct classification of a well depends on the mobility of the liquid hydrocarbons within the reservoir. If the liquid hydrocarbons measured at the surface are not also liquid in the reservoir, then the well should be classified as a gas well [Rule 79(11)(C)].

The true permeability of a reservoir to oil is given as if all the pore space in the rock were filled with oil (in effect, single phase oil). The true permeability of a reservoir to gas is given as if all the pore space in the rock were filled with gas (also a single phase). If both gas and oil are present within the pores of a reservoir (and therefore two phases), the gas and oil each interfere with the mobility of the other phase. The effective or *relative* permeability of that reservoir to oil is reduced considerably, and the effective or *relative* permeability of that reservoir to gas is also reduced significantly[2].

The *relative* permeability both of gas and of oil is a rock property specific to each reservoir and depends on the characteristic pore geometry (both pore size and configuration). It is not appreciably affected by saltwater saturation unless very high, nor by bottomhole pressure. In general, the *relative* permeability to oil is much more adversely affected in sandstone reservoirs than in carbonate reservoirs[3]. There is no appreciable oil mobility until oil occupies at least 20-25% of the pore space in a carbonate and 35-40% of the pore space in a sandstone (McCain, 1973, The Properties of Petroleum Fluids).

Few operators have sufficient information to determine the relative permeability of their reservoir to oil but PVT analysis can indicate the maximum proportion of liquid hydrocarbons versus gaseous hydrocarbons to be found at various reservoir pressures. As long as the maximum liquid/gas ratio is less than 25% in a carbonate reservoir and less than 40% in a sandstone reservoir, then no liquid hydrocarbons will move from the reservoir to the surface.

The examiners recommend that wells be considered for permanent gas classification if the reservoir is single-phase gas at discovery (retrograde condensate) and, regardless of pressure depletion, the proportion of liquid hydrocarbons to gas will be less than 40% in a sandstone reservoir or 25% in a carbonate. If, however, an appreciable amount of the liquid hydrocarbons in a reservoir become mobile as the reservoir pressure is depleted, then no well in that reservoir should be classified as a permanent gas well even if the reservoir were single phase gas at discovery.

Legal cases

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2. For example, a particular sandstone, with pore space occupied by 50% gas and 50% oil, was tested and showed *relative* permeabilities to gas of only 25% and to oil of only 10% of the true perrmeabilities.

3. One particular sandstone was tested with oil occupying 50% of the pore space, and its *relative* oil permeability was less than 1%. A particular dolomite was tested with oil occupying 50% of the pore space, and its *relative* permeability to oil was 15%.

To date, all legal challenges to the Commission's classifications have concerned wells which the Commission classified as gas and whose operators wanted them treated as oil wells. In fact, all cases to date have considered only circumstances where operators have attempted to manipulate the phase state of the produced hydrocarbons at the surface. For example, several court cases affirmed the Commission's decision that "white oil" produced from LTX (low temperature extraction) units in the Panhandle Field is not crude oil for well classification purposes. There have been no cases litigated where the Commission classified a well as oil that the operator wanted to be treated as gas.

Recommendation

The current production of the subject well indicates it is now a gas well. However, the request to classify it permanently as a gas well should be denied as it is not completed in a retrograde condensate reservoir. The Gilbert Woods (9490) reservoir contained liquid hydrocarbons at its discovery which could be expected to be mobile certainly in the oil rim. A well in this field may remain a gas well throughout its producing life, particularly if completed high in the gas cap. However, other wells in this reservoir may be completed in the oil rim and therefor be classified as oil wells. If a particular well is completed near the gas/oil contact, the proportion of reservoir fluids produced may change as the reservoir is depleted. Therefor, no well in a two-phase reservoir such as the Gilbert Woods (9490) Field should be permanently classified as gas or oil.

FINDINGS OF FACT

1. Notice of this hearing was given to Square Mile Energy, LLC., the only operator in the Gilbert Woods (9490) Field on April 15, 2005.

2. The Gilbert Woods (9490) Field was discovered in 1991, but the discovery well produced only a small amount before being abandoned in 1992.

3. January 11-13, 2005, Square Mile Energy, L.L.C. tested its Appelt et al Unit Lease, Well No. 1, at a maximum daily rate of 2687 MCF, with a gas/liquid hydrocarbon ratio of 26,870 cubic feet per barrel.

4. The Appelt et al Unit Lease Well No. 1 had an initial bottomhole pressure of 4082 psi, which is essentially virgin pressure at the pressure gradient of 0.44 psi/foot.

5. The Appelt et al Unit Lease, Well No. 1, should not be permanently classified as a gas well as it is not completed in a retrograde condensate reservoir and instead produces from an associated reservoir with a gas cap and oil rim.

a. The well has a gas/oil ratio less than 100,000 cubic feet per barrel and the liquid produced has an API gravity of less than 40°.

b. The well failed the test requirements of Form G-5 to be treated as a gas well.

c. A test of hydrocarbons produced on March 4, 2005, showed this well produces single-phase gas only at pressures above 7305 psi, well above the measured reservoir pressure.

d. A May 9, 2005, test showed the retrograde dew point of this sample was 9364 psi.

6. Liquid hydrocarbons produced from this reservoir at some time may meet the statutory definition of crude petroleum oil.

7. The Appelt et al Unit Lease, Well No. 1, can be classified as an associated gas well as long as it meets the standard gas well criteria and may be reclassified as an oil well in the future if it meets the standard oil well criteria.

8. There are no other wells completed in the Gilbert Wells (9490) Field and cancellation of any overproduction in the field will not affect any other operators.

CONCLUSIONS OF LAW

1. Proper notice was given as required by statute.

2. All things have been done or occurred to give the Railroad Commission jurisdiction to resolve this matter.

3. The Square Mile Exploration Company Appelt et al Unit Lease, Well No. 1, is not completed in a gas condensate reservoir based on the definition in Statewide Rule 79(a)(11)(C).

4. Permanent classification of the Square Mile Exploration Company Appelt et al Unit Lease, Well No. 1, as a gas well is not necessary to prevent waste or protect correlative rights.

5. Square Mile Exploration Company did not prove that the Appelt et al Unit Lease, Well No. 1, permanently should be classified as a gas well pursuant to Statewide Rule 79.

6. Cancellation of overproduction for the Square Mile Exploration Company Appelt et al Unit Lease, Well No. 1, in the Gilbert Wells (9490) Field will not harm correlative rights.

7. The Square Mile Exploration Company Appelt et al Unit Lease, Well No. 1, in the Gilbert Wells (9490) Field, meets the criteria for an administrative grant of gas well classification to be reviewed annually.

EXAMINER'S RECOMMENDATION

Based on the above findings and conclusions, the examiners recommend that application of Square Mile Energy, L.L.C. for the permanent classification of its Appelt et at Lease, Well No. 1, in the Gilbert Wells (9490) Field, be **DENIED.** The Gilbert Wells (9490) Field should be balanced as of the date of the Final Order.

Respectfully submitted,

Margaret Allen
Technical Hearings Examiner

James M. Doherty
Legal Examiner